NOVA SCOTIA
Environment

Comment Index

Draft Terms of Reference for Preparation of an Environmental Assessment Report: Replacement Effluent Treatment Facility Project

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25	Anonymous	February 7, 2020

Northern Pulp Nova Scotia Corporation

Number	Source	Date Received
1	Northern Pulp Nova Scotia Corporation	March 30, 2020

Fisheries and Oceans Canada	Pêches et Océans Canada

P.O. Box 1006, P500
Dartmouth, NS B2Y 4A2

February 7, 2020

P.Geo
Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442
Halifax, NS B3J 2P8

Subject: Northern Pulp ETF Project – Fisheries and Oceans comments on the Draft Terms of Reference for the Environmental Assessment Report

Dear ,

Fisheries and Oceans Canada (DFO) received the request to review the Draft Terms of Reference (TOR) for the Environmental Assessment Report on January 8, 2020.

Subsequent to comments submitted on the Focus Report to you on November 8, 2019, a decision was made by the federal Minister of the Environment not to designate this project for a federal environmental assessment. However, DFO and other potential federal regulators are required to conduct a environmental effects evaluation of components of the project located on federal lands under Section 82 of the *Impact Assessment Act* (the Act). To this end, the comments submitted on the provincial TOR below, are not intended to cover all federal requirements that may be necessary to inform federal decision making on whether the project is likely to cause significant adverse environmental effects and potential impacts to Aboriginal and treaty rights.

As noted in the following comments the Federal Authorities may require the consideration of additional factors which may not be covered in the Provincial Environmental Assessment to fulfill their obligations under Section 82 of the Act.

<u>Comments on the Terms of Reference:</u>

As a general comment, the proponent should attempt to gather information directly from and collaborate with affected First Nations throughout this assessment process. Particularly with regard to development of assessment methodology (e.g., adverse and significant effects), description of environmental setting (e.g., ice conditions), and incorporation and collection of Indigenous Knowledge. Consideration of information provided will enable the proponent to evaluate potential implications for the design, installation and operation of the project and apply mitigation where necessary.

Canada

Section 3.2, Project Location, Page 11/37

The first paragraph states: "Discuss the compatibility of the Project location in relation to the people and their community and traditional activities and land uses by the Mi'kmaq of Nova Scotia." DFO suggests that traditional activities should be further defined to include any First Nations that have an Food, Social or Ceremonial (FSC) fisheries in both freshwater and marine environments. This should also be extended to include all Indigenous communities, including those located in neighbouring provinces, that may be impacted by the project construction or operation, such as those that hold FSC or commercial communal fishing licences in the area of the project.

Section 3.3, Project Design and Components

DFO suggests that all aspects of the physical construction activities be outlined in detail including any temporary structures such as access roads for construction and the disposal location for any proposed dredge materials. Scheduling information for all phases and proposed mitigation should also be provided.

Section 4.0 Regulatory Environment:

DFO recommends that the language around section 82 of the *Impact Assessment Act* in this section be updated with the suggested text below:

"A review under Section 82 of the federal *Impact Assessment Act* (the Act) to determine whether significant adverse environmental effects from components of the project on federal lands is required before Federal Authorities involved can exercise any power, perform any duty or function, or provide financial assistance to enable the project to proceed. Therefore the Federal Authorities may require the consideration of additional factors which may not be covered in the Provincial Environmental Assessment to fulfill their obligations under Section 82 of the Act. The Proponent is encouraged to consult the Act to determine any additional obligations under Section 82 ."

Section 8.0 Assessment Methodology

DFO suggests that the Terms of Reference provide clarity to the proponent with regard to the assessment methodology and instruction to develop a clear definition of adverse effects and significant environmental effects for each Valued Component.

DFO also suggests that should the proponent plan to apply offsetting as a mitigation to determine significance, the proponent be required to provide a preliminary offsetting plan, developed in consultation with affected First Nations and other resource users as part of the EA documentation.

DFO also recommends that analysis for any potential impacts related to the physical construction activities and potential impacts from the effluent be assessed separately.

.../3

Section 9.2.4 Wetlands

Wetlands may support fish both directly and/or indirectly, DFO recommends that any wetlands potentially impacted by project activities also be evaluated for potential impacts to fish and fish habitat.

Section 9.4.2 Freshwater Aquatic and Marine Environment

DFO recommends that the terms of reference provide further clarification on the definitions of fish and fish habitat and aquatic species at risk such that the EA report assesses any changes to the "fish and fish habitat" as defined in subsection 2(1) of the *Fisheries Act.*

Section 10 Adverse Effects and Environmental Effects Assessment

DFO recommends that the proponent review guidance for assessment methodology and thresholds of significance related to the *Impact Assessment Act*.

The statement "Where impacts to fish habitat cannot be avoided or mitigated discuss compensation measures to ensure that impacts are offset" should be clarified to ensure that offsetting measures are related to a physical activity as outlined in the Fish and Fish Habitat Protection Policy Statement, August 2019 as opposed to monetary compensation.

Section 11 Proposed Mitigation

Clarification should be provided in this section in relation to offsetting impacts to fish and fish habitat, financial compensation, or other accommodations.

As indicated above, DFO notes that if offsetting impacts to fish and fish habitat is included as a mitigation then a preliminary offsetting plan should be provided, developed in consultation with any potentially impacted First Nations or other resource users.

Section 12 Residual Effects and Environmental Effects

If possible, this section should refer to the Impact Assessment Agency's guidance on determining whether a project is likely to cause significant or adverse environmental effects. The TOR could highlight that there are additional federal requirements as per section 82 of the *Impact Assessment Act*, and that the proponent should consider these requirements when assessing residual effects and determining significance.

Section 15.2 Consultation with the Mi'kmaq of Nova Scotia

DFO will be undertaking consultation with the Mi'kmaq of Nova Scotia led by Pictou Landing First Nation and potentially Indigenous communities outside Nova Scotia. DFO will continue to coordinate consultation with the province of Nova Scotia, to the extent possible. There is a federal commitment to ensure respect for the rights of Indigenous peoples of Canada as recognized and affirmed by section 35 of the Constitution Act, 1982; to fostering reconciliation and working in partnership with Indigenous communities as well as implementing the United Nations Declaration on the Rights of Indigenous Peoples. DFO will require the proponent to provide information through the assessment process that can assist the department with undertaking these important commitments.

Please note that DFO has previously provided a number of technical comments during the review of the documents submitted for the proposed project in relation to DFO's mandate. There is an expectation that these comments will be considered in the development of any future reports submitted by the Proponent.

If you have any questions or comments, please contact me at our Dartmouth office at or by email at @dfo-mpo.gc.ca.

Yours sincerely,

A/Manager
Regulatory Reviews – Ecosystem Management

cc:
, Pictou Landing First Nation

Environment and Climate Change Canada | Environnement et Changement climatique Canada

Environmental Protection Branch
16th Floor Queen Square
45 Alderney Drive
Dartmouth, NS B2Y 2N6

February 7, 2020

Nova Scotia Environment
1902 Barrington Street, Suite 2085
Halifax, NS B3J 2P8

Dear

Re: Northern Pulp Replacement Effluent Treatment Facility Project – Draft Terms of Reference for the Preparation of an Environmental Assessment Report

In response to your January 8, 2020 request, Environment and Climate Change Canada (ECCC) has reviewed the Draft Terms of Reference (TOR) for the preparation of an Environmental Assessment Report for the Northern Pulp Replacement Effluent Treatment Facility Project. The attached comments are offered for your consideration in finalizing the TOR.

The department's review focused on issues within our mandate and available expertise involving potential project interactions with migratory birds and species at risk as well the potential need for the department to issue a Disposal at Sea Permit in relation to the construction of the marine pipeline and effluent discharge structure.

We note that for relevant portions of the Draft TOR, the proponent is directed to consider the issues raised in the department's submissions on the Environmental Assessment Report and the Focus Report and, to consult with relevant government departments as part of the collection of baseline data, designing modeling and receiving water studies, and development of mitigation and monitoring programs. The department is prepared to continue working with the province, the proponent and other departments in this regard.

Also, as described in the Draft TOR, ECCC may be required to undertake a review along with other federal departments under Section 82 of the *Impact Assessment Act*. The proponent is encouraged to consider the advice in the attached comments and consult with ECCC, the province and other federal departments to help identify the most timely and efficient means of managing the information requirements for all of the respective regulatory and environmental assessment processes.

If you have any questions or concerns, please feel free to contact me, or lead EA coordinator for this project.

Yours truly

Head, Environmental Assessment
Environmental Protection Operations Directorate, Atlantic

cc:

Northern Pulp Replacement Effluent Treatment Facility Project Environmental Assessment Report – Draft Terms of Reference
Environment and Climate Change Comments, February 7, 2020

Section 3.0 Project Description

3.4 Construction

Describe the construction of all Project components and supporting infrastructure. This will include but not be limited to:

- **Dredge management /disposal plans that characterize and quantify marine sediments to be dredged and disposed (or re-used) in accordance with Environment and Climate Change Canada (ECCC) standards and in consultation with relevant government departments. Identify areas where dredging activities will occur and identify the location, quantity and chemistry of any dredge materials that are expected to require land-based disposal.**

ECCC Comments:

It is recommended this also include the identification of any marine disposal sites including permanent side cast and open water locations.

ECCC also notes that based on the sediment data submitted in support of the Focus Report, additional sampling and analysis will be required along certain sections of the marine pipeline route. This is required even if the proponent intends to exclusively re-use the trenched material as cover (i.e. there is no excess material remaining). ECCC should be consulted to discuss these requirements in further detail.

Section 4.0 Regulatory Environment

Describe the existing regulatory environment (Federal, Provincial and Municipal) including all permitting, licensing and regulatory requirements that apply to all phases of the Project and associated infrastructure. Provide a schedule indicating anticipated dates for required regulatory approvals.

Significant portions of the proposed Project to be evaluated by the EA Report are located on federal lands; therefore, federal authorities have indicated that they must make a determination as to whether the Project is likely to cause significant adverse effects and/or in the case of Public Services and Procurement Canada (PSPC) seek an Order in Council prior to providing authorizations, licenses, or leases. To ensure potential environmental effects are addressed to the satisfaction of federal authorities under Section 82 of the

***Impact Assessment Act*, provide all necessary authorizations, licenses, or leases for all applicable federal authorities.**

ECCC Comment:

ECCC has consulted with the other departments likely to be involved in a Section 82 review under the *Impact Assessment Act* and have proposed the following language for consideration:

A review under Section 82 of the federal *Impact Assessment Act* (the Act) to determine whether significant adverse environmental effects from components of the project on federal lands is required before Federal Authorities can exercise any power, perform any duty or function, or provide financial assistance to enable the project to proceed. Therefore, the Federal Authorities may require the consideration of additional factors which may not be covered in the Provincial Environmental Assessment to fulfill their obligations under Section 82 of the Act. The Proponent is encouraged to consult the Act to determine any additional obligations under Section 82.

Section 6.0 Description of Alternatives to the Project and,
Section 7.0 Other Methods of Carrying out the Project

Include an analysis of alternative means of carrying out the Project; describing functionally different ways to meet the Project need and achieve the Project purpose.

Discuss other methods for meeting the need for the Project, including but not limited to, pipelines and treatment technologies. This section shall also discuss alternate locations for the project.

The rationale for rejecting other described methods of carrying out the Project must be provided including a discussion of how environmental sustainability and impact avoidance criteria were applied.

ECCC Comment:

If the disposal of excess trenched material at sea remains a possibility and, if the proponent wishes to utilize the EA Report to the extent possible to satisfy the *Impact Assessment Act* Section 82 review discussed Section 4.0 and the Disposal at Sea regulatory requirements, then the following additional information will be needed regarding alternatives to disposal and alternative disposal methods:

- Consideration of reduction/reuse opportunities of excess sidecast material
- Consideration of disposing excess sidecast material on land vs. at sea
- Consideration of alternative disposal at sea options (sidecast vs. open water disposal)

Section 9.0 Existing Environment

9.4 Flora and Fauna

Identify flora, fauna, and habitat types that will be intersected by all components of the Project. Appropriate files surveys agreed to by Nova Scotia Lands and Forestry (NSLAF) – Wildlife Division, shall be conducted as part of the evaluation. Surveys should be described by results, methodology, and spatial and temporal boundaries.

ECCC Comment:

For clarification, "flora" by definition does not include lichens. ECCC suggests that lichen assessments for all species covered by the NS At-Risk Lichens SMP might be considered (https://novascotia.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_BFL_At-Risk-Lichens.pdf

9.4.1 Terrestrial Environment

(Bullet 8, p.21)

- **[Conduct] Bird baseline study for Common Nighthawk (*Chordeiles minor*), including rationale for survey point selection to the satisfaction on NSLAF.**

ECCC Comment:

ECCC requests that the proponent conduct Common Nighthawk surveys using established protocols during the breeding season.

Section 10.0 Adverse Effects and Environmental Effects Assessment

10.2.3 Marine

The proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. In conducting the effects assessment on marine resources, the EA Report must identify and evaluate, to the satisfaction of relevant departments:

- **Marine pipeline construction methods along the full route and construction requirements (e.g. blasting) using results from geotechnical investigations**

ECCC Comment:

ECCC recommends this include consideration of any disposal (or re-use) activities that are part of pipeline construction.

ECCC recommends that all sediment sampling results be referenced in the effects assessment along with the results of geotechnical investigations.

10.4 Flora and Fauna

10.4.2 Freshwater Aquatic and Marine Environment

Evaluate the potential effects on aquatic environments, including fish and fish habitat.

While considering the effects that the project may have on freshwater and marine species, include a full account of species at risk or of concern and significant habitats. This section must include activities that may affect avifauna in the aquatic environments.

ECCC Comment:

ECCC recommends the marine benthic invertebrates (e.g. polychaete worms, mussel spat, small clams) be included in the bioaccumulation/biomagnification assessment of the discharge plume. This will help assess the potential impact of biomagnification on migratory birds such as shorebirds.

Section 11 Mitigation

11.4 Flora and Fauna

11.4.1 Terrestrial Environment

… based on concerns raised by government reviewers during the review of the EARD and the Focus Report, the EA Report must also include, but not be limited to the following additional items:

b) mitigation and monitoring plan for the Eastern Wood-Peewee (*Contopus virens*, SARA Special Concern, NSESA Vulnerable) and Barn Swallow (*Hirundo rustica*, SARA Threatened, NSEA, Endangered) found during the course of filed surveys and Kildeer (*Charadrius vociferous*) identified to be likely breeding in the Project area, in consultation with both ECCC and NSLAF.

ECCC Comment:

In addition to the two species identified, ECCC recommends that additional species at risk be considered in the required mitigation and monitoring program. This should include consideration of impacts to other at-risk landbirds (e.g. Evening Grosbeak, Bobolink, Canada Warbler) as well as at-risk bats and invertebrates.

Health Canada Santé Canada

Environmental Health Program (EHP) Atlantic Region
Regulatory Operations and Enforcement Branch
Suite 1625, 1505 Barrington Street
Halifax, NS B3J 3Y6

February 7, 2020

Environmental Assessment Branch
Nova Scotia Environment
1903 Barrington Street, Suite 2085
PO Box 442
Halifax, Nova Scotia, B3J 2P8

Subject: Health Canada's Response to the *Draft Terms of Reference for the Preparation of An Environmental Assessment Report for Public Review and Comment Regarding the Replacement Effluent Treatment Facility Project Proposed by Northern Pulp Nova Scotia Corporation*.

Dear :

Thank-you for your e-mail dated January 8th, 2020 requesting Health Canada's review of the "*Draft Terms of Reference for the Preparation of An Environmental Assessment Report for Public Review and Comment Regarding the Replacement Effluent Treatment Facility Project Proposed by Northern Pulp Nova Scotia Corporation*" for issues with respect to human health.

Health Canada is providing the following comments for your consideration:

#1 Document Reference:

Section 10.0- Adverse Effects And Environmental Effects Assessment: "…Full hazard identification and qualitative risk assessment associated with Project construction and operation, including those which have or may have an environmental impact (directly or indirectly)…"

Health Canada Comments:

A quantitative Human Health Risk Assessment (HHRA) is recommended by Health Canada guidance if the problem formulation stage of the HHRA predicts elevated Contaminants of Potential Concern (COPCs) in one or more environmental media for the proposed project, and for projects with operational pathways & a potential for human exposure to contaminants. Please refer to Health Canada's *Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk,* Section 6 for further details.

Sent by e-mail to EA@novascotia.ca and @novascotia.ca

#2 Document Reference:

Section 10.6 - Include monitoring and mitigation measures for elevated COPCs in air emissions in HHRA problem formulation.

Health Canada Comments:

As only the problem formulation for an HHRA was completed in the Focus Report, monitoring and mitigation measures for elevated COPCs were not identified. In addition to air emissions, COPCs may also be elevated in water, country food, soil, sediment etc., therefore consider rewording the TOR to reflect the following:

Should the completed HHRA identify risks to human health, it is recommended that the HHRA be refined to reduce uncertainty and/ or that mitigation measures are identified that would help to reduce human exposure to COPCs. Please refer to Health Canada's *Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk* for further details.

#3 Health Canada Comments:

In reference to comment #13(d) provided by Health Canada on the review of the Focus Report:

> *In addition, the elevated temperature of the effluent and the potential for nutrient loading may pose bacteriological risks to bathers. The two provincial parks in the near vicinity of the marine portion of the project have beaches and a beach is located in Pictou Landing First Nation which is utilized by the people of that community. Bacteriological risks associated with the effluent for recreational water users was not evaluated in the HHRA problem formulation report or the Focus Study. Evaluation of this risk should be completed and monitoring and mitigation measures should be identified as applicable.*

The draft Terms of Reference does not address bacteriological risks to recreational water users. As the elevated temperature of the effluent and the potential for nutrient loading has the potential to affect bacteriological water quality, monitoring and mitigation measures should be identified in the Environmental Assessment Report, as applicable.

#4 Health Canada Comments:

Due to the potential impact to country/traditional foods from this project, please refer the proponent to the following for further guidance:

> *Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Country Foods. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario*

Sent by e-mail to EA@novascotia.ca and @novascotia.ca

#5 Health Canada Comments:

Due to the potential impact to recreational water, in addition to Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Water Quality, please refer the proponent to the following guidance in the draft TOR:

> *Health Canada (2012). Guidelines for Canadian Recreational Water Quality, Third Edition. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.*

If you have any questions, please contact the undersigned at your convenience.

Sincerely,

Regional Environmental Assessment Specialist
Health Canada, Atlantic Region
Ph:
@canada.ca

Sent by e-mail to EA@novascotia.ca and jonathan.kay@novascotia.ca

Public Services and Procurement Canada | Services publics et Approvisionnement Canada

Public Services and Procurement Canada
1713 Bedford Row
Halifax, Nova Scotia
B3J 3C9

February 7, 2020

P.Geo
Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442
Halifax, NS B3J 2P8

Dear

Re: Public Services and Procurement Canada: Comments on the Draft Terms of Reference for the Environmental Assessment Report for the Replacement Effluent Treatment Facility Proposal- Northern Pulp Nova Scotia

Please accept Public Services and Procurement Canada (PSPC) review comments on the above referenced document for your consideration.

Context

Public Services and Procurement Canada has reviewed the Province of Nova Scotia draft terms of reference for an environmental assessment report (EAR) in relation to the replacement effluent treatment facility (RETF) being proposed by Northern Pulp Nova Scotia (NPNS). As custodian for the potentially affected portion of the federal seabed, PSPC may at some point be asked to provide the proponent with a lease or licenses to construct and operate the effluent pipeline on federal lands. In order to consider such an application, the Department would first need to make a project effects determination pursuant to the federal Impact Assessment Act (IAA). In particular, should PSPC become a Federal Authority pursuant to the IAA, PSPC would need to assess the likelihood of significant impacts occurring as a result of the project, and whether or not any such impacts could be mitigated.

PSPC will rely in part on the information provided during the provincial environmental assessment process to meet related information requirements. Accordingly, PSPC is providing input on the draft terms of reference in the interests of assisting our provincial colleagues in their efforts to conduct a fulsome and efficient environmental assessment of the proposal. The Department is also providing comments in order to inform both the Province and NPNS of potential federal information requirements should PSPC be triggered at some point as a Federal Authority pursuant to IAA.

Specific Comments on the TOR

- *Section 3.3 2nd bullet of marine based section of Pipeline route:*

  "……the major existing infrastructure, adjacent land uses that will intersect with the pipeline route and important environmental features…..suggest removing the word "important" as it is subjective.

Canada

- *Section 4.0 Under "Regulatory Environment, 2nd paragraph, last sentence, page 15*: The document currently states: <u>"To ensure potential environmental effects are addressed to the satisfaction of federal authorities under Section 82 of the Impact Assessment Act, provide all necessary authorizations, licenses, or leases for all applicable federal authorities."</u>

  Suggested wording change: "A review under Section 82 of the IAA to determine whether significant adverse environmental effects from components of the project on federal lands is required before involved Federal Authorities involved can exercise any power, perform any duty or function, or provide financial assistance to enable a project to proceed. Therefore the Federal Authorities may require the consideration of additional factors which may not be covered in the Provincial Environmental Assessment. The Proponent is encouraged to consult Section 82 of the IIAA to determine any additional obligations.

- *Section 8.0 Assessment Methodology – Second bullet*:

  This should include local and regional study areas and the rationale on how their spatial boundaries were determined. Cumulative effects of the project should also be assessed

- *Section 9.1.2.-Second paragraph, page 18: Suggest adding additional paragraph(s) reflecting the following:*

  Marine geotechnical survey results provided by the Focus Report included investigative and analytical results pertaining to ice scour. The survey report stated that dredging constraints may present themselves in certain areas along the Caribou pipeline route component due to sub-bottom geographical features (i.e. bedrock depth). In particular, the report indicated that some uncertainty exists with regard to the determination of bedrock depth owing to the coarse nature of overlying glacial till in three areas, mostly located in the areas of highest ice scouring. The report also indicated that a 70x100 meter patch in the near shore area west of Munroes Island shows sea bottom disturbances likely due to "ice grounding".

  The survey results include the statement: "the ice scour depth parameter is perhaps the most important measurement in estimating the minimum trenching depths required for a pipeline installation". PSPC is of the opinion that risk factors associated with trenching and burying the pipe vs. laying on the surface of the ocean floor and covering are not the same, particularly with regard to potential impacts from ice scour. PSPC would require confirmatory survey analyses of bedrock depths in these areas. The Department would also require an additional ice scour survey to be carried out immediately following spring break up, 2020. Results will need to be accounted for in the final pipeline design and associated impact assessment elements.

- *Section 9.2.3 Marine Water:*

  Provide a minimum of two years of baseline information to account for yearly variations.

  Marine sediment baseline sampling to include contaminants of potential concerns associated with marine construction or the treated effluent.

- *Section 9.4. Flora and Fauna, first sentence: end with:*

  "Identify flora, fauna and habitat types that will be intersected by all components of the project - suggest inserting "or potentially impacted by the project".

- *Section 9.6. Socio-Economic Conditions:*

The spatial boundaries in this section should be expanded to include the fishing industry, forestry industry etc. Studies need to assess both positive and negative impacts.

- *Section 9.7. Second paragraph*:

  Reference is made to requirement for a Mi'kmaq Ecological Knowledge Study (MEKS). Federal requirements as provided for by the IAA provide for an arguably broader scope of investigation in this regard, referring to "Indigenous Knowledge" (not just ecological knowledge), and "community knowledge". Other factors included by the IAA include potential impacts on (such items as) health, social, economic and use rights. PSPC considers the accommodation of Indigenous concerns associated with the project to be paramount in terms of importance. In this regard, it is expected that the company would develop a set of terms of reference specific to Indigenous issues and consult with the Indigenous community with regard to scope prior to undertaking related studies. The Indigenous community should also be engaged and validate study results prior to finalization, including the MEKS. Informational outcomes would be critical respecting the development of any federal environmental effects determinations related to permitting, licensing, leasing or authorizations.

- *Section 9.8. Last sentence:*

  Add "….and involved federal departments".

- *Section 10.5. Second paragraph, second sentence. Add:*

  Include appropriate invertebrates and lower trophic level test organisms and assess the potential for bioaccumulation for all test animals.

- *Section 10.7*

  Identify the potential impact on the current use of land and resources for traditional purposes and any Aboriginal specific land claims within the study area. – This should also include marine environments

- *Section 14.5. Other Monitoring Plans*

  Add a requirement for the development of mitigation monitoring plans for all proposed mitigation.

Sincerely,
Original signed by:

Nova Scotia Operations Manager
Public Service and Procurement Canada
Environmental Services
Atlantic Region

Transport Canada Transports Canada

February 7, 2020

P.Geo.
Contaminated Sites Specialist
Nova Scotia Environment

Thank you for the opportunity to review and comment on the Environmental Assessment Draft Terms of Reference for the proposed Northern Pulp Replacement Effluent Treatment Facility Project in Pictou, Nova Scotia.

As Transport Canada has previously noted, the proponent will need to apply for a *Canadian Navigable Waters Act* (CNWA) approval. Additionally, the proponent may be required to apply for a lease or license, should the plan be for the effluent pipeline to cross at or near Transport Canada lands at the Caribou Ferry Terminal. To date, neither of these applications has been received.

The Department has consulted with other Federal Authorities also involved in this project and we suggest the following wording for the second paragraph in Section 4.0 Regulatory Environment:

> A review under Section 82 of the federal *Impact Assessment Act* (the Act) to determine whether significant adverse environmental effects from components of the project on federal lands is required before Federal Authorities involved in the project can exercise any power, perform any duty or function, or provide financial assistance to enable the project to proceed. Therefore the Federal Authorities may require the consideration of additional factors which may not be covered in the Provincial Environmental Assessment to fulfill their obligations under Section 82 of the Act. The Proponent is encouraged to consult the Act to determine any additional obligations under Section 82.

Lastly, it should be noted that where the potential effects on navigation or navigable waters are mentioned in the draft Terms of Reference (see subsections 10.5, 10.8, and 11.7), an assessment of these effects, including any navigation related effects identified through consultation with the Mi'kmaq of Nova Scotia, will be undertaken as part of the Proponent's application for CNWA approval. Direct effects on navigation are mitigated by way of terms and conditions incorporated into any approval issued pursuant to the CNWA.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

, M.Sc.
Regional Senior Environmental Supervisor

Canada

NOVA SCOTIA
Department of Business

Centennial Building
1660 Hollis Street
Suite 600
Halifax, Nova Scotia
Canada B3J 3C8

Date: February 4, 2020

To: Nova Scotia Environment

From: The Department of Business

Subject: Draft terms of reference for the preparation of an Environmental Assessment Report for the Northern Pulp Effluent Treatment Facility

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The mandate of the Department of Business (DOB) is to lead and align provincial government efforts behind a common agenda for inclusive economic growth. This mandate focuses on strategic priorities and opportunities that encourage Nova Scotia's innovation, competitiveness, entrepreneurship, and export orientation.

Fulfilling this mandate involves working collaboratively with our Crown corporations (Develop Nova Scotia, Halifax Convention Centre Corporation (Events East Group), Innovacorp, Invest Nova Scotia, Nova Scotia Business Inc. and Tourism Nova Scotia), key partners in other levels of government, entrepreneurs, large businesses, post-secondary institutions, venture capital investors and Nova Scotians.

In March 2019, DOB provided comments on the Environmental Assessment Registration Document (EA) submitted by Northern Pulp Nova Scotia Corporation for the replacement of their effluent treatment facility.

The March 2019 decision by the Minister of Environment on the proposed effluent treatment plan replacement required Northern Pulp Nova Scotia Corporation to complete an EA Focus Report to better understand the potential for adverse effects or significant environmental effects.

The EA Focus Report required by the Minister of Environment responded to the concerns raised by DOB during the review of the EA Registration Document. DOB reviewed the EA Focus Report submitted by Northern Pulp Nova Scotia Corporation in October 2019 and had no further comments.

On December 17, 2019, the Minister of Environment made the decision to require the company to complete an EA Report. DOB feels the EA Report required by the Minister of Environment will respond to the concerns raised by DOB during the review of the EA Registration Document.

DOB has reviewed the proposed draft terms of reference for the preparation of an Environmental Assessment Report and has no comments.

NOVA SCOTIA

Environment

Barrington Place
1903 Barrington Street
Suite 2085
Halifax, Nova Scotia
Canada B3J 2P8

Date: February 7, 2020

To: , Department of Environment

From: Department of Lands and Forestry

Subject: Draft Terms of Reference for the Environmental Assessment Report Regarding the Replacement Effluent Treatment Facility Project.

Scope:

This Draft Terms of Reference is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document and in the subsequent October 2019 Focus Report. Northern Pulp has been asked to prepare an Environmental Assessment Report addressing the deficiencies in information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that are likely to arise from the Project, including any not explicitly identified in the Terms of Reference.

Documents Reviewed:

The following document and associated appendixes were consulted as part of this review: *Nova Scotia Environment. January 8, 2020. Draft Terms of Reference for the Preparation of an Environmental Assessment Report for Public Review and Comment, Regarding the Replacement Effluent Treatment Facility Project Proposed by Northern Pulp Nova Scotia Corporation. 37pp.*

Comments:

The Department of Lands and Forestry provides the following comments for consideration of inclusion in the final Terms of Reference:

- Page 16, add: **Provide reviewers spatial files of the project area boundaries.**
- Page 19, *Evaluation of the wetlands shall include wildlife habitat potential (including rare and endangered species)* ***and use****,*
- Page 20, Section 9.4.1 Terrestrial Environment. Discussions of old growth forest should also be done in consultation with the Forestry division of the Department of Lands and Forestry, as they can provide this information.
- Page 21, Section 9.4.1 Terrestrial Environment. Definitions of sensitive fauna

and species-at-risk should be provided for clarity in the process. The following definition should be used and is derived from *Nova Scotia Environment. 2009. Guide to Addressing Wildlife Species and Habitat in an EA Registration Document. 9pp.:* ***Priority species are identified as follows: 1) Species identified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as at risk, and species listed under the Federal Species-at Risk Act. 2) Species listed under the Nova Scotia Endangered Species Act. 3) Species designated as Species of Conservation Concern (Red or Yellow) by the Nova Scotia General Status of Wild Species (S1, S2, or S3 or any combination thereof as defined by the ACCDC)).***

- Page 21, Section 9.4.1 Terrestrial Environment.
  Bird surveys transects to provide a complete view of bird species distribution and habitat use along the pipeline route, including transect bird surveys and fall migratory bird survey, identification of nests of bird species which are protected under the Wildlife Act, regardless of whether they are active or not must also be considered;
  This may be better described by rewriting as the following:
  Bird survey transects to provide a complete view of bird species distribution and habitat use along the pipeline route, which may require additional bird surveys. Fall migratory bird surveys are required. Identification of nests of bird species which are protected under the Wildlife Act, or with respect to certain species, protected under the Migratory Bird Convention Act, regardless of whether they are active or not must also be considered;
- Page 21, Section 9.4.1 Terrestrial Environment. Add: ***Detailed description of survey methodology and site selection is required in order to properly assess the validity of survey results, including surveys that were already completed as part of previous submissions.***
- Page 22, 9.4.4 Freshwater Aquatic and Marine Environment. Use of the phrase “critical habitat” should be clarified. Is this referring to federally identified Critical Habitat for Endangered and Threatened species? If it is not, terminology should be changed to avoid confusion.
- Page 26, 10.2.4 Wetlands. The following should also be included in the effects assessment: ***Impacts to wildlife and wildlife habitat as a result of wetland specific construction activities*****.**
- Page 28. 10.4.1 Terrestrial Environment. Potential effects on flora and fauna and avifauna species/communities during all phases of the project, should also include **the risk and potential impacts associated with a pipeline rupture or spill at any point along the pipeline route, including wetland crossings**.
- Page 32, 11.4.1 Terrestrial Environment. *Discuss commitments to provide contingency and remediation plans for impacts to terrestrial habitat as a result of accidental events* ***at all stages of construction and operation****.*
- Page 32, 11.4.1 Terrestrial Environment. *a) mitigation measures that will be taken to avoid destroying rare priority species* ***and associated habitat*** *detected in the 2019 floristic surveys.*
- Page 32, 11.4.1 Terrestrial Environment. In addition to Eastern Wood-pewee and Barn Swallow, Common Nighthawk (*Chordeiles minor,* SARA Threatened, NSESA Threatened) was identified during 2019 field surveys and a mitigation and monitoring plan will need to be developed to address this species, along with

any other species at risk likely to found in the project area.

- Page 33, 11.4.1 Terrestrial Environment. The following should be added:
  h) mitigation measures for non-migratory bird species protected under the Wildlife Act and the Endangered Species Act;
  i) measures to avoid creating temporary or artificial habitat(sandpits) during construction that may encourage turtle nesting; and operation of the replacement facility and pipeline to reduce adverse impacts of light, noise, and dust on wildlife and wildlife habitat.
  j) standards or BMPs to avoid entrapment of wildlife as a result of construction activities (i.e. trenching).
- Page 33, Section 11.4.2 *Describe the measures that will be taken to minimize* ***or avoid*** *the introduction of non-native species to the area.*
- Page 35, Section 14.4 - add before heading on Human Health:
  Discuss wetland post construction monitoring; describe activities for post construction monitoring that may include repairs, vegetation management, and necessary monitoring mechanisms (i.e. lighting)

Date: February 5, 2020.

To: , Nova Scotia Environment

From: , Consultation Division
Nova Scotia Office of Aboriginal Affairs

Subject: **Replacement Effluent Treatment Facility Project**

The Nova Scotia Office of Aboriginal Affairs (OAA) has reviewed the EA Report draft Terms of Reference for the proposed Replacement Effluent Treatment Facility by Northern Pulp Nova Scotia, dated January 2020. The following review considers whether the information required under the draft Terms of Reference will assist the Province in assessing the potential of the proposed project to adversely impact established and/or asserted Mi'kmaw Aboriginal and Treaty Rights.

Section 15.0 CONSULTATION PROGRAM (page 36)

Section 15.2 Consultation with the Mi'kmaq of Nova Scotia
The first paragraph should reference adverse impacts to established or asserted Mi'kmaw Aboriginal and Treaty Rights. Recommend first sentence be changed to:

"To assist the provincial Government in their consultation process with the Mi'kmaq of Nova Scotia, the EA Report must describe all steps taken by the Proponent to identify the concerns of Mi'kmaq of Nova Scotia about the adverse effects or environmental effects of the Project as well as any adverse impacts to established or asserted Aboriginal and Treaty Rights."

Recommend second sentence of first paragraph be changed to:

"It shall provide a summary of all concerns expressed by the Mi'kmaq of Nova Scotia, including any adverse impacts to established or asserted Aboriginal and Treaty Rights and all steps taken by the Proponent to address or accommodate these concerns and impacts. Moreover, the EA Report must describe any outstanding concerns."

Regarding the section on distribution of information to the Mi'kmaq of Nova Scotia, recommend the first sentence of the third paragraph be changed to:

"The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed, the date they were distributed, and the method used to distribute them, to inform the Mi'kmaq of Nova Scotia."

Regarding the proponent engagement section, recommend changing the first sentence in the sixth paragraph to:

“The EA Report will include any plans for ongoing public consultation or formation of a community liaison committee (CLC) during construction, operation and decommissioning.”

60 Research Drive
Suite A
Bible Hill, Nova Scotia
B6L 2R2

NOVA SCOTIA

Agriculture

Date: February 7, 2020

To: , Nova Scotia Environment

From: Executive Director, Policy and Corporate Services, Nova Scotia Department of Agriculture

Subject: Northern Pulp ETF Project - EA Report Draft Terms of Reference

Thank you for the opportunity to review the Northern Pulp ETF Project - EA Report Draft Terms of Reference document.

The Nova Scotia Department of Agriculture has no new additional terms to add at this time.

Date: February 7, 2020.

To: , Nova Scotia Environment

From: , Curator of Archaeology
Communities, Culture, and Heritage

Subject: **Replacement Effluent Treatment Facility Project**

Page 23, 9.8 Archaeological Resources
Twice the word “features” is used in this paragraph. Please change to “features and/or artifacts”.

Page 30, 10.9, Archaeological Resources
Please include the use of the ARIA. Change wording to “As part of an archaeological resource impact assessment process, evaluate the potential effects of any changes……”.

Recommended addition to the second sentence given PLFN is leading the Consultation. Change to “In conducting the effects assessment on archaeological resources, it is recommended that the Proponent consult with CCH, Pictou Landing First Nation and the KMKNO-ARD”.

Page 34, 11.8, Archaeological Resources
Please change to “Describe mitigation measures and recommendations to preserve, protect, or recover…”.

60 Research Drive
Suite A
Bible Hill, Nova Scotia
B6L 2R2

NOVA SCOTIA

Fisheries and Aquaculture

Date:	February 7, 2020
To:	, Nova Scotia Environment
From:	Executive Director, Policy and Corporate Services, Nova Scotia Department of Fisheries and Aquaculture
Subject:	Northern Pulp ETF Project - EA Report Draft Terms of Reference

Thank you for the opportunity to review the Northern Pulp ETF Project - EA Report Draft Terms of Reference document.

The Nova Scotia Department of Fisheries and Aquaculture has no new additional terms to add at this time.

NOVA SCOTIA
Department of Municipal Affairs and Housing

Maritime Centre, Floor 14 North
1505 Barrington Street
PO Box 216
Halifax, NS B3J 2M4

Date: February 7, 2020

To: Department of Environment

From: Department of Municipal Affairs & Housing

Subject: Northern Pulp Effluent Treatment Facility Terms of Reference for the Environmental Assessment Report

As requested, the Department of Municipal Affairs and Housing has reviewed the Environmental Draft Terms of Reference for the proposed Northern Pulp Effluent Treatment Facility.

Consultation with municipalities is one of the Department's areas of mandate. We would like to ensure that the proponent undertakes adequate consultation with municipalities in the vicinity of the undertaking or where the undertaking is located in order to confirm conditions for compliance with municipal planning policies and by-law provisions. Explicitly listing municipalities in Sections 9.7, 10.8, 11.7 and 15 would help ensure adequate consultation will occur.

Thank you for the opportunity to review the Registration Documents for the above-noted project. Should you require additional information, please contact the Department.

c: Planner, DMAH

NOVA SCOTIA

Department of Transportation and Infrastructure Renewal

1672 Granville Street.
PO Box 186
Halifax, Nova Scotia
B3J 2N2
Bus:
Fax: 902-424-0532
tpwpaff@novascotia.ca

Date: February 7, 2020

To: Nova Scotia Environment

From: , Chief Engineer

Subject: Northern Pulp Nova Scotia Corporation (NPNS) Environmental Assessment Report Draft Terms of Reference for the Replacement Effluent Treatment Facility Project

Dear ,

TIR staff have reviewed and prepared the attached comments on the Environmental Assessment Report Draft Terms of Reference for the Replacement Effluent Treatment Facility Project of Northern Pulp Nova Scotia Corporation (NPNS).

Sincerely,

Chief Engineer

Comments on Design Drawings

1. Section 3.3 “Land-Based Sections of Pipeline Route” should include that design drawings of proposed pipeline alignment within current highway right-of-way must show sufficient detail in legend, plan, profile, and cross-sections at regular intervals and key locations, at an appropriate scale including but not limited to: dimensions of pipe and trench/thrust pit excavation limits from adjacent key features e.g. utilities & municipal infrastructure, structures/foundations, original ground surface, edge of asphalt, edge of shoulder, top/bottoms of cut/fill slopes, current/proposed right-of-way boundaries, intersecting roads, etc. Also, the location/limits of air release valve(s) and any corresponding enclosure structures and access provisions to/from adjacent highway.

Section 3.2 Project Description: Project Location

1. Section 3.2 requires the proponent to “provide details of existing agreements to develop the project on lands not owned by the proponent and to provide detailed plans for the required acquisition or use of private and crown lands and discuss contingencies should these lands not be available.” This section should also include identifying any easements required to maintain access to adjacent private lands. Also, TIR’s review and acceptance of alignment and design details (see previous comments on design drawings) may be required before this can be finalized.

Section 3.3 Project Description: Project Design and Components

1. “Land-Based Sections of Pipeline Route” (page 13) required risk assessment should ensure this considers future construction/maintenance activities that may be undertaken by TIR or others e.g. ditching, culvert replacement, roadside brush cutting, future highway twinning, installation of underground and/or overhead utilities or municipal services etc.

2. “Marine Based Sections of Pipeline Route” (page 14) should also require consideration of impacts that plans for dredging to install pipe below the seabed immediately adjacent to the Harvey A. Veniot causeway may have on stability/settlement of the causeway structure.

Section 3.4 Project Description: Construction

1. Section 3.4 should also require plans to outline/show work plans (including construction access locations) that address traffic operational constraints and requirements TIR has previously communicated to the proponent as conditions for consideration of construction within current ROW e.g. lane closures or stoppage of traffic on Highway 106 for construction or future maintenance not permitted for any significant length of time, trenchless technology and sleeving required to cross below active roadways/structures and facilitate future pipe maintenance/replacement etc.

Section 10.8 Adverse Effects and Environmental Effects Assessment: Existing and Planned Land Uses

1. Section 10.8 states “discuss the anticipated changes in traffic density and patterns during all phases of the Project including its effect on transportation”. Any traffic impacts due to the project need to have proper mitigation measures to minimize impact on existing traffic. Any new construction traffic created as a result of this project needs to be mitigated as well. Any road closures, traffic diversions, or proposed speed limit changes, would need to be analyzed and approved by the Department.

Section 11.7 Proposed Mitigation: Existing and Planned Land Uses

1. Section 11.7 states “Discuss the mitigation measures planned to address anticipated impacts from any predicted changes in traffic speed, traffic routes, marine navigation, exclusion zones and density in adjacent residential and commercial areas”. I am assuming this is closely related to the extract from the report stated in Section 11.6 of the EA Report Draft.

General Comments on EA Report Draft TOR

1. Plans to have the pipeline in the HROW on Hwy 106 would require approval by the Department and would require a Working-Within-Highway-Right-Of-Way Permit and meet any necessary Departmental specifications. If there are private properties involved, permission would need to be obtained from any private property owners. This would also apply to any new accesses that are created on provincially owned roads.

2. An approved TIR Work Within Highway Right-of-Way Permit with all required terms, conditions, agreements and refundable/non-refundable security deposits in place is required before any construction can commence within TIR highway right-of-way or within 100 meters of the highway centerline and/or 60 meters from the ROW boundary as per the Public Highways Act.

3. If there are any work areas that are created on a provincially owned road, these work areas will need to be compliant with the appropriate section of the Nova Scotia Temporary Workplace Traffic Control Manual.

4. If there are changes to signage or pavement markings, or any road closures that are required, they would need to be approved through the local Departmental staff.

5. If there are requirements to move overweight/oversize items, this may trigger the requirement for a Special Moves Permit. The proponent is encouraged to contact our provincial contact for Special Moves.

6. Any transportation routes for any overweight/oversize loads would need to be provided so that any necessary analysis could be done on the route to determine that any overweight/oversize items can be safely transported on the route indicated. This would be done in conjunction with the Special Moves Permit if one was deemed necessary for this project.

7. The TOR should include more detail on the information required by TIR for - the proposed effluent transmission pipeline within TIR highway right-of-way (or property that is currently owned by TIR) to ensure the proposal can be thoroughly reviewed to ensure it is feasible from a design/construction standpoint and is acceptable to TIR.

8. Include reference to liability to remediate any future impacts that may result from an effluent leak/release within or adjacent to crown property.

9. Include reference to requirement for compliance with Transportation of Dangerous Goods Regulations.

1 INTRODUCTION

1.1 Background

The Replacement Effluent Treatment Facility Project (the Project or undertaking) proposed by Northern Pulp Nova Scotia Corporation (Northern Pulp or the Proponent) was registered for environmental assessment (EA) as a Class 1 undertaking pursuant to Part IV of the *Environment Act* on February 7, 2019.

On March 29, 2019, the Minister of Environment determined that the registration information was insufficient to make a decision on the Project, and a Focus Report was required in accordance with clause 13(1)c of the Environmental Assessment Regulations, pursuant to Part IV of the *Environment Act*.

On October 2, 2019, Northern Pulp submitted the Focus Report for EA, in accordance with Part IV of the Environment Act. Public comments on the Focus Report were accepted until November 8, 2019.

On December 17, 2019, the Minister of Environment concluded that Northern Pulp would be required to complete an EA Report on this Project.

1.2 Purpose of the Terms of Reference

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an Environmental Assessment Report) to be provided to address gaps or deficiencies in the required information.

The purpose of this document is to identify for Northern Pulp the information requirements for the preparation of an EA Report. Northern Pulp is expected to prepare an Environmental Assessment Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that are likely to arise from the Project, including any not explicitly identified in the Terms of Reference. The EA Report will be used to meet the requirements of a provincial Class I Undertaking.

Northern Pulp must include in its EA Report all the information requested within the Terms of Reference, as a minimum, in accordance with the Environmental Assessment Regulations pursuant to Part IV of the *Environment Act*. The Terms of Reference include Valued Ecosystem Components (VECs) which must be adequately addressed in the EA Report. **While the Terms of Reference provide a framework for preparing a complete EA Report, it is the responsibility of the Proponent to provide sufficient data and analysis on any potential environmental effects of the Project to permit a proper evaluation by governments, the Mi'kmaq of Nova Scotia and the public.**

PLFN Comments: The focus report was confusing in its layout, with important information split

between the main body of the focus report and the appendices. Not sure how this can be avoided again but may be worth mentioning.

The EA Report is expected to provide a comprehensive and complete assessment of the potential effects of the Project, presented in a clear format that can easily be reviewed by the Minister, governments, the Mi'kmaq of Nova Scotia and the public. If the Minister decides to refer the EA Report to an EA Review Panel for review, the EA Report will serve as the cornerstone of the Panel's review and evaluation of the potential effects of the Project and thus must be a stand-alone document. The EA Report will also allow governments, the Mi'kmaq of Nova Scotia and members of the public to understand the Project, the existing environment, and the potential environmental effects of the Project.

1.3 Proposed Project

This Section is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document (EARD). In response to this Draft Terms of Reference, Northern Pulp is required to provide information on any changes to the Project as a result of the *Boat Harbour Act* deadline. The Northern Pulp Northern Bleached Softwood Kraft pulp mill is located at Abercrombie Point adjacent to Pictou Harbour in Pictou County, Nova Scotia (NS). The proposed Project consists of the development of a new effluent (wastewater) treatment facility (ETF) constructed on Northern Pulp property, and a transmission pipeline that will carry treated effluent overland and in the marine environment and discharge via an engineered diffuser (marine outfall).

The ETF is proposed to employ the AnoxKaldnes BAS™ Biological Activated Sludge process purchased from Veolia Water Technologies, which combines Moving Bed Biofilm Reactor (MBBR) technology with conventional activated sludge. Once treated onsite at Northern Pulp's facility, effluent is proposed to be sent through an approximately 15 km long pipeline, of which approximately 8.7 km is included in the overland section. An additional land-based section of effluent pipeline, less than 1 km will be installed on mill property as a part of the ETF design by KSH Solutions. Approximately 1.5 km of the treated effluent pipeline will follow a marine crossing in Pictou Harbour adjacent to the Pictou Causeway. The land-based section of the pipeline begins on the north side of Pictou Harbour where it enters the Nova Scotia Department of Transportation and Infrastructure Renewal's (TIR's) Highway 106 right-of-way (ROW) and runs generally north, parallel to Highway 106, along the outermost eastern portion of the ROW toward Caribou, NS. The pipeline will then travel through the marine environment to the proposed outfall location approximately 4.0 km offshore within the Northumberland Strait.

1.4 Environmental Assessment Requirements

The Project is a Class I Undertaking pursuant to Schedule A of the Environmental Assessment Regulations made under Section 49 of the *Environment Act*. In accordance with Section 18(b) of the Environmental Assessment Regulations, the Minister of Environment has determined that an EA Report is required.

The Environmental Assessment Regulations require that the proposed Terms of Reference for the EA Report be prepared by the EA Administrator (Administrator) and made available for public review. Public comments on the Draft Terms of Reference will be accepted from January 8 – February 7, 2020.

All comments will be provided to Northern Pulp within 5 days of the end of the comment period. Northern Pulp will then have 21 days to respond in writing to the comments. Within 14 days from the final date for written response from Northern Pulp, the Final Terms of Reference for the EA Report shall be provided to Northern Pulp.

The Proponent is required to submit the EA Report within 2 years of receipt of the Final Terms of Reference. If the EA Report does not meet the Terms of Reference, Northern Pulp will be required to include further information before the EA Report can be accepted. Upon acceptance of the EA Report, Nova Scotia Environment (NSE) has 14 days to publish a notice advising the public where the EA Report can be accessed for review and comment.

Once the EA Report has been accepted, the Minister has the option to refer the EA Report to an EA Review Panel for review. At the conclusion of this process, the Minister has 3 decision options: a) the undertaking is approved with conditions; b) the undertaking is approved without conditions; or c) the undertaking is rejected.

1.5 Access to Information for the Environmental Assessment Process

Copies of the Draft Terms of Reference for the Preparation of the EA Report may be examined at the following locations:

- Pictou Library, 40 Water Street, Pictou, NS
- New Glasgow Library, 182 Dalhousie Street, New Glasgow NS
- EA website https://www.novascotia.ca/nse/ea/

All information pertaining to this portion of the EA review will be posted to the EA website as it becomes available.

2 PREPARATION AND PRESENTATION OF THE ENVIRONMENTAL ASSESSMENT REPORT

Pursuant to the Environmental Assessment Regulations, the EA Report must include, but not be limited to, the following information:

- a description of the proposed undertaking;
- the reason for the undertaking;
- other methods of carrying out the undertaking;

PLFN Comments: The TOR should require Northern Pulp to provide a more fact based and scientific examination of tertiary treatment options which acknowledges that there are multiple options for tertiary treatment. Not all wetlands are the same. Surface flow wetlands have different size requirements than engineered wetlands. These need to be further examined and definitive reasons set out as to why they are not feasible as they could result in much improved water quality.

- a description of alternatives to the undertaking;
- a description of the environment that might reasonably be affected by the undertaking;
- the environmental effects of the undertaking, including identifying any effects on species at risk, species of conservation concern and their habitats;
- an evaluation of advantages and disadvantages to the environment of the undertaking;
- measures that may be taken to prevent, mitigate or remedy negative environmental effects and maximize the positive environmental effects on the environment;
- a discussion of adverse effects or significant environmental effects which cannot or will not be

avoided or mitigated through the application of environmental control technology;

- a program to monitor environmental effects produced by the undertaking during its construction, operation and abandonment phases;
- a program of public information to explain the undertaking; and
- information obtained under subsection 19(2) which the Administrator considers relevant.

The information obtained under subsection 19(2) shall be prepared taking into consideration comments from:

- the public;
- departments of Government;
- the Government of Canada and its agencies;
- municipalities in the vicinity of the undertaking or in which the undertaking is located;
- an affected aboriginal people or cultural community; and
- neighbouring jurisdictions to Nova Scotia in the vicinity of the undertaking.

In preparing the EA Report, Northern Pulp shall refer to comments from the above-noted parties during the EA review of both the EARD and the Focus Report submitted by Northern Pulp to NSE, to identify and include the supplementary information required to provide a comprehensive and complete assessment of the potential effects of the Project. The EA Report must be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence-based and supported by credible sources of information. This report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report. Northern Pulp is expected to prepare an EA Report that fulfils the intent of the Terms of Reference and considers all the effects that are likely to arise from the Project, including those not explicitly identified in the Terms of Reference.

The order in which information is presented is at the discretion of the Proponent; however, a concordance table will be required to indicate where the information can be found. In the event that the Minister has decided to refer the EA Report to an EA Review Panel for review, the Proponent may provide additional information to assist the EA Panel in making their recommendation to the Minister and assist the Minister in making the decision for the Project.

Since the EA Report is intended for public review, the information should include an Executive Summary presented non-technical language. The Proponent will be required to submit an electronic copy of the EA Report in accordance with the EA Branch Bulletin on Requirements for Submitting Electronic Copies of Environmental Assessment (EA) Documents for publication on the Department's website.

2.1.1 **The EA Report must include, but not be limited to, the following information, as identified under the corresponding sections.**

3 PROJECT DESCRIPTION

Nova Scotia Environment expects Northern Pulp to provide information, as part of its comment on the draft Terms of Reference, about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes, if any, may affect the Terms of Reference.

Describe each component of the Project as it is planned through its full life cycle, including site preparation, construction, commissioning, operation, maintenance, and decommissioning:

- changes to existing mill infrastructure and in-mill improvements;
- **PLFN Comment: commissioning the mill itself following a lengthy period of hibernation;**
- effluent treatment facility (ETF);
- land-based sections of pipeline; and
- marine based sections of pipeline and the diffuser.

Where final decisions have not been made in regard to an element of Project design, or several options exist for a particular component or activity, the assessment of effects of that element of the Project on the environment should be conducted at the same level of detail for all available options.

3.1 The Proponent

Outline the Proponent's corporate commitment to sustainable development and environmental protection goals and principles including pertinent corporate policies, programs, plans, strategies, protocols, guidelines, codes, and environmental management systems (EMS**). PLFN Comments: Provide copies of all policies and plans referred to in the report.**

Provide summary information on the nature of the management structure and organizational accountability for designing, constructing, operating and modifying the Project; implementing environmental mitigation measures and environmental monitoring; and managing potential adverse environmental effects.

Provide details on relevant corporate experience (the Proponent and related companies) and experience in building and operating other similar facilities. Provide a record of the environmental performance and capability of the Proponent in conducting this type of Project.

3.2 Project Location

Provide a concise description of the geographical setting in which the Project is to be constructed/operated. Describe how the Project site was chosen, including a discussion of the specific environmental considerations used in site selection of all Project components, and the advantages of the proposed site. Describe the Project's compatibility with existing local and regional land-use policies and plans, and opportunities to integrate Project planning into regional scale development efforts. Discuss compatibility of the Project location in relation to people and their community and traditional activities and land uses by the Mi'kmaq of Nova Scotia. **PLFN Comments: Report should describe any legal impediments to using the proposed route and all list all consents and approvals required and obtained to date. Where no consents have been obtained explain how this will be overcome.**

Describe the ultimate boundaries of the Project in a regional context including existing and proposed land uses and infrastructure such as road networks, highway realignment, railways, power lines, pipelines, proximity to permanent and seasonal residences, individual and community water supplies, wetlands, water bodies, streams, ecologically sensitive areas, and archaeological sites. Include mapping at an appropriate scale.

Provide details on ownership of property within the Project footprint including lands owned by the Proponent, the Crown, or private lands. Provide details of existing agreements to develop the Project on lands not owned by the Proponent. Provide detailed plans for the required acquisition or use of private lands and Crown Lands and discuss any contingencies should these lands not be available for Project development.

Provide a list and map of communities in the region, including Mi'kmaq communities, potentially affected by the Project and indicate the distance between those communities and the specific Project components as appropriate. Identify proposed local shipping routes for importing and exporting products.

3.3 Project Design and Components

Describe the design plans and appropriate design standards for all Project components, associated and ancillary works, and other characteristics that will assist in understanding the Project, including: changes to existing mill infrastructure and in-mill improvements, **PLFN Comment: commissioning of mill itself follow hibernation,** ETF, land-based sections of pipeline, and marine based sections of pipeline and the diffuser. All associated infrastructure and components must be detailed. Also discuss environmental controls planned for the Project and how environmental protection, conservation, best management practices (BMPs), and best available technology have been considered in the design.

Provide potential design variations and implications (including advantages or disadvantages to the environment) of those variations. **PLFN Comment: This should include tertiary treatment options.** Describe any assumptions which underlie the details of the Project design. Where specific codes of practice, guidelines and policies apply to items to be addressed, those documents shall be cited.

For the EA Report, all site-specific data must be collected using equipment installed, operated, maintained and calibrated as specified by the manufacturer's instructions. All samples are to be collected, preserved and analyzed, by qualified personnel, in accordance with recognized industry standards and procedures and at accredited laboratories. Data shall undergo quality assurance and quality control (QA/QC) processes. **PLFN Comment: Data shall be collected over appropriate period of time and explanation of the time period provided. Where models are used, all data and modelling inputs shall be provided so that model and be replicated and verified.**

In addition to the above, this section will include, but not be limited to information on the following Project design components:

Changes to Existing Mill Infrastructure and In-Mill Improvements

- Preliminary design overview for any in-mill improvement projects necessary to achieve the design assumptions for the Project (e.g., in-mill cooling towers);
- Preliminary design overview of other projects that interact with the performance of the ETF (e.g., oxygen delignification) and a schedule for these projects relative to the proposed ETF construction schedule; and
- A waste dangerous goods management plan to accommodate for worst case scenario within design of the proposed ETF. It is important to note that the ETF is not proposed to treat waste dangerous goods based on the information provided in the EARD and in accordance with requirements of NSE.

PLFN Comments: *Commissioning of mill after hibernation*

- **Details of the commissioning process and impact on the performance of the ETF**

Effluent Treatment Facility (ETF)

- Footprint, location and preliminary designs for the ETF;
- Equipment description and specifications, including appropriate diagrams and flow charts for the proposed ETF and infrastructure components;
- Details (including characteristics and toxicities) and quantities of all products produced, stored, and imported to and exported from the facility (including by-products and chemical intermediaries);
- Justification of spill basin size and appropriateness of multi-purpose usage. Consider worst-case scenarios and requirements under the Dangerous Goods Management Regulations;
- Proposed design for the spill basin, including but not limited to, management and disposal of contaminated material that may be present at the site, liner details, secondary containment features, clean-out access and connection to the mill infrastructure and ETF;
- Submit additional data regarding the complete physical and chemical characterization of NPNS' raw wastewater at Point A (as defined in EARD and Focus Report), to support the assessment of the appropriateness of the proposed treatment technology. The sampling data for complete characterization (i.e., broad chemical analysis) must be statistically relevant and adequately represent ETF influent for various operating conditions that may exist at the mill (e.g., seasonality, flow rates, changes in sources of fibre or production, start-up and shut-down cycles, etc.);
- Using NPNS' raw wastewater characterization results, evaluate all contaminants of potential concern (COPCs) with respect to the effluent discharge quality following treatment using the proposed technology. This statistically relevant assessment shall include, but not be limited to, bench-scale testing of the mill's actual Point A effluent. Provide results of all expected COPCs influent and effluent concentration ranges. Include chemical oxygen demand (COD) fractionation (soluble and total) concentrations in the assessment; **PLFN Comments: How can this be done with mill not producing pulp?**
- Comparison of the effluent characterization results from the above assessment with appropriate regulations and/or guidelines, including the draft Pulp and Paper Effluent Regulations (PPER) daily and monthly average limits; **PLFN Comments: We would also like to see how the effluent compares to the NSE Tier 1 EQS for both marine and freshwater discharge.**
- Effluent flow data to support the proposed peak treatment capacity of 85,000 m^3 flow of effluent per day using actual daily flow data from Point A over a minimum 1-year period; **PLFN Comments: Provide historical data from "unregulated" flow meter historically used at this location even though not relied on in analysis. Also not clear how this will be done now without production.**
- Information regarding how the facility will achieve compliance with COD influent limits once the in-mill changes and ETF are operational; and
- Evaluation of sludge disposal options and management plans, including the rationale for the preferred option. If the preferred option uses the biomass boiler, provide a secondary disposal option.

Land-Based Sections of Pipeline Route

- Information on corridor width requirements, accounting for minimal possible corridor width requested by TIR;
- Appropriate, intrusive geotechnical survey results to support proposed pipeline construction methods;
- Risk assessment of pipeline design, including the following:
    - An evaluation of the probability of a potential leak, spill or release from the pipeline installation and its operation, based on a literature review and on comparable design.
    - Identification of points of the system that are susceptible to failure.
    - Based on the risk assessment, a suitable secondary containment system (e.g., a double-walled pipeline system) and proposed locations. Secondary containment is at a minimum required within the Town of Pictou's water supply protection area;

Commented [ ]: Not clear what this means.

PLFN Comments: The issue of secondary containment was not addressed well in the focus report. Simply making the pipe thicker, does not eliminate issues around stress points such as joints, welds, elbows, etc. The pipe is going through a source water protection zone and unless a detailed hydrogeological investigation is undertaken in tandem with the geotechnical investigation, it is in appropriate to surmise the groundwater flow direction in the vicinity of the pipe nor to comment on the risk to the GW supply from a potential leak.

- Preferred option(s) for both external and internal leak detection technologies for all sections of the on-land pipeline, with specific consideration to any section of the pipeline located in the Town of Pictou's water supply protection area and near private supply wells. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline;

PLFN Comments: If referencing a plant SOP, please provide the SOP for review. This comment is asking for specifics and it is expected the response will include specifics, not generic references to SOPs and possible and available technologies.

- Maps, at an appropriate scale of the Project location and pipeline route that show Project components, boundaries with UTM coordinates, major existing infrastructure, important environmental features, and adjacent land uses that will intersect with the pipeline route (e.g., road networks, railways, power lines, pipelines, proximity to settled areas, individual and community water supplies, watercourses, wetlands, ecologically sensitive areas, priority flora and fauna and archaeological sites); and
- A list of all properties (i.e., Parcel Identification Numbers) that will intersect with the pipeline route.
- **PLFN Comments: List all consents required for the land route and the status of each and if no consent yet obtained, the basis on which proponent believes the consent will be forthcoming..**

__Marine Based Sections of Pipeline Route__

- Selected options for both external and internal leak detection technologies for marine sections of the pipeline. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline; and

PLFN Comment: If referencing a plant SOP, please provide the SOP for review. This comment is asking for specifics and it is expected the response will include specifics, not generic references to SOPs and possible and available technologies.

- Maps, at an appropriate scale, detailing: the Project location, the Project components (e.g., confirmed locations of marine sections of the proposed pipeline including diffuser), boundaries of the proposed site with UTM coordinates, the major existing infrastructure, adjacent land uses that will intersect with the pipeline route, and important environmental features (e.g., spatial and temporal marine habitat distribution, marine refuge (Scallop Buffer Zone 24), etc.).

PLFN Comment: The recommendations from the original Geotech should be implemented. Bedrock should be adequately confirmed along the pipe line route.

3.4 Construction

Describe the construction of all Project components and supporting infrastructure. This will include but not be limited to:

- Proposed construction schedule for all Project components (including those mentioned in Section 3.3 of the Terms of Reference), including days of the week, times of the day, seasonal schedules and anticipated commencement and completion dates;
- All physical works and activities carried out during the construction phase are to be identified and described by location. This, includes but is not limited to: clearing and grubbing; blasting; site access and roadways; marine construction methods; road construction methods; dangerous goods storage areas; disposal at sea; watercourse crossings or diversions; utilities; and description of equipment used for construction activities, both terrestrial and marine;
- Dredge management/disposal plans that characterize and quantify marine sediments to be dredged and disposed (or re-used) in accordance with Environment and Climate Change Canada (ECCC) standards and in consultation with relevant government departments. Identify areas where dredging activities will occur and identify the location, quantity and chemistry of any dredge materials that are expected to require land-based disposal;

PLFN Comment: Sampling plan to be disclosed to PLFN for feedback prior to initiation of the field program.

- Evaluation of pipe jacking feasibility where crossing roads or structure locations that includes addressing limitations associated with practical pipe length at crossings and available space for thrust/reception pits on either side of crossings;

PLFN Comment: Prior documents noted that it would be up to the contractor to determine the pipe line construction method. If this is still going to be the stance, it should be made clear that all possible options must be assessed in the EA and any approval limited to those options.

- Evaluation of the effects of excavating and replacing large rock fill along the alignment route near Harvey A. Veniot Pictou Causeway;

- Storage areas for fuels, explosives and dangerous goods; and

PLFN Comment: These should be marked on a Site plan. At the very least multiple potential locations should be identified so that it can be ensured they meet industry standard.

- Waste disposal plans (types of waste, methods of disposal, quantity).

PLFN Comment: An actual plan should be required rather than a reference to an SOP.

3.5 Operation

Describe the operation of all Project components and supporting infrastructure to all components. The description of the operation shall include but not be limited to the following:

- Routine and maintenance operations for all Project components;
- Environmental controls and BMPs, including pollution prevention techniques in addition to traditional treatment and disposal practices;
- A spill basin management plan that proactively addresses the management of different types of materials, including compatible and non-compatible waste dangerous goods, sequential spills/leaks/releases, clean-out and liquid/solid removal procedures for the different types of collected materials, and appropriate final disposal procedures that observe applicable provincial and federal regulations; and
- A plan to ensure adequate staffing and operation oversight of ETF by trained personnel at all times.

3.6 Decommissioning and Reclamation

Describe the proposed plans for decommissioning the Project, including all infrastructure and reclamation of any impacted site. The EA Report shall also discuss the post-decommissioning land use options of the property.

PLFN Comment: This should also include plan for proper abandonment of the pipe and diffuser.

4 REGULATORY ENVIRONMENT

Describe the existing regulatory environment (Federal, Provincial and Municipal) including all permitting, licensing and regulatory requirements that apply to all phases of the Project and associated infrastructure. Provide a schedule indicating anticipated dates for required regulatory approvals.

Significant portions of the proposed Project to be evaluated by the EA Report are located on federal lands; therefore, federal authorities have indicated that they must make a determination as to whether the Project is likely to cause significant adverse effects and/or in the case of Public Services and Procurement Canada (PSPC) seek an Order in Council prior to providing authorizations, licenses, or leases. To ensure potential environmental effects are addressed to the satisfaction of federal authorities under Section 82 of the *Impact Assessment Act*, provide all necessary authorizations, licenses, or leases for all applicable federal authorities.

Describe applicable guidelines and standards that would apply to the Project. Those applicable standards or guidelines shall also be referenced in the appropriate sections of the EA Report and linked to environmental protection objectives.

PLFN Comment: It should be made clear that to the extent that the information that will need to be submitted to obtain federal approvals ad permits is not otherwise included in the assessment report, it could be provided under this section.

5 NEED FOR AND PURPOSE OF THE PROJECT

The need for and purpose of the Project should be established from the perspective of the Proponent. The Project is being designed to meet specific objectives and these objectives should be discussed. If the objectives of the Project are related to or contribute to a larger private or public sector policy, program or plan, this information should be included.

6 DESCRIPTION OF ALTERNATIVES TO THE PROJECT

Include an analysis of alternative means of carrying out the Project; describing functionally different ways to meet the Project need and achieve the Project purpose.

PLFN Comment: Tertiary treatment was not properly evaluated by the proponent as demonstrated by the Focus Report. This should be required and repeated here.

7 OTHER METHODS FOR CARRYING OUT THE PROJECT

Discuss other methods for meeting the need for the Project, including but not limited to, pipelines and treatment technologies. This section shall also discuss alternate locations for the Project.

The rationale for rejecting other described methods of carrying out the Project must be provided, including a discussion of how environmental sustainability and impact avoidance criteria were applied.

PLFN Comments: The Focus Report provides an example of what no to do: selecting the type of wetland that requires the most amount of land possible and then claiming the space is not available, when there are other types of engineered wetlands that use less space and could fit the on the site.

8 ASSESSMENT METHODOLOGY

Include the study strategy, methodology and boundaries used for preparing the EA Report. The following must be clearly defined:

- Temporal boundaries (i.e., duration of specific Project activities and potential impacts) for construction and operation through to decommissioning and post-decommissioning;
- Study boundaries or Project area and all space that will be potentially impacted, by the Project as proposed, or subject to subsequent modifications, and the methodology used to identify the study boundaries;
- Valued Ecosystem Components (VECs) within the study boundaries and the methodology used to identify the VECs. The methodology used for VEC identification shall include input from members of the public, government departments and agencies, other experts, and other interested parties, as well as direct engagement with the Mi'kmaq of Nova Scotia;

PLFN Comment: We expect this will be done directly with PLFN and not only through the MEK

process or through the KMKNO

- Where appropriate, identify environmental protection objectives (including those contained in applicable legislation or guidelines) associated with each VEC;
- Strategy for investigating the interactions between the Project and each VEC and how that strategy was used to coordinate the individual studies undertaken; and
- Method for predicting and evaluating Project impacts upon the environment; determining necessary avoidance, mitigation, remediation and/or compensation (in this order of consideration); and determining the significance of any residual impacts. The EA Report is to be prepared using an accepted and proven EA methodology and a qualified person should predict and evaluate Project impacts upon the environment. If there are no predicted effects to a specific VEC, provide reasons to support that claim. A complete discussion and analysis of predicted effects (direct and indirect effects) should be provided that is qualitative and quantitative, evidence-based and supported by credible sources of information. Provide a list of literature and sources used in the preparation of the EA Report. **PLFN Comment: All data and other modelling inputs to be provided so that model can be replicated and verified.**

- The following sections outline specific concerns and requirements related to the existing environment, adverse effects and environmental effects assessment, proposed mitigation, residual environmental impacts, proposed compliance and effects monitoring, and the public information program that are to be addressed in the EA Report for the proposed Project. **PLFN Comment: All data and other modelling inputs to be provided so that model can be replicated and verified.**

9 EXISTING ENVIRONMENT

Provide a baseline description of the environment in the vicinity of the Project and all other areas that could be impacted by the Project. This description must include the components of the existing environment and environmental processes, their interrelations and interactions, as well as variability in these components, processes and interactions over time scales appropriate to the effects assessment. The Proponent's description of the existing environment shall be in sufficient detail to permit the identification, assessment and evaluation of the significance of potentially adverse environmental effects that may be caused by the Project.

The EA Report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report, <u>considering comments on those documents during their respective EA review processes. The EA Report shall be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence-based and supported by credible sources of information</u>. Supplementary information shall be included to provide a comprehensive and complete assessment of the potential effects and may provide additional information to assist the EA Panel in making their recommendation to the Minister in the case of a panel review and to assist the Minister in making the decision for the Project.

PLFN Comment: This is important from a review and consultation perspective. The manner in which the Focus Report was prepared was at times confusing to follow, with important information provided in the EARD, the body of the focus report and as an appendix to the FR.

The use of GIS for documenting significant features and reports would be a great benefit for

reviewers and for tracking of the overall project including should the project be approved through the construction phase.

The EA Report shall clearly indicate baseline data/information which is not available or where existing data cannot accurately represent environmental conditions in the Project area. If the background data have been extrapolated or otherwise manipulated to depict environmental conditions in the Project area, modelling methods and equations shall be described and shall include calculations of margins of error.

For the EA Report, the spatial boundaries must include the Project footprint and relevant receiving environments such as airsheds and watersheds. Temporal boundaries must address applicable guidelines, standards and regulatory requirements and include Project construction, operation, decommissioning and post-decommissioning.

The Proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. Where technical reports are included or referenced, they must be finalized and signed by the qualified individual(s). Also provide the name and credentials of the person(s) conducting baseline studies/surveys. Mapping clearly indicating the extent of studies/surveys, sampling points, and illustrating key findings should also be included and presented logically within the EA Report in a location that allows for ease of review. Wherever possible, mapping should be presented at common scales and datum to allow for comparison and overlap of mapped features.

PLFN Comment: Modelling inputs to be provided. We are not asking for the software, we have access to that, we need the inputs. Given these are crucial to the proper evaluation of the EA, it is not expected that they will be noted as containing proprietary information.

The components of the environment to be discussed shall include identified VECs and those indicated within Sections 9.1 – 9.8.

9.1 Geophysical Environment

9.1.1 Topography, Geomorphology and Geology

Topographical maps should be provided locating the Project in both regional and local contexts. Describe the physical geography of the Project study area including post-glaciated landforms, coastal features, and marine features.

9.1.2 Geology

Include a description of bedrock geology, surficial geology and soils. The results of the geotechnical survey referenced in Section 3 of the Terms of Reference should be included. Geological properties of all Project sites in the study area which may influence stability, occupational health and safety, rehabilitation programs, or the quality of discharge water leaving any area disturbed by the Project should be described. The EA Report must consider the potential for Acid Rock Drainage/Metal Leaching (ARD/ML) where new bedrock may be exposed and/or excavated.

The marine component of the Project should also include a discussion pertaining to surficial sediment characteristics and mobility under present and future environmental conditions. This section should also identify any mineral resources that may be impacted by the Project.

PLFN Comment: Depth to bedrock also required as it may impact dredge activities and pipeline routing.

9.2 Water Resources

Include a description of groundwater, surface water, marine water and wetland resources potentially affected by the Project.

9.2.1 Groundwater

Provide a description of the regional and local hydrogeology of the study area. A discussion of groundwater use in the study area, including both current and likely potential future uses must be provided. Provide a map showing all water supply wells locations and potentially affected watercourses within 500 metres of the pipeline route.

9.2.2 Surface Water

Provide a general hydrologic, hydraulic and water quality description of all surface water bodies in the study area, including upstream and downstream to all Project components. Existing uses, withdrawal capacities, and users of the watercourses shall be identified, including use by the Mi'kmaq of Nova Scotia.

9.2.3 Marine Water

Provide baseline studies that characterize environmental conditions for the four seasons over a minimum of one year for the marine environment, including: climate, water quantity (e.g., current profiles, wave height, tide levels) , water quality (e.g., temperature, salinity, chemical and physical water quality), and marine sediment chemical characterization in the vicinity of proposed marine outfall location. These studies must be to the satisfaction of relevant government departments and are to be used to support modeling activities.

Commented [ ]: This should reference the area that might be impacted by effluent sediment.

Provide marine sediment chemical characterization along the proposed marine based pipeline section routes. Marine sampling locations must be clearly identified.

Conduct an intrusive marine geotechnical investigation in the areas identified to have potential bedrock of uncertain depth and along proposed route near base of Harvey A. Veniot Pictou Causeway.

Provide an ice scour baseline study for at least two winter seasons.

PLFN Comment: The proposed scope for each of the above studies should be provided to the applicable governing body as well as PLFN for review prior to initiation in the field.

9.2.4 Wetlands

Identify the location, size and class(es) of any wetland and/or wetland complexes within the predicted zone of influence and conduct a wetland evaluation. Evaluation of the wetlands shall include wildlife habitat potential (including rare and endangered species), groundwater recharge potential, role of the wetland in surface water regulation (stormwater retention and flood control) and the role of the wetland in watershed health. Based on the results of the evaluation, the EA Report must specifically identify wetlands that:

- Support a significant species or species assemblages;
- Support high wildlife value; and/or
- Have high social or cultural importance.

Describe all work activities and predict the effects (direct and indirect), with supporting rationale, on impacted wetland and wetland functions.

Wetland evaluations shall include additional assessment of adjacent wetland areas and anticipated extent of impacts associated with construction activities. The wetland evaluation must include identification of assessment areas and catchment areas used in the evaluation and include any associated outputs or assessment scoring outputs.

Baseline studies must describe and document pre-construction conditions, including, but not limited to, wetland class distribution, vegetation community structure, soil characteristics, and hydrology trends.

9.3 Atmospheric Resources

Atmospheric resources will include ambient air quality, the acoustic environment, greenhouse gas emissions, and impacts on climate.

9.3.1 Climate

Include a discussion of regional climate conditions and meteorology in the vicinity of the Project as well as expected changes over the next 50 years due to climate change. This section should include climate norms, extreme conditions, as well as trends in these conditions and climate change impacts, as well as the effect these changes may have on the Project and plans to mitigate against those impacts.

In addition to historical and projected climate data, the climate sub-section of the existing environment should include a summary of greenhouse gas emission projections for the Project, including plans to mitigate those emissions in both the design and operation.

Please follow the EA guidance documents when completing this section:
https://novascotia.ca/nse/ea/docs/Development.Climate.Change.Guide.pdf.

9.3.2 Air Quality

For the study area, provide a review of baseline ambient air quality and meteorological data, including annual and seasonal climatic conditions for the region.

Provide a description of existing ambient air quality conditions for the study area, with particular attention to ambient and peak levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O3), particulate matter (total suspended particulate (TSP), fine particulate matter (diameter less than 2.5 microns) ($PM_{2.5}$) and coarse particulate matter (diameter less than 10 microns) (PM_{10}), total reduced sulphur (TRS) and volatile organic compounds (VOCs) levels.

Commented [ ]: These should be based on current data collected following the cessation of operations at the mill.

Discuss the influence of local and regional emission sources and the influence of climate and weather conditions. The data should be used for the development of an appropriate model(s) for the study area to be provided in the EA Report. Also describe any potentially sensitive receptors and/or locations.

PLFN Comment: The model needs to take into account the dynamic aspect of the site being coastal. There also needs to be an inclusion for the added biosolids into the site boiler. Aermod and Calpuff.

9.3.3 Ambient Noise and Light Levels

Describe the existing ambient acoustical environment at the Project site (including the marine environment), and in any other areas where Project activities could be expected to have an environmental

Commented [ ]: Is this based on post-production/hibernation?

effect.

Provide the spatial boundaries of existing noise and vibration levels, as well as locations of recording stations and length of record for any acoustic or vibration data presented. Consider the effects of different meteorological conditions on noise propagation. Provide information on any existing relevant standards, guidelines or objectives with respect to noise and vibration levels.

Describe existing ambient light levels at the Project site and at any other areas where Project activities could have an environmental effect on light levels. Describe night-time illumination levels during different weather conditions and seasons.

9.4 Flora and Fauna

Identify flora, fauna, and habitat types that will be intersected by all components of the Project. Appropriate field surveys agreed to by Nova Scotia Lands and Forestry (NSLAF) – Wildlife Division, shall be conducted as part of the evaluation. Surveys should be described by results, methodology, and spatial and temporal boundaries.

9.4.1 Terrestrial Environment

This section must include, but not be limited to the following:

- Identification of typical species of flora, sensitive flora, flora species-at-risk, and potential habitat for flora species-at-risk in the study area;
- Identification of areas of old growth forest. Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; the Nova Scotia Museum of Natural History, and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to NSLAF – Wildlife Division. Available data, survey results, and detailed mitigation measures that demonstrate a special emphasis on avoidance of impacts shall be included in the EA Report;

Identification of any existing or planned wildlife management areas, ecological reserves or wilderness areas as well as managed wetlands and significant wildlife habitat;

- Identify and delineate on a map 'roadless areas' and discuss their potential value to Nova Scotia's protected areas network. Include areas with high wildlife concentrations, wildlife corridors or habitats rare/unique to Nova Scotia;
- Identification of typical species of fauna (including invertebrate species), sensitive fauna, fauna species-at-risk, and potential habitat for fauna species-at-risk in the study area. Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; Nova Scotia Communities, Culture and Heritage; the latest Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list; the Atlas of Breeding Birds of the Maritime Provinces; and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed by professional biologists in a manner that is acceptable to NSLAF – Wildlife Division and Canadian Wildlife Service;
- Additional migratory bird surveys at representative survey points along the pipeline route;
- Bird surveys transects to provide a complete view of bird species distribution and habitat use along the pipeline route, including transect bird surveys and fall migratory bird survey.

Identification of nests of bird species, which are protected under the *Wildlife Act*, regardless of whether they are active or not must also be considered;

- Bird baseline survey for common nighthawk (*Chordeiles minor*), including rationale for survey point selection to the satisfaction of NSLAF;
- Raptor nest survey to identify nest locations for the entire Project area including the pipeline route;
- Herptile survey for the Project area, which includes the pipeline route, to include both spring and fall survey information. Prior to conducting survey, develop survey methodology in consultation with NSLAF; and
- When surveys are necessary to supplement the available data and adequately describe the use of the area by migratory birds during different times of the year (breeding season, migration, winter), emphasis will be placed on determining whether any bird species-at-risk, colonial nesting species, species particularly vulnerable to habitat fragmentation, etcetera, occur or breed in or near the study area.

9.4.2 Freshwater Aquatic and Marine Environment

This section must include, but not be limited to the following:

- Fish and fish habitat baseline surveys for the marine environment;
- Description of any freshwater fish or fish habitat that exists in any identified watercourse or any other receiving watercourse that may be impacted by the development. The description of these species and habitat should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish;
- Description the relative distribution and abundance of valued fish resource components within the predicted zone of influence. Fish species, age, health, and diversity shall be described;
- Description of any seasonal variation in the location, abundance and activities of aquatic species should be included. Describe and identify key habitat features, such as spawning, rearing, nursery, feeding, migration and overwintering areas, as they occur within the Project area. Also describe the criteria utilized for determining the zone of influence this Project has on the fish habitat;
- Description of the marine habitat and species of fish, including pelagic and demersal finfish, shellfish, crustaceans, and marine mammals, likely to be present within the surrounding marine environment. The description of these species and habitats should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish and marine mammals;
- Baseline data for existing mercury concentrations in fish tissue that are adequate to be used for comparison purposes for impact monitoring programs. Provide data on total mercury in whole fillets accompanied by fish species and size data; and
- Baseline study for fish and shellfish tissue with chemical analysis that includes COPCs of representative key marine species important for commercial, recreational and Aboriginal fisheries (food, social and ceremonial) in the vicinity of the proposed effluent pipeline and diffuser location.

The locations of samples must be clearly identified.

9.5 Agriculture, Aquaculture and Forestry Resources

Identify and describe agricultural resources in the study area. Identify agricultural operations in the study area and describe crop types, growing seasons and growing methods.

Describe all commercial, recreational and Aboriginal fisheries (including food social ceremonial (FSC) as well as commercial), aquaculture, and harvesting (e.g., marine plants, shellfish) in the study area. Describe the commercial and recreational species, caught, grown or harvested, and their economic importance. Identify fishing, aquaculture and harvesting locations, the amount caught, and methods used.

Identify and describe forestry activities in the study area.

9.6 Socio-Economic Conditions

Describe the current socio-economic conditions of the study area, including population demographics and economic conditions (including Aboriginal Peoples). Provide details of employment rates and trends at the municipal and regional level. The spatial boundaries of this analysis should include areas within which employees of the Project are expected to reside. Identify key industries in the region (both land-based and marine-based) and describe their contribution to the local and regional economies. Provide details of residential and commercial property values. Describe any local and regional economic development goals and objectives identified through community consultation, or existing economic development plans and strategies.

9.7 Existing and Planned Land Uses

Describe the patterns of current and planned land use and settlement in the study area including residential, industrial, agricultural, parks, and protected areas. Provide details of areas under existing mineral exploration licenses as well as areas licensed for pulpwood harvesting. Identify locations of abandoned mine workings, mine tailings and waste rock disposal areas, as well as contaminated sites. This section shall include map(s) to illustrate land uses and provide distances to significant settlements.

The EA Report must also identify lands and resources of special social, cultural or spiritual value to the Mi'kmaq of Nova Scotia, with particular emphasis on any current use of land for traditional purposes. A Mi'kmaq Ecological Knowledge Study (MEKS) should be used to identify land and resource use that have and/or continue to be pursued by the Mi'kmaq of Nova Scotia.

9.8 Archaeological Resources

Identify any areas containing features of historical, paleontological, cultural or archaeological importance in a manner acceptable to the Nova Scotia Communities, Culture and Heritage (CCH). Describe the nature of the features located in those areas. Particular attention shall be given to Mi'kmaq of Nova Scotia archaeological sites and burial sites. All heritage research permits acquired, and engagement with the Mi'kmaq of Nova Scotia during this analysis should be identified in the document. Results of the Archaeological Resource Impact Assessment reports related to Indigenous land use and known archaeological sites of interest to the Mi'kmaq, should be provided to the Office of Aboriginal Affairs and PLFN.

10 ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS ASSESSMENT

Describe the effects of the Project on the environment during all phases of the Project (construction, operation, and decommissioning and reclamation), including any environmental change on health, socio-economic conditions, archaeology, and the current use of land for traditional purposes by the Mi'kmaq of Nova Scotia. The EA Report shall identify and describe the accidents and/or malfunctions that may occur during all phases of the Project and assess the effects on VECs. **PLFN Comment: including, but not limited to, their predicted probability of occurring.**

Provide a detailed contingency plan that considers site-specific conditions and sensitivities, the lifespan of different components and includes, but is not limited to:

- Full hazard identification and qualitative risk assessment associated with Project construction and operation, including those which have or may have an environmental impact (directly or indirectly);
- Prevention, mitigation and contingency measures to mitigate potential Project impacts;
- Discussion of measures to mitigate potential impacts or damages on the environment, properties and human health (e.g., liability insurance, financial security, etc.);
- Emergency response procedures;
- Description and quantification of releases that could occur under both normal conditions and a 'worst-case scenario';
- Description the types, fate and distribution of contaminants within the study area under normal and worst-case scenarios during construction, operations and post-reclamation;
- Discussion of potential Project impacts on emergency and health services in communities near the Project area, and associated mitigation and contingency measures in the events of major Project related accidents and malfunctions;
- Description of the cumulative effects of Project activities; and
- The effects assessment shall also consider impacts of the environment (including weather and climate) on the Project, including a discussion of how potential climate change will impact all components of the Project.
- **PLFN Comment: Predicted probability of occurrence for accidents and malfunctions.**

10.1 Geophysical Environment

Potential effects of the Project on the geophysical environment must be discussed in the EA Report.

The EA Report must also discuss the potential cumulative and residual effects of the Project on the geophysical environment and the significance of these effects.

10.2 Water Resources

In conducting the effects assessment on water resources, the EA Report must identify and evaluate:

- Changes in groundwater and surface water quality as a result of effluent discharges from the Project site;
- Potential effects on groundwater quality and quantity and associated impacts to users of groundwater;
- Potential cumulative and residual effects of the Project on water resources and the significance of these effects including ecosystem integrity and changes in hydrology to areas immediately adjacent to the Project area;

- Where wetland avoidance is not possible, the EA Report must discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.
- The Canadian Council for Ministers of the Environment (CCME) Water Quality Guidelines with background water quality results shall be used to ensure the protection of relevant water uses (aquatic life, recreational use, agricultural use, and drinking water supply) and shall be used as the basis for evaluating the significance of the predicted impacts; and
- It is recommended Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Water Quality, be reviewed and applied in the evaluation where relevant.

10.2.1 Groundwater

Provide an assessment of the potential risk to groundwater resources associated with the construction and operation of the pipeline. The assessment shall include but is not limited to quantitative calculation of time of travel between the pipeline and water supply wells and watercourses, delineation of well capture zones and determination of groundwater flow directions. The results of this assessment shall be considered in the final pipeline design in terms of providing for greater protection in areas of greatest risk.

The groundwater assessment results need to be discussed with the Town of Pictou to establish confidence that the risk of negative impacts to the Town water supply has been reduced to an acceptable level.

10.2.2 Surface Water

In conducting the effects assessment on surface water resources, the EA Report must identify and evaluate:

- Potential effects to surface water quality on fish and fish habitat, community water supplies (protected and unprotected), and recreational and agricultural users.

10.2.3 Marine

The proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. In conducting the effects assessment on marine resources, the EA Report must identify and evaluate, to the satisfaction of relevant government departments:

- Marine pipeline construction methods along the full route and construction requirements (e.g., blasting), using results from geotechnical investigations;

PLFN Comment: The method has to be examined. Not sufficient to state that method will be decided by the contractor.

- Adequacy of proposed pipeline burial depths with respect to ice scour;

PLFN Comment: report must answer questions: (a) Is burial depth achievable? (b) Has bedrock been delineated? (c) Is underwater blasting required?

- Geotechnical assessment of stability of underwater excavation works near base of Causeway with respect to causeway embankment and structures;

PLFN Comment: Archaeologic resources have been identified in this area. Investigation will require and Archeological Response Plan.

- Potential risk of impacts to the marine environment resulting from leaks from marine based sections of pipeline;
- Receiving water study that assesses fate and transport of COPCs in the receiving water environment for a range of scenarios reflective of conditions possible at the chosen site. This study shall identify potential short and long-term impacts. This study is to be completed using modelling techniques and scenarios for all COPCs in the receiving environment, based on the results of the effluent characterization in Section 3.6 of the Terms of Reference and other relevant studies, such as Human Health Risk Assessment. All baseline climate and marine water quantity and quality data should be applied to this study for model setup, calibration and validation. Results shall include, but not be limit to, discharge plume dimensions and dilution ratios; **PLFN Comment: All data and other modelling inputs to be provided so that model can be replicated and verified.**
- Goodness of Fit statistical procedures are to be applied to evaluate model adequacy in representing the receiving water environment for the calibration and validation periods. Assessment must be provided on the adequacy of the seasonal variation and lengths of observed datasets used in model setup and calibration/validation. A summary of model confidence in adequately representing multi-year effluent discharge transportation of COPCs and accretion/build-up within the receiving water environment is to be included; **PLFN Comment: 3D modeling to be used in marine modelling.**
- Potential build-up of COPCs resulting from the proposed activity (e.g., shoreline accumulation). Provide the estimated dilution potentials at various distances from the diffusers based on calibrated model results as appropriate;
- In conjunction with the above, provide sediment transport modelling, including model(s) and scenarios to assess the impacts of sediment transport within near-field and far-field model areas. The results of the modelling activities are to be assessed with respect to chemical and physical characterization of the distributed solids, interaction with marine sediments and waters, and effects within the marine environment, particularly to marine organisms; and
- Based on the results of the receiving water study, evaluate whether colour is expected to be visible at the ocean surface above the diffuser site, including influence of in-water reactions (e.g., potential stratification of the water column) on colour levels. Assess impact of colour and its interaction and effect on the marine sediments and associated marine life.

10.2.4 Wetlands

In conducting the effects assessment on wetlands, the EA Report must identify and evaluate:

- Potential direct and indirect impacts to wetlands and how Project development will adhere to the Nova Scotia Wetland Conservation Policy; and
- Where wetland avoidance is not possible, discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.

10.3 Atmospheric Resources

Describe the sources, types and estimated quantities of air emissions from the mill facility for all potential air contaminants of concern related to the Project under routine conditions and in the case of malfunctions and accidental events on a seasonal and annual basis. Air contaminants to be evaluated should include but not be limited to, impacts of CO, hydrogen sulphide (H_2S), nitrogen oxides (expressed as nitrogen dioxide)(NO_2), O_3, SO_2, TSP, $PM_{2.5}$, PM_{10}, TRS, speciated VOCs, semivolatile VOCs, polycyclic aromatic hydrocarbons (PAHs) and metals. The description shall include appropriate models based on known or measured atmospheric conditions throughout the year.

PLFN Comment: This must include assessment of the burning of bio-solids and sludge in the boilers. Should also include a discussion on known impacts, if any, of prolonged exposure to concentrations below regulated limits.

For all Project phases, construction, operation and decommissioning, estimate the GHG emissions and provide an inventory of GHG emissions from all Project components. This includes carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs),sulfur hexafluoride (SF6), nitrogen trifluoride (NF3) and conversion of these emissions to an equivalent amount of CO2. Also include an inventory of the precursors or tropospheric ozone (CO, NOx, and VOCs).

Where possible, include a comparison of the above information with estimates of total GHG contributions from NS, and from similar facilities in Canada. The EA Report must also include a discussion of measures that have been considered and/or are proposed to reduce air emissions and reduce or offset GHG emissions.

While considering the effects on air quality, the EA Report must discuss the potential impacts of predicted increases in noise and light levels during all phases of the Project, on surrounding residential, commercial, recreational and institutional areas, and marine and terrestrial habitats.

It is recommended Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air and Noise, be reviewed and applied in the evaluation where relevant.

PLFN Comment: This should rephrased to be mandatory.

In addition, based on concerns raised by government reviewers, the EA Report must also include, but not be limited to the following additional items:

Revised air dispersion modelling including the following:

- Consideration of the effects of fumigation and coastal interaction in the modelling;

PLFN Comment: AERMOD AND CALPUF to be used.

- Modelling based on the operating scenario for the occasion when the highest concentration of an air contaminant occurs at ground level. The operating condition that corresponds to the maximum air contaminant concentration at ground level may occur when the facility is at the maximum production level or running at a lower production level or when the process is in transition. The report shall include a description of the operating conditions that result in the maximum ground level concentration of an air contaminant;

- Identification of individual emission rates as measured or estimated and include the reference and justification for values used;
- Comparison of the maximum predicted ground level concentrations of all contaminants with relevant ambient air quality criteria. In the absence of NS adopted ambient air quality criteria, the Proponent shall utilize criteria from Federal **PLFN Comment: and** other Provincial jurisdictions;
- Comparison of the maximum predicted ground level concentrations of all contaminants with their relevant upper risk thresholds;
- Risk assessment and mitigation plan for contaminants that demonstrate a predicted exceedance of a relevant upper risk threshold;
- Inclusion of isopleth mapping for all contaminants predicted to exceed relevant ambient air quality criteria;
- Identification of discrete receptors on all isopleth mapping;
- Mitigation options to address any predicted exceedances of relevant ambient air quality criteria used in the modelling. The model shall be rerun incorporating the mitigation projects to demonstrate no predicted exceedances; and Implementation schedule for potential mitigation options.
- **PLFN Comment: All data and other modelling inputs to be provided so that model can be replicated and verified.**

10.4 Flora and Fauna

10.4.1 Terrestrial Environment

Identify and evaluate the potential effects on flora and fauna and avifauna species/communities during all phases of the Project. Include a full account of impacts on species at risk or of concern, significant habitats and protected areas or areas of potential value to Nova Scotia's protected areas network that may be potentially disturbed, altered or removed. The effects assessment must also consider the potential for effects to flora and fauna associated with landscape fragmentation and sensory disturbances.

10.4.2 Freshwater Aquatic and Marine Environment

Evaluate the potential effects on aquatic environments, including fish and fish habitat.

While considering the effects that the Project may have on freshwater and marine species, include a full account species at risk or of concern and significant habitats. This section must include activities that may affect avifauna in the aquatic environments. Also consider potential effects to marine species from blasting, dredging and other marine construction, as well as vessel traffic and Project operation. Where impacts to fish habitat cannot be avoided or mitigated, discuss compensation measures to ensure impacts are offset. **PLFN Comment: Must include explanation as to why effects cannot be avoided.**

Assessment of COPCs in the baseline fish and shellfish populations and potential effects due to expected discharge quality.

Include a summary of the potential effects on flora/fauna known to be important to the Mi'kmaq of Nova Scotia.

10.5 Agriculture, Aquaculture and Forestry Resources

Include an effects assessment of the Project on existing and future agriculture activity within the study area.

Assess the impacts on commercial/recreational fishing, aquaculture or other marine harvesting which may be impacted by the proposed Project. The effects assessment should consider changes in commercial/recreational fishing, aquaculture or other marine harvesting species, including contamination of species consumed by people as a result of increased erosion, sedimentation and from effluent discharges from the Project, displacement, mortality or loss and/or alteration of habitat. Also discuss navigation restrictions and loss of traditional fishing areas of the Mi'kmaq of Nova Scotia.

Conduct an impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon information, studies and an understanding of expected movement of contaminants according to the revised receiving water study. Based on the assessment of applicability of Point C representing Project ETF effluent quality, chronic and acute toxicity testing of non-diluted treated effluent is to be conducted through a series of controlled laboratory experiments. Species used in the assessment should be applicable to the receiving water environment. Consideration should be given to using either the plant's current effluent or another acceptable and representative substitute. The selection of information sources, representative marine species and assessment methodology must first be agreed upon by relevant government departments.

Commented : This needs to change as there will be no production. Historical data if reliable and collected over a suitable time period may be an option.

Undertake a model-based evaluation of the chronic effects of thermal cooling water discharge on fish and fish habitat in the receiving water. Based on the results of the evaluation, develop appropriate mitigation measures and/or project changes.

The EA Report must include a discussion on the potential effects on any forestry resources within the Project area.

10.6 Human Health

Provide the completed Human Health Risk Assessment (HHRA) in accordance with Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk Assessment and other Guidance for Evaluating Human Health Impacts in Environmental Assessment documents for noise, air quality, drinking and recreational water, etc. as applicable. Federal contaminated sites guidance documents such as the Detailed Quantitative Risk Assessment (DQRA) may be used to supplement the EA Guidance documents where appropriate. The risk assessment must consider human consumption of fish and other seafood, consumption of potentially contaminated drinking water, exposure to recreational water and sediment, outdoor air inhalation, and any other potential exposure pathways. The analysis must inform the identification of contaminants of concern and updating of the receiving water study.

The HHRA must consider baseline data and represent all marine species which are harvested and consumed in the area with respect to the marine component of the Project and in all types of fisheries-commercial, food, social and ceremonial. In addition, information for these species should be included in the baseline studies for COPCs in marine organism tissues where possible. The HHRA must consider bioaccumulation and the potential for biomagnification in the food chain. The exposure route associated with consumption of seaweed and sea vegetables must also be included.

The HHRA is to include appropriate receiving water study and associated modelling activity results (e.g., contaminant fate and transport) as to accurately assess the potential risk to human health.

Include monitoring and mitigation measures for elevated COPCs in air emissions in HHRA problem formulation.

Screen COPCs in Project effluent discharge according to guidance from Health Canada. Incorporate findings from receiving water study. Discuss the potential for interactive effects from similarly acting chemicals. Include an evaluation of the risk associated with exposure to chemical mixtures. Provide calculation of Hazard Quotients (HQ) and Incremental Lifetime Cancer Risk (ILCR) which account for additivity.

Ensure any screening values used from the EPA are adjusted to be consistent with the health protection endpoints prescribed by Health Canada and CCME.

Provide clarification on methodology applied to selection of COPCs for seafood ingestion in consultation with Health Canada.

10.7 Socio-Economic Conditions

Identify potential impacts of the Project on economic conditions, populations and employment.

Identify potential impacts of the proposed Project on residential property values and property demand during all phases of the Project (including temporary accommodation required during construction).

Describe the effect of the proposed Project on present and future commercial, residential, institutional, recreational and resource land uses within the study area, including impacts to areas under mineral exploration licenses or forestry licenses.

Identify the potential impact on recreational opportunities, including the effects on aesthetics from areas surrounding the Project area. This analysis should be supported by visual impact assessments from both the land and water.

Identify the potential impact on the current use of land and resources for traditional purposes and any Aboriginal specific land claims within the study area.

While considering the effects on economic conditions and employment, include a discussion on expenditures and the anticipated direct and indirect employment positions that will be created during all phases of the Project.

10.8 Existing and Planned Land Uses

The EA Report must consider the effects that may restrict the ability of people to use and enjoy adjacent lands and marine area presently, and in the future. Describe the potential impacts from existing or planned land uses in the study area. This shall include a discussion of Project interactions with any rural planning initiatives, parks, protected areas, contaminated sites, former mine workings, and mine disposal areas.

Identify and evaluate potential effects on traditional and current recreational and commercial use by the Mi'kmaq of Nova Scotia.

Discuss the anticipated changes in traffic density and patterns during all phases of the Project including the effects on transportation.

While assessing the effects on navigation and navigable waters, consider navigation patterns of all waters that may be impacted by the Project. Potential effects on traditional and current recreational and commercial use must be identified and evaluated.

10.9 Archaeological Resources

Evaluate the potential effects of any changes in the environment as a result of Project activities on physical and cultural resources, structures and/or sites of historic, archaeological, or paleontological significance.

In conducting the effects assessment on archaeological resources, it is recommended that the Proponent consult with CCH and with the Archaeology Research Division of KMKNO.

11 PROPOSED MITIGATION

Describe all measures that have, or will be, taken to avoid or mitigate negative impacts, and maximize the positive environmental effects of the Project (as described in Section 9.0 of the Terms of Reference). Mitigation includes the elimination, reduction or control of the adverse effects or the significant environmental effects of the Project and may include restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

Describe proposed compensation that will be provided when environmental damage is unavoidable or cannot be adequately mitigated by any other means.

In considering mitigation measures to be employed, the EA Report must describe any legislation, regulations, guidelines, policies, BMPs, and specifications that will be adhered to during construction and operation of the facility that will lead to mitigation of environmental impacts.

11.1 Geophysical Environment

If applicable, describe alternatives to disrupting net acid producing bedrock. When no practical alternative to exposing acid producing bedrock exists, mitigation plans shall be developed for minimizing the impacts on the aquatic environment. Discuss commitments to provide contingency and remediation plans for watercourses that have been degraded due to the disturbance of net acid producing bedrock or tills.

If contaminated soils are to be disturbed, discuss methods to minimize adverse impacts.

Provide applicable mitigation measures and preliminary agreements and plans that meet Provincial regulatory disposal and transportation requirements for potential dredge materials.

PLFN Comment: Should be a discussion on the location of erodible soils. This should be identified for proper implementation of erosion and sedimentation control. Where blasting will occur, there will need to be pre-blast surveys.

11.2 Water Resources

11.2.1 Groundwater Quality and Quantity

Describe actions that will be taken to mitigate any negative impacts on groundwater quality and quantity.

Provide a Groundwater Protection Plan based on the assessment of risks to local water supplies (municipal and private) and the environment. This plan should include management/contingency response actions and reference the groundwater monitoring plan as well.

Describe measures to be employed in the event of accidental contamination or dewatering of any water supply wells as a result of the construction or operation of the Project, including compensation for loss or degradation of water supplies. Describe mitigation measures planned to prevent and remediate contamination of groundwater from the accidental release of a hazardous substance.

Discuss commitments to provide contingency and remediation plans for any contamination of groundwater resources, including decrease of water quality.

11.2.2 Surface Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to surface water resources, including but not limited to erosion and run-off control features and storm drainage management.

Discuss all mitigation measures planned to prevent the release of hazardous substances into local surface waters.

Discuss commitments to provide contingency and remediation plans for any impact to surface water resources, including decrease of water quality or quantity.

11.2.3 Marine Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to marine water resources.

Discuss all mitigation measures planned to prevent the release of hazardous substances into marine waters.

Discuss commitments to provide contingency and remediation plans for any impact to marine water resources, including decrease of water quality or quantity.

11.2.4 Wetland Resources

Describe measures to avoid, minimize or otherwise mitigate effects on wetland resources within the Project area. Specifically, the EA Report must describe measures to maintain ecological and hydrological integrity of any wetlands in the area. Where avoidance is not possible, provide wetland specific mitigations proposed to lessen impacts of the Project at all stages and describe commitments to monitoring and compensation for any loss of wetland habitat. Also provide discussion and commitment regarding remediation/rehabilitation of aquatic habitat as a result of incidental releases of treated effluent in wetlands.

11.3 Atmospheric Resources

Describe measures to avoid, minimize or otherwise mitigate effects on biological receptors during all phases of the Project (vegetation, fish, wildlife, and human health).

Specifically, describe measures that will be taken to control emissions including but not limited to CO, H_2S, nitrogen oxides expressed as NO_2, O_3, SO_2, TSP, $PM_{2.5}$ and PM_{10}, TRS, speciated VOCs, semivolatile VOCs, PAHs and metals. Describe any GHG mitigation plans.

Describe all measures that will be taken to mitigate any potential increase in noise and light levels during construction and operation.

11.4 Flora and Fauna

11.4.1 Terrestrial Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on flora species. Include any landscaping plans for preservation of existing vegetation.

Describe the measures that will be taken to minimize the impacts of the Project at all stages on terrestrial fauna and avifauna. Include any plans for preservation of existing habitat and compensation for loss or degradation of terrestrial habitat (i.e., habitat rehabilitation/replacement). Measures to comply with wildlife legislation (e.g., *Migratory Birds Convention Act* and regulations) should also be provided.

Discuss commitments to provide contingency and remediation plans for impacts to terrestrial habitat as a result of accidental events.

In addition, based on concerns raised by government reviewers during the review of the EARD and the Focus Report, the EA Report must also include, but not be limited to the following additional items:

- Mitigation plan developed in consultation with NSLAF that includes additional details to protect wildlife and wildlife habitat, including birds, mammals, herptiles, raptors, and species and risk. The plan must include but not be limited to the following:
  a) mitigation measures that will be taken to avoid destroying rare priority species detected in the 2019 floristic surveys;
  b) mitigation and monitoring plan for the Eastern Wood-Pewee (*Contopus virens*, SARA Special Concern, NSESA Vulnerable) and Barn Swallow (*Hirundo rustica*, SARA Threatened, NSESA Endangered) found during the course of field surveys and Kildeer (*Charadrius vociferous*) identified to likely be breeding in the Project area, in consultation with both ECCC and NSLAF;
  c) additional details on how impacts to the Double-Crested Cormorant (*Phalacrocorax auratus*) colony located along the east side of Highway 106 causeway will be mitigated during installation of the pipeline across Pictou Harbour. Identify appropriate mitigation measures to protect Double-crested Cormorant nests in the event of a pipeline rupture;
  d) specific measures to be developed to discourage waterfowl from accessing the spill basin and other open ETF components;
  e) specific measure to be developed to control of spread of invasive species;
  f) specific measures to be developed to address potential foraging and overwintering habitat for turtles; and
  g) a training program for field staff to enable them to recognize the potential for species occurrences and procedures to follow.

11.4.2 Freshwater Aquatic and Marine Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on marine and freshwater aquatic species, avifauna and their habitats. Include any plans for preservation of existing habitat and compensation for loss or degradation of aquatic habitat.

Describe the measures that will be taken to minimize the introduction of non-native species to the area.

Discuss commitments to provide contingency and remediation plans for impacts to aquatic habitat as a result of accidental events.

11.5 Agriculture, Aquaculture and Forestry Resources

Discuss measures that will be taken to minimize the impacts of the Project on agriculture, fishing, aquaculture, marine harvesting, and forestry.

11.6 Human Health

Provide suitable avoidance and/or mitigation measures to prevent and minimize potential Project impacts on human health.

11.7 Socio-Economic Conditions

Describe actions that will be taken to mitigate adverse impacts on private and commercial property, existing industry and businesses, planned land use, recreation and other human activities, including traditional activities and land uses by the Mi'kmaq of Nova Scotia.

Provide a dispute resolution policy for addressing Project related complaints and concerns that may be received throughout construction, operation, decommissioning and reclamation, and post-decommissioning.

11.8 Existing and Planned Land Uses

Describe the measures planned to minimize the potential impacts of the Project on existing and planned land uses. Discuss the mitigation measures planned to address anticipated impacts from any predicted changes in traffic speed, traffic routes, marine navigation, exclusion zones and density in adjacent residential and commercial areas.

11.9 Archaeological Resources

Describe mitigation measures to preserve, protect, or recover any resources of cultural or archaeological value that are identified in the study area.

12 RESIDUAL EFFECTS AND ENVIRONMENTAL EFFECTS

This section of EA Report shall list and contain a detailed discussion and evaluation of the residual impacts for each VEC, including the criteria for determining significance. Residual impacts are those adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technologies or other acceptable means. Those impacts that can be mitigated or avoided shall be clearly distinguished from those impacts that will not be mitigated or avoided.

These impacts become important in the evaluation of a proposed Project as they represent the environmental cost of the Project.

13 EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

Present an overall evaluation of the advantages and disadvantages to the environment, including the

VECs, during the construction, operation and decommissioning phases of the Project. The evaluation of the disadvantages shall include an examination and justification of each disadvantage.

PLFN Comment: Any advantage should be based on proper scientific or empirical evidence. Note that since the Boat Harbour treatment facility can no longer be used, and the Province is required to remediate it, the advantages associated with the closure and remediation of Boat Harbour are not relevant and cannot be attributed to the ETF project and should not be referred to in the environmental assessment report as it was in the Focus Report and the EARD.

14 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

Include a framework upon which compliance and effects monitoring will be based throughout the life of the proposed Project, including decommissioning and post-decommissioning activities. Monitoring programs must be designed to determine the effectiveness of the implemented mitigation measures. The EA Report shall describe the compliance reporting methods to be used, including reporting frequency, duration, methods, parameters, comparison standards or guidelines, format, and receiving agencies. Mapping clearly illustrating baseline and proposed monitoring locations should also be included.

Recognizing that the effectiveness of compliance and effects monitoring depends on a workforce that can identify and address potential impacts during construction and operation of the Project, the framework shall include procedures for providing training and orientation to on site employees during construction and operation of the Project.

The description of the compliance and effects monitoring program shall also include any procedures/plans for addressing potential exceedances of environmental protection standards, guidelines or approvals.

The discussion of compliance monitoring shall include, but not be limited to Sections 14.1 – 14.4.

PLFN Comment: Important to note that ultimately whatever programs are proposed have to be Approved by NSE or the applicable Federal department. From our perspective the bare minimum requirements under the legislation/Approval would not be sufficient. This is an opportunity for NP to demonstrate their environmental stewardship. How will NSE ensure that sufficient staff are available for compliance monitoring and enforcement should this project be approved and construction proceeds? What is the role of PLFN in deciding what/how to monitor and in the monitoring process itself.

14.1 Geophysical Environment

Describe plans and procedures for assessing ARD potential and associated monitoring in the event of disturbance or exposure.

14.2 Water Resources

Wetland specific post construction monitoring and comparison to baseline condition must be provided to identify post-construction wetland indicator performance and adaptive management to address impacts at all project stages. The report should address compensation measures that may be required to ensure no net loss of wetland area and functions.

Submit a groundwater quality and level monitoring plan for the construction, operation and decommissioning phases of the Project, including the pipeline route and mill site location. This is to include the location of monitoring wells, monitoring sampling frequency and monitoring parameters. The plan must consider the final pipeline design as well as the potential risk to the environment and local water supplies as a result of pipeline construction and possible pipeline leak. The plan must address, as a minimum, sensitive areas along the pipeline route, such as shallow water table intersecting surface water features, proximity to water supply wells and areas along the pipeline more susceptible to failure. Locations where the pipeline may be constructed below the seasonal high-water table shall be identified.

Discuss plans for a survey of structures if blasting is planned, to include wells, building foundations, etcetera, which may experience damage or impact due to seismic vibrations or air concussion.

Discuss any surface water monitoring plans for the construction, operation and decommissioning phases of the Project, including both water quality and quantity aspects.

Develop a marine discharge plume delineation monitoring program to confirm plume dimensions, and effluent concentrations and characteristics in support of the Environmental Effects Monitoring program.

14.3 Fish and Fish Habitat

Submit an Environmental Effects Monitoring program that includes water quality, sediment and tissue sampling and is based on the results of various relevant baseline studies and receiving water study. The program should at a minimum be designed based on applicable regulatory requirements.

14.4 Atmospheric Resources

Complete an ambient air quality monitoring plan, acceptable to the Department, based on the results of the air dispersion modelling. This plan must include but not be limited to sampling locations, parameters, monitoring methods, protocols and frequency. The plan shall ensure adequate monitoring coverage of areas where predicted levels of air contaminants are elevated.

Describe plans for GHG monitoring, reduction targets and reduction plans.

Discuss the plans for monitoring baseline, construction and operational noise levels at the site, and at any residential or commercial areas near the Project.

14.5 Human Health

Provide suitable monitoring measures to confirm impact predictions. Where monitoring is proposed, include a plan for reporting/communicating reporting exceedances of relevant guidelines/thresholds **PLFN Comment: and for monitoring and adapting to changes thresholds and parameters as science and regulations evolve.**

14.6 Other Monitoring Plans

Include any other monitoring plan which may include an Environmental Protection Plan or other guidelines, polices or plans, proposed for the construction, operation and decommissioning of the Project.

15 CONSULTATION PROGRAM

A Notice regarding the Draft Terms of Reference for Preparation of an Environmental Assessment Report pursuant to the Nova Scotia *Environment Act* was published in the Chronicle Herald and Royal Gazette on January 8, 2020 and posted on the NSE internet site (www.gov.ns.ca/nse/ea/). Information pertaining to this EA will be available on this site.

The Class I EA process for the Project includes the following opportunities to participate (specifically government departments/agencies, the Mi'kmaq of Nova Scotia and the general public will be invited to provide comments):

- the Draft Terms of Reference; and
- the Environmental Assessment (EA) Report.

15.1 Public Consultation

For any consultation undertaken with the general public, the EA Report must describe ongoing and proposed consultation and information sessions.

Describe all steps taken by the Proponent to identify the concerns of the public about the adverse effects or environmental effects of the Project. It shall provide a summary of all concerns expressed by the public and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the general public.

15.2 Consultation with the Mi'kmaq of Nova Scotia

To assist the provincial Government in their consultation process with the Mi'kmaq of Nova Scotia, the EA Report must describe all steps taken by the Proponent to identify the concerns of Mi'kmaq of Nova Scotia about the adverse effects or environmental effects of the Project. It shall provide a summary of all concerns expressed by the Mi'kmaq of Nova Scotia and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns. **PLFN Comment: So that PLFN does not have to re-invent the wheel, comments and concerns from prior stages of the environmental assessment process should be taken as continuing comments and concerns.**

During the EA process, NSE will serve as the provincial Crown consultation coordinator.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the Mi'kmaq of Nova Scotia.

In parallel to Proponent engagement with the Mi'kmaq of Nova Scotia, the Government of Nova Scotia will undertake continued consultation directly with the Mi'kmaq of Nova Scotia pursuant to the Mi'kmaq-Nova Scotia-Canada Consultation Process (2010).

The Proponent is encouraged to engage the Mi'kmaq of Nova Scotia as referenced in the Nova Scotia Office of Aboriginal Affairs' Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia (2011).

Include any plans for ongoing community consultation or formation of a community liaison committee (CLC) during construction, operation and decommissioning.

16 ASSESSMENT SUMMARY AND CONCLUSION

This section of the EA Report shall summarize the overall findings of the EA with emphasis on the main environmental issues identified and predict the significance of adverse environmental effects of the Project.

PLFN Comment: The plain language summary is important for PLFN members and members of the general public. Consideration should be given to enhanced direction in this section to ensure the public is fully informed.

From:	
To:	Environment Assessment Web Account
Subject:	Draft terms of reference for EAR for Northern Pulp
Date:	January 8, 2020 12:55:23 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
Exercise caution when opening attachments or clicking on links / Faites preuve de prudence si vous ouvrez une pièce jointe ou cliquez sur un lien

Could you please notify me where I can access the Draft Terms of Reference for Northern Pulps EAR

Thank you

From:
To: Environment Assessment Web Account
Cc:
Subject: Re Draft Terms of Reference for Northern Pulp proposed treatment facility, Jan. 8, 2020
Date: January 8, 2020 8:08:15 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
Exercise caution when opening attachments or clicking on links / Faites preuve de prudence si vous ouvrez une pièce jointe ou cliquez sur un lien

Dear DOE
Regarding the above TOR, for several years in the first decade of this century the Pictou County Watershed Coalition attended repeated meetings with NS Department of Health representatives in search of baseline data on the health of Pictonians and how their health might have been and continue to be affected by the presence of the Northen Pulp mill. To date such a study has still not been undertaken.
There is no way this new EA can be adequately completed without this information. If NP undertakes the required studies, I urge the Province to complete a detailed health survey of Pictou County residents as soon as possible so that this information can be considered within the EA.
For your convenience I quote below one of the many correspondences we conducted during the above period...to no avail.
Yours sincerely,

Letter mailed Nov. 18/2009

Pictou County Watershed Coalition

November 18 2009

Dear

We are writing on behalf of the Pictou County Watershed Coalition. Thank you for your October 7, 2009 written response to our letter of Sept. 1, 2009, in which we stated our concerns over the health impacts of the poor air and water quality in Pictou County, and requested a baseline health study of the population. As you know, the incidence of some cancers and other illnesses in the County is the highest in the Province, if not in Canada, and we suspect that environmental factors play a role in this.

Before responding to your letter, the Coalition has asked me to clarify that our letter of Sept. 1 was sent to the Department of Environment to your attention as Minister. We also copied the letter to numerous individuals at various levels of government, including Premier Dexter and Health Minister Maureen MacDonald. We understand that a health study is more within the mandate of the Department of Health and appreciate your forwarding our letter to Ms.

MacDonald for her review and consideration. At this date we are still awaiting her response, which is disappointing considering the urgency of the issue.

In reference to your letter, we are encouraged that your Department recognizes the link between health and the quality of the environment, and we trust that your Department will do everything possible to ensure that the various pollution sources in the Pictou County watersheds will be cleaned up so that the citizens of Pictou County can live in a healthy environment in future. We also look forward to your Department's co-operation in providing relevant data which may be of assistance in completing the baseline health study. We look forward to working with you so that we may address health concerns as they relate to pollution sources in our County.

Sincerely,

Spokesperson
PCWC

From:	
To:	Environment Assessment Web Account
Subject:	NO PIPE
Date:	January 9, 2020 10:32:48 AM

There will be no pipe in the Northumberland Strait. This mill has destroyed more then enough of our land and waters over the years. The fact they turn 85 million litres of fresh water into waste effluent every day in operation should be enough on its own to shut this place down. Jobs come and go, people have to adapt to new circumstances everyday and I am speaking from experience.
No pipe.

Sent from my iPhone

From:	@hotmail.com
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	January 9, 2020 11:47:19 AM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: replacement_effluent_treatment_facility_project Comments: Enough is enough. We the people have been through this enough. NP has shown time and time again their lack of commitment to upgrading their facility in a timely manner. The mill is beyond itâ?Ts life expectancy and itâ?Ts time now to shut it down and remediate the land it sits on and allow new green business to take its place. For the sake of our people, for the sake of our environment, and the sake of our tax payers dollars. Please shut it down so clean up can begin. The history of neglect is there and the indemnity agreement stands. We need to pull away from NP before they cost us further monies and damage to the environment. Name: Email: @hotmail.com Address: Municipality: email_message: Privacy-Statement: agree x: y:

From:
To: Environment Assessment Web Account
Cc: Sean.Fraser@parl.gc.ca
Subject: Feedback regarding Northern Pulp"s Terms of Reference
Date: January 9, 2020 12:37:56 PM

NS Department of Environment,

Please consider my feedback on the TOR regarding the Effluent Proposal

1. As the Studies are completed, the Proponent needs to make them available to the public so they can be reviewed in advance. Having 2000 pages to review within a 30 day period is not a sufficient amount of time to review the info and comment accurately.

2. The Proponent needs to address the additional air pollution that will come from the burning of the sludge and list the technology that will be used as well as a specific timeline, the cost and who will pay for it.

3. The Proponent needs to list the timeline for the implementation of O2 Delignification system as well as the cost and who is paying for it.

4. The Proponent needs to have timelines and goals set by the Government to ensure the TOR is being met. This info needs to be made public and scheduled updates need to be provided by the Proponent

5. The Proponent must list in detail examples of Bleach Kraft Mills that are using the exact same technology with the same the type of outflow and characteristics that the Northumberland Strait has. For example, comparing mills in Howe Sound, BC that are discharging effluent into 200-400ft of water is not the same as discharging effluent into 10-65 feet of water that has very little tidal activity, major ice scouring, etc.

6. The Proponent needs to conduct very detailed studies on Lobsters, Lobster Larvae and other shellfish that are within the Strait

7. The Proponent needs to conduct very detailed studies on all endangered or species at risk marine species. IE. Atlantic Salmon, Striped Bass etc.

8. The Proponent needs to conduct very detailed studies on all endangered or species at risk that are land based species.

9. The Proponent needs to spend adequate time and resources conducting baseline studies for Wetlands

10. The Proponent needs to spend adequate time and resources conducting baseline studies for the species that habit the land based portion of the pipe route. 2-3 days of observation is not adequate. This needs to be conducted over several months of the year spanning multiple seasons to ensure that the migration, hibernation, offspring etc is all being considered.

11. The Proponent needs to find another route for the land based portion of the pipe when it comes to the Pictou Town Water supply. The water supply cannot assume any risk and the only way to do so, is to go around it via another route.

12. The Proponent needs to provide a full and complete Human Health Risk Assessment based on the data from the proposed system.

13. The Proponent needs to find a way to reduce air emissions to well below safe limits, even during higher than normal production. The Focus Report showed various emissions exceeding safe limits.

Thank you for the consideration

From:
To: Environment Assessment Web Account
Subject: New ETF proposal
Date: January 9, 2020 1:13:52 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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By honoring the commitment to close Boat Harbour, the Nova Scotia government FINALLY showed some decentsy and actual concern for the HORRIBLE environmental disaster they helped to create. Any backsteping on this action will show the colonialist attitudes and actions that are so prevalent in Nova Scotia.

Its time for these old, hate-based ideals to end. It's time for Nova Scotia to end its racist, ignorant path and step into a future that is not based on greed, and raping the earth for all her natural resources.

It's time for Nova Scotia and ALL her people to be heard. We need to be able to live honorably. We, as a people, need to be able to see the natural beauty that surrounds without seeing dollar signs attached to it.

To those who make their living off of the earth, please see the harm you are doing and be better human beings.
The human race is at a pivotal point in history. If we as a people don't change, then we are all to blame for the climate disasters we face from today onwards.

From:
To: Environment Assessment Web Account
Subject: Preparation of Terms of Reference - Effluent Treatment Northern Pulp Nova Scotia Corporation Northern Bleached Softwood Kraft pulp
Date: January 12, 2020 7:47:12 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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May I say, that this is truly sad, this decision was supposedly arrived at on December 19th, yet on January 7th there was a 37 page document prepared with such detail, and technical material/filler that it is surprising, to say the least, that this document could be assembled within 18 short days over the Christmas / New Year Holiday season! I fully believe that this was prepared well in advance and that is obvious as the Terms of Reference (ToR) are requesting seasonal characterization of the effluent, which cannot be completed with the mill in a non-operating state. Many of the items within this report cover issues not even associated with the Effluent Treatment Plant, which was supposedly what this ToR was all about. This document is fully intended to ensure that mill will never run again! Well done Stephen McNeil, Well Done, you ensure Nova Scotia will be a have not province for a long time to come!!

This ordeal has resulted in 3 – 11,000 people being pushed around, insulted, prejudiced against, and finally impoverished, by groups that know nothing of science, but only fear mongering, suspicions, guessing, and rumors! Was it not the Lobster Fishermen who said confederation bride would destroy the fishery? Truth is that the Lobster Catch (see below ~ 50,000 more tonnes in 2017 than 1990) is almost doubled in tonnage since the 1980/90's. Was that fear based on science, or just a bunch of guys sitting around on a wharf. The increase in Lobster is probably due to Fishery management by the DFO, rather than anything else, but the numbers do indicate there does not appear to be any adverse effect to the Lobster fishery. Although the data does not look at each location within Atlantic Canada, it is well known that local catches are up in and around Pictou County, however, I am sure someone in the Department can validate or refute that statement for me. How much more does the Lobster Fisherman need to make?

You are an embarrassment to society, Steven McNeil and all the followers. I cannot believe when you have a company spending money and wanting to spend money why you let this slip away. Nova Scotia apparently does not need Forestry, they need handouts and transfer payments, because they don't want to work, or at least the politicians and the Department of Environment don't want people to work, unless they are selling Knickknacks on a wharf!!

I am confident you will not respond to this, and I feel quite sure that when some individuals send in their suspicions, guesses, and hunches they will be listened to, much more than a fact based submission. To allow people completely unfamiliar with the science is unfair not only to the Pulp Mill, but to the good people of Nova Scotia who will lose much of their livelihood, and self-respect because Stephen McNeil & his followers succumbed to a small group of uninformed individuals.
Sincerely Yours

Data from DFO https://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm

Year	Lobster Metric Tonnes Live Weight
1990	47853
1991	48450
1992	41944
1993	41061
1994	41541
1995	41120
1996	39934
1997	40079
1998	41186
1999	44777
2000	45511
2001	52123
2002	48940
2003	49837
2004	47479
2005	51616
2006	55008
2007	48870
2008	58984
2009	58342
2010	67227
2011	66978
2012	74790
2013	74686
2014	92779
2015	90875
2016	90624
2017	97452

From:	@gmail.com
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	January 16, 2020 4:16:28 PM

Project: replacement_effluent_treatment_facility_project Comments: Any proposal for an effluent pipeline through or near the well field that supplies Pictous drinking water should be a non-starter. Given the shoddy record of the pulp mills regard for the environment -- non-functioning scrubbers, unacceptable particulate emissions, leaking effluent lines -- theres no earthly reason to expect better in future. Shame on the government if it takes this ghastly charade seriously. The mill will do no more than it must to keep the environment clean, and weve already seen for more than fifty years how little it cares about the publics health. Name: Email: @gmail.com Address: Municipality: email_message: Privacy-Statement: agree x: y:

January 15/20

With Regards: The Draft Terms of Reference
Northern Pulp

Concern # 1 Who is buying the new ETF for Northern Pulp. Is it tax payers money which I totally disagree No public money should be used on project.

2 Why do they think they can run a pipe across a water shed & wetlands, which supply drinking water to a Town Pictou, & rural area. Pump waste into a shallow fresh & salt fish habitate. The only deep water is in Channel where the Ferry to PEI departs. The decision was made in the 90's by Federal Fishery Department. No Pipe into Strait. Worst scenario is a dead toxic Northumberland Strait and a toxic Boat Harbour.

#3 The 3 Septic tanks at Northern Pulp. What toxic material is being released into Boat Harbour. Also everything being released out of the stacks. & I believe the plan to burn dried material from holding ponds. No Pipe too much risk

From:	
To:	Environment Assessment Web Account
Subject:	Environmental Assessment Report - Northern Pulp - comments submitted by February 7th, 2020
Date:	January 25, 2020 6:55:46 PM

I wish to put forward the following comments:

I am still concerned about expansion of the HDPE pipe that has been promoted in the previous two submissions. I have tried to alert my concerns about the high rate of expansion of the pipe in a confined trench. That pipe is meant to be used in an open sea bottom where it can naturally snake around and relieve any stresses. No attention was paid to my concerns.

I am also concerned about the necessary air release valves on the high spots that may relieve unnoticed, especially in the Town of Pictou watershed. This would certainly not be good. Notes in previous submissions went unaddressed.

Underwater leak detection went unaddressed.

Ability to sample the effluent at the diffuser went unaddressed.

My greatest concern is the amount of wood the mill has been using of late. Production has risen from 500 imperial tons per day in the original design which would require 1000 cords of wood to 1000 tons per day which requires the equivalent of 2000 cords of wood. Besides affecting the treatment of effluent, it is a race to the bottom in our forests in Nova Scotia. This is all for a company that is not publicly traded so there is no way that we can share the profit or get a true business picture of the operation. The harvesting and trucking in 1965 involved six times the workers that this increased production requires today. We have literally lost our forests, our rural communities and changed our climate. Yes we need a pulp and paper mill. But not kraft process and about 500 tons per day. We need our Acadian forest back. We need people back on the land. Not those big harvesters. We need 10 year interventions taking not more than 30 per cent of the overstory. Real foresters would agree with me. This is what they preached before Scott.

Thank you

Yarmouth, N.S.

From:	Minister, Env
To:	Environment Assessment Web Account
Subject:	FW: Correspondence #55676 RE: Northern Pulp
Date:	January 28, 2020 12:32:25 PM

From:
Sent: January 28, 2020 10:48 AM
To: Minister, Env <Minister.Environment@novascotia.ca>;
Subject: Re: Correspondence #55676 RE: Northern Pulp

Dear Mr. Minister:

Thank you for your reply of Jan. 23. The link provided for comments, at the bottom of your letter, does nor work so I am sending comments directly to you.

I also consider protection of the natural environment to be a top priority but, as explained in an item I wrote based on readily available information, to post on Facebook Jan. 12 and pasted below I could not see how Northern Pulp posed a threat.

At age 85 I have seen 50 years of destruction and degradation of the natural environment; mostly due to fragmentation of habitat by 100 series highways and siltation of streams by runoff from public and private highway construction/ditch cleaning. Destruction of this type could perhaps be minimized by better communication between Environment, Natural Resources, Agriculture and Highways.

START OF PASTE:

My take on the NP hype. Kraft paper, which I understand is what NP produces, is made by heating wood chips in a solution of Sodium sulfide ($Na2S.9H2O$) and Sodium hydroxide ($NaOH$). These chemicals, both strongly alkaline, enable lignin to be extracted from the cellulose fibers of the wood. Lignin is the glue which holds cellulose fibers together to make cell walls.

There is bound to be some Sodium sulfide and Sodium hydroxide in the discharge from a Kraft paper plant so it is prudent to ensure sufficient dilution before discharge. Or discharge in such a way that dilution will quickly take place. The proposed pipe (I think) was going to have perforations so not all of the discharge would be in one location.

But one of the current severe problems with respect to oceans is acidification due to excess $CO2$. So both of these chemicals would be desirable if delivered in relatively diluted form. (Abrupt and large changes in composition may have unforeseen effects on solubility of other chemicals in a solution containing many other chemicals, such as sea water).

There would no doubt be appreciable amounts of lignin in the liquid initially released from the plant. Many of our soils would benefit from application of the entire mill discharge, including lignin, but I think transportation of the waste would be too costly; too much water.

So once again, the ocean is right there and lignin would also be harmless (every time driftwood gets ground up lignin enters the ocean and most river water will contain some lignin) provided it reached the ocean widely dispersed.

NP ran into trouble, if anything, because they were being too cautious. Having Ottawa swinging back and forth on the fence did not help either.

END OF PASTE:

Yours truly,

On 1/23/2020 1:56 PM, Minister, Env wrote:

Good Afternoon,

Please find attached a response to your email to the Honourable Gordon Wilson, Minister of Environment.

Thank you,
NSE Correspondence Coordinator
NS Environment
1894 Barrington Street, 18th floor
PO Box 442
Halifax NS B3J 2P8
Phone: (902) 424-3736
Minister.environment@novascotia.ca

Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442
Halifax, Nova Scotia B3J 2P8

Via Fax at (902) 424-6925

Dear Sir or Madam:

RE: Replacement Effluent Treatment Facility Project proposed by Northern Pulp Nova Scotia Corporation

I have reviewed the draft Terms of Reference for the above noted project. The following are my comments:

1. Page 12 - paragraph 1 - All cited specific codes of practice, guidelines and polices should be provided if not available to the public online. It is not sufficient that these items be just cited, they must be made available for the public to review.

2. Page 14 -paragraph 3 - Northern Pulp should provide details of response protocol to leaks which are detected *during periods of ice coverage*, in addition to those times when there is no ice. If a leak occurs in the middle of winter and there is significant ice coverage and flows, how does Northern Pulp propose to detect and fix the leak?

3. Page 18 - paragraph 9.2.3 - Marine environmental conditions are impacted by more than just the four seasons - consideration should be given to moon phases (big tides), wind, temperature, and extreme conditions (storms). Also, averages should not be used - should use maximums and minimums.

4. Page 19 - paragraph 3 - An ice scour study should also include historical analysis. What if the two winter seasons that they study are both mild or with little ice?

5. Page 22 - paragraph 5 - Baseline data should include shellfish tissue, as it does in the paragraph that follows.

6. page 22 - paragraph 8 - Recreational fishing has more than an "economic" importance. There are also social, mental health, and food source benefits which should be described.

7. Page 36 - last paragraph - The current community liaison committee is ineffective and secretive, leading to further distrust. Any community liaison committee should be more transparent so that the public knows who to provide their concerns to and then receive feedback, which will foster trust and understanding within the greater community.

8. General concerns:

   (a) The Environmental Assessment Report should use the definitions set out in the relevant legislation

   (b) The name and credentials of all those conducting studies and providing conclusions should be disclosed in the EAR

   (c) Consideration should be given to the various uses of the marine water by the commercial fishery (ex wash down, lobster floats, Logans fish plant)

   (d) specific reference should be made to the air quality concerns of the spill basin

Please consider amending the Terms of Reference to address my concerns. Thank you.

Yours truly.

@gmail.com
fax

From:
To: Environment Assessment Web Account
Subject: Draft of terms of reference for EA Northern Pulp effluent treatment project
Date: February 1, 2020 8:22:25 PM
Attachments: To coments re EA draft terms.docx

Sirs:

Please see the enclosed word document regarding my comments toward the draft "terms of reference" for an EA for the Northern Pulp effluent treatment project. Can my comments be considered toward a final document.

Thanking you............

To: Hon. Gordon Wilson

Minister of Environment

Nova Scotia Environment

Date: Jan 16.2020

From:

Re: Draft Terms of Reference for the Preparation of an Environmental Assessment---- Northern Pulp Wastewater Treatment Project

I am a Pictou County resident in and retired in 2006 with a career in technical services. I had worked with in 1966 and 1967 and am also a woodlot owner.

I had submitted comments of concern for the two previous reports to The Department of Environment and follow up with comments regarding this request for a full Environmental Assessment.

I have found the Terms of Reference to be complete for definition and mitigation of the risks involved regarding the influence to air, land and water along with the potential for operation failures of installed equipment. It is not at all clear however, what is missing in the “Focus Report” studies which limits the project from meeting current or proposed new Federal or Provincial environmental guidelines for the pulping industry. To move forward, I believe that it is essential that all parties must have a very clear and fact based description of the needed process and results as this has a very big influence on our province.

There includes in this draft only brief request for reference to other world pulping installations. I feel that it is essential that we base decisions on not only models and studies of such a project but on installations and proven results at many other world projects as this. With 131 Kraft mills in North America and more worldwide, there will be many excellent examples of the performance of effluent treatment facilities. All of these mills will operate under specific Government environmental guidelines and there will be many where detailed environmental reviews have been made of the operations. For those mills which are Kraft, there should be the ability to make direct comparisons to the Northern Pulp project. Particularly in Europe and North America, there should exist well documented studies of Kraft mill environmental performance. Just as an example, the world has been building pipelines for much more than a century and proven examples of best practices for acceptable risk should be readily available.

I believe that there must be a complete section in the environmental Assessment which makes a real comparison to other installations and the proven results of comparable projects with their influence on the environment. We are not dealing with a new science when studying this project proposal although there certainly are many details of influence which need definition. All world pulp mills deliver treated effluent to receiving water systems and have exhaust air systems to the atmosphere. There will be many which should be very similar to this proposed project.

I would appreciate your consideration toward requesting detailed information of environmental performance studies for comparison project installations in several if not many other installations in other jurisdictions worldwide. It is also important to be very precise and clear in the demand for project information.

Thanking you………

From: @gmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: February 2, 2020 3:16:18 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
Exercise caution when opening attachments or clicking on links / Faites preuve de prudence si vous ouvrez une pièce jointe ou cliquez sur un lien

Project: replacement_effluent_treatment_facility_project Comments: There is no safe place to put a pipe. Not through the town of Pictous watershed, not out into prime fishing areas, not along the causeway endangering Pictou Harbour, not along the highway to Caribou because a spill would halt traffic, not near tourist destinations Pictou Lodge and the town of Pictou and not emptying anywhere near the ferry terminal - what a lovely mess to greet arriving tourists. The truth is that the mill has been a rotten neighbour - spills that had to be detected by random people out strolling in nature, *years* without scrubbers while fully aware of the particulates they were releasing on an unaware public, the rampant and ugly clear cutting to satisfy the owners in Indonesia owners with a hellish reputation around the globe, the volume of fresh water sold at give-away prices, and the profits that go overseas. And still this monster, which is more than 25 years past its promised lifespan, wants to continue to destroy everything around it. Busine sses come and businesses go because of the revolting smell who knows what opportunities have been missed simply because of the smell. As far away as Alberta people were asking us if Pictou still stinks. Then theres the freakishly high rates of cancer in this part of the province. And I havent even touched on the gross injustices done to Pictou Landing First Nations over the last 50-some years. It would be immoral, and should be illegal, for the mill to re-start in the future. The company has other mills where employees can go, and the logging companies had five years to figure out how to diversify their earnings. Enough is enough. Name: Email: @gmail.com Address: Municipality: Pictou email_message: Privacy-Statement: agree x: y:

From:
To: Environment Assessment Web Account
Subject: Fishing Industry Associations" submission on Draft Terms of Reference, Northern Pulp
Date: February 7, 2020 8:47:17 AM
Attachments: Fishing Industry comments on draft Terms of Reference for Northern Pulp EA, Feb 2020.docx

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Dear Minister Wilson and Nova Scotia Environment EA Staff:

Please find attached comments submitted by Gulf Nova Scotia Fleet Planning Board; Prince Edward Island Fishermen's Association; and the Maritime Fishermen's Union regarding the draft Terms of Reference for Northern Pulp's Environmental Assessment.

Best regards,

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January 30, 2020

COMMENTS ON THE DRAFT TERMS OF REFERENCE FOR THE PREPARATION OF AN ENVIRONMENATL ASSESSMENT REPORT FOR PUBLIC REVIEW AND COMMENT – *REGARDING THE REPLACEMENT EFFLUENT TREATMENT FACILITY PROJECT PROPOSED BY NORTHERN PULP NOVA SCOTIA CORPORATION*

SUBMITTED BY: Prince Edward Island Fishermen's Association, Gulf Nova Scotia Fleet Planning Board and the Maritime Fishermen's Union

The Gulf Nova Scotia Fleet Planning Board (GNSFPB), the Prince Edward Island Fishermen's Association (PEIFA) and the Maritime Fishermen's Union (MFU), including its subsidiary R&D company Homarus Inc., have reviewed the Draft Terms of Reference for the preparation of an Environmental Assessment report for public review and comment - *Regarding the Replacement Effluent Treatment Facility Proposed by Northern Pulp Nova Scotia Corporation*. The Terms of Reference are robust, but deficiencies remain regarding many key questions our organizations have regarding the effects to the ecosystem of the Northumberland Strait. These three organizations represent the interests of over 3000 commercial fishing licenses in New Brunswick, Prince Edward Island, and Gulf Nova Scotia.

These 3000 fishers are multi-species fishers which means that although lobster is the key species fished in the region, economically, this is not the only species fishers harvest. Some other commercially fished species include, but are not limited to: Atlantic halibut, bluefin tuna, Atlantic mackerel, Atlantic herring, Scallop, soft shell clam, smelts, snow crab, rock crab, and toad crab, just to name a few. The most economically significant species is American lobster which in recent years has grown in value, in the Gulf alone to over $250 million dollars. This is approximately 63% of the value of all the regions fisheries. The lobster landings from the Gulf represent 30% of the Canadian landed volume, coming from only 1% of the Canadian waters (https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/atl-arc/report-stat-rapport/lobster-homard/index-eng.html), a portion of which is being threatened by this proposed project.

The GNSFPB, PEIFA and MFU have been engaged since the beginning of this process and have reviewed all previously submitted documentation. We still have significant concerns going forward due to the threats posed to the sustainability of commercial fisheries.

Please review the following comments concerning "Draft terms of reference for the preparation of an environmental assessment report for public review and comment - *Regarding the Replacement Effluent Treatment Facility Proposed by Northern Pulp Nova Scotia Corporation*"

1.) **Forward - This document presents the Draft Terms of Reference for public review and comment. The Minister of Environment invites interested Nova Scotians to examine the Draft Terms of Reference and provide comments on their adequacy and suggestions for their modification**
   a. Does this mean comments from other Provinces, with an obvious investment in the project will not be considered?

2.) **Introduction - If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected**
   a. The term "significant" needs to be defined in the context of this terms of reference. The term significant, as defined by Webster dictionary is: "the quality of being worthy of attention; importance." What is important to the fishers may not be important to Northern Pulp Nova Scotia Corporation and therefore saying "there would be no significant harm to the ecosystem" is really just according to the mill and not the fishers. This is not quantifiable and is therefore just an opinion. The term scientifically significant or statistically significant is actually defined by a probability. "The probability being measured is how likely it is that different results found by different scientists is due to accident." Scientific significance would be the ideal definition used in this process, but ultimately, it CANNOT just be an opinion based on the what the company deems as significant.

3.) **Preparation and Presentation of the Environmental Assessment Report – The information obtained under subsection 19(2) shall be prepared taking into consideration comments from:**
   - **the public;**
   - **departments of Government;**
   - **the Government of Canada and its agencies;**
   - **municipalities in the vicinity of the undertaking or in which the undertaking is located;**
   - **an affected aboriginal people or cultural community; and**
   - **neighbouring jurisdictions to Nova Scotia in the vicinity of the undertaking.**
   a. We are aware that fishing organizations could fit into "the public" or "neighbouring jurisdictions to Nova Scotia" but there is no requirement for Northern Pulp Nova Scotia Corporation to consider comments from fishing organizations. Based on the economic value of the Northumberland Strait to

these organizations this section should be amended to include those organizations whose livelihoods are directly affected by this project.

  b. Under "Government of Canada and its agencies" this should also list which agencies. Previous comments submitted were done so by the Maritimes Region Department of Fisheries and Oceans (DFO). The fishing organizations affected by this project are not represented by DFO Maritimes region but rather DFO Gulf Region. It is essential that scientists in DFO Gulf region are included in this list of comments to be taken into consideration.

4.) **Project Description - Comparison of the effluent characterization results from the above assessment with appropriate regulations and/or guidelines, including the draft Pulp and Paper Effluent Regulations (PPER) daily and monthly average limits;**
  a. The appropriate regulations and/or guidelines should be included in this section. It is very possible that toxins affecting different fish species will be missed because it is not defined that Northern Pulp must use them as a comparison.

5.) **Project Description - Effluent flow data to support the proposed peak treatment capacity of 85,000 m3 flow of effluent per day using actual daily flow data from Point A over a minimum 1-year period;**
  a. The 1-year period should be defined in the terms of reference to confirm that the year chosen by Northern Pulp is not a year with numerous shut downs or low productivity; therefore skewing results in their favour.

6.) **Description of alternatives to the project - Include an analysis of alternative means of carrying out the Project; describing functionally different ways to meet the Project need and achieve the Project purpose. AND Other methods for carrying out the project - Discuss other methods for meeting the need for the Project, including but not limited to, pipelines and treatment technologies. This section shall also discuss alternate locations for the Project. The rationale for rejecting other described methods of carrying out the Project must be provided, including a discussion of how environmental sustainability and impact avoidance criteria were applied.**
  a. These 2 sections are really vague, I'm worried that Northern Pulp is not being given enough direction on this and in turn we will end up with holes in the data again.

7.) **Assessment Methodology - Study boundaries or Project area and all space that will be potentially impacted, by the Project as proposed, or subject to subsequent modifications, and the methodology used to identify the study boundaries;**
  a. In the past there was never a methodology shared for how the study boundaries were chosen and the study area appeared extremely small considering the volume of effluent proposed to be released. There needs to be assurance that more area is covered under the study boundaries, especially in the marine environment. There are no walls at the edge of the study area to maintain the

COPCs and other elements, but the boundaries are being treated like a closed system, when in actuality they are not.

8.) **Assessment Methodology - Valued Ecosystem Components (VECs) within the study boundaries and the methodology used to identify the VECs. The methodology used for VEC identification shall include input from members of the public, government departments and agencies, other experts, and other interested parties, as well as direct engagement with the Mi'kmaq of Nova Scotia;**
   a. Again, fishing organizations are excluded from this list. By assuming they are included in "other interested parties" this removes the requirement to engage with the fishing organizations and they are overlooked in the process. The fishing organizations need to be included in the engagement and input portions of this process.

9.) **Assessment Methodology - Method for predicting and evaluating Project impacts upon the environment; determining necessary avoidance, mitigation, remediation and/or compensation (in this order of consideration); and determining the significance of any residual impacts.**
   a. This is another example of "significance". How is Northern Pulp going to determine the significance of residual impacts? This needs to be defined.

10.) **Existing Environment - Provide a baseline description of the environment in the vicinity of the Project and all other areas that could be impacted by the Project. This description must include the components of the existing environment and environmental processes, their interrelations and interactions, as well as variability in these components, processes and interactions over time scales appropriate to the effects assessment. The Proponent's description of the existing environment shall be in sufficient detail to permit the identification, assessment and evaluation of the significance of potentially adverse environmental effects that may be caused by the Project.**
   a. This is a key paragraph to understanding the ecosystem and baseline information for the area. The statement "interactions over time scales" is important because ecosystem's communities in the Northumberland Strait shift based on temperature and therefore time of the year. This should help clarify with Northern Pulp that a two-day baseline study is insufficient to this study. Two days in January and two days in May could look completely different.

11.) **Existing Environment - Provide baseline studies that characterize environmental conditions for the four seasons over a minimum of one year for the marine environment, including: climate, water quantity (e.g., current profiles, wave height, tide levels), water quality (e.g., temperature, salinity, chemical and physical water quality), and marine sediment chemical characterization in the vicinity of proposed marine outfall location. These studies must be to the satisfaction of relevant government departments and are to be used to support modeling activities.**

a. Water quality should be monitored throughout the water column (surface, mid and bottom). This profile changes according to depth and therefore should be documented. What's happening and changing at the surface has less to do with lobster populations as they are bottom dwellers, but it does affect pelagic species. Both need to be considered in the scope of this project.

12.) **Existing Environment - Include a discussion of regional climate conditions and meteorology in the vicinity of the Project as well as expected changes over the next 50 years due to climate change. This section should include climate norms, extreme conditions, as well as trends in these conditions and climate change impacts, as well as the effect these changes may have on the Project and plans to mitigate against those impacts.**

a. YES, "expected changes over the next 50 years due to climate change". As fishing organizations, we are the front line of seeing change in the environment regularly. That could be a shift in species biomass or arrival of new species to our area. These three fishing organizations take part in DFO science assessments which talk about climate change and how it is affecting the different species; their interactions with prey, habitat, etc. It is vital to understand these changes to be prepared for them. Climate change combined with the proposed release of effluent could have a synergistic effect on the Northumberland Strait over time. It is essential to thoroughly assess this possibility.

13.) **Existing Environment - Baseline study for fish and shellfish tissue with chemical analysis that includes COPCs of representative key marine species important for commercial, recreational and Aboriginal fisheries (food, social and ceremonial) in the vicinity of the proposed effluent pipeline and diffuser location. The locations of samples must be clearly identified.**

a. This should include a list of the COPC's (contaminants of potential concern) to be tested.

14.) **Adverse Effects and Environmental Effects Assessment - Description of the cumulative effects of Project activities**

a. Cumulative effects can increase with time. For this reason a timeline should be included as a requirement for this section. For example, what are the cumulative effects after 1, 5, 10, 20 and 50 years? The 50-year timeline lines up with the climate change comment in number 12.

15.) **Adverse Effects and Environmental Effects Assessment - Surface Water**

a. The surface water section looks good, but maybe section 10.2.3 should be Bottom Water with the identical requirements to surface water. As stated above different species live in different portions of the water column so understanding bottom, mid and surface water changes is essential to understanding the ecosystem.

16.) **Adverse Effects and Environmental Effects - Assess the impacts on commercial/recreational fishing, aquaculture or other marine harvesting which may be impacted by the proposed Project. The effects assessment should consider changes in commercial/recreational fishing, aquaculture or other marine harvesting species, including contamination of species consumed by people as a result of increased erosion, sedimentation and from effluent discharges from the Project, displacement, mortality or loss and/or alteration of habitat. Also discuss navigation restrictions and loss of traditional fishing areas of the Mi'kmaq of Nova Scotia.**

a. The changes being considered in commercial/recreational fishing should also include the displacement of marine species due to the shift in current flow and water quality. Mortality is not always the cause of a fishery being degraded; the majority of commercially fished species have the ability to walk away from undesirable areas resulting in a reduction in landings.

17.) **Adverse Effects and Environmental Effects - Based on the assessment of applicability of Point C representing Project ETF effluent quality, chronic and acute toxicity testing of non-diluted treated effluent is to be conducted through a series of controlled laboratory experiments.**

a. This section should also include sub-lethal effects.

18.) **Proposed Mitigation - Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to marine water resources. Discuss all mitigation measures planned to prevent the release of hazardous substances into marine waters.**

a. In other sections of the Terms of Reference a request has been made to include measures for worst case scenarios. This should be the same here to provide mitigation measures for worst case scenarios.

19.) **Proposed Compliance and Effects Monitoring Programs - Submit an Environmental Effects Monitoring program that includes water quality, sediment and tissue sampling and is based on the results of various relevant baseline studies and receiving water study. The program should at a minimum be designed based on applicable regulatory requirements.**

a. This should also include monitoring of biomass and community structure to determine if the community in the vicinity is shifting due to changes in the water quality and currents.

From:
To: Minister, Env; Environment Assessment Web Account
Cc: ec.ministre-minister.ec@canada.ca; ceaa.northernpulp.acee@cess-acee.gc.ca @gmail.com; @gmail.com; @gmail.com; @hotmail.com
Subject: RE: Draft Terms of Reference for The Preparation of an Environmental Assessment Report Regarding the Replacement Effluent Treatment Facility Project
Date: February 7, 2020 12:57:11 PM
Attachments: Minister of Environment.pdf

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Please find enclosed correspondence from in relation to the above-noted.

Thank you.

Regards,

MacIsaac Clarke & Duffy
Barristers and Solicitors

195 Foord Street
PO Box 849
Stellarton, Nova Scotia
B0K 1S0
Ph: (902) 752-5143
FAX: (902) 928-1299

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February 7th, 2020

Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442
Halifax, NS, B3J 2P8
Fax: (902) 424-6925

EA@novascotia.ca

Gordon Wilson
Department of Environment
1894 Barrington Street, Suite 1800
P.O. Box 442
Halifax, NS
B3J 2P8

Minister.Environment@novascotia.ca

Minister of Environment

Re: **Draft Terms of Reference for The Preparation of an Environmental Assessment Report Regarding the Replacement Effluent Treatment Facility Project**
Proposed by Northern Pulp Nova Scotia Corporation

Please be advised we are writing on behalf of the Harbour Authority of Caribou (hereafter "the Authority"), Pictou County, Nova Scotia.

Located at the mouth of Caribou Harbour, the Authority operates the busiest fishing port in Northern Nova Scotia. It is a hub of fishing activity from April to early December. The facility managed by the Authority is the 'heart' of the commercial fishing industry in northern mainland Nova Scotia. It is also the site of the Northern Pulp Nova Scotia's (NPNS) proposed marine effluent pipeline and effluent outfall.

The Authority has again retained our firm to provide input to the Terms of Reference (TOR) for the Preparation of an Environment Assessment Report regarding the replacement ETF project proposed by Northern Pulp Nova Scotia Corporation on behalf of The Authority and the commercial fishermen who are our patrons.

We submit the following suggested changes to the Draft TOR. These suggestions reflect issues raised in our submission in response to Northern Pulp's Focus Report, including:

a) Leak repair to the marine pipe in Caribou Harbour in winter months virtually impossible
b) Risk of ice damage to marine pipe
c) Risk of siltation in the harbour during construction causing significant harm to marine life and to current users of the harbour
d) Effluent will enter Caribou Harbour with significant harmful effects

Some of the issues raised by the Authority are addressed in the Draft TOR. Our suggested additions to the Draft TOR are made so that the final TOR will direct Northern Pulp to address all issues of concern fully and satisfactorily.

1. Marine uses: In all sections of the Draft TOR which refer to land uses, the term "and marine uses" should be added. This change should be made in sections 3.2, 3.6, 9.7, 11.6.
   (A major part of Northern Pulp's proposed project is marine based. It is important that the TOR fully address all marine uses, present and planned, and the potential impact of the project on all marine uses.)

2. 3.3 Marine based sections of the pipeline
   Add: "Identification of all points of the marine based pipeline system that are susceptible to damage or failure."

3. 3.3 Marine based section of the pipeline
   Add to bullet point re leak detection and response protocols: "Provide details of response protocol to leaks in marine portion of pipe which are detected during periods of ice coverage."

4. 3.3 Marine based section of the pipeline, last bullet point starting Maps

Add: Locations and boundaries should be provided in latitude/longitude as well as UTM, so that they can be easily compared to data from fishermen's charts and navigation systems.

5. 3.4 Construction
   Add a new bullet point: "Evaluate the impacts of disturbance of soil, including sedimentation, during and following excavation/construction on marine uses, marine life and habitat."

6. 9.2.3 Marine Water

Draft TOR reads: Provide baseline studies that characterize environmental conditions for the four seasons over a minimum of one year for the marine environment,
Add: Studies must also characterize conditions during extremes of high and low tides, including spring tides and storm conditions with high winds, in particular nor'easters.

7. 9.2.3 Marine Water
   Draft TOR reads: Provide an ice scour baseline study for at least two winter seasons.

Add: "Provide a baseline study of ice scour and ice grounding for at least two winter seasons, and provide all available historical information on ice scour and grounding in the area for the last 20 years."

8. 10.0 Adverse Effects and Environmental Effects Assessment
   Add new point: "Provide details of response protocol to leaks in marine portion of pipe which are detected during periods of ice coverage."

9. 10.2.3 Marine, bullet 2: Draft TOR reads *"Adequacy of proposed pipeline burial depths with respect to ice scour;"*

Change to read: "Adequacy of proposed pipeline burial depths with respect to ice scour, ice grounding and other factors including ice movement and tides and currents during extreme conditions."

10. 10.2.3 Marine, bullet 7:
    Add "and marine accumulation" after "eg shoreline accumulation"

We thank you for your attention to these issues.

Yours truly,
MACISAAC CLARKE & DUFFY

cc Client
Minister of Environment and Climate Change
Canadian Environmental Assessment Agency NS Regional Office

From: @gmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: February 7, 2020 1:41:42 PM

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Project: replacement_effluent_treatment_facility_project Comments: page 19 - requirement for at least two winter seasons for ice scour baseline study - if EA report is due in March of 2022 - will that timeline be possible unless data is already being collected this winter page 19 - Climate change impacts - important aspect but wondering what role the government holds in providing the required information re: norms, extreme conditions etc. page 22 - 9.6 Socio-economic conditions - relevance of this particular bullet is unclear Name:
Email: @gmail.com Address: Municipality:
email_message: Privacy-Statement: agree x: y:

From:
To: Environment Assessment Web Account
Subject: Draft Terms of Reference NPNS EA
Date: February 7, 2020 2:26:48 PM
Attachments: image003.png
EAC ToR NP ltr to NS Environment February 7 2020.pdf
Draft ToR with changes EAC ECELAW Feb 2020.pdf

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Hello,

Attached please find a letter from the Ecology Action Centre, with legal counsel from East Coast Environmental Law, regarding the draft Terms of Reference for the EA Report for Northern Pulp. Also attached please find a draft ToR document with recommended changes and comments.

Please feel free to contact me if you have any questions about these documents.

Thank you.

ECOLOGY ACTION CENTRE
2705 Fern Lane, Halifax, Nova Scotia, B3K 4L3
cell.
coastal@ecologyaction.ca
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Ecology Action Centre

Ecology Action Centre

tel. 902.429.2202 2705 Fern Lane,
fax. 902.405.3716 Halifax, NS, B3K 4L3

February 7, 2020

Via email: EA@novascotia.ca

Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442
Halifax, Nova Scotia
B3J 2P8

To whom it may concern,

Re: Draft Terms of Reference for the Environmental Assessment Report on the Replacement Effluent Treatment Facility Project proposed by Northern Pulp Nova Scotia Corporation.

This letter is in response to the NS Environment public invitation to submit comments on the above noted document.

The Ecology Action Centre is in full support of the NS Environment Minister's December 17, 2019 decision to order a full Environmental Assessment Report from Northern Pulp Nova Scotia Corporation ("the Proponent"). As articulated by the Minister in that decision, there was 'not enough information provided in the Focus Report to properly assess whether there may be adverse effects or significant environmental effects on fish, air, water resources and human health'.

We understand the complexities inherent in creating a coherent and comprehensive Terms of Reference that will ensure an EA Report that will provide the public and the Minister with clear and sufficient information to consider the environmental effects of the Project. The previous documents provided by the Proponent did not meet that standard and, in our opinion, demonstrated an inclination toward meeting only the most basic requirements.

Given that history, we encourage government to establish very clear and specific requirements in the Terms of Reference ("ToR") to ensure that the Proponent is accountable to produce an EA Report that fully addresses those requirements. Throughout the ToR, the government must 'require' rather than 'recommend' directions to the Proponent. The Proponent must be required to commit to environmental controls that have been proven to mitigate environmental impact, such as an oxygen delignification system. The EA Report must have stated timelines and firm commitments by the Proponent for implementation of such necessary environmental controls. The government must articulate that the concordance table will be required to indicate where both information and resolution or mitigation of a concern can be found, to avoid the Proponent's ability to reference the topic without sufficiently addressing the concern (i.e. Total Suspended Solids concern).

To facilitate our review of the draft ToR and in an effort to provide clarity to our comments, we have attached to this letter a version of the draft ToR with some recommended changes.

In addition, there are a few terms used in the draft ToR that we recommend be defined or clarified, these include:

- Contaminants of potential concern (COPC)
- Ecologically sensitive areas
- Environmental protection objectives
- Predicted zone of influence

We are concerned about the ToR's Section 15.2 'Consultation with the Mi'kmaq of Nova Scotia'. The Proponent's Focus Report failed to meet the government's requirement to provide a Mi'kmaq Ecological Knowledge Study. Without a comprehensive plan for facilitated engagement and communication that has been agreed upon by all involved parties, any efforts by the Proponent will not be successful in engaging in a meaningful way. Despite the time constraints of the EA process, this complex requirement would benefit from additional up-front efforts to engage the necessary parties to develop a plan, which would then be embedded into the EA Report process.

An outstanding issue that must be addressed before a successful EA Report can be prepared is the pipeline's path and the risk to the Town of Pictou's water supply. Given the Town has firmly stated that this risk is too high and cannot be mitigated, Ecology Action Centre recommends that NS Environment accept the Town's position and require the Proponent to come up with an alternative pipeline route.

We trust that NS Environment will draw upon the technical expertise required to improve the Terms of Reference and thereby ensure that the EA Report will contain the necessary information to allow the Environment Minister to make an evidence-based sound decision on this matter.

Sincerely,

, Coastal Adaptation Senior Coordinator
, Marine Science and Conservation Coordinator
, Wilderness Coordinator

, Executive Director
East Coast Environmental Law Association

DRAFT TERMS OF REFERENCE FOR THE PREPARATION OF AN ENVIRONMENTAL ASSESSMENT REPORT FOR PUBLIC REVIEW AND COMMENT

Regarding the Replacement Effluent Treatment Facility Project Proposed by Northern Pulp Nova Scotia Corporation

NOVA SCOTIA ENVIRONMENT

January 8, 2020

FOREWARD

Current Context

On December 17, 2019, following an environmental assessment review of the Northern Pulp Effluent Treatment Facility Focus Report, the Minister of Environment decided that an Environmental Assessment Report was required to address deficiencies in the information provided. On December 20, 2019, Northern Pulp announced its intent to cease operations at the Northern Pulp Mill. Notwithstanding that announcement, on January 2, 2020, Northern Pulp informed Nova Scotia Environment of its intent to continue with the Environmental Assessment Report process. Since the company has chosen to continue with the process, Nova Scotia Environment is required to release this draft Terms of Reference in accordance with the Environmental Assessment Regulations.

This Draft Terms of Reference is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document and in the subsequent October 2019 Focus Report.

The *Boat Harbour Act* sets out a deadline of January 31, 2020. Further to the above, Nova Scotia Environment expects Northern Pulp to provide information as part of its input on this draft Terms of Reference about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes may affect the Terms of Reference.

Environmental Assessment Process to Date/Next Steps

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an Environmental Assessment Report) to be provided to address gaps or deficiencies in the required information.

Northern Pulp registered it Effluent Treatment Facility for environmental assessment on February 7, 2019. A thorough environmental assessment review concluded that the Registration Document did not provide enough information to determine if adverse effects or significant environmental effects would result from the Project. On March 29, 2019, the Minister determined that the company would have up to one year to submit a Focus Report to address identified information gaps in the Registration Document.

On October 2, 2019, the company submitted a Focus Report. A thorough environmental assessment review of this information concluded that the company failed to provide enough information to properly assess whether there may be adverse effects or significant environmental effects as a result of the Project and, on December 17, 2019, the Minister decided an Environmental Assessment Report was required. Through the environmental assessment review process, concerns were raised about incorrect and incomplete baseline information; assumptions and methodology used in the analysis; and the absence of mitigation measures related to the potential environmental effects. Further specifics regarding these deficiencies are outlined in comments provided during the consultation period, which are posted on our website and reflected in this Draft Terms of Reference, for the preparation of an Environmental Assessment Report.

Northern Pulp is expected to prepare an Environmental Assessment Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that are likely to arise from the Project, including any not explicitly identified in the Terms of Reference.

Regulations require that Draft Terms of Reference for the Environmental Assessment Report be prepared by the Environmental Assessment Administrator and subsequently be made available for public review and comment prior to being finalized and provided to the Proponent (Northern Pulp).

This document presents the Draft Terms of Reference for public review and comment. The Minister of Environment invites interested Nova Scotians to examine the Draft Terms of Reference and provide comments on their adequacy and suggestions for their modification. **Only those comments related to specifics of the Terms of Reference will be used to inform the finalization of the Terms of Reference through this process. As required by the Environmental Assessment Regulations, the company must be advised of comments received through this process.**

Comments should be submitted in writing through the EA website at https://novascotia.ca/nse/ea/comments.asp, by email at EA@novascotia.ca or by mail to the following address on or before **February 7, 2020**, and addressed to:

Environmental Assessment Branch Nova Scotia Environment
P.O. Box 442, Halifax, Nova Scotia B3J 2P8 EA@novascotia.ca

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2020-2-6 7:51 PM
Comment [1]: Add to TOC

2020-2-6 7:51 PM
Comment [2]: Add to TOC

2020-2-6 7:51 PM
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2020-2-6 7:52 PM
Comment [4]: Add to TOC

2020-2-6 7:52 PM
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2020-2-6 7:52 PM
Comment [6]: Add to TOC

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2020-2-6 7:53 PM
Comment [7]: Add to TOC

2020-2-6 7:37 PM
Comment [8]: Should be 14.6 here and in text.

1.0 INTRODUCTION

1.1 Background

The Replacement Effluent Treatment Facility Project (the Project or undertaking) proposed by Northern Pulp Nova Scotia Corporation (Northern Pulp or the Proponent) was registered for environmental assessment (EA) as a Class 1 undertaking pursuant to Part IV of the *Environment Act* on February 7, 2019.

On March 29, 2019, the Minister of Environment determined that the registration information was insufficient to make a decision on the Project, and a Focus Report was required in accordance with clause 13(1)c of the Environmental Assessment Regulations, pursuant to Part IV of the *Environment Act*.

On October 2, 2019, Northern Pulp submitted the Focus Report for EA, in accordance with Part IV of the Environment Act. Public comments on the Focus Report were accepted until November 8, 2019.

On December 17, 2019, the Minister of Environment concluded that Northern Pulp would be required to complete an EA Report on this Project.

1.2 Purpose of the Terms of Reference

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an Environmental Assessment Report) to be provided to address gaps or deficiencies in the required information.

The purpose of this document is to identify for Northern Pulp the information requirements for the preparation of an EA Report. Northern Pulp is expected to prepare an Environmental Assessment Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that are likely to arise from the Project, including any not explicitly identified in the Terms of Reference. The EA Report will be used to meet the requirements of a provincial Class I Undertaking.

Northern Pulp must include in its EA Report all the information requested within the Terms of Reference, as a minimum, in accordance with the Environmental Assessment Regulations pursuant to Part IV of the *Environment Act*. The Terms of Reference include Valued Ecosystem Components (VECs) which must be adequately addressed in the EA Report. While the Terms of Reference provide a framework for preparing a complete EA Report, it is the responsibility of the Proponent to provide sufficient data and analysis on any potential environmental effects of the Project to permit a proper evaluation by governments, the Mi'kmaq of Nova Scotia and the public.

The EA Report is expected to provide a comprehensive and complete assessment of the potential effects of the Project, presented in a clear format that can easily be reviewed by the Minister, governments, the

Mi'kmaq of Nova Scotia and the public. If the Minister decides to refer the EA Report to an EA Review Panel for review, the EA Report will serve as the cornerstone of the Panel's review and evaluation of the potential effects of the Project and thus must be a stand-alone document. The EA Report will also allow governments, the Mi'kmaq of Nova Scotia and members of the public to understand the Project, the existing environment, and the potential environmental effects of the Project.

1.3 Proposed Project

This Section is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document (EARD). In response to this Draft Terms of Reference, Northern Pulp is required to provide information on any changes to the Project as a result of the *Boat Harbour Act* deadline*.* The Northern Pulp Northern Bleached Softwood Kraft pulp mill is located at Abercrombie Point adjacent to Pictou Harbour in Pictou County, Nova Scotia (NS). The proposed Project consists of the development of a new effluent (wastewater) treatment facility (ETF) constructed on Northern Pulp property, and a transmission pipeline that will carry treated effluent overland and in the marine environment and discharge via an engineered diffuser (marine outfall).

The ETF is proposed to employ the AnoxKaldnes BASTM Biological Activated Sludge process purchased from Veolia Water Technologies, which combines Moving Bed Biofilm Reactor (MBBR) technology with conventional activated sludge. Once treated onsite at Northern Pulp's facility, effluent is proposed to be sent through an approximately 15 km long pipeline, of which approximately 8.7 km is included in the overland section. An additional land-based section of effluent pipeline, less than 1 km will be installed on mill property as a part of the ETF design by KSH Solutions. Approximately 1.5 km of the treated effluent pipeline will follow a marine crossing in Pictou Harbour adjacent to the Pictou Causeway. The land-based section of the pipeline begins on the north side of Pictou Harbour where it enters the Nova Scotia Department of Transportation and Infrastructure Renewal's (TIR's) Highway 106 right-of-way (ROW) and runs generally north, parallel to Highway 106, along the outermost eastern portion of the ROW toward Caribou, NS. The pipeline will then travel through the marine environment to the proposed outfall location approximately 4.0 km offshore within the Northumberland Strait.

1.4 Environmental Assessment Requirements

The Project is a Class I Undertaking pursuant to Schedule A of the Environmental Assessment Regulations made under Section 49 of the *Environment Act*. In accordance with Section 18(b) of the Environmental Assessment Regulations, the Minister of Environment has determined that an EA Report is required.

The Environmental Assessment Regulations require that the proposed Terms of Reference for the EA Report be prepared by the EA Administrator (Administrator) and made available for public review. Public comments on the Draft Terms of Reference will be accepted from January 8 – February 7, 2020.

All comments will be provided to Northern Pulp within 5 days of the end of the comment period. Northern Pulp will then have 21 days to respond in writing to the comments. Within 14 days from the final date for written response from Northern Pulp, the Final Terms of Reference for the EA Report shall be provided to Northern Pulp.

The Proponent is required to submit the EA Report within 2 years of receipt of the Final Terms of Reference. If the EA Report does not meet the Terms of Reference, Northern Pulp will be required to include further information before the EA Report can be accepted. Upon acceptance of the EA Report, Nova Scotia Environment (NSE) has 14 days to publish a notice advising the public where the EA Report can be accessed for review and comment.

Once the EA Report has been accepted, the Minister has the option to refer the EA Report to an EA Review Panel for review. At the conclusion of this process, the Minister has 3 decision options: a) the undertaking is approved with conditions; b) the undertaking is approved without conditions; or c) the undertaking is rejected.

1.5 Access to Information for the Environmental Assessment Process

Copies of the Draft Terms of Reference for the Preparation of the EA Report may be examined at the following locations:

- Pictou Library, 40 Water Street, Pictou, NS
- New Glasgow Library, 182 Dalhousie Street, New Glasgow NS
- EA website https://www.novascotia.ca/nse/ea/

All information pertaining to this portion of the EA review will be posted to the EA website as it becomes available.

2.0 PREPARATION AND PRESENTATION OF THE ENVIRONMENTAL ASSESSMENT REPORT

Pursuant to the Environmental Assessment Regulations, the EA Report must include, but not be limited to, the following information:

- a description of the proposed undertaking;
- the reason for the undertaking;
- other methods of carrying out the undertaking;
- a description of alternatives to the undertaking;
- a description of the environment that might reasonably be affected by the undertaking;
- the environmental effects of the undertaking, including identifying any effects on species at risk, species of conservation concern and their habitats;
- an evaluation of advantages and disadvantages to the environment of the undertaking;
- measures that may be taken to prevent, mitigate or remedy negative environmental effects and maximize the positive environmental effects on the environment;
- a discussion of adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technology;
- a program to monitor environmental effects produced by the undertaking during its construction, operation and abandonment phases;
- a program of public information to explain the undertaking; and
- information obtained under subsection 19(2) which the Administrator considers relevant.

The information obtained under subsection 19(2) shall be prepared taking into consideration comments from:

- the public;
- departments of Government;
- the Government of Canada and its agencies;
- municipalities in the vicinity of the undertaking or in which the undertaking is located;
- an affected aboriginal people or cultural community; and
- neighbouring jurisdictions to Nova Scotia in the vicinity of the undertaking.

In preparing the EA Report, Northern Pulp shall refer to comments from the above-noted parties during the EA review of both the EARD and the Focus Report submitted by Northern Pulp to NSE, to identify and include the supplementary information required to provide a comprehensive and complete assessment of the potential effects of the Project. The EA Report must be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence-based and supported by credible sources of information. This report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report. Northern Pulp is expected to prepare an EA Report that fulfils the intent of the Terms of Reference and considers all the effects that are likely to arise from the Project, including those not explicitly identified in the Terms of Reference.

The order in which information is presented is at the discretion of the Proponent; however, a concordance table will be required to indicate where the information on both the concern and the resolution or mitigation of the concern can be found. In the event that the Minister has decided to refer the EA Report to an EA Review Panel for review, the Proponent may provide additional information to assist the EA Panel in making their recommendation to the Minister and assist the Minister in making the decision for the Project.

Since the EA Report is intended for public review, the information should include an Executive Summary presented non-technical language. The Proponent will be required to submit an electronic copy of the EA Report in accordance with the EA Branch Bulletin on Requirements for Submitting Electronic Copies of Environmental Assessment (EA) Documents for publication on the Department's website.

The EA Report must include, but not be limited to, the following information, as identified under the corresponding sections.

3.0 PROJECT DESCRIPTION

Nova Scotia Environment expects Northern Pulp to provide information, as part of its comment on the draft Terms of Reference, about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes, if any, may affect the Terms of Reference.

Describe each component of the Project as it is planned through its full life cycle, including site preparation, construction, commissioning, operation, maintenance, and decommissioning:

- changes to existing mill infrastructure and in-mill improvements;
- effluent treatment facility (ETF);
- land-based sections of pipeline; and
- marine based sections of pipeline and the diffuser.

Where final decisions have not been made in regard to an element of Project design, or several options exist for a particular component or activity, the assessment of effects of that element of the Project on the environment should be conducted at the same level of detail for all available options.

3.1 The Proponent

Outline the Proponent's corporate commitment to sustainable development and environmental protection goals and principles including pertinent corporate policies, programs, plans, strategies, protocols, guidelines, codes, and environmental management systems (EMS).

Provide summary information on the Proponent's environmental record including any enforcement actions taken under federal or provincial environmental legislation over the past 10 years. This shall include, but is not limited to, written warnings, directives, orders or other actions taken by an enforcement officer, Administrator or the Minister.

Provide summary information on the nature of the management structure and organizational accountability for designing, constructing, operating and modifying the Project; implementing environmental mitigation measures and environmental monitoring; and managing potential adverse environmental effects.

Provide details on relevant corporate experience (the Proponent and related companies) and experience in building and operating other similar facilities. Provide a record of the environmental performance and capability of the Proponent in conducting this type of Project.

3.2 Project Location

Provide a concise description of the geographical setting in which the Project is to be constructed/operated. Describe how the Project site was chosen, including a discussion of the specific environmental considerations used in site selection of all Project components, and the advantages and disadvantages of the proposed site. Describe the Project's compatibility with existing local and regional land-use policies and plans, and opportunities to integrate Project planning into regional scale development efforts. Discuss compatibility of the Project location in relation to people and their community and traditional activities and land uses by the Mi'kmaq of Nova Scotia.

Describe the spatial and temporal boundaries of the Project in a regional context including existing and proposed land uses and infrastructure such as road networks, highway realignment, railways, power lines, pipelines, proximity to permanent and seasonal residences, individual and community water supplies, wetlands, watercourses (as defined by the Environment Act), parks, protected areas, ecologically sensitive areas, and cultural and archaeological sites. Include mapping at an appropriate scale.

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Provide details on ownership of property within the Project footprint including lands owned by the Proponent, the Crown, or private lands. Provide details of existing agreements to develop the Project on lands not owned by the Proponent. Provide detailed plans for the required acquisition or use of private lands and Crown Lands and discuss any contingencies should these lands not be available for Project development.

Provide a list and map of communities in the region, including Mi'kmaq communities, potentially affected by the Project and indicate the distance between those communities and the specific Project components as appropriate. Identify proposed local shipping routes for importing and exporting products.

3.3 Project Design and Components

Describe the design plans and appropriate design standards for all Project components, associated and ancillary works, and other characteristics that will assist in understanding the Project, including: changes to existing mill infrastructure and in-mill improvements, ETF, land-based sections of pipeline, and marine based sections of pipeline and the diffuser. All associated infrastructure and components must be detailed. Also discuss environmental controls planned for the Project and how environmental protection, conservation, best management practices (BMPs), and best available technology have been considered in the design.

Provide potential design variations and implications (including advantages or disadvantages to the environment) of those variations. Describe any assumptions which underlie the details of the Project design. Where specific codes of practice, guidelines and policies apply to items to be addressed, those documents shall be cited.

For the EA Report, all site-specific data must be collected using equipment installed, operated, maintained and calibrated as specified by the manufacturer's instructions. All samples are to be collected, preserved and analyzed, by qualified personnel, in accordance with recognized industry standards and procedures and at accredited laboratories. Data shall undergo quality assurance and quality control (QA/QC) processes.

In addition to the above, this section will include, but not be limited to information on the following Project design components:

Changes to Existing Mill Infrastructure and In-Mill Improvements

- Preliminary design overview for any in-mill improvement projects necessary to achieve the design assumptions for the Project (e.g., in-mill cooling towers);
- Preliminary design overview of other projects that interact with the performance of the ETF (e.g., oxygen delignification) and a schedule for these projects relative to the proposed ETF construction schedule; and
- A waste dangerous goods management plan to accommodate for worst case scenario within design of the proposed ETF. It is important to note that the ETF is not proposed to treat waste dangerous goods based on the information provided in the EARD and in accordance with requirements of NSE.

Effluent Treatment Facility (ETF)

- Footprint, location and preliminary designs for the ETF;
- Equipment description and specifications, including appropriate diagrams and flow charts for the proposed ETF and infrastructure components;
- Details (including characteristics and toxicities) and quantities of all products produced, stored, and imported to and exported from the facility (including by-products and chemical intermediaries);
- Justification of spill basin size and appropriateness of multi-purpose usage. Describe worst-case scenarios and how such will be addressed.
- Address requirements under the Dangerous Goods Management Regulations;
- Proposed design for the spill basin, including but not limited to, management and disposal of contaminated material that may be present at the site, liner details, secondary containment features, clean-out access and connection to the mill infrastructure and ETF;

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- Submit additional data regarding the complete physical and chemical characterization of NPNS' raw wastewater at Point A (as defined in EARD and Focus Report), to support the assessment of the appropriateness of the proposed treatment technology. The sampling data for complete characterization (i.e., broad chemical analysis) must be statistically relevant and adequately represent ETF influent for various operating conditions that may exist at the mill (e.g., seasonality, flow rates, changes in sources of fibre or production, start-up and shut-down cycles, etc.);
- Using NPNS' raw wastewater characterization results, evaluate all contaminants of potential concern (COPCs) with respect to the effluent discharge quality following treatment using the proposed technology. This statistically relevant assessment shall include, but not be limited to, bench-scale testing of the mill's actual Point A effluent. Provide results of all expected COPCs influent and effluent concentration ranges. Include chemical oxygen demand (COD) fractionation (soluble and total) concentrations in the assessment;
- Comparison of the effluent characterization results from the above assessment with all applicable federal and provincial regulations and/or guidelines, including the most current draft of the modernized Pulp and Paper Effluent Regulations (PPER) daily and monthly average limits;
- Effluent flow data to support the proposed peak treatment capacity of 85,000 m^3 flow of effluent per day using actual daily flow data from Point A over a minimum 1-year period;
- Information regarding how the facility will achieve compliance with COD influent limits once the in-mill changes and ETF are operational; and
- Evaluation of sludge disposal options and management plans, including the rationale for the preferred option. If the preferred option uses the biomass boiler, provide a secondary disposal option.

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Land-Based Sections of Pipeline Route

- Information on corridor width requirements, accounting for minimal possible corridor width requested by TIR;
- Appropriate, intrusive geotechnical survey results to support proposed pipeline construction methods;
- Risk assessment of pipeline design, including the following:
    - An evaluation of the probability of a potential leak, spill or release from the pipeline installation and its operation, based on a literature review and on comparable design.
    - Identification of points of the system that are susceptible to failure.
    - Based on the risk assessment, a suitable secondary containment system (e.g., a double-walled pipeline system) and proposed locations. Secondary containment is at a minimum required in all areas where the pipeline crosses over or near surface water including wetlands and within the Town of Pictou's water supply protection area;
- Preferred option(s) for both external and internal leak detection technologies for all sections of the on-land pipeline, with specific consideration to any section of the pipeline that crosses over or near surface water, including wetlands or is located in the Town of Pictou's water supply protection area and near private supply wells. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline;
- Maps, at an appropriate scale of the Project location and pipeline route that show Project components, boundaries with UTM coordinates, major existing infrastructure, important environmental features, and adjacent land uses that will intersect with the pipeline route (e.g., road networks, railways, power lines, pipelines, proximity to settled areas, individual and community

water supplies, watercourses, wetlands, ecologically sensitive areas, priority flora and fauna and archaeological sites); and
- A list of all properties (i.e., Parcel Identification Numbers) that will intersect with the pipeline route.

Marine Based Sections of Pipeline Route

- Selected options for both external and internal leak detection technologies for marine sections of the pipeline. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline; and
- Maps, at an appropriate scale, detailing: the Project location, the Project components (e.g., confirmed locations of marine sections of the proposed pipeline including diffuser), boundaries of the proposed site with UTM coordinates, the major existing infrastructure, adjacent land uses that will intersect with the pipeline route, and important environmental features (e.g., spatial and temporal marine habitat distribution, marine refuge (Scallop Buffer Zone 24), etc.).

3.4 Construction

Describe the construction of all Project components and supporting infrastructure. This will include but not be limited to:

- Proposed construction schedule for all Project components (including those mentioned in Section 3.3 of the Terms of Reference), including days of the week, times of the day, seasonal schedules and anticipated commencement and completion dates;
- All physical works and activities carried out during the construction phase are to be identified and described by location. This, includes but is not limited to: clearing and grubbing; blasting; site access and roadways; marine construction methods; road construction methods; dangerous goods storage areas; disposal at sea; watercourse crossings or diversions; utilities; and description of equipment used for construction activities, both terrestrial and marine;
- Dredge management/disposal plans that characterize and quantify marine sediments to be dredged and disposed (or re-used) in accordance with requirements in the Disposal at Sea Regulations under the Canadian Environmental Protection Act and Environment and Climate Change Canada (ECCC) standards and guidelines and in consultation with relevant government departments. Identify areas where dredging activities will occur and identify the location, quantity and chemistry of any dredge materials that are expected to require land-based disposal;
- Evaluation of pipe jacking feasibility where crossing roads or structure locations that includes addressing limitations associated with practical pipe length at crossings and available space for thrust/reception pits on either side of crossings;
- Evaluation of the effects of excavating and replacing large rock fill along the alignment route near Harvey A. Veniot Pictou Causeway;
- Storage areas for fuels, explosives and dangerous goods including how these sites will comply with Dangerous Goods Management Regulations; and
- Waste disposal plans (types of waste, methods of disposal, quantity).

3.5 Operation

Describe the operation of all Project components and supporting infrastructure to all components. The description of the operation shall include but not be limited to the following:

- Routine and maintenance operations for all Project components;
- Environmental controls and BMPs, including pollution prevention plans and techniques in addition to traditional treatment and disposal practices;
- A spill basin management plan that proactively addresses the management of different types of materials, including compatible and non-compatible waste dangerous goods, sequential spills/leaks/releases, clean-out and liquid/solid removal procedures for the different types of collected materials, and appropriate final disposal procedures that observe applicable provincial and federal statutes and regulations; and
- A plan to ensure adequate on-site staffing and operation oversight of ETF by trained personnel at all times.

3.6 Decommissioning and Reclamation

Describe the proposed plans for decommissioning the Project, including all infrastructure and reclamation of any impacted site. The EA Report shall also discuss the post-decommissioning land use options of the property.

4.0 REGULATORY ENVIRONMENT

List all federal and provincial statutes and regulations and all municipal plans and by-laws that apply to the Project and identify specific provisions within each that apply to the Project. Include a schedule of each permit, license, approval or other regulatory permission required that apply to all phases of the Project and associated infrastructure. Include anticipated dates of application and receipt of each and any public engagement required as part of the permitting or approval process.

Significant portions of the proposed Project to be evaluated by the EA Report are located on federal lands; therefore, federal authorities have indicated that they must make a determination as to whether the Project is likely to cause significant adverse effects and/or in the case of Public Services and Procurement Canada (PSPC) seek an Order in Council prior to providing authorizations, licenses, or leases. To ensure potential environmental effects are addressed to the satisfaction of federal authorities under Section 82 of the *Impact Assessment Act*, provide all necessary authorizations, licenses, or leases for all applicable federal authorities.

Describe applicable guidelines and standards that would apply to the Project. Those applicable standards or guidelines shall also be referenced in the appropriate sections of the EA Report and linked to environmental protection objectives.

5.0 NEED FOR AND PURPOSE OF THE PROJECT

Describe the need for and purpose of the Project including any potential benefits of the Project and how the Project will contribute to sustainability, established from the perspective of the Proponent. The Project is being designed to meet specific objectives and these objectives should be discussed. If the objectives of the Project are related to or contribute to a larger private or public sector policy, program or plan, this information should be included.

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6.0 DESCRIPTION OF ALTERNATIVES TO THE PROJECT

Include an analysis of alternative means of carrying out the Project; describing functionally different ways to meet the Project need and achieve the Project purpose.

7.0 OTHER METHODS FOR CARRYING OUT THE PROJECT

Discuss other methods for meeting the need for the Project, including but not limited to, pipelines and treatment technologies. This section shall also discuss alternate locations for the Project.

The rationale for rejecting other described methods of carrying out the Project must be provided, including a discussion of how environmental sustainability and impact avoidance criteria were applied.

8.0 ASSESSMENT METHODOLOGY

Include the study strategy, methodology and boundaries used for preparing the EA Report. The following must be clearly defined:

- Temporal boundaries (i.e., duration of specific Project activities and potential impacts) for construction and operation through to decommissioning and post-decommissioning;
- Study boundaries or Project area and all space that will be potentially impacted, by the Project as proposed, or subject to subsequent modifications, and the methodology used to identify the study boundaries including the predicted area of influence;
- Valued Ecosystem Components (VECs) within the study boundaries and the methodology used to identify the VECs. The methodology used for VEC identification shall include input from members of the public, government departments and agencies, other experts, and other interested parties, as well as direct engagement with the Mi'kmaq of Nova Scotia. How the input has been used must be specifically identified in the methodology;
- Where appropriate, identify environmental protection objectives (including those contained in applicable legislation or guidelines) associated with each VEC;
- Strategy for investigating the interactions between the Project and each VEC and how that strategy was used to coordinate the individual studies undertaken; and
- Method for predicting and evaluating the Project impacts upon the environment; determining necessary avoidance, mitigation, remediation and/or compensation (in this order of consideration); and determining the significance of any residual impacts.

The EA Report is to be prepared using an accepted and proven EA methodology and a qualified person should predict and evaluate Project impacts upon the environment, as defined by section 3 of the Environment Act. If there are no predicted effects to a specific VEC, provide reasons to support that claim. A complete discussion and analysis of predicted effects (direct, indirect and cumulative effects) should be provided that is qualitative and quantitative, evidence-based and supported by credible sources of information. Provide a list of literature and sources used in the preparation of the EA Report.

The following sections outline specific concerns and requirements related to the existing environment, adverse effects and environmental effects assessment, proposed mitigation, residual environmental impacts, proposed compliance and effects monitoring, and the public information program that are to be addressed in the EA Report for the proposed Project.

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9.0 EXISTING ENVIRONMENT

Provide a baseline description of the environment, as defined by section 3 of the Environment Act, in the vicinity of the Project and all other areas that could be impacted by the Project. This description must include the components of the existing environment and environmental processes, their interrelations and interactions, as well as variability in these components, processes and interactions over time scales appropriate to the effects assessment. The Proponent's description of the existing environment shall be in sufficient detail to permit the identification, assessment and evaluation of the significance of potentially adverse environmental effects that may be caused by the Project and any change to the Project that may be caused by the environment.

The EA Report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report, considering comments on those documents during their respective EA review processes. The EA Report shall be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence- based and supported by credible sources of information. Supplementary information shall be included to provide a comprehensive and complete assessment of the potential effects and may provide additional information to assist the EA Panel in making their recommendation to the Minister in the case of a panel review and to assist the Minister in making the decision for the Project.

The EA Report shall clearly indicate baseline data/information which is not available or where existing data cannot accurately represent environmental conditions in the Project area. If the background data have been extrapolated or otherwise manipulated to depict environmental conditions in the Project area, modelling methods and equations shall be described and shall include calculations of margins of error.

For the EA Report, the spatial boundaries must include the Project footprint and relevant receiving environments such as airsheds and watersheds. Temporal boundaries must address applicable guidelines, standards and regulatory requirements and include Project construction, operation, decommissioning and post-decommissioning.

The Proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. Where technical reports are included or referenced, they must be finalized and signed by the qualified individual(s). Also provide the name and credentials of the person(s) conducting baseline studies/surveys. Mapping clearly indicating the extent of studies/surveys, sampling points, and illustrating key findings should also be included and presented logically within the EA Report in a location that allows for ease of review. Wherever possible, mapping should be presented at common scales and datum to allow for comparison and overlap of mapped features.

The components of the environment to be discussed shall include identified VECs and those indicated within Sections 9.1 – 9.8.

9.1 Geophysical Environment

9.1.1 Topography, Geomorphology and Geology
Topographical maps should be provided locating the Project in both regional and local contexts. Describe the physical geography of the Project study area including post-glaciated landforms, coastal features, and marine features.

9.1.2 Geology
Include a description of bedrock geology, surficial geology and soils. The results of the geotechnical survey referenced in Section 3 of the Terms of Reference should be included. Geological properties of all Project sites in the study area which may influence stability, occupational health and safety, rehabilitation programs, or the quality of discharge water leaving any area disturbed by the Project should be described. The EA Report must identify and consider the potential for Acid Rock Drainage/Metal Leaching (ARD/ML) where new bedrock may be exposed and/or excavated.

Assessment of the marine component of the Project must include information on surficial sediment characteristics and mobility under present and future environmental conditions. This section should also identify any mineral resources that may be impacted by the Project.

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9.2 Water Resources
Include a description of groundwater, surface water, marine water and wetlands potentially affected by the Project.

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9.2.1 Groundwater
Provide a description of the regional and local hydrogeology of the study area. A discussion of groundwater use in the study area, including both current and likely potential future uses must be provided. Provide a map showing all water supply wells locations and all watercourses within 500 metres of the pipeline route.

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9.2.2 Surface Water
Provide a general hydrologic, hydraulic and water quality description of all surface watercourses in the study area, including upstream and downstream to all Project components. Existing uses, withdrawal capacities, and users of the watercourses shall be identified, including use by the Mi'kmaq of Nova Scotia.

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9.2.3 Marine Water
Provide baseline studies that characterize environmental conditions for the four seasons over a minimum of one year for the marine environment, including: climate, water quantity (e.g., current profiles, wave height, tide levels) , water quality (e.g., temperature, salinity, chemical and physical water quality), and marine sediment chemical characterization based on near-field and far-field studies of the proposed marine outfall location. These studies must be to the satisfaction of relevant government departments and are to be used to support modeling activities.

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Provide marine sediment chemical characterization along the proposed marine based pipeline section routes. Marine sampling locations must be clearly identified.

Conduct an intrusive marine geotechnical investigation in the areas identified to have potential bedrock of uncertain depth and along proposed route near base of Harvey A. Veniot Pictou Causeway.

Provide an ice scour baseline study for at least two winter seasons.

9.2.4 Wetlands

Identify the location, size and class(es) of any wetland and/or wetland complexes within the predicted zone of influence and conduct a wetland evaluation on each. Evaluation of the wetlands shall include wildlife habitat potential (including the potential for core or critical habitat of any species-at-risk and habitat for migratory birds), groundwater recharge potential, role of the wetland in surface water regulation (stormwater retention and flood control) and the role of the wetland in watershed health. Based on the results of the evaluation, the EA Report must provide more detailed information on wetlands that:

- Support any species-at-risk, significant species or species assemblages;
- Support core or critical habitat or high wildlife value; and/or
- Have social or cultural importance.

Describe all work activities and predict the effects (direct and indirect), with supporting rationale, on impacted wetland and wetland functions.

Wetland evaluations shall include additional assessment of adjacent wetland areas and anticipated extent of impacts associated with construction activities. The wetland evaluation must include identification of assessment areas and catchment areas used in the evaluation and include any associated outputs or assessment scoring outputs.

Baseline studies must describe and document pre-construction conditions, including, but not limited to, wetland class distribution, vegetation community structure, soil characteristics, and hydrology trends.

9.3 Atmospheric Resources

Describe the atmospheric resources including ambient air quality, the acoustic environment, greenhouse gas emissions, and impacts on climate.

9.3.1 Climate

Include a discussion of regional climate conditions and meteorology in the vicinity of the Project as well as expected changes over the next 50 years due to climate change, considering changes in all four seasons. This section should include climate norms, extreme conditions, as well as trends in these conditions and climate change impacts, as well as the effect these changes may have on the Project and plans to mitigate against those impacts.

In addition to historical and projected climate data, include a summary of greenhouse gas emission projections for the Project and plans to mitigate those emissions in both the design and operation.

Please follow the EA guidance documents when completing this section: https://novascotia.ca/nse/ea/docs/Development.Climate.Change.Guide.pdf.

9.3.2 Air Quality

For the study area, provide a review of baseline ambient air quality and meteorological data, including annual and seasonal climatic conditions for the region.

Provide a description of existing ambient air quality conditions for the study area, with particular attention to ambient and peak levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone

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(O3), particulate matter (total suspended particulate (TSP), fine particulate matter (diameter less than 2.5 microns) (PM2.5) and coarse particulate matter (diameter less than 10 microns) (PM10), total reduced sulphur (TRS) and volatile organic compounds (VOCs) levels.

Discuss the influence of local and regional emission sources and the influence of climate and weather conditions. Use the data in the development of an appropriate model(s) for the study area to be provided in the EA Report. Also describe any potentially sensitive receptors and/or locations.

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9.3.3 Ambient Noise and Light Levels
Describe the existing ambient acoustical environment at the Project site (including the marine environment), and in any other areas where Project activities could be expected to have an environmental effect.

Provide the spatial boundaries of existing noise and vibration levels, as well as locations of recording stations and length of record for any acoustic or vibration data presented. Consider the effects of different meteorological conditions on noise propagation. Provide information on any existing relevant standards, guidelines or objectives with respect to noise and vibration levels.

Describe existing ambient light levels at the Project site and at any other areas where Project activities could have an environmental effect on light levels. Describe night-time illumination levels during different weather conditions and seasons.

9.4 Flora and Fauna
Identify flora, fauna, and habitat types that will be intersected by all components of the Project. Appropriate field surveys agreed to by Nova Scotia Lands and Forestry (NSLAF) – Wildlife Division, shall be conducted as part of the evaluation. Surveys should be described by results, methodology, and spatial and temporal boundaries.

9.4.1 Terrestrial Environment
This section must include, but not be limited to the following:

- Identification of typical species of flora, sensitive flora, flora species-at-risk, and potential core and critical habitat for flora species-at-risk in the study area;
- Identification of areas of old growth forest. Current information on old growth forests shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; the Nova Scotia Museum of Natural History, and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to NSLAF – Wildlife Division. Available data, survey results, and detailed mitigation measures that demonstrate a special emphasis on avoidance of impacts shall be included in the EA Report;
- Identification of any existing or planned parks wildlife management areas, ecological reserves or wilderness areas, nature reserves as well as managed wetlands and significant wildlife habitat;
- Identify and delineate on a map 'roadless areas' and discuss their potential value to Nova Scotia's protected areas network. Include areas with high wildlife concentrations, wildlife corridors or habitats rare/unique to Nova Scotia;
- Identification of typical species of fauna (including invertebrate species), sensitive fauna, fauna species-at-risk, and potential core and critical habitat for fauna species-at-risk in the study area.

Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; Nova Scotia Communities, Culture and Heritage; the latest Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list; the Atlas of Breeding Birds of the Maritime Provinces; and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed by professional biologists in a manner that is acceptable to NSLAF – Wildlife Division and Canadian Wildlife Service;

- Additional migratory bird surveys at representative survey points along the pipeline route;
- Bird surveys transects to provide a complete view of bird species distribution and habitat use along the pipeline route, including transect bird surveys and fall migratory bird survey. Identification of nests of bird species, which are protected under the *Wildlife Act*, Endangered Species Act, Migratory Birds Convention Act and federal Species at Risk Act regardless of whether they are active or not must also be considered;
- Bird baseline survey for common nighthawk (*Chordeiles minor*), including rationale for survey point selection to the satisfaction of NSLAF;
- Raptor nest survey to identify nest locations for the entire Project area including the pipeline route;
- Herptile survey for the Project area, which includes the pipeline route, to include both spring and fall survey information. Prior to conducting survey, develop survey methodology in consultation with NSLAF; and
- When surveys are necessary to supplement the available data and adequately describe the use of the area by migratory birds during different times of the year (breeding season, migration, winter), emphasis will be placed on determining whether any bird species-at-risk, colonial nesting species, species particularly vulnerable to habitat fragmentation, etcetera, occur or breed in or near the study area.

9.4.2 Freshwater Aquatic and Marine Environment

This section must include, but not be limited to the following:

- Description and baseline surveys of fish and fish habitat in the marine environment, including characterisation of benthic vegetation in the area predicted zone of influence and particulate settlement;
- Description and baseline surveys of any freshwater fish or fish habitat in any identified watercourse or any other watercourse that may be impacted by the Project.
- Identify any potential core or critical habitat for species-at-risk, ecologically sensitive areas and migratory routes of fish;
- Description of the relative distribution and abundance of valued fish resource components within the predicted zone of influence. Fish species, age, health, and diversity shall be described;
- Description of any seasonal variation in the location, abundance and activities of aquatic species. Describe and identify key habitat features, such as spawning, rearing, nursery, feeding, migration and overwintering areas, as they occur within the Project area. Also describe the criteria utilized for determining the zone of influence this Project has on the fish habitat;
- Description of the marine habitat and species of fish, including pelagic and demersal finfish, shellfish, crustaceans, and marine mammals, likely to be present within the surrounding marine environment. The description of these species and habitats should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish and marine mammals;
- Baseline data for existing mercury concentrations in fish tissue that are adequate to be used for comparison purposes for impact monitoring programs. Provide data on total mercury in whole fillets accompanied by fish species and size data; and

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- Baseline study for fish and shellfish tissue with chemical analysis that includes COPCs of representative key marine species important for commercial, recreational and Aboriginal fisheries (food, social and ceremonial) in the vicinity of the proposed effluent pipeline and diffuser location. The locations of samples must be clearly identified.
- Include fish assemblage characterisation. Biases and shortcomings associated with sampling methods (e.g. video sampling) should be noted for all studies and multiple methods used to ensure accurate characterisation.

9.5 Agriculture, Aquaculture and Forestry Resources

Identify and describe agricultural resources in the study area. Identify agricultural operations in the study area and describe livestock, crop types, growing seasons and growing methods.

Describe all commercial, recreational and Aboriginal fisheries (including food social ceremonial (FSC) as well as commercial), aquaculture, and harvesting (e.g., marine plants, shellfish) in the study area. Describe the commercial and recreational species, caught, grown or harvested, and their economic importance. Identify fishing, aquaculture and harvesting locations, the amount caught, and methods used.

Identify and describe forestry activities in the study area.

9.6 Socio-Economic Conditions

Describe the current socio-economic conditions of the study area, including population demographics and economic conditions for all residents of the area. Provide details of employment rates and trends at the municipal and regional level. The spatial boundaries of this analysis should include areas within which employees of the Project are expected to reside. Identify key industries in the region (both land-based and marine-based) and describe their contribution to the local and regional economies. Provide details of residential and commercial property values. Describe any local and regional economic development goals and objectives identified through community consultation, or existing economic development plans and strategies. Describe any community plans or strategic plans for the area, including plans for the development of new or existing economic activities.

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9.7 Existing and Planned Land Uses

Describe the patterns of current and planned land use and settlement in the study area including residential, industrial, agricultural, parks, and protected areas. Provide details of areas under existing mineral exploration licenses as well as areas licensed for pulpwood harvesting. Identify locations of abandoned mine workings, mine tailings and waste rock disposal areas, as well as contaminated sites. This section shall include map(s) to illustrate land uses and provide distances to significant settlements.

The EA Report must also identify lands and resources of special social, cultural or spiritual value to the Mi'kmaq of Nova Scotia, with particular emphasis on any current use of land for traditional purposes. A Mi'kmaq Ecological Knowledge Study (MEKS) should be used to identify land and resource use that have and/or continue to be pursued by the Mi'kmaq of Nova Scotia.

9.8 Archaeological Resources

Identify any areas containing features of historical, paleontological, cultural or archaeological importance in a manner acceptable to the Nova Scotia Communities, Culture and Heritage (CCH). Describe the nature of the features located in those areas. Particular attention shall be given to Mi'kmaq of Nova Scotia archaeological sites and burial sites. All heritage research permits acquired, and engagement with the

Mi'kmaq of Nova Scotia during this analysis should be identified in the document. Results of the Archaeological Resource Impact Assessment reports related to Indigenous land use and known archaeological sites of interest to the Mi'kmaq, should be provided to the Office of Aboriginal Affairs and PLFN.

10.0 ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS ASSESSMENT

Describe the effects of the Project on the environment during all phases of the Project (construction, operation, and decommissioning and reclamation), including any environmental change on health, socio-economic conditions, archaeology, and the current use of land for traditional purposes by the Mi'kmaq of Nova Scotia. The EA Report shall identify and describe the accidents and/or malfunctions that may occur during all phases of the Project and assess the effects on VECs.

Provide a detailed contingency plan that considers site-specific conditions and sensitivities, the lifespan of different components and includes, but is not limited to:

- Full hazard identification and qualitative risk assessment associated with Project construction and operation, including those which have or may have an environmental impact (directly or indirectly);
- Prevention, mitigation and contingency measures to mitigate potential Project impacts;
- Discussion of measures to mitigate potential impacts or damages on the environment, properties and human health (e.g., liability insurance, financial security, etc.);
- Emergency response procedures;
- Description and quantification of releases that could occur under both normal conditions and a 'worst-case scenario';
- Description the types, fate and distribution of contaminants within the study area under normal and worst-case scenarios during construction, operations and post-reclamation;
- Discussion of potential Project impacts on emergency and health services in communities near the Project area, and associated mitigation and contingency measures in the events of major Project related accidents and malfunctions;
- Description of the cumulative effects of all Project activities, including but not limited to modelling how changes in temperature, sea level, acidity and oxygen concentrations in the Northumberland Strait may interact with effects of effluent over the lifetime of the project to affect fish and fish habitat; and
- The effects assessment shall also consider impacts of the environment (including weather and climate) on the Project, including a discussion of how climate change may impact all components of the Project.

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10.1 Geophysical Environment
Potential effects of the Project on the geophysical environment must be discussed in the EA Report.

The EA Report must also discuss the potential cumulative and residual effects of the Project on the geophysical environment and the significance of these effects.

10.2 Water Resources
In conducting the effects assessment on water resources, the EA Report must identify and evaluate:

- Changes in groundwater and surface water quality as a result of effluent discharges from the Project site;
- Potential effects on groundwater quality and quantity and associated impacts to users of groundwater;
- Potential cumulative and residual effects of the Project on all water resources including surface water, marine water, groundwater and wetlands; and the significance of these effects including ecosystem integrity and changes in hydrology to areas adjacent to the Project area;
- Where wetland avoidance is not possible, the EA Report must discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.
- The Canadian Council for Ministers of the Environment (CCME) Water Quality Guidelines with background water quality results shall be used to ensure the protection of relevant water uses (aquatic life, recreational use, agricultural use, and drinking water supply) and shall be used as the basis for evaluating the significance of the predicted impacts; and
- Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Water Quality, shall be reviewed and applied in the evaluation where relevant.

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10.2.1 Groundwater

Provide an assessment of the potential risk to groundwater resources associated with the construction and operation of the pipeline. The assessment shall include but is not limited to quantitative calculation of time of travel between the pipeline and water supply wells and watercourses, delineation of well capture zones and determination of groundwater flow directions. The results of this assessment shall be considered in the final pipeline design in terms of providing for greater protection in areas of greatest risk.

The groundwater assessment results need to be discussed with the Town of Pictou to establish confidence that the risk of negative impacts to the Town water supply has been reduced to an acceptable level.

10.2.2 Surface Water

In conducting the effects assessment on surface water resources, the EA Report must identify and evaluate:

- Potential effects to surface water quality on fish and fish habitat, community water supplies (protected and unprotected), and recreational and agricultural users.
- Potential effects to surface water quality following an accident or malfunction of the pipeline.

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10.2.3 Marine

The proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. In conducting the effects assessment on the marine environment, the EA Report must identify and evaluate, to the satisfaction of relevant government departments:

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- Marine pipeline construction methods along the full route and construction requirements (e.g., blasting), using results from geotechnical investigations;
- Adequacy of proposed pipeline burial depths with respect to ice scour;
- Geotechnical assessment of stability of underwater excavation works near base of Causeway with respect to causeway embankment and structures;

- Potential risk of impacts to the marine environment resulting from leaks from marine based sections of pipeline;
- Receiving water study that assesses fate and transport of COPCs in the receiving water environment for a range of scenarios reflective of conditions possible at the chosen site. This study shall identify potential short and long-term impacts. This study is to be completed using modelling techniques and scenarios for all COPCs in the receiving environment, based on the results of the effluent characterization in Section 3.6 of the Terms of Reference and other relevant studies, such as Human Health Risk Assessment. All baseline climate and marine water quantity and quality data shall be applied to this study for model setup, calibration and validation. Results shall include, but not be limit to, discharge plume dimensions and dilution ratios;
- Goodness of Fit statistical procedures are to be applied to evaluate model adequacy in representing the receiving water environment for the calibration and validation periods. Assessment must be provided on the adequacy of the seasonal variation and lengths of observed datasets used in model setup and calibration/validation. A summary of model confidence in adequately representing multi-year effluent discharge transportation of COPCs and accretion/build-up within the receiving water environment is to be included;
- Potential build-up of COPCs resulting from the proposed activity (e.g., shoreline accumulation). Provide the estimated dilution potentials at various distances from the diffusers based on calibrated model results as appropriate;
- In conjunction with the above, provide sediment transport modelling, including model(s) and scenarios to assess the impacts of sediment transport within near-field and far-field model areas. The results of the modelling activities are to be assessed with respect to chemical and physical characterization of the distributed solids, interaction with marine sediments and waters, and effects within the marine environment, particularly to marine organisms; and
- Based on the results of the receiving water study, evaluate whether colour is expected to be visible at the ocean surface above the diffuser site, including influence of in-water reactions (e.g., potential stratification of the water column) on colour levels. Assess impact of colour and its interaction and effect on the marine sediments and associated marine life.
- Conduct a risk assessment for benthic vegetation, invertebrate community and fish assemblage.

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10.2.4 Wetlands

In conducting the effects assessment on wetlands, the EA Report must identify and evaluate:

- Potential direct and indirect impacts to wetlands and how Project development will adhere to the Nova Scotia Wetland Conservation Policy; and
- Where wetland avoidance is not possible, discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.

10.3 Atmospheric Resources

Describe the sources, types and estimated quantities of air emissions from the mill facility for all potential air contaminants of concern related to the Project under routine conditions and in the case of malfunctions and accidental events on a seasonal and annual basis. Air contaminants to be evaluated should include but not be limited to, impacts of CO, hydrogen sulphide (H2S) nitrogen oxides (expressed as nitrogen dioxide) (NO2), O3, SO2, TSP, PM25, PM10, TRS, speciated VOCs, semivolatile VOCs, polycyclic aromatic hydrocarbons (PAHs) and metals. The description shall include appropriate models based on known or measured atmospheric conditions throughout the year.

For all Project phases, construction, operation and decommissioning, estimate the GHG emissions and provide an inventory of GHG emissions from all Project components. This includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3) and conversion of these emissions to an equivalent amount of CO_2. Also include an inventory of the precursors or tropospheric ozone (CO, NOx, and VOCs).

Where possible, include a comparison of the above information with estimates of total GHG contributions from NS, and from similar facilities in Canada. The EA Report must also include a discussion of measures that have been considered and/or are proposed to reduce air emissions and reduce or offset GHG emissions.

While considering the effects on air quality, the EA Report must discuss the potential impacts of predicted increases in noise and light levels during all phases of the Project, on surrounding residential, commercial, recreational and institutional areas, human health and marine and terrestrial species and habitats.

Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air and Noise, shall be reviewed and applied in the evaluation where relevant.

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In addition, based on concerns raised by government reviewers, the EA Report must also include, but not be limited to the following additional items:

Revised air dispersion modelling including the following:

- Consideration of the effects of fumigation and coastal interaction in the modelling;
- Modelling based on the operating scenario for the occasion when the highest concentration of an air contaminant occurs at ground level. The operating condition that corresponds to the maximum air contaminant concentration at ground level may occur when the facility is at the maximum production level or running at a lower production level or when the process is in transition. The EA Report shall include a description of the operating conditions that result in the maximum ground level concentration of an air contaminant;
- Air emission modeling must take into account both proximity to population centres and the effects of nearby large waterbodies. The AERMOD air emissions modeling software does not meet this requirement. The CALPUFF or similar modelling software is recommended;
- Identification of individual emission rates as measured or estimated and include the reference and justification for values used;
- Comparison of the maximum predicted ground level concentrations of all contaminants with relevant ambient air quality criteria. In the absence of NS adopted ambient air quality criteria, the Proponent shall utilize criteria from Federal or other Provincial jurisdictions;
- Comparison of the maximum predicted ground level concentrations of all contaminants with their relevant upper risk thresholds;
- Risk assessment and mitigation plan for contaminants that demonstrate a potential predicted exceedance of a relevant upper risk threshold;
- Inclusion of isopleth mapping for all contaminants predicted to exceed relevant ambient air quality criteria;

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- Identification of discrete receptors on all isopleth mapping;
- Mitigation options to address any predicted exceedances of relevant ambient air quality criteria used in the modelling. The model shall be rerun incorporating the mitigation projects to demonstrate no predicted exceedances; and
- Implementation schedule for potential mitigation options.
- Plan to demonstrate capacity to reduce emissions.

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10.4 Flora and Fauna

10.4.1 Terrestrial Environment
Identify and evaluate the potential effects on flora and fauna and avifauna species/communities during all phases of the Project. Include a full account of impacts on species at risk or of concern, significant habitats and protected areas or areas of potential value to Nova Scotia's protected areas network that may be potentially disturbed, altered or removed. The effects assessment must also consider the potential for effects to flora and fauna associated with landscape fragmentation and sensory disturbances.

10.4.2 Freshwater Aquatic and Marine Environment
Evaluate the potential effects on aquatic environments, including fish and fish habitat.

While considering the effects that the Project may have on freshwater and marine species, include a full account of species at risk or of concern and significant habitats, including potential core and critical habitats. This section must include activities that may affect avifauna in the aquatic environments. This section must also include evaluation of impacts on invertebrate communities and benthic vegetation using appropriate sampling methods (e.g. grabs) and adequate sample size. Also consider potential effects to marine species from blasting, dredging and other marine construction, as well as vessel traffic and Project operation. Where impacts to fish habitat cannot be avoided or mitigated, discuss compensation measures to ensure impacts are offset.

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Assessment of COPCs in the baseline fish and shellfish populations and potential effects due to expected discharge quality.

Include a summary of the potential effects on flora/fauna known to be important to the Mi'kmaq of Nova Scotia.

10.5 Agriculture, Tourism, Aquaculture and Forestry Resources
Include an effects assessment of the Project on existing and future agriculture activity within the study area.

Include an effects assessment of the Project on existing and future tourism in the region.

Assess the impacts on commercial/recreational fishing, aquaculture or other marine harvesting which may be impacted by the proposed Project. The effects assessment should consider changes in commercial/recreational fishing, aquaculture or other marine harvesting species, including contamination of species consumed by people as a result of increased erosion, sedimentation and from effluent discharges from the Project, displacement, mortality or loss and/or alteration of habitat. Also discuss navigation restrictions and loss of traditional fishing areas of the Mi'kmaq of Nova Scotia.

Conduct an impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon information, studies and an understanding of expected movement of contaminants according to the revised receiving water study. Based on the assessment of applicability of Point C representing Project ETF effluent quality, chronic and acute toxicity testing of non-diluted treated effluent is to be conducted through a series of controlled laboratory experiments. Species used in the assessment should be applicable to the receiving water environment. Consideration should be given to using either the plant's current effluent or another acceptable and representative substitute. The selection of information sources, representative marine species and assessment methodology must first be agreed upon by relevant government departments.

Undertake a model-based evaluation of the chronic effects of thermal cooling water discharge on fish and fish habitat in the receiving water. Based on the results of the evaluation, develop appropriate mitigation measures and/or project changes.

The EA Report must include a discussion on the potential effects on any forestry resources within the Project area.

10.6 Human Health

Provide the completed Human Health Risk Assessment (HHRA) in accordance with Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk Assessment and other Guidance for Evaluating Human Health Impacts in Environmental Assessment documents for noise, air quality, drinking and recreational water, etc. as applicable. Federal contaminated sites guidance documents such as the Detailed Quantitative Risk Assessment (DQRA) may be used to supplement the EA Guidance documents where appropriate. The risk assessment must consider human consumption of fish and other seafood, consumption of potentially contaminated drinking water, exposure to recreational water and sediment, outdoor air inhalation, and any other potential exposure pathways. The analysis must inform the identification of contaminants of concern and updating of the receiving water study.

The HHRA must consider baseline data and represent all marine species which are harvested and consumed in the area with respect to the marine component of the Project and in all types of fisheries- commercial, food, social and ceremonial. In addition, information for these species should be included in the baseline studies for COPCs in marine organism tissues where possible. The HHRA must consider bioaccumulation and the potential for biomagnification in the food chain. The exposure route associated with consumption of seaweed and sea vegetables must also be included.

The HHRA is to include appropriate receiving water study and associated modelling activity results (e.g., contaminant fate and transport) as to accurately assess the potential risk to human health.

Include monitoring and mitigation measures for elevated COPCs in air emissions in HHRA problem formulation.

Screen COPCs in Project effluent discharge according to guidance from Health Canada. Incorporate findings from receiving water study. Discuss the potential for interactive effects from similarly acting chemicals. Include an evaluation of the risk associated with exposure to chemical mixtures. Provide calculation of Hazard Quotients (HQ) and Incremental Lifetime Cancer Risk (ILCR) which account for additivity.

Ensure any screening values used from the EPA are adjusted to be consistent with the health protection endpoints prescribed by Health Canada and CCME.

Provide clarification on methodology applied to selection of COPCs for seafood ingestion in consultation with Health Canada.

10.7 Socio-Economic Conditions
Identify potential impacts of the Project on economic conditions, populations and employment.

Identify potential impacts of the proposed Project on residential property values and property demand during all phases of the Project (including temporary accommodation required during construction).

Describe the effect of the proposed Project on present and future commercial, residential, institutional, recreational and resource land uses within the study area, including impacts to areas under mineral exploration licenses or forestry licenses.

Identify the potential impact on recreational opportunities, including the effects on aesthetics from areas surrounding the Project area. This analysis should be supported by visual impact assessments from both the land and water.

Identify the potential impact on the current use of land and resources for traditional purposes and any Aboriginal specific land claims within the study area.

While considering the effects on economic conditions and employment, include a discussion on expenditures and the anticipated direct and indirect employment positions that will be created during all phases of the Project.

10.8 Existing and Planned Land Uses
The EA Report must consider the effects that may restrict the ability of people to use and enjoy adjacent lands and marine area presently, and in the future. Describe the potential impacts from existing or planned land uses in the study area. This shall include a discussion of Project interactions with any rural planning initiatives, parks, protected areas, contaminated sites, former mine workings, and mine disposal areas.

Identify and evaluate potential effects on traditional and current recreational and commercial use by the Mi'kmaq of Nova Scotia.

Discuss the anticipated changes in traffic density and patterns during all phases of the Project including the effects on transportation.

While assessing the effects on navigation and navigable waters, consider navigation patterns of all waters that may be impacted by the Project. Potential effects on traditional and current recreational and commercial use must be identified and evaluated.

10.9 Archaeological Resources
Evaluate the potential effects of any changes in the environment as a result of Project activities on physical and cultural resources, structures and/or sites of historic, archaeological, or paleontological significance.

In conducting the effects assessment on archaeological resources consult with CCH and with the Archaeology Research Division of KMKNO.

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11.0 PROPOSED MITIGATION

Describe all measures that have, or will be, taken to avoid or mitigate adverse effects, and maximize the positive environmental effects for all aspects of the Project (as described in Section 9.0 of the Terms of Reference). Mitigation includes the elimination, reduction or control of the adverse effects or the significant environmental effects of the Project and may include restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

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Describe proposed compensation that will be provided when environmental damage is unavoidable or cannot be adequately mitigated by any other means.

In considering mitigation measures to be employed, the EA Report must describe any legislation, regulations, guidelines, policies, BMPs, and specifications that will be adhered to during construction and operation of the facility that will lead to mitigation of environmental impacts.

11.1 Geophysical Environment

If applicable, describe alternatives to disrupting net acid producing bedrock. When no practical alternative to exposing acid producing bedrock exists, mitigation plans shall be developed to mitigate the impacts on the aquatic environment. Discuss commitments to provide contingency and remediation plans for watercourses that have been degraded due to the disturbance of net acid producing bedrock or tills.

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If contaminated soils are to be disturbed, discuss methods to avoid adverse impacts.

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Provide applicable mitigation measures and preliminary agreements and plans that meet Provincial regulatory disposal and transportation requirements for potential dredge materials.

11.2 Water Resources

11.2.1 Groundwater Quality and Quantity

Describe actions that will be taken to avoid and mitigate any negative impacts on groundwater quality and quantity.

Provide a Groundwater Protection Plan based on the assessment of risks to local water supplies (municipal and private) and the environment. This plan should include management/contingency response actions and reference the groundwater monitoring plan as well.

Describe measures to be employed in the event of accidental contamination or dewatering of any water supply wells as a result of the construction, operation or decommissioning of the Project, including compensation for loss or degradation of water supplies. Describe mitigation measures planned to prevent and remediate contamination of groundwater from the accidental release of a hazardous substance.

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Discuss commitments to provide contingency and remediation plans for any contamination of groundwater resources, including decrease of water quality.

11.2.2 Surface Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to avoid and reduce impacts to surface water resources, including but not limited to erosion and run- off control features and storm drainage management.
Discuss all mitigation measures planned to prevent the release of hazardous substances into local surface waters.
Discuss commitments to provide contingency and remediation plans for any impact to surface water resources, including decrease of water quality or quantity.

11.2.3 Marine Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to avoid and reduce impacts to marine water resources.

Discuss all mitigation measures planned to prevent the release of hazardous substances into marine waters.

Discuss commitments to provide contingency and remediation plans for any impact to marine water resources, including decrease of water quality or quantity.

11.2.4 Wetlands

Describe measures to avoid, minimize or otherwise mitigate effects on wetlands within the Project area. Specifically, the EA Report must describe measures to maintain ecological and hydrological integrity of any wetlands in the area. Where avoidance is not possible, provide wetland specific mitigations proposed to lessen impacts of the Project at all stages and describe commitments to monitoring and compensation for any loss of wetland habitat. Also provide discussion and commitment regarding remediation/rehabilitation of aquatic habitat as a result of incidental releases of treated effluent in wetlands.

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11.3 Atmospheric Resources

Describe measures to avoid, minimize or otherwise mitigate effects on biological receptors during all phases of the Project (vegetation, fish, wildlife, and human health).

Specifically, describe measures that will be taken to control emissions including but not limited to CO, H_2S, nitrogen oxides expressed as NO_2, O_3, SO_2, TSP, PM2.5, PM10, TRS, speciated VOCs, semivolatile VOCs, PAHs and metals. Describe any GHG mitigation plans.

11.4 Flora and Fauna

11.4.1 Terrestrial Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on flora species. Include any landscaping plans for preservation of existing vegetation.

Describe the measures that will be taken to minimize the impacts of the Project at all stages on terrestrial fauna and avifauna. Include any plans for preservation of existing habitat and compensation for loss or degradation of terrestrial habitat (i.e., habitat rehabilitation/replacement). Measures to comply with federal and provincial wildlife legislation, including but not limited to the Wildlife Act, Endangered Species Act, Species at Risk Act, *Migratory Birds Convention Act* and regulations) must also be provided.

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Describe commitments to provide contingency and remediation plans for impacts to terrestrial habitat as a result of accidental events.

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In addition, based on concerns raised by government reviewers during the review of the EARD and the Focus Report, the EA Report must also include, but not be limited to the following additional items:

- Mitigation plan developed in consultation with NSLAF that includes additional details to protect wildlife and wildlife habitat, including birds, mammals, herptiles, raptors, and species-at-risk. The plan must include but not be limited to the following:

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  a) mitigation measures that will be taken to avoid destroying rare priority species detected in the 2019 floristic surveys;

  b) mitigation and monitoring plan for the Eastern Wood-Pewee (*Contopus virens*, SARA Special Concern, NSESA Vulnerable) and Barn Swallow (*Hirundo rustica*, SARA Threatened, NSESA Endangered) found during the course of field surveys and Kildeer (*Charadrius vociferous*) identified to likely be breeding in the Project area, in consultation with both ECCC and NSLAF;

c) additional details on how impacts to the Double-Crested Cormorant (*Phalacrocorax auratus*) colony located along the east side of Highway 106 causeway will be mitigated during installation of the pipeline across Pictou Harbour. Identify appropriate mitigation measures to protect Double-crested Cormorant nests in the event of a pipeline rupture;

d) specific measures to be developed to discourage waterfowl from accessing the spill basin and other open ETF components;

e) specific measure to identify and control of spread of invasive species;

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f) specific measures to address potential foraging and overwintering habitat for turtles; and

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g) a training program for field staff to enable them to recognize the potential for species occurrences and procedures to follow.

11.4.2 Freshwater Aquatic and Marine Environment

Discuss measures that will be taken to avoid and mitigate the impacts of the Project construction, operation and decommissioning on marine and freshwater aquatic species, avifauna and their habitats, including benthic vegetation and invertebrate communities. Include any plans for preservation of existing habitat and compensation for loss or degradation of aquatic habitat.

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Describe the measures that will be taken to minimize the introduction of non-native species to the area.

Discuss commitments to provide contingency and remediation plans for impacts to aquatic habitat as a result of accidental events.

11.5 Agriculture, Tourism, Aquaculture and Forestry Resources
Discuss measures that will be taken to avoid and mitigate the impacts of the Project on agriculture, fishing, aquaculture, marine harvesting, tourism and forestry.

11.6 Human Health
Describe actions that will be taken to prevent, minimize and mitigate potential direct and indirect Project related impacts on human health during construction, operation and decommissioning of the Project.

11.6 Socio-Economic Conditions
Describe actions that will be taken to mitigate adverse impacts on private and commercial property, existing industry and businesses, planned land use, recreation and other human activities, including traditional activities and land uses by the Mi'kmaq of Nova Scotia.

Provide a dispute resolution policy for addressing Project related complaints and concerns that may be received throughout construction, operation, decommissioning and reclamation, and post-decommissioning.

11.7 Existing and Planned Land Uses
Describe the measures planned to minimize the potential impacts of the Project on existing and planned land uses.

Discuss the mitigation measures planned to address anticipated impacts from any predicted changes in traffic speed, traffic routes, marine navigation, exclusion zones and density in adjacent residential and commercial areas.

11.8 Archaeological Resources
Describe mitigation measures to preserve, protect, or recover any resources of cultural or archaeological value that are identified in the study area.

12.0 RESIDUAL EFFECTS AND ENVIRONMENTAL EFFECTS

This section of EA Report shall list and contain a detailed discussion and evaluation of the residual impacts for each VEC, including the criteria for determining significance. Residual impacts are those adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technologies or other acceptable means. Those impacts that can be mitigated or avoided shall be clearly distinguished from those impacts that will not be mitigated or avoided.

These impacts become important in the evaluation of a proposed Project as they represent the environmental cost of the Project.

13.0 EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

Present an overall evaluation of the advantages and disadvantages to the environment, including the VECs, during the construction, operation and decommissioning phases of the Project. The evaluation of the disadvantages shall include an examination and justification of each disadvantage.

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14.0 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

Include a framework upon which compliance and effects monitoring will be based throughout the life of the proposed Project, including decommissioning and post-decommissioning activities. Monitoring programs must be designed to determine the effectiveness of the implemented mitigation measures. The EA Report shall describe the compliance reporting methods to be used, including reporting frequency, duration, methods, parameters, comparison standards or guidelines, format, and receiving agencies. Mapping clearly illustrating baseline and proposed monitoring locations must also be included.

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Recognizing that the effectiveness of compliance and effects monitoring depends on a workforce that can identify and address potential impacts during construction and operation of the Project, the framework shall include training and orientation procedures that address potential impacts, compliance and monitoring requirements to on site employees during construction and operation of the Project.

2020-2-4 11:55 AM
Deleted: for providing training and orientation

The description of the compliance and effects monitoring program shall also include any procedures/plans for addressing potential exceedances of environmental protection regulations, standards, guidelines and approvals.

2020-2-4 11:57 AM
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The discussion of compliance monitoring shall include, but not be limited to Sections 14.1 – 14.4.

14.1 Geophysical Environment

Describe plans and procedures for assessing ARD potential and associated monitoring in the event of disturbance or exposure.

14.2 Water Resources

Wetland specific post construction monitoring and comparison to baseline condition must be provided to identify post-construction wetland indicator performance and adaptive management to address impacts at all project stages. The EA Report must address compensation measures that may be required to ensure no net loss of wetland area and functions.

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Submit a groundwater quality and level monitoring plan for the construction, operation and decommissioning phases of the Project, including the pipeline route and mill site location. This is to include the location of monitoring wells, monitoring sampling frequency and monitoring parameters. The plan must consider the final pipeline design as well as the potential risk to the environment and local water supplies as a result of pipeline construction and possible pipeline leak. The plan must address, as a minimum, sensitive areas along the pipeline route, such as shallow water table intersecting surface water features, proximity to water supply wells and areas along the pipeline more susceptible to failure. Locations where the pipeline may be constructed below the seasonal high-water table shall be identified.

Discuss plans for a survey of structures if blasting is planned, to include wells, building foundations, etcetera, which may experience damage or impact due to seismic vibrations or air concussion.

Describe surface water monitoring plans for the construction, operation and decommissioning phases of the Project, including both water quality and quantity aspects.

2020-2-4 12:13 PM
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Develop a marine discharge plume delineation monitoring program to confirm plume dimensions, and effluent concentrations and characteristics in support of the Environmental Effects Monitoring program.

14.3 Fish and Fish Habitat

Submit an Environmental Effects Monitoring program that includes water quality, sediment and tissue sampling and is based on the results of various relevant baseline studies and receiving water study. The program must, at a minimum, be designed to address all applicable regulatory requirements.

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2020-2-4 12:15 PM
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14.4 Atmospheric Resources

Complete an ambient air quality monitoring plan, acceptable to the Department, based on the results of the air dispersion modelling. This plan must include but not be limited to sampling locations, parameters, monitoring methods, protocols and frequency. The plan shall ensure adequate monitoring coverage of areas where predicted levels of air contaminants are elevated.

Describe plans for GHG monitoring, reduction targets and reduction plans.

Discuss the plans for monitoring baseline, construction and operational noise levels at the site, and at any residential or commercial areas near the Project.

14.5 Human Health

Provide suitable monitoring measures to confirm impact predictions. Where monitoring is proposed, include a plan for reporting/communicating reporting exceedances of relevant guidelines/thresholds.

14.5 Other Monitoring Plans

Include any other monitoring plan which may include an Environmental Protection Plan or other guidelines, polices or plans, proposed for the construction, operation and decommissioning of the Project.

15.0 CONSULTATION PROGRAM

A Notice regarding the Draft Terms of Reference for Preparation of an Environmental Assessment Report pursuant to the Nova Scotia *Environment Act* was published in the Chronicle Herald and Royal Gazette on January 8, 2020 and posted on the NSE internet site (www.gov.ns.ca/nse/ea/). Information pertaining to this EA will be available on this site.

The Class I EA process for the Project includes the following opportunities to participate (specifically government departments/agencies, the Mi'kmaq of Nova Scotia and the general public will be invited to provide comments):

- the Draft Terms of Reference; and
- the Environmental Assessment (EA) Report.

15.1 Public Consultation

For any consultation undertaken with the general public, the EA Report must describe ongoing and proposed consultation and information sessions.

Describe all steps taken by the Proponent to identify the concerns of the public about the adverse effects or environmental effects of the Project. Include a summary of all concerns expressed by the public and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

2020-2-5 10:13 PM
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The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the general public.

15.2 Consultation with the Mi'kmaq of Nova Scotia

To assist the provincial Government in their consultation process with the Mi'kmaq of Nova Scotia, the EA Report must describe all steps taken by the Proponent to identify the concerns of Mi'kmaq of Nova Scotia about the adverse effects or environmental effects of the Project. It shall provide a summary of all concerns expressed by the Mi'kmaq of Nova Scotia and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

During the EA process, NSE will serve as the provincial Crown consultation coordinator.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the Mi'kmaq of Nova Scotia.

In parallel to Proponent engagement with the Mi'kmaq of Nova Scotia, the Government of Nova Scotia will undertake continued consultation directly with the Mi'kmaq of Nova Scotia pursuant to the Mi'kmaq- Nova Scotia-Canada Consultation Process (2010).

The Proponent is encouraged to engage the Mi'kmaq of Nova Scotia as referenced in the Nova Scotia Office of Aboriginal Affairs' Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia (2011).

Include any plans for ongoing community consultation or formation of a community liaison committee (CLC) during construction, operation and decommissioning.

16.0 ASSESSMENT SUMMARY AND CONCLUSION

This section of the EA Report shall summarize the overall findings of the EA with emphasis on the main environmental issues identified and predict the significance of adverse environmental effects of the Project.

From:	
To:	Environment Assessment Web Account; Minister, Env
Cc:	
Subject:	Comments of the Friends of the Northumberland Strait on the Draft Terms of Reference for the Preparation of an Environmental Assessment Report
Date:	February 7, 2020 2:48:06 PM
Attachments:	2020 02 07 - Letter and Comment of FONS on Draft Terms of Reference of EA Report on NPNS ETF Final.pdf

Good afternoon,

Please see the attached file enclosing comments on behalf of the Friends of the Northumberland Strait (FONS) on the Draft Terms of Reference for the Preparation of an Environmental Assessment Report in regard to the proposed Replacement Effluent Treatment Facility Project of Northern Pulp Nova Scotia Corporation.

Please confirm that this attachment has been received and accepted by the Environmental Assessment Branch at your earliest convenience. If there should be a technical difficulty, we shall arrange for alternate submission.

Best regards,

Legal Administrative Assistant/Office Administrator | Ecojustice
520-1801 Hollis Street, Halifax, NS B3J 3N4
T: | 1-800-926-7744 ext.
F: 902-417-1701

Ecojustice is Canada's largest environmental law charity. Help us build the case for a better earth.

VANCOUVER CALGARY TORONTO OTTAWA HALIFAX

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520-1801 Hollis St
Halifax, NS B3J 3N4
, ext
File No: 1003

February 7, 2020

The Honourable Minister Gordon Wilson
Department of Environment
Barrington Tower
1894 Barrington Street, Suite 1800
P.O. Box 442
Halifax, NS B3J 2P8
Minister.Environment@novascotia.ca

Environmental Assessment Branch
Nova Scotia Environment
PO Box 442
Halifax, NS B3J 2P8
EA@novascotia.ca

Sent via Electronic Mail

Re: Submission in response to request for comments on Draft Terms of Reference for Environmental Assessment Report – Northern Pulp Nova Scotia proposed replacement Effluent Treatment Facility

On behalf of the Friends of the Northumberland Strait (FONS) we write to provide comments on the January 8, 2020 Draft Terms of Reference (TOR) for the Environmental Assessment Report in respect of the above-captioned project.

We support the efforts of the Minister and Nova Scotia Environment to create these TOR, and we hope they will lead to a thorough analysis of all environmental impacts associated with this proposed project.

Our comments on the draft TOR are attached, as shown via a red markup of specific sections of the text of the January 8, 2020 draft TOR.

We provide these comments to assist the Minister and Nova Scotia Environment in creating a workable framework for the preparation of the Environmental Assessment Report for the ETF project. If the proponent uses this framework appropriately, it can assist greatly in ensuring that the proponent's Environmental Assessment Report is comprehensive and conducts a science-based evaluation of the environmental impacts of this proposed project.

The environmental assessment in this case must not be rushed, as it can only be done properly once the proponent and its advisors have objectively obtained and compiled a fulsome set of baseline data regarding the actual conditions in the entire study area for the project. Reliable and representative baseline information must be obtained from many data points throughout annual cycles, and must accurately reflect both typical and extreme weather conditions and marine and atmospheric dynamics, as well as climate change impacts. It is crucial that the impacts of a continuous discharge of air emissions and treated effluent, at any concentration, be assessed realistically and in light of the levels of harmful substances accumulating in our environment from industrial emissions and other human activity. The assessment must encompass not only the immediate environments of Pictou County and the Northumberland Strait, but also the Gulf of St. Lawrence and the North Atlantic Ocean. The diluted effluent and other project emissions will impact all such areas and an assessment that fails to look seriously at alternatives, or even past 100 metres from the proposed diffuser, will not yield any useful result nor help the Minister make the ultimate decision whether to approve or reject this project.

We trust that the Environmental Assessment Report process will result in a genuine assessment of the true impact of sending this project's waste substances into the air, land and waters of our region and our world.

FONS and Ecojustice are grateful to Dr. Ellen Sweeney, Dr. Oliver Fringer, Dr. Daniel Rainham, Dr. Lynn Cameron and Arthur MacKay for their advice and comments on the draft TOR. Their comments are incorporated herein and were of great assistance to us in preparing the attached submissions.

Sincerely,

Barrister & Solicitor

Barrister & Solicitor

c. Friends of the Northumberland Strait, by electronic mail

DRAFT TERMS OF REFERENCE FOR THE PREPARATION OF AN

ENVIRONMENTAL ASSESSMENT REPORT

FOR PUBLIC REVIEW AND COMMENT

Regarding the Replacement Effluent Treatment Facility Project
Proposed by Northern Pulp Nova Scotia Corporation

Comments of the Friends of the Northumberland Strait as represented by Ecojustice
Proposed changes shown using track changes

~~NOVA SCOTIA ENVIRONMENT~~

~~January 8~~February 7, 2020

FOREWARD

Current Context

On December 17, 2019, following an environmental assessment review of the Northern Pulp Effluent Treatment Facility Focus Report, the Minister of Environment decided that an Environmental Assessment Report was required to address deficiencies in the information provided. On December 20, 2019, Northern Pulp announced its intent to cease operations at the Northern Pulp Mill. Notwithstanding that announcement, on January 2, 2020, Northern Pulp informed Nova Scotia Environment of its intent to continue with the Environmental Assessment Report process. Since the company has chosen to continue with the process, Nova Scotia Environment is required to release this draft Terms of Reference in accordance with the Environmental Assessment Regulations.

This Draft Terms of Reference is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document and in the subsequent October 2019 Focus Report.

The *Boat Harbour Act* sets out a deadline of January 31, 2020. Further to the above, Nova Scotia Environment expects Northern Pulp to provide information as part of its input on this draft Terms of Reference about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes may affect the Terms of Reference.

Environmental Assessment Process to Date/Next Steps

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an Environmental Assessment Report) to be provided to address gaps or deficiencies in the required information.

Northern Pulp registered its Effluent Treatment Facility for environmental assessment on February 7, 2019. A thorough environmental assessment review concluded that the Registration Document did not provide enough information to determine if adverse effects or significant environmental effects would result from the Project. On March 29, 2019, the Minister determined that the company would have up to one year to submit a Focus Report to address identified information gaps in the Registration Document.

On October 2, 2019, the company submitted a Focus Report. A thorough environmental assessment review of this information concluded that the company failed to provide enough information to properly assess whether there may be adverse effects or significant environmental effects as a result of the Project and, on December 17, 2019, the Minister decided an Environmental Assessment Report was required. Through the environmental assessment review process, concerns were raised about incorrect and incomplete baseline information; assumptions and methodology used in the analysis; and the absence of mitigation measures related to the potential environmental effects. Further specifics regarding these deficiencies are outlined in comments provided during the consultation period, which are posted on our website and reflected in this Draft Terms of Reference, for the preparation of an Environmental Assessment Report.

Northern Pulp is expected to prepare an Environmental Assessment Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that may ~~are likely to~~ arise from the Project, including any not explicitly identified in the Terms of Reference.

Regulations require that Draft Terms of Reference for the Environmental Assessment Report be prepared by the Environmental Assessment Administrator and subsequently be made available for public review and comment prior to being finalized and provided to the Proponent (Northern Pulp).

This document presents the Draft Terms of Reference for public review and comment. The Minister of Environment invites interested Nova Scotians to examine the Draft Terms of Reference and provide comments on their adequacy and suggestions for their modification. **Only those comments related to specifics of the Terms of Reference will be used to inform the finalization of the Terms of Reference through this process. As required by the Environmental Assessment Regulations, the company must be advised of comments received through this process.**

Comments should be submitted in writing through the EA website at https://novascotia.ca/nse/ea/comments.asp, by email at EA@novascotia.ca or by mail to the following address on or before **February 7, 2020**, and addressed to:

Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442, Halifax, Nova Scotia B3J 2P8
EA@novascotia.ca

[TABLE OF CONTENTS REMOVED]

1.0 INTRODUCTION

1.1 Background

The Replacement Effluent Treatment Facility Project (the Project or undertaking) proposed by Northern Pulp Nova Scotia Corporation (Northern Pulp or the Proponent) was registered for environmental assessment (EA) as a Class 1 undertaking pursuant to Part IV of the *Environment Act* on February 7, 2019.

On March 29, 2019, the Minister of Environment determined that the registration information was insufficient to make a decision on the Project, and a Focus Report was required in accordance with clause 13(1)c of the Environmental Assessment Regulations, pursuant to Part IV of the *Environment Act*.

On October 2, 2019, Northern Pulp submitted the Focus Report for EA, in accordance with Part IV of the Environment Act. Public comments on the Focus Report were accepted until November 8, 2019.

On December 17, 2019, the Minister of Environment concluded that Northern Pulp would be required to complete an Environmental Assessment Report (EA Report) on this Project.

1.2 Purpose of the Terms of Reference

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an EA Report) to be provided to address gaps or deficiencies in the required information.

The purpose of this document is to identify for Northern Pulp the information requirements for the preparation of an EA Report. Northern Pulp is expected to prepare an EA Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The EA Report must consider all the effects that ~~are likely to~~may arise from the Project, including any not explicitly identified in the Terms of Reference. The EA Report will be used to meet the requirements of a provincial Class I Undertaking.

Northern Pulp must include in its EA Report all the information requested within the Terms of Reference, as a minimum, in accordance with the Environmental Assessment Regulations pursuant to Part IV of the *Environment Act*. The Terms of Reference include Valued Ecosystem Components (VECs) which must be adequately addressed in the EA Report. While the Terms of Reference provide a framework for preparing a complete EA Report, it is the responsibility of the Proponent to provide sufficient data and analysis on any potential environmental effects of the Project to permit a proper evaluation by governments, the Mi'kmaq of Nova Scotia and the public.

The EA Report is expected to provide a comprehensive and complete assessment of the potential effects of the Project, presented in a clear format that can easily be reviewed by the Minister, governments, the Mi'kmaq of Nova Scotia and the public. If the Minister decides to refer the EA Report to an EA Review Panel for review, the EA Report will serve as the cornerstone of the Panel's review and evaluation of the potential effects of the Project and thus must be a stand-alone document. The EA Report will also allow governments, the Mi'kmaq of Nova Scotia and members of the public to understand the Project, the existing environment, and the potential environmental effects of the Project.

1.3 Proposed Project

This Section is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document (EARD). In response to this Draft Terms of Reference, Northern Pulp is required to provide information on any changes to the Project as a result of the *Boat Harbour Act* deadline. The Northern Pulp Northern Bleached Softwood Kraft pulp mill is located at Abercrombie Point adjacent to Pictou Harbour in Pictou County, Nova Scotia (NS). The proposed Project consists of the development of a new effluent (wastewater) treatment facility (ETF) constructed on Northern Pulp property, and a transmission pipeline that will carry treated effluent overland and in the marine environment and discharge via an engineered diffuser (marine outfall).

The ETF is proposed to employ the AnoxKaldnes BAS™ Biological Activated Sludge process purchased from Veolia Water Technologies, which combines Moving Bed Biofilm Reactor (MBBR) technology with conventional activated sludge. Once treated onsite at Northern Pulp's facility, effluent is proposed to be sent through an approximately 15 km long pipeline, of which approximately 8.7 km is included in the overland section. An additional land-based section of effluent pipeline, less than 1 km will be installed on mill property as a part of the ETF design by KSH Solutions. Approximately 1.5 km of the treated effluent pipeline will follow a marine crossing in Pictou Harbour adjacent to the Pictou Causeway. The land-based section of the pipeline begins on the north side of Pictou Harbour where it enters the Nova Scotia Department of Transportation and Infrastructure Renewal's (TIR's) Highway 106 right-of-way (ROW) and runs generally north, parallel to Highway 106, along the outermost eastern portion of the ROW toward Caribou, NS. The pipeline will then travel through the marine environment to the proposed outfall location approximately 4.0 km offshore within the Northumberland Strait.

1.4 Environmental Assessment Requirements

The Project is a Class I Undertaking pursuant to Schedule A of the Environmental Assessment Regulations made under Section 49 of the *Environment Act*. In accordance with Section 18(b) of the Environmental Assessment Regulations, the Minister of Environment has determined that an EA Report is required.

The Environmental Assessment Regulations require that the proposed Terms of Reference for the EA Report be prepared by the EA Administrator (Administrator) and made available for public review. Public comments on the Draft Terms of Reference will be accepted from January 8 – February 7, 2020.

All comments will be provided to Northern Pulp within 5 days of the end of the comment period. Northern Pulp will then have 21 days to respond in writing to the comments. Within 14 days from the final date for written response from Northern Pulp, the Final Terms of Reference for the EA Report shall be provided to Northern Pulp.

The Proponent is required to submit the EA Report within 2 years of receipt of the Final Terms of Reference. If the EA Report does not meet the Terms of Reference, Northern Pulp will be required to include further information before the EA Report can be accepted. Upon acceptance of the EA Report,

Nova Scotia Environment (NSE) has 14 days to publish a notice advising the public where the EA Report can be accessed for review and comment.

Once the EA Report has been accepted, the Minister has the option to refer the EA Report to an EA Review Panel for review. At the conclusion of this process, the Minister has 3 decision options: a) the undertaking is approved with conditions; b) the undertaking is approved without conditions; or c) the undertaking is rejected.

1.5 Access to Information for the Environmental Assessment Process

Copies of the Draft Terms of Reference for the Preparation of the EA Report may be examined at the following locations:

- Pictou Library, 40 Water Street, Pictou, NS
- New Glasgow Library, 182 Dalhousie Street, New Glasgow NS
- EA website https://www.novascotia.ca/nse/ea/

All information pertaining to this portion of the EA review will be posted to the EA website as it becomes available.

It is recommended that the proponent make all reports and supporting documents developed in connection with the EA Report available to the public for review as soon as each report or document is completed.

2.0 PREPARATION AND PRESENTATION OF THE ENVIRONMENTAL ASSESSMENT REPORT

Pursuant to the Environmental Assessment Regulations, the EA Report must include, but not be limited to, the following information:

- a description of the proposed undertaking;
- the reason for the undertaking;
- other methods of carrying out the undertaking;
- a description of alternatives to the undertaking;
- a description of the environment that might reasonably be affected by the undertaking;
- the environmental effects of the undertaking, including identifying any effects on species at risk, species of conservation concern and their habitats;
- an evaluation of advantages and disadvantages to the environment of the undertaking;
- measures that may be taken to prevent, mitigate or remedy negative environmental effects and maximize the positive environmental effects on the environment;
- a discussion of adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technology;
- a program to monitor environmental effects produced by the undertaking during its construction, operation and abandonment phases;
- a program of public information to explain the undertaking; and
- information obtained under subsection 19(2) which the Administrator considers relevant.

The information obtained under subsection 19(2) shall be prepared taking into consideration comments from:

- the public;
- departments of Government;
- the Government of Canada and its agencies;
- municipalities in the vicinity of the undertaking or in which the undertaking is located;
- an affected aboriginal people or cultural community; and
- neighbouring jurisdictions to Nova Scotia in the vicinity of the undertaking.

In preparing the EA Report, Northern Pulp shall refer to comments from the above-noted parties during the EA review of both the EARD and the Focus Report submitted by Northern Pulp to NSE, to identify and include the supplementary information required to provide a comprehensive and complete assessment of the potential effects of the Project. The EA Report must be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence-based and supported by credible sources of information. This report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report. Northern Pulp is expected to prepare an EA Report that fulfils the intent of the Terms of Reference and considers all the effects that ~~are likely to~~may arise from the Project, including those not explicitly identified in the Terms of Reference.

The order in which information is presented is at the discretion of the Proponent; however, a concordance table will be required to indicate where the information can be found. In the event that the Minister has decided to refer the EA Report to an EA Review Panel for review, the Proponent may provide additional information to assist the EA Panel in making their recommendation to the Minister and assist the Minister in making the decision for the Project. Such additional information must also be made available to the public in a reasonable and timely manner.

Since the EA Report is intended for public review, the information should include an Executive Summary presented non-technical language. The Proponent will be required to submit an electronic copy of the EA Report in accordance with the EA Branch Bulletin on Requirements for Submitting Electronic Copies of Environmental Assessment (EA) Documents for publication on the Department's website.

In the EA Report where documents information and reports are referenced or relied upon copies shall be appended or working weblinks to current electronic versions shall be provided.

All maps and charts included in the EA Report or supporting reports shall use and provide coordinates in a manner that is understandable and accessible to the public without specialized surveyor knowledge (i.e. using standard latitude and longitude coordinates in addition to GPS and UTM references).

The EA Report must include, but not be limited to, the following information, as identified under the corresponding sections.

3.0 PROJECT DESCRIPTION

Nova Scotia Environment expects Northern Pulp to provide information, as part of its comment on the draft Terms of Reference, about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes, if any, may affect the Terms of Reference.

Describe each component of the Project as it is planned through its full life cycle, including site preparation, construction, commissioning, operation, maintenance, and decommissioning, and also including malfunctions, accidents, spills, service disruptions, re-starts and unplanned events:

- changes to existing mill infrastructure, mill site, and in-mill improvements;
- effluent treatment facility (ETF);
- land-based sections of pipeline; and
- marine based sections of pipeline and the diffuser.

Where final decisions have not been made in regard to an element of Project design, or several options exist for a particular component or activity, the assessment of effects of that element of the Project on the environment should be conducted at the same level of detail for all available options.

3.1 The Proponent

Outline the Proponent's corporate commitment to sustainable development and environmental protection goals and principles including pertinent corporate policies, programs, plans, strategies, protocols, guidelines, codes, and environmental management systems (EMS).

Provide summary information on the nature of the management structure and organizational accountability for designing, constructing, operating and modifying the Project; implementing environmental mitigation measures and environmental monitoring; and managing potential adverse environmental effects.

Provide details on relevant corporate experience (the Proponent and related companies) and experience in building and operating other similar facilities. Provide a record of the environmental performance and capability of the Proponent in conducting this type of Project.

3.2 Project Location

Provide a concise description of the geographical setting in which the Project is to be constructed/operated. Describe how the Project site was chosen, including a discussion of the specific environmental considerations used in site selection of all Project components, and the advantages of the proposed site. Describe the Project's compatibility with existing local and regional land-use policies and plans, as well as existing uses of freshwater bodies and the marine areas, and opportunities to integrate Project planning into regional scale development efforts. Discuss compatibility of the Project location in relation to people and their community and traditional activities and land uses by the Mi'kmaq of Nova Scotia.

Describe the ultimate boundaries of the Project in a regional context including existing and proposed land uses and infrastructure such as road networks, highway realignment, railways, power lines, pipelines, proximity to permanent and seasonal residences, individual and community water supplies, wetlands, water bodies, streams, ecologically sensitive areas, and archaeological sites. Include mapping at an appropriate scale.

Provide details on ownership of property within the Project footprint including lands owned by the Proponent, the Crown, or private lands. Provide details of existing agreements to develop the Project on lands not owned by the Proponent. Provide detailed plans for the required acquisition or use of private lands and Crown Lands and discuss any contingencies should these lands not be available for Project development.

Provide a list and map of communities in the region, including Mi'kmaq communities, potentially affected by the Project and indicate the distance between those communities and the specific Project components as appropriate. Identify proposed local shipping routes for importing and exporting products.

Provide a detailed description of the mill site and property at Abercrombie Point, including historical and current uses of the site, and a comprehensive description of current environmental conditions and environmental issues associated with past activities and operations at the mill or on the Abercrombie Point site. The description shall include all known or suspected spills and contaminants historical or recent, present on or under the site, along with detailed information as to their extent, precise location, depth concentration mobility and composition and shall be depicted in detail on appropriate maps charts and diagrams.

3.3 Project Design and Components

Describe the design plans and appropriate design standards for all Project components, associated and ancillary works, and other characteristics that will assist in understanding the Project, including: changes to the mill site existing mill infrastructure and in-mill improvements, ETF, land-based sections of pipeline, and marine based sections of pipeline and the diffuser. All associated infrastructure and components must be detailed. Also discuss environmental controls planned for the Project and how environmental protection, conservation, best management practices (BMPs), and best available technology have been considered in the design.

Provide potential design variations and implications (including advantages or disadvantages to the environment) of those variations. Describe any assumptions which underlie the details of the Project design. Where specific codes of practice, guidelines and policies apply to items to be addressed, those documents shall be cited.

For the EA Report, all site-specific data must be collected using equipment installed, operated, maintained and calibrated as specified by the manufacturer's instructions. All samples are to be collected, preserved and analyzed, by qualified personnel, in accordance with recognized industry standards and procedures and at accredited laboratories. Data shall undergo quality assurance and quality control (QA/QC) processes. The standards and procedures used for all data collection, sampling and testing programs shall be appended to the EA Report, along with field and laboratory notes, logs and reports.

In addition to the above, this section will include, but not be limited to information on the following Project design components:

Changes to Existing Mill Infrastructure and In-Mill Improvements

- Preliminary design overview for any in-mill improvement projects necessary to achieve the design assumptions for the Project (e.g., in-mill cooling towers);
- Preliminary design overview of other projects that interact with the performance of the ETF (e.g., oxygen delignification) with sufficient detail to identify with precision the particular design and specifications of each such "other project" and a schedule for these projects relative to the proposed ETF construction schedule;~~ and~~
- A waste dangerous goods management plan to accommodate for worst case scenario within design of the proposed ETF. It is important to note that the ETF is not proposed to treat waste dangerous goods based on the information provided in the EARD and in accordance with requirements of NSE; and~~.~~
- A waste dangerous goods management plan or environmental protection plan for the mill site as a whole addressing future disposal of run-off and other sources from locations on the mill site which are or have been discharged through the effluent stream.

Effluent Treatment Facility (ETF)

- Footprint, location and preliminary designs for the ETF;
- Equipment description and specifications, including appropriate diagrams and flow charts for the proposed ETF and infrastructure components;
- Details (including characteristics and toxicities) and quantities of all products produced, stored, and imported to and exported from the facility (including by-products and chemical intermediaries);
- Justification of spill basin size and appropriateness of multi-purpose usage. Consider worst-case scenarios and requirements under the Dangerous Goods Management Regulations;

- Proposed design for management of mill site run-off landfill run-off leachate and other wastes generated by the site and mill operations;
- Proposed design for the spill basin, including but not limited to, management and disposal of contaminated material that may be present at the site, liner details, secondary containment features, clean-out access and connection to the mill infrastructure and ETF;
- Submit additional data regarding the complete physical and chemical characterization of NPNS' raw wastewater at Point A (as defined in EARD and Focus Report), to support the assessment of the appropriateness of the proposed treatment technology. The sampling data for complete characterization (i.e., broad chemical analysis) must be statistically relevant and adequately represent ETF influent for all ~~various~~ operating conditions that may exist at the mill (e.g., seasonality, flow rates, changes in sources of fibre or production, accidents, system disruptions, spills, malfunctions, start-up and shut-down cycles, etc.);
- Using NPNS' raw wastewater characterization results, identify and e~~e~~valuate all contaminants of potential concern (COPCs) and all persistent organic pollutants (POPs), with respect to the effluent discharge quality following treatment using the proposed technology. This statistically relevant assessment shall include, but not be limited to, bench-scale testing of the mill's actual Point A effluent. Provide results of all expected COPCs, POPs and influent and effluent concentration ranges. Include chemical oxygen demand (COD) fractionation (soluble and total) concentrations in the assessment;
- Comparison of the effluent characterization results from the above assessment with appropriate regulations and/or guidelines, including the draft Pulp and Paper Effluent Regulations (PPER) daily and monthly average limits;
- Effluent flow data to support the proposed peak treatment capacity of 85,000 m^3 flow of effluent per day using actual daily flow data from Point A over a minimum 1-year period;
- Provide analysis and documentation showing past exceedances from 2015-2020 of COD and ~~I~~information regarding how the facility will achieve compliance with COD influent and effluent limits once the in-mill changes and ETF are operational; and
- Evaluation of sludge disposal options and management plans, including the rationale for the preferred option. If the preferred option uses the biomass boiler, provide a secondary disposal option.
- Provide details of all operational conditions which have the potential to compromise the effective functioning of any component of the proposed new ETF and how any compromised function will be detected in a timely manner, the potential length of time any system or function could be compromised, and how materials in process, including effluent and other processing substances, will be addressed until system function is fully restored.

Land-Based Sections of Pipeline Route

- Information on corridor width requirements, accounting for minimal possible corridor width requested by TIR;
- Appropriate, intrusive geotechnical survey results to support proposed pipeline construction methods;
- Risk assessment of pipeline design, including the following:

- An evaluation of the probability of a potential leak, spill or release from the pipeline installation and its operation, based on a literature review and on comparable design.
  - Identification of points of the system that are susceptible to failure.
  - Based on the risk assessment, a suitable secondary containment system (e.g., a double-walled pipeline system) and proposed locations. Secondary containment is at a minimum required within the Town of Pictou's water supply protection area;

- Preferred option(s) for both external and internal leak detection technologies for all sections of the on-land pipeline, with specific consideration to any section of the pipeline located in the Town of Pictou's water supply protection area and near private supply wells. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline;

- Maps, at an appropriate scale of the Project location and pipeline route that show Project components, boundaries with UTM coordinates, major existing infrastructure, important environmental features, and adjacent land uses that will intersect with the pipeline route (e.g., road networks, railways, power lines, pipelines, proximity to settled areas, individual and community water supplies, watercourses, wetlands, ecologically sensitive areas, priority flora and fauna and archaeological sites); and

- A list of all properties (i.e., Parcel Identification Numbers) that will intersect with the pipeline route.

Marine Based Sections of Pipeline Route

- Selected options for both external and internal leak detection technologies for marine sections of the pipeline. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline for all times of the year including during periods of inclement weather and/or winter ice cover;

- Identify all sections of the marine pipeline that are at risk of damage, rupture or failure, including but not limited to the points where the pipeline transitions from a land-based to a marine environment and all points along the marine route where the pipeline may be exposed to ice ice grounding storm and wave risks and

- Maps, at an appropriate scale, detailing: the Project location, the Project components (e.g., confirmed locations of marine sections of the proposed pipeline including diffuser), boundaries of the proposed site with UTM coordinates, the major existing infrastructure, adjacent land and sea uses that will intersect with the pipeline route, and important environmental features (e.g., spatial and temporal marine habitat distribution, marine refuge (Scallop Buffer Zone 24), etc.). Map coordinates should be provided in a manner that is understandable and accessible to the public without specialized surveyor knowledge (i.e. using standard latitude and longitude coordinates).

3.4 Construction

Describe in detail the construction of all Project components and supporting infrastructure. This will include but not be limited to:

- Proposed construction schedule for all Project components (including those mentioned in Section

3.3 of the Terms of Reference), including days of the week, times of the day, seasonal schedules and anticipated commencement and completion dates;

- All physical works and activities carried out during the construction phase are to be identified and described by location. This, includes but is not limited to: clearing and grubbing; blasting; site access and roadways; marine construction methods; road construction methods; dangerous goods storage areas; disposal at sea; watercourse crossings or diversions; utilities; and description of equipment used for construction activities, both terrestrial and marine;

- Dredge management/disposal plans that characterize and quantify marine sediments to be dredged and disposed (or re-used) in accordance with Environment and Climate Change Canada (ECCC) standards and in consultation with relevant government departments. Identify areas where dredging activities will occur, and provide methodology for identification and avoidance of all sensitive marine areas. Identify the location, quantity and chemistry of any dredge materials that are expected to require land-based disposal and evaluate the impact of disturbance of soil and resulting sedimentation during and after excavation/construction;

- Evaluation of pipe jacking feasibility where crossing roads or structure locations that includes addressing limitations associated with practical pipe length at crossings and available space for thrust/reception pits on either side of crossings;

- Evaluation of the effects of excavating and replacing large rock fill along the alignment route near Harvey A. Veniot Pictou Causeway;

- Storage areas for fuels, explosives and dangerous goods; and

- Waste disposal plans (types of waste, methods of disposal, quantity).

3.5 Operation

Describe the operation of all Project components and supporting infrastructure to all components. The description of the operation shall include but not be limited to the following:

- Routine and maintenance operations for all Project components;

- Environmental controls and BMPs, including pollution prevention techniques in addition to traditional treatment and disposal practices;

- A spill basin management plan that proactively addresses the management of different types of materials, including compatible and non-compatible waste dangerous goods, sequential spills/leaks/releases, clean-out and liquid/solid removal procedures for the different types of collected materials, and appropriate final disposal procedures that observe applicable provincial and federal regulations; and

- A plan to ensure adequate staffing and operation oversight of ETF by trained personnel at all times.

3.6 Decommissioning and Reclamation

Describe the proposed plans for decommissioning the Project, including all infrastructure and reclamation of any impacted site. The EA Report shall also discuss the post-decommissioning land use options of the property.

4.0 REGULATORY ENVIRONMENT

Describe the existing regulatory environment (Federal, Provincial and Municipal) including all permitting, licensing and regulatory requirements that apply to all phases of the Project and associated infrastructure. Provide a schedule indicating anticipated dates for required regulatory approvals.

Significant portions of the proposed Project to be evaluated by the EA Report are located on federal lands; therefore, federal authorities have indicated that they must make a determination as to whether the Project is likely to cause significant adverse effects and/or in the case of Public Services and Procurement Canada (PSPC) seek an Order in Council prior to providing authorizations, licenses, or leases. To ensure potential environmental effects are addressed to the satisfaction of federal authorities under Section 82 of the *Impact Assessment Act*, provide a detailed list of all necessary authorizations, licenses, or leases for all applicable federal authorities and the proponent's plan and estimated timelines to apply for all such instruments and receive decisions.

Describe all applicable guidelines and standards that would apply to the Project and provide copies of, or links to all such materials. Where there is a choice as to which standard to apply the content of each standard and the advantages and disadvantages of using each standard shall be examined and a detailed justification shall be provided as to why a particular standard has been chosen. Those applicable standards or guidelines shall also be referenced in the appropriate sections of the EA Report and linked to environmental protection objectives.

Commented]: It is unclear what is meant by "environmental protection objectives" and how and why they need to be linked to applicable standards and guidelines.

5.0 NEED FOR AND PURPOSE OF THE PROJECT

The need for and purpose of the Project should be established from the perspective of the Proponent. The Project is being designed to meet specific objectives and these objectives should be discussed. If the objectives of the Project are related to or contribute to a larger private or public sector policy, program or plan, this information should be included.

6.0 DESCRIPTION OF ALTERNATIVES TO THE PROJECT

Include an analysis of alternative means of carrying out the Project; describing functionally different ways to meet the Project need and achieve the Project purpose. The analysis shall include examination of the full range of factors, benefits and drawbacks relating to use of alternative and new technologies, including those that would not require effluent treatment and discharge of effluent and other emissions into the environment. Alternatives will be considered in terms of all relevant factors including but not limited to their relative effectiveness in preventing or controlling adverse environmental effects and shall not be evaluated solely as to their relative profitability for the proponent.

7.0 OTHER METHODS FOR CARRYING OUT THE PROJECT

Discuss other methods for meeting the need for the Project, including but not limited to, pipelines and treatment technologies. This section shall also discuss alternate locations for the Project and alternative pipeline routes and discharge sites.

The rationale for rejecting other described methods of carrying out the Project must be provided, including a discussion of how environmental sustainability and impact avoidance criteria were applied.

8.0 ASSESSMENT METHODOLOGY

Include the study strategy, methodology and boundaries used for preparing the EA Report. The following must be clearly defined:

- Temporal boundaries (i.e., duration of specific Project activities and potential impacts) for construction and operation through to decommissioning and post-decommissioning;

- The study area (also referred to as "study boundaries" and "Project area") shall include ~~Study boundaries or Project area and~~ all space that will be potentially impacted, by the Project as proposed, or subject to subsequent modifications, and the methodology used to identify the study area~~boundaries~~; at a minimum the study area is to include terrestrial areas encompassing and in proximity to, the mill site and the overland pipeline route, all terrestrial areas that could be impacted by an effluent leak or spill from the overland pipeline, all sections of the marine pipeline route and the near and far field marine areas as set out in NPNS' previous receiving water study models;

For greater certainty, the study area shall include, *inter alia*, any areas and ecosystems that will come into contact with the mill's air emissions effluent and suspended solids at any quantity or concentration. The marine portions of the study area shall include at a minimum Caribou Harbour, Caribou Channel, Pictou Harbour, Pictou Island, Munroe's Island, Pictou Road, Pictou Landing, Boat Harbour, the coast of Nova Scotia from Cape John to Arisaig, the coast of Prince Edward Island from Point Prim to Murray Harbour and the Northumberland Strait within and between all such areas.

- Valued Ecosystem Components (VECs) within the study boundaries and the methodology used to identify the VECs. The methodology used for VEC identification shall include input from members of the public, government departments and agencies, other experts, and other interested parties, as well as direct engagement with the Mi'kmaq of Nova Scotia;

- Where appropriate, identify environmental protection objectives (including those contained in applicable legislation or guidelines) associated with each VEC;

- Strategy for investigating the interactions between the Project and each VEC and how that strategy was used to coordinate the individual studies undertaken; and

- Method for predicting and evaluating Project impacts upon the environment; determining necessary avoidance, mitigation, remediation and/or compensation (in this order of consideration); and determining the significance of any residual impacts.

The EA Report is to be prepared using an accepted and proven EA methodology and a qualified person should predict and evaluate Project impacts upon the environment. If there are no predicted effects to a specific VEC, provide reasons to support that claim. A complete discussion and analysis of predicted effects (direct and indirect effects) should be provided that is qualitative and quantitative, evidence-based and supported by credible sources of information. Provide a list of literature and sources used in the preparation of the EA Report.

The following sections outline specific concerns and requirements related to the existing environment, adverse effects and environmental effects assessment, proposed mitigation, residual environmental impacts, proposed compliance and effects monitoring, and the public information program that are to be addressed in the EA Report for the proposed Project.

Commented]: These TOR do not, and should, provide a mecnanism for obtaining public input and how the proponent is required to use he public input to identify VECs

Commented : As per the comment above, it is unclear what is meant by "environmental protec ion objectives". In this context, it is also not clear how to determine what would constitute an "appropriate" context within which to iden ify them in relation to each VEC.

9.0 EXISTING ENVIRONMENT

Provide a baseline description of the environment in the vicinity of the Project and all other areas that could be impacted by the Project. This description must include the components of the existing environment and environmental processes, their interrelations and interactions, as well as variability in these components, processes and interactions over time scales appropriate to the effects assessment. The Proponent's description of the existing environment shall be in sufficient detail to permit the identification, assessment and evaluation of the significance of potentially adverse environmental effects that may be caused by the Project.

The EA Report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report, considering comments on those documents during their respective EA review processes. The EA Report shall be a stand-alone document that presents a complete discussion and analysis of potential and predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence- based and supported by credible sources of information. Supplementary information shall be included to provide a comprehensive and complete assessment of the potential effects and may provide additional information to assist the EA Panel in making their recommendation to the Minister in the case of a panel review and to assist the Minister in making the decision for the Project.

The EA Report shall clearly indicate baseline data/information which is not available or where existing data cannot accurately represent environmental conditions in the ~~Project~~ study area. If the background data have been extrapolated or otherwise manipulated to depict environmental conditions in the ~~Project~~ study area, modelling methods and equations shall be described and shall include calculations of margins of error.

For the EA Report, the spatial boundaries must include the Project footprint and relevant receiving environments such as airsheds and watersheds. Temporal boundaries must address applicable guidelines, standards and regulatory requirements and include Project construction, operation, decommissioning and post-decommissioning.

The Proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. Where technical reports are included or referenced, they must be finalized and signed by the qualified individual(s). Also provide the name and credentials of the person(s) conducting baseline studies/surveys. Mapping clearly indicating the extent of studies/surveys, sampling points, and illustrating key findings should also be included and presented logically within the EA Report in a location that allows for ease of review. Wherever possible, mapping should be presented at common scales and datum to allow for comparison and overlap of mapped features.

The components of the environment to be discussed shall include identified VECs and those indicated within Sections 9.1 – 9.8.

9.1 Geophysical Environment

9.1.1 Topography, Geomorphology and Geology

Topographical maps should be provided locating the Project in both regional and local contexts. Describe the physical geography of the Project study area including post-glaciated landforms, coastal features, and marine features.

9.1.2 Geology

Include a description of bedrock geology, surficial geology and soils. The results of the geotechnical survey referenced in Section 3 of the Terms of Reference should be included. Geological properties of all Project sites in the study area which may influence stability, occupational health and safety, rehabilitation programs, or the quality of discharge water leaving any area disturbed by the Project should be described. The EA Report must consider the potential for Acid Rock Drainage/Metal Leaching (ARD/ML) where new bedrock may be exposed and/or excavated.

The marine component of the Project should also include a discussion pertaining to surficial sediment characteristics and mobility under present and future environmental conditions. This section should also identify any mineral resources that may be impacted by the Project.

9.2 Water Resources

Include a description of groundwater, surface water, marine water and wetland resources that may be ~~potentially~~ affected by the Project.

9.2.1 Groundwater

Provide a description of the regional and local hydrogeology of the study area. A discussion of groundwater use in the study area, including both current and likely potential future uses must be provided. Provide a map showing all water supply wells locations and potentially affected watercourses within 500 metres of the pipeline route.

9.2.2 Surface Water

Provide a general hydrologic, hydraulic and water quality description of all surface water bodies in the study area, including upstream and downstream to all Project components. Existing uses, withdrawal capacities, and users of the watercourses shall be identified, including use by the Mi'kmaq of Nova Scotia.

9.2.3 Marine Water

Provide baseline studies that characterize environmental conditions for all seasons and conditions, on a bi-weekly basis, ~~the four seasons~~ over a minimum of one year for the marine environment, including: climate, water quantity (e.g., current profiles, water column stratification wave height, tide levels), water quality (e.g., temperature, salinity, nutrient levels chemical and physical water quality), and marine sediment chemical characterization in the vicinity of proposed marine outfall location, the near-shore, coastal, island and harbour areas, and over the full study area at multiple locations. These studies shall include characterization of both normal and extreme and/or atypical environmental conditions (e.g. extreme high or low tides water levels detailed localized and overall currents and water flows water and air temperatures, wave heights, wind, storms and ice). These studies must be conducted to the satisfaction of relevant government departments and are to be used to support modeling activities.

Provide marine sediment chemical characterization along the proposed marine based pipeline section routes and over the full study area at multiple locations. Marine sampling locations must be clearly identified and justified.

Marine sediment characterization must include a survey to detect and assess existence of algal blooms and/or algal cysts in the Northumberland Strait throughout the full study area at multiple locations. The survey should be conducted over all 4 seasons and for a minimum duration of 2 years. Sampling locations must be recorded. A plan should be in place for ongoing and regular routine sampling following construction.

Conduct an intrusive marine geotechnical investigation in the areas identified to have potential bedrock of uncertain depth and along proposed route near base of Harvey A. Veniot Pictou Causeway.

Provide a comprehensive sea ice baseline study including detailed bi-weekly measurements over two winter seasons as to ice depth extent movement ice grounding ice scour shoreline accumulation and duration of ice cover as well as predicted changes over the projected lifespan of the proposed ETF for the study area at multiple locations. The study shall also include and assess all existing data (from all relevant sources) on sea ice in the study area since 1990.

~~n ice scour baseline study for at least two winter seasons.~~

9.2.4 Wetlands

Identify the location, size and class(es) of any wetland and/or wetland complexes within the predicted zone of influence and conduct a wetland evaluation. Evaluation of the wetlands shall include wildlife habitat potential (including rare and endangered species), groundwater recharge potential, role of the wetland in surface water regulation (stormwater retention and flood control) and the role of the wetland in watershed health. Based on the results of the evaluation, the EA Report must specifically identify wetlands that:

- Support a significant species or species assemblages;
- Support high wildlife value; and/or
- Have high social or cultural importance.

Describe all work activities and predict the effects (direct and indirect), with supporting rationale, on impacted wetland and wetland functions.

Wetland evaluations shall include additional assessment of adjacent wetland areas and anticipated extent of impacts associated with construction activities. The wetland evaluation must include identification of assessment areas and catchment areas used in the evaluation and include any associated outputs or assessment scoring outputs.

Baseline studies must describe and document pre-construction conditions, including, but not limited to, wetland class distribution, vegetation community structure, soil characteristics, and hydrology trends.

9.3 Atmospheric Resources

Atmospheric resources will include ambient air quality, the acoustic environment, greenhouse gas emissions, and impacts on climate.

9.3.1 Climate

Include a discussion of regional climate conditions and meteorology in the vicinity of the Project as well as expected changes over the next 50 years due to climate change. This section should include climate norms, extreme conditions, as well as trends in these conditions and climate change impacts, as well as the effect these changes may have on the Project and plans to mitigate against those impacts.

In addition to historical and projected climate data, the climate sub-section of the existing environment should include a summary of greenhouse gas emission projections for the Project, including plans to mitigate those emissions in both the design and operation.

Please follow the EA guidance documents when completing this section:
https://novascotia.ca/nse/ea/docs/Development.Climate.Change.Guide.pdf.

9.3.2 Air Quality

For the study area, provide a review of baseline ambient air quality and meteorological data, including annual and seasonal climatic conditions for the region.

Provide a description of existing ambient air quality conditions for the study area, with particular attention to ambient and peak levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O3), particulate matter (total suspended particulate (TSP), fine particulate matter (diameter less than 2.5 microns) ($PM_{2.5}$) and coarse particulate matter (diameter less than 10 microns) (PM_{10}), total reduced sulphur (TRS) and volatile organic compounds (VOCs) levels.

Discuss the influence of local and regional emission sources and the influence of climate and weather conditions. The data should be used for the development of an appropriate model(s) for the study area to be provided in the EA Report.

Also describe any potentially sensitive receptors and/or locations. The EA Report shall expressly define the term "receptor" and will describe the steps taken to evaluate the existence of potential receptors in relation to stated and justified criteria. The criteria shall be drawn from relevant and current scientific literature which will be cited and access to copies or weblinks provided.

9.3.3 Ambient Noise and Light Levels

Describe the existing ambient acoustical environment at the Project site (including the marine environment), and in any other areas where Project activities could be expected to have an environmental effect.

Provide the spatial boundaries of existing noise and vibration levels, as well as locations of recording stations and length of record for any acoustic or vibration data presented. Consider the effects of different meteorological conditions on noise propagation. Provide information on any existing relevant standards, guidelines or objectives with respect to noise and vibration levels.

Describe existing ambient light levels at the Project site and at any other areas where Project activities could have an environmental effect on light levels. Describe night-time illumination levels during different weather conditions and seasons.

9.4 Flora and Fauna

Identify flora, fauna, and habitat types that will be intersected by all components of the Project. Appropriate field surveys agreed to by Nova Scotia Lands and Forestry (NSLAF) – Wildlife Division, shall be conducted as part of the evaluation over all four seasons. Surveys ~~should~~ shall be described by results, methodology, and spatial and temporal boundaries.

9.4.1 Terrestrial Environment

This section must include, but not be limited to the following:

- Identification of typical species of flora, sensitive flora, flora species-at-risk, and potential habitat for flora species-at-risk in the study area;
- Identification of areas of old growth forest. Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; the Nova Scotia Museum of Natural History, and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to NSLAF – Wildlife Division. Available data, survey results, and detailed mitigation measures that demonstrate a special emphasis on avoidance of impacts shall be included in the EA Report;
- Identification of any existing or planned wildlife management areas, ecological reserves or wilderness areas as well as managed wetlands and significant wildlife habitat;
- Identify and delineate on a map 'roadless areas' and discuss their potential value to Nova Scotia's protected areas network. Include areas with high wildlife concentrations, wildlife corridors or habitats rare/unique to Nova Scotia;

- Identification of typical species of fauna (including invertebrate species), sensitive fauna, fauna species-at-risk, and potential habitat for fauna species-at-risk in the study area. Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; Nova Scotia Communities, Culture and Heritage; the latest Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list; the Atlas of Breeding Birds of the Maritime Provinces; and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed by professional biologists in a manner that is acceptable to NSLAF – Wildlife Division and Canadian Wildlife Service;

- Additional migratory bird surveys at representative survey points along the pipeline route;

- Bird surveys transects to provide a complete view of bird species distribution and habitat use along the pipeline route, including transect bird surveys and fall migratory bird survey. Identification of nests of bird species, which are protected under the *Wildlife Act*, regardless of whether they are active or not must also be considered;

- Bird baseline survey for common nighthawk (*Chordeiles minor*), including rationale for survey point selection to the satisfaction of NSLAF;

- Raptor nest survey to identify nest locations for the entire ~~Project~~ study area including the pipeline route;

- Herptile survey for the ~~Project~~ study area, which includes the pipeline route, to include both spring and fall survey information. Prior to conducting survey, develop survey methodology in consultation with NSLAF; and

- When surveys are necessary to supplement the available data and adequately describe the use of the area by migratory birds during different times of the year (breeding season, migration, winter), emphasis will be placed on determining whether any bird species-at-risk, colonial nesting species, species particularly vulnerable to habitat fragmentation, etcetera, occur or breed in or near the study area.

9.4.2 Freshwater Aquatic and Marine Environment

This section must include, but not be limited to the following:

- Fish and fish habitat baseline surveys for the marine environment over the study area;

- Baseline survey and study of the abundance and health of all marine invertebrates, plankton and other marine ecosystem foundational species over the study area;

- Description of any freshwater fish or fish habitat that exists in any identified watercourse or any other receiving watercourse that may be impacted by the development. The description of these species and habitat should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish;

- Description the relative distribution and abundance of valued fish resource components within the ~~predicted zone of influence~~study area. Fish species, age, health, and diversity shall be described;

- Description of any seasonal variation in the location, abundance and activities of aquatic species shall~~ould~~ be included. Describe and identify key habitat features, such as spawning, rearing, nursery, feeding, migration and overwintering areas, as they occur within the Project area~~. Also describe the criteria utilized for determining the zone of influence this Project has on the fish habitat~~;

- Description of the marine habitat and species of fish, including pelagic and demersal finfish, shellfish, crustaceans, and marine mammals, as well as all marine invertebrates plankton and other benthic organisms and marine ecosystem foundational species likely to be present within the surrounding marine environment in the study area. The description of these species and habitats should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish and marine mammals;

- Baseline gene expression profiling study including but not limited to endocrine pathway genes for fish and shellfish.

- Baseline data for existing mercury concentrations in fish tissue and benthic invertebrates sampled in the study area that are adequate to be used for comparison purposes for impact monitoring programs. Provide data on total mercury in whole fillets accompanied by fish species and size data; and

- Baseline study for fish and shellfish tissue with chemical analysis that includes COPCs and POPs of representative key marine species including foundational species and invertebrates important for commercial, recreational and Aboriginal fisheries (food, social and ceremonial) in the vicinity of the proposed effluent pipeline and diffuser location, as well as over the study area at multiple locations. The locations of samples must be clearly identified and justified.

9.5 Agriculture, Aquaculture, Fishery and Forestry Resources

Identify and describe agricultural resources in the study area. Identify agricultural operations in the study area and describe crop types, growing seasons and growing methods.

Describe all commercial, recreational and Aboriginal fisheries (including food social ceremonial (FSC) as well as commercial), aquaculture, and harvesting (e.g., marine plants, shellfish) in the study area. Describe the commercial and recreational species, caught, grown or harvested, and their economic importance. Identify fishing, aquaculture and harvesting locations, the amount caught, and methods used. Describe also all uses of sea water for activities associated with fishing and fish processing.

Identify and describe forestry activities in the study area.

9.6 Socio-Economic Conditions

Describe the current socio-economic conditions of the study area, including population demographics and economic conditions (including Aboriginal Peoples). Provide details of employment rates and trends at the municipal and regional level. The spatial boundaries of this analysis should include areas within which employees of the Project are expected to reside. Identify key industries in the region (both land-based and marine-based) and describe their contribution to the local and regional economies. Provide details of residential and commercial property values. Describe any local and regional economic development goals and objectives identified through community consultation, or existing economic development plans and strategies.

9.7 Existing and Planned Land and Marine Area Uses

Describe the patterns of current and planned land use and settlement in the study area including residential, industrial, agricultural, tourist destinations, parks, and protected areas. Provide details of areas under existing mineral exploration licenses as well as areas licensed for pulpwood harvesting. Identify locations of abandoned mine workings, mine tailings and waste rock disposal areas, as well as contaminated sites. This section shall include map(s) to illustrate land uses and provide distances to significant settlements.

Describe the existing planned and potential marine uses of the area potentially impacted by the project.

The EA Report must also identify lands, including marine areas, and resources of special social, cultural or spiritual value to the Mi'kmaq of Nova Scotia, with particular emphasis on any current uses ~~of land~~ for traditional purposes. Past and historical land and marine area uses of the Mi'kmaq of Nova Scotia should also be identified including uses prior to creation of the Boat Harbour Effluent Treatment Facility. A Mi'kmaq Ecological Knowledge Study (MEKS) should be used to identify land, including marine areas, and resource use that have and/or continue to be pursued by the Mi'kmaq of Nova Scotia.

9.8 Archaeological Resources

Identify any land and marine areas containing features of historical, paleontological, cultural or archaeological importance in a manner acceptable to the Nova Scotia Communities, Culture and Heritage (CCH). Describe the nature of the features located in those areas. Particular attention shall be given to Mi'kmaq of Nova Scotia archaeological sites and burial sites. All heritage research permits acquired, and engagement with the Mi'kmaq of Nova Scotia during this analysis should be identified in the document. Results of the Archaeological Resource Impact Assessment reports related to Indigenous land use and known archaeological sites of interest to the Mi'kmaq, should be provided to the Office of Aboriginal Affairs and PLFN.

10.1 ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS ASSESSMENT

Describe the effects of the Project on the environment during all phases of the Project (construction, operation, and decommissioning and reclamation), including any environmental change on health, socio-economic conditions, archaeology, and the current use of land for traditional purposes by the Mi'kmaq of Nova Scotia. The EA Report shall identify and describe the accidents and/or malfunctions as well as any process changes, system disruptions, planned or unplanned shutdowns and start-ups, and associated or other changes in air, effluent and other emissions, that may occur during all phases of the Project, and assess the effects individual and cumulative on VECs.

Provide a detailed contingency plan that considers site-specific conditions and sensitivities, the lifespan of different components and current age and condition of existing equipment that will be operated in connection with the ETF, and includes, but is not limited to:

- Full hazard identification quantitative and qualitative risk assessment associated with Project construction and operation, including those which have or may have an environmental impact (directly or indirectly);
- Prevention, mitigation and contingency measures to mitigate potential Project impacts;
- Discussion of measures to mitigate potential impacts or damages on the environment, properties and human health (e.g., liability insurance, financial security, etc.);
- Emergency response procedures; Description and quantification of releases that could occur under both normal conditions and a 'worst-case scenario';

- Description the types, fate and distribution of contaminants within the study area under normal and worst-case scenarios during construction, operations and post-reclamation;

- Discussion of potential Project impacts on emergency and health services in communities near the ~~Project~~ study area, and associated mitigation and contingency measures in the events of major Project related accidents and malfunctions;

- Description of the cumulative effects of Project activities; and

- The effects assessment shall also consider impacts of the environment on the Project, ~~(~~including but not limited to impacts of weather and climate, and extreme events such as storms, extreme temperatures very high and low tides significant ice movement etc.) ~~on the Project,~~ The effects assessment shall include~~ing~~ a discussion of how potential climate change and associated ocean warming and weather changes ~~–~~will impact all components of the Project during the expected lifespan of the ETF.

Modelling

All models used to predict environmental effects and conditions shall be calibrated, set up, operated and interpreted in accordance with the applicable program manuals and established industry standards. The standards manuals and methodologies used and the steps taken to conduct all aspects of the modelling exercises must be set out and justified in detail in the applicable study discussing the modelling exercise and results. All aspects of each modelling exercise must be performed by qualified and trained personnel, and credentials for all personnel must be provided. All input data for all models must be included in the EA Report report package in appropriate useable formats such that the modelling exercises can be replicated by independent modellers using the same or comparable modelling applications.

Modelling studies shall discuss all available data, and data ranges, for all modelling conducted, and the selection of all particular input data for each model must be explained and justified. As well modelling of alternative scenarios shall be conducted using alternative input data and parameters also drawn from available baseline data (following compilation of the comprehensive data required by all sections of these terms of reference). The study shall detail efforts made to ensure that data is accurate and representative of actual and worst-case conditions in the entire study area over the full year in all seasons and in all conditions.

10.1 Geophysical Environment

Potential effects of the Project on the geophysical environment must be discussed in the EA Report.

The EA Report must also discuss the potential cumulative and residual effects of the Project on the geophysical environment and the significance of these effects.

10.2 Water Resources

In conducting the effects assessment on water resources, the EA Report must identify and evaluate:

- Changes in groundwater and surface water quality as a result of effluent discharges from the Project site;

- Potential effects on groundwater quality and quantity and associated impacts to users of groundwater;

- Potential cumulative and residual effects of the Project on water resources and the significance of these effects including ecosystem integrity and changes in hydrology to areas immediately adjacent to the ~~Project~~ study area;

- Where wetland avoidance is not possible, the EA Report must discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.

- The Canadian Council for Ministers of the Environment (CCME) Water Quality Guidelines with background water quality results ~~shall be used to ensure the protection of relevant water uses~~ (freshwater aquatic life, recreational use, agricultural use, and drinking water supply) ~~and~~ shall be used as a tool to assist in ~~the basis for~~ evaluating the significance of the predicted impacts on freshwaters;

- ~~And~~Compliance with all applicable legislation and regulatory standards must be discussed and clearly evaluated and demonstrated including compliance with the *Fisheries Act* and regulations made thereunder, including the *Pulp and Paper Effluent Regulations,* and the *Canadian Environmental Protection Act, 1999*, and regulations made thereunder, including but not limited to the *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations.*

- Any standard or guideline which the proponent seeks to apply to assist in evaluating adverse effects and environmental effects must be explained and its application justified and all requirements of each such standard or guideline must be fully examined, in relation to actual and predicted ecosystem conditions, sensitivities and uses. As stated above, complete copies of such standards or guidelines must be appended or linked in an accessible manner to the EA Report or individual supporting study.

- It is recommended Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Water Quality, be reviewed and applied in the evaluation where relevant.

10.2.1 Groundwater

Provide an assessment of the potential risk to groundwater resources associated with the construction and operation of the pipeline. The assessment shall include but is not limited to quantitative calculation of time of travel between the pipeline and water supply wells and watercourses, delineation of well capture zones and determination of groundwater flow directions. The results of this assessment shall be considered in the final pipeline design in terms of providing for greater protection in areas of greatest risk.

The groundwater assessment results need to be discussed with the Town of Pictou to establish confidence that the risk of negative impacts to the Town water supply has been reduced to an acceptable level.

10.2.2 Surface Water

In conducting the effects assessment on surface water resources, the EA Report must identify and evaluate:

- Potential effects to surface water quality on fish and fish habitat, community water supplies (protected and unprotected), and recreational and agricultural users.

10.2.3 Marine

Subject to the express requirements of these terms of reference, ~~T~~the proponent is ~~encouraged~~ required to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. In conducting the effects assessment on marine resources, the EA Report must identify and evaluate, to the satisfaction of relevant government departments:

- Marine pipeline construction methods along the full route and construction requirements (e.g., blasting), using results from geotechnical investigations;

- Adequacy of proposed pipeline burial depths with respect to ice scour and ice grounding;

- Geotechnical assessment of stability of underwater excavation works near base of Causeway with respect to causeway embankment and structures;

- Potential risk of impacts to the marine environment resulting from leaks from marine based sections of pipeline;

- Receiving water study that assesses fate and transport of COPCs and POPs in the receiving water environment for a range of scenarios reflective of conditions possible at the chosen site and over the full study area. Modelling shall include a detailed analysis of fate and transport including in coastal, near-shore, island and harbour areas, as well the more open areas of the Strait. This study shall identify potential short and long-term impacts. This study is to be completed using 3 dimensional modelling techniques and scenarios for all COPCs and POPs in the receiving environment, based on the results of the effluent characterization in Section 3.6 of the Terms of Reference and other relevant studies, such as Human Health Risk Assessment. All baseline climate and marine data (tides local and overall currents water flows waves water levels salinity ice cover temperature water column stratification freshwater inputs and all other dynamics as well as water quantity and quality data, including but not limited to conditions associated with seasonal changes and extreme weather events and dynamics), should be applied to this study for model setup, calibration and validation. Results shall include, but not be limited to, discharge plume dimensions and dilution ratios;

- Goodness of Fit and other appropriate industry-standard statistical procedures are to be applied to evaluate model adequacy in representing the receiving water environment for the calibration and validation periods. Assessment must be provided on the adequacy of the seasonal variation and lengths of observed datasets used in model setup and calibration/validation. A summary of model confidence in adequately representing multi-year effluent discharge transportation of COPCs and POPs and accretion/build-up within the receiving water environment is to be included;

- Potential build-up of COPCs and POPs resulting from the proposed activity (e.g., marine and shoreline accumulation) including but not limited to build-up of COPCs and POPs within marine plants and benthic invertebrates and subsequent biomagnification in the food chain). Provide the estimated dilution potentials at various distances from the diffusers based on calibrated model results as appropriate;

- In conjunction with the above, provide 3 dimensional sediment transport modelling, including model(s) and scenarios to assess the impacts of sediment transport within near-field and far-field model areas and the full study area. Modelling shall include a detailed analysis of sediment transport and accumulation in coastal near-shore island and harbour areas as well the more open areas of the Strait. Sediment transport modelling shall be conducted using all appropriate modules for study area conditions including a properly calibrated MIKE (or comparable industry standard) sediment transport module that accurately accounts for the three dimensional currents in the study area. The results of the modelling activities are to be assessed with respect to chemical and physical characterization of the distributed solids, interaction with marine sediments and waters, and effects within the marine environment, particularly to marine organisms including build-up of COPCs and POPs within marine species marine plants and benthic intervebrates; and

- Based on the results of the receiving water study, evaluate whether colour is expected to be visible at the ocean surface above the diffuser site, including influence of in-water reactions (e.g., potential stratification of the water column) on colour levels. Assess impact of colour and its interaction and effect on the marine sediments and associated marine life.

- All marine models must incorporate all appropriate industry-standard modules designed specifically to account for all relevant conditions in the study area, including but not limited to the influence of sea ice and climate change effects in reaching the results and predictions. All marine models must include worst-case scenarios in the range of predicted outcomes and results.

10.2.4 Wetlands

In conducting the effects assessment on wetlands, the EA Report must identify and evaluate:

- Potential direct and indirect impacts to wetlands and how Project development will adhere to the Nova Scotia Wetland Conservation Policy; and
- Where wetland avoidance is not possible, discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.

10.3 Atmospheric Resources

Describe the sources, types and estimated quantities of air emissions from the mill facility and spill basin for all potential air contaminants of concern related to the Project under routine conditions and in the case of process changes, system disruptions, planned or emergency shutdowns and start-ups, malfunctions and accidental events on a seasonal and annual basis. Air contaminants to be evaluated should include but not be limited to, impacts of CO, hydrogen sulphide (H_2S), nitrogen oxides (expressed as nitrogen dioxide)(NO_2), O_3, SO_2, TSP, $PM_{2.5}$, PM_{10}, TRS, speciated VOCs, semivolatile VOCs, polycyclic aromatic hydrocarbons (PAHs) and metals. The description shall include appropriate models based on known or measured atmospheric conditions throughout the year.

For all Project phases, construction, operation and decommissioning, estimate the GHG emissions and provide an inventory of GHG emissions from all Project components. This includes carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), sulfur hexafluoride (SF6), nitrogen trifluoride (NF3) and conversion of these emissions to an equivalent amount of CO2. Also include an inventory of the precursors or tropospheric ozone (CO, NOx, and VOCs).

Where possible, include a comparison of the above information with estimates of total GHG contributions from NS, and from similar facilities in Canada. The EA Report must also include a discussion of measures that have been considered and/or are proposed to reduce air emissions and reduce or offset GHG emissions to ensure all air and GHG emissions remain below safe levels under all operating conditions including service disruptions and unplanned events, shut-downs and start-ups.

While considering the effects on air quality, the EA Report must discuss the potential impacts of predicted increases in noise and light levels during all phases of the Project, on surrounding residential, commercial, recreational and institutional areas, and marine and terrestrial habitats.

It is recommended Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air and Noise, be reviewed and applied in the evaluation where relevant.

In addition, based on concerns raised by government reviewers, the EA Report must also include, but not be limited to the following additional items:

Revised air dispersion modelling including the following:

- Consideration of the effects of fumigation and coastal interaction in the modelling;
- Modelling based on the operating scenario for the occasion when the highest concentration of an air contaminant occurs at ground level. The operating condition that corresponds to the maximum air contaminant concentration at ground level may occur when the facility is at the maximum production level or running at a lower production level or when the process is in transition. The report shall include a description of the operating conditions that result in the maximum ground level concentration of an air contaminant;
- Identification of individual emission rates as measured or estimated and include the reference and justification for values used;
- Comparison of the maximum predicted ground level concentrations of all contaminants with relevant ambient air quality criteria. In the absence of NS adopted ambient air quality criteria, the Proponent shall utilize criteria from Federal or other Provincial jurisdictions;
- Comparison of the maximum predicted ground level concentrations of all contaminants with their relevant upper risk thresholds;
- Risk assessment and mitigation plan for contaminants that demonstrate a predicted exceedance of a relevant upper risk threshold;
- Inclusion of isopleth mapping for all contaminants predicted to exceed relevant ambient air quality criteria;
- Identification of discrete receptors on all isopleth mapping;
- Mitigation options to address any predicted exceedances of relevant ambient air quality criteria used in the modelling. The model shall be rerun incorporating the mitigation projects to demonstrate no predicted exceedances; and
- Implementation schedule for potential mitigation options.

All air dispersion models must incorporate all appropriate industry-standard modules designed specifically to account for all relevant conditions in the full study area, including but not limited to the influence of marine, coastal and terrestrial environments during all seasons, and including climate change effects in reaching the results and predictions. All models must include worst-case scenarios in predicted outcomes and results.

10.4 Flora and Fauna

10.4.1 Terrestrial Environment

Identify and evaluate the potential effects on flora and fauna and avifauna species/communities during all phases of the Project. Include a full account of impacts on species at risk or of concern, significant habitats and protected areas or areas of potential value to Nova Scotia's protected areas network that may be potentially disturbed, altered or removed. The effects assessment must also consider the potential for effects to flora and fauna associated with landscape fragmentation and sensory disturbances.

10.4.2 Freshwater Aquatic and Marine Environment

Evaluate the potential effects on aquatic environments, including but not limited to fish, fish forage and fish habitat.

While considering the effects that the Project may have on freshwater and marine species, include a full account species at risk or of concern and significant habitats. This section must include activities that may affect avifauna in the aquatic environments. Also consider potential effects to marine species from blasting, dredging and other marine construction, as well as vessel traffic and Project operation. Where impacts to fish habitat cannot be avoided or mitigated, discuss compensation measures to ensure impacts are offset.

Assessment of COPCs in the baseline fish and shellfish populations and potential effects due to expected discharge quality.

Include a summary of the potential effects on flora/fauna known to be important to the Mi'kmaq of Nova Scotia.

10.5 Agriculture, Aquaculture, Fishery and Forestry Resources

Include an effects assessment of the Project on existing and future agriculture activity within the study area.

Assess the impacts on commercial/recreational fishing, aquaculture or other marine harvesting which may be impacted by the proposed Project. The effects assessment should consider changes in commercial/recreational fishing, aquaculture or other marine harvesting species, including contamination of species consumed by people as a result of increased ~~-~~erosion, sedimentation and from effluent discharges from the Project, displacement, mortality or loss and/or alteration of habitat. Also discuss navigation restrictions and loss of traditional fishing areas of the Mi'kmaq of Nova Scotia.

Conduct an impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon information, studies and an understanding of expected movement of contaminants according to the revised receiving water study. Based on the assessment of applicability of Point C representing Project ETF effluent quality, chronic and acute toxicity testing of non-diluted treated effluent is to be conducted through a series of controlled laboratory experiments. Species used in the assessment should be applicable to the receiving water environment. Consideration should be given to using either the plant's current effluent or another acceptable and representative substitute. The selection of information sources, representative marine species and assessment methodology must first be agreed upon by relevant government departments.

Undertake a model-based evaluation of the chronic effects of thermal cooling water discharge on fish and fish habitat in the receiving water. Based on the results of the evaluation, develop appropriate mitigation measures and/or project changes.

The EA Report must include a discussion on the potential effects on any forestry resources within the ~~Project~~ study area.

10.6 Human Health

Provide the completed Human Health Risk Assessment (HHRA) in accordance with Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk Assessment and other Guidance for Evaluating Human Health Impacts in Environmental Assessment documents for noise, air quality, drinking and recreational water, etc. as applicable. Federal contaminated sites guidance documents such as the Detailed Quantitative Risk Assessment (DQRA) may be used to supplement the EA Guidance documents where appropriate. The risk assessment must consider human consumption of fish and other seafood, consumption of potentially contaminated drinking water, exposure to recreational water and sediment, outdoor air inhalation, and any other potential exposure pathways. The analysis must inform the identification of contaminants of concern and updating of the receiving water study.

The HHRA must consider baseline data and represent all marine species which are harvested and consumed in the area with respect to the marine component of the Project and in all types of fisheries-commercial, food, social and ceremonial. In addition, information for these species should be included in the baseline studies for COPCs in marine organism tissues where possible. The HHRA must consider bioaccumulation and the potential for biomagnification in the food chain. The exposure route associated with consumption of seaweed and sea vegetables must also be included.

The HHRA is to include appropriate receiving water study and associated modelling activity results (e.g., contaminant fate and transport) as to accurately assess the potential risk to human health.

Include monitoring and mitigation measures for elevated COPCs in air emissions in HHRA problem formulation.

Screen COPCs in Project effluent discharge according to guidance from Health Canada. Incorporate findings from receiving water study. Discuss the potential for interactive effects from similarly acting chemicals. Include an evaluation of the risk associated with exposure to chemical mixtures. Provide calculation of Hazard Quotients (HQ) and Incremental Lifetime Cancer Risk (ILCR) which account for additivity.

Ensure any screening values used from the EPA are adjusted to be consistent with the health protection endpoints prescribed by Health Canada and CCME.

Provide clarification on methodology applied to selection of COPCs for seafood ingestion in consultation with Health Canada.

The HHRA should require identification and consideration of susceptible populations and their histories of exposure. Vulnerable or susceptible populations should be included in risk assessments, including women (and pregnant women) and children who may be more susceptible to exposures to toxic substances and subsequent health outcomes based on the timing of exposure and windows of susceptibility. Low dose, cumulative and synergistic effects must be considered as a result of exposure to complex mixtures of toxic substances, including endocrine disrupting chemicals. As well, sex- and gender-based analysis should be applied to any evaluation of health risk and exposure to toxic substances.

10.7 Socio-Economic Conditions

Identify potential impacts of the Project on economic conditions, populations and employment.

Identify potential impacts of the proposed Project on residential property values and property demand during all phases of the Project (including temporary accommodation required during construction).

Describe the effect of the proposed Project on present and future commercial, residential, institutional, recreational and resource land uses within the study area, including impacts to areas under mineral exploration licenses or forestry licenses.

Identify the potential impact on recreational opportunities, including the effects on aesthetics from areas surrounding the Project area. This analysis should be supported by visual impact assessments from both the land and water.

Identify the potential impact on the current use of land and marine resources for traditional purposes and any Aboriginal specific land claims within the study area.

While considering the effects on economic conditions and employment, include a discussion on expenditures and the anticipated direct and indirect employment positions that will be created during all phases of the Project.

10.8 Existing and Planned Land and Marine Area Uses

The EA Report must consider the effects that may restrict the ability of people to use and enjoy adjacent lands and marine areas presently, and in the future. Describe the potential impacts from existing or planned land uses in the study area. This shall include a discussion of Project interactions with any rural planning initiatives, parks, protected areas, contaminated sites, former mine workings, and mine disposal areas.

Identify and evaluate potential effects on traditional and current recreational and commercial use by the Mi'kmaq of Nova Scotia.

Discuss the anticipated changes in traffic density and patterns during all phases of the Project including the effects on transportation.

While assessing the effects on navigation and navigable waters, consider navigation patterns of all waters that may be impacted by the Project. Potential effects on traditional and current recreational and commercial use must be identified and evaluated.

10.9 Archaeological Resources

Evaluate the potential effects of any changes in the environment as a result of Project activities on physical and cultural resources, structures and/or sites of historic, archaeological, or paleontological significance.

In conducting the effects assessment on archaeological resources, it is recommended that the Proponent consult with CCH and with the Archaeology Research Division of KMKNO.

11.0 PROPOSED MITIGATION

Describe all measures that have, or will be, taken to avoid or mitigate negative impacts, and maximize the positive environmental effects of the Project (as described in Section 9.0 of the Terms of Reference). Mitigation includes the elimination, reduction or control of the adverse effects or the significant environmental effects of the Project and may include restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

Describe proposed compensation that will be provided when environmental damage is unavoidable or cannot be adequately mitigated by any other means.

In considering mitigation measures to be employed, the EA Report must describe any legislation, regulations, guidelines, policies, BMPs, and specifications that will be adhered to during construction and operation of the facility that will lead to mitigation of environmental impacts.

11.1 Geophysical Environment

If applicable, describe alternatives to disrupting net acid producing bedrock. When no practical alternative to exposing acid producing bedrock exists, mitigation plans shall be developed for minimizing the impacts on the aquatic environment. Discuss commitments to provide contingency and remediation plans for watercourses that have been degraded due to the disturbance of net acid producing bedrock or tills.

Discuss measures to be taken to investigate the existence of contaminated soils, known or unknown, in advance of project construction and as construction proceeds. If contaminated soils are to be disturbed, discuss methods to minimize and eliminate adverse impacts.

Provide applicable mitigation measures and preliminary agreements and plans that meet Provincial regulatory disposal and transportation requirements for potential dredge materials.

11.2 Water Resources

11.2.1 Groundwater Quality and Quantity

Describe actions that will be taken to mitigate any negative impacts on groundwater quality and quantity.

Provide a Groundwater Protection Plan based on the assessment of risks to local water supplies (municipal and private) and the environment. This plan should include management/contingency response actions and reference the groundwater monitoring plan as well.

Describe measures to be employed in the event of accidental contamination or dewatering of any water supply wells as a result of the construction or operation of the Project, including compensation for loss or degradation of water supplies. Describe mitigation measures planned to prevent and remediate contamination of groundwater from the accidental release of a hazardous substance.

Discuss commitments to provide contingency and remediation plans for any contamination of groundwater resources, including decrease of water quality.

11.2.2 Surface Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to surface water resources, including but not limited to erosion and run-off control features and storm drainage management.

Discuss all mitigation measures planned to prevent the release of hazardous substances into local surface waters.

Discuss commitments to provide contingency and remediation plans for any impact to surface water resources, including decrease of water quality or quantity.

11.2.3 Marine Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to marine water resources.

Discuss all mitigation measures planned to prevent the release of hazardous substances into marine waters.

Discuss commitments to provide contingency and remediation plans for any impact to marine water resources, including decrease of water quality or quantity.

11.2.4 Wetland Resources

Describe measures to avoid, minimize or otherwise mitigate effects on wetland resources within the Project area. Specifically, the EA Report must describe measures to maintain ecological and hydrological integrity of any wetlands in the area. Where avoidance is not possible, provide wetland specific mitigations proposed to lessen impacts of the Project at all stages and describe commitments to monitoring and compensation for any loss of wetland habitat. Also provide discussion and commitment regarding remediation/rehabilitation of aquatic habitat as a result of incidental releases of treated effluent in wetlands.

11.3 Atmospheric Resources

Describe measures to avoid, minimize or otherwise mitigate effects on biological receptors during all phases of the Project (vegetation, fish, wildlife, and human health).

Specifically, describe measures that will be taken to control emissions including but not limited to CO, H_2S, nitrogen oxides expressed as NO_2, O_3, SO_2, TSP, $PM_{2.5}$ and PM_{10}, TRS, speciated VOCs, semivolatile VOCs, PAHs and metals. Describe any GHG mitigation plans.

Describe all measures that will be taken to mitigate any potential increase in noise and light levels during construction and operation.

11.4 Flora and Fauna

11.4.1 Terrestrial Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on flora species. Include any landscaping plans for preservation of existing vegetation.

Describe the measures that will be taken to minimize the impacts of the Project at all stages on terrestrial fauna and avifauna. Include any plans for preservation of existing habitat and compensation for loss or degradation of terrestrial habitat (i.e., habitat rehabilitation/replacement). Measures to comply with wildlife legislation and associated regulations (e.g., *Migratory Birds Convention Act* ~~and regulations~~ *Species at Risk Act* and the *Endangered Species Act*) should also be provided.

Discuss commitments to provide contingency and remediation plans for impacts to terrestrial habitat as a result of accidental events.

In addition, based on concerns raised by government reviewers during the review of the EARD and the Focus Report, the EA Report must also include, but not be limited to the following additional items:

- Mitigation plan developed in consultation with NSLAF that includes additional details to protect wildlife and wildlife habitat, including birds, mammals, herptiles, raptors, and species and risk. The plan must include but not be limited to the following:

  a) mitigation measures that will be taken to avoid destroying rare priority species detected in the 2019 floristic surveys;

  b) mitigation and monitoring plan for the Eastern Wood-Pewee (*Contopus virens*, SARA Special Concern, NSESA Vulnerable) and Barn Swallow (*Hirundo rustica*, SARA Threatened, NSESA Endangered) found during the course of field surveys and Kildeer (*Charadrius vociferous*) identified to likely be breeding in the Project area, in consultation with both ECC and NSLAF;

  c) additional details on how impacts to the Double-Crested Cormorant (*Phalacrocorax auratus*) colony located along the east side of Highway 106 causeway will be mitigated during installation of the pipeline across Pictou Harbour. Identify appropriate mitigation measures to protect Double-crested Cormorant nests in the event of a pipeline rupture;

  d) specific measures to be developed to discourage waterfowl from accessing the spill basin and other open ETF components;

e) specific measure to be developed to control of spread of invasive species;

f) specific measures to be developed to address potential foraging and overwintering habitat for turtles; and

g) a training program for field staff to enable them to recognize the potential for species occurrences and procedures to follow.

11.4.2 Freshwater Aquatic and Marine Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on marine and freshwater aquatic species, avifauna and their habitats. Include any plans for preservation of existing habitat and compensation for loss or degradation of aquatic habitat.

Describe the measures that will be taken to minimize the introduction of non-native species to the area.

Discuss commitments to provide contingency and remediation plans for impacts to aquatic habitat including marine habitats as a result of accidental events.

11.5 Agriculture, Aquaculture, Fishery and Forestry Resources

Discuss measures that will be taken to minimize the impacts of the Project on agriculture, fishing, aquaculture, marine harvesting, and forestry.

11.6 Human Health

Provide suitable avoidance and/or mitigation measures to prevent and minimize potential Project impacts on human health.

11.6 Socio-Economic Conditions

Describe actions that will be taken to mitigate adverse impacts on private and commercial property, existing industry and businesses, planned land use, existing and planned marine uses recreation and other human activities, including traditional activities and land and marine uses by the Mi'kmaq of Nova Scotia.

Provide a dispute resolution policy for addressing Project related complaints and concerns that may be received throughout construction, operation, decommissioning and reclamation, and post-decommissioning.

11.7 Existing and Planned Land and Marine Area Uses

Describe the measures planned to minimize the potential impacts of the Project on existing and planned land and marine uses.

Discuss the mitigation measures planned to address anticipated impacts from any predicted changes in traffic speed, traffic routes, marine navigation, fishing activities exclusion zones and density in adjacent residential and commercial areas.

11.8 Archaeological Resources

Describe mitigation measures to preserve, protect, or recover any resources of cultural or archaeological value that are identified in the study area.

12.0 RESIDUAL EFFECTS AND ENVIRONMENTAL EFFECTS

This section of EA Report shall list and contain a detailed discussion and evaluation of the residual impacts for each VEC, including the criteria for determining significance. Residual impacts are those adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technologies or other acceptable means. Those impacts that can be mitigated or avoided shall be clearly distinguished from those impacts that will not be mitigated or avoided.

The discussion and evaluation shall include all COPCs, POPs and sediments/solids that are to be discharged, or may be discharged following treatment into the marine environment (and/or other receiving environments) under any operating conditions including due to malfunctions system changes or disruptions and the residual effects and environmental effects (including but not limited to human health) of each such COPC and POP and the ongoing cumulative effects of such discharge on all aspects of the receiving environment, both locally and within the larger marine environment of the Northumberland Strait the Gulf of St. Lawrence and the North Atlantic Ocean over the full lifespan of the ETF.

These impacts become important in the evaluation of a proposed Project as they represent the environmental cost of the Project.

13.0 EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

Present an overall evaluation of the advantages and disadvantages to the environment, including the VECs, during the construction, operation and decommissioning phases of the Project. The evaluation of the disadvantages shall include an examination and justification of each disadvantage.

14.0 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

Include a framework upon which compliance and effects monitoring will be based throughout the life of the proposed Project, including decommissioning and post-decommissioning activities. Monitoring programs must be designed to determine the effectiveness of the implemented mitigation measures. The EA Report shall describe the compliance reporting methods to be used, including reporting frequency, duration, methods, parameters, comparison standards or guidelines, format, and receiving agencies. Mapping clearly illustrating baseline and proposed monitoring locations should also be included.

Recognizing that the effectiveness of compliance and effects monitoring depends on a workforce that can identify and address potential impacts during construction and operation of the Project, the framework shall include procedures for providing training and orientation to on site employees during construction and operation of the Project.

The description of the compliance and effects monitoring program shall also include any procedures/plans for addressing potential exceedances of environmental protection standards, guidelines or approvals in a timely and effective manner.

The discussion of compliance monitoring shall include, but not be limited to Sections 14.1 – 14.4.

14.1 Geophysical Environment

Describe plans and procedures for assessing ARD potential and associated monitoring in the event of disturbance or exposure.

14.2 Water Resources

Wetland specific post construction monitoring and comparison to baseline condition must be provided to identify post-construction wetland indicator performance and adaptive management to address impacts at all project stages. The report should address compensation measures that may be required to ensure no net loss of wetland area and functions.

Submit a groundwater quality and level monitoring plan for the construction, operation and decommissioning phases of the Project, including the pipeline route and mill site location. This is to include the location of monitoring wells, monitoring sampling frequency and monitoring parameters. The plan must consider the final pipeline design as well as the potential risk to the environment and local water supplies as a result of pipeline construction and possible pipeline leak. The plan must address, as a minimum, sensitive areas along the pipeline route, such as shallow water table intersecting surface water features, proximity to water supply wells and areas along the pipeline more susceptible to failure. Locations where the pipeline may be constructed below the seasonal high-water table shall be identified.

Discuss plans for a survey of structures if blasting is planned, to include wells, building foundations, etcetera, which may experience damage or impact due to seismic vibrations or air concussion.

Discuss any surface water monitoring plans for the construction, operation and decommissioning phases of the Project, including both water quality and quantity aspects.

Develop a marine discharge plume delineation monitoring program to confirm plume dimensions, and effluent concentrations and characteristics in support of the Environmental Effects Monitoring program.

14.3 Fish and Fish Habitat

Submit an Environmental Effects Monitoring program that includes water quality, sediment and tissue sampling and is based on the results of various relevant baseline studies and receiving water study. The program should at a minimum be designed based on applicable regulatory requirements. The program should also demonstrate that fish and shellfish are not affected in size abundance or sub-lethally. The program should also provide for timely and effective means to address and correct all adverse effects on fish and fish habitat.

Submit a post construction monitoring program for regular sampling of gene expression profiling, including but not limited to endocrine pathway genes for fish and shellfish.

Submit a post construction sampling and monitoring program for algal blooms and algal cysts in the Northumberland Strait between Nova Scotia mainland Pictou Island and Prince Edward Island at multiple locations and sampled at regular intervals over all seasons.

14.4 Atmospheric Resources

Complete an ambient air quality monitoring plan, acceptable to the Department, based on the results of the air dispersion modelling. This plan must include but not be limited to sampling locations, parameters, monitoring methods, protocols and frequency. The plan shall ensure adequate monitoring coverage of areas where elevated levels of air contaminants may occur and will set out steps to address and eliminate any such exceedances in a timely and effective manner. ~~predicted levels of air contaminants are elevated.~~

Describe plans for GHG monitoring, reduction targets and reduction plans.

Discuss the plans for monitoring baseline, construction and operational noise levels at the site, and at any residential or commercial areas near the Project.

14.5 Human Health

Provide suitable monitoring measures over the study area to confirm impact predictions. ~~Where~~ The proposed monitoring measures shall ~~is proposed,~~ include a plan for reporting/communicating ~~reporting~~ exceedances of relevant guidelines/thresholds and set out steps to address and eliminate such exceedances in a timely and effective manner.

Monitoring must be conducted over the study area for COPCs, POPs, and including endocrine disrupting chemicals that have low dose, cumulative and synergistic effects as a result of exposure to complex mixtures of toxic substances

14.5 Other Monitoring Plans

Include any other monitoring plan which may include an Environmental Protection Plan or other guidelines, polices or plans, proposed for the construction, operation and decommissioning of the Project.

15.1 CONSULTATION PROGRAM

A Notice regarding the Draft Terms of Reference for Preparation of an ~~Environmental Assessment Report~~EA Report pursuant to the Nova Scotia *Environment Act* was published in the Chronicle Herald and Royal Gazette on January 8, 2020 and posted on the NSE internet site (www.gov.ns.ca/nse/ea/). Information pertaining to this EA will be available on this site.

The Class I EA process for the Project includes the following opportunities to participate (specifically government departments/agencies, the Mi'kmaq of Nova Scotia and the general public will be invited to provide comments):

- the Draft Terms of Reference; and
- the Environmental Assessment (EA) Report.

15.1 Public Consultation

For any consultation undertaken with the general public, the EA Report must describe ongoing and proposed consultation and information sessions. All public information and consultation sessions shall be held only after appropriate and timely notice is given to the public and only after sufficient information and time is provided to enable the public to understand and respond to the issues raised.

Describe all steps taken by the Proponent to identify the concerns of the public about the adverse effects or environmental effects of the Project. ~~It~~ The EA Report shall provide a summary of all concerns expressed by the public and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the general public.

15.2 Consultation with the Mi'kmaq of Nova Scotia

To assist the provincial Government in their consultation process with the Mi'kmaq of Nova Scotia, the EA Report must describe all steps taken by the Proponent to ~~identify the concerns of~~ meet with and consult the Mi'kmaq of Nova Scotia about the adverse effects or environmental effects of the Project and their concerns about the Project. It shall provide a summary of all concerns expressed by the Mi'kmaq of Nova Scotia and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

During the EA process, NSE will serve as the provincial Crown consultation coordinator.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the Mi'kmaq of Nova Scotia.

In parallel to Proponent engagement with the Mi'kmaq of Nova Scotia, the Government of Nova Scotia will undertake continued consultation directly with the Mi'kmaq of Nova Scotia pursuant to the Mi'kmaq-Nova Scotia-Canada Consultation Process (2010).

The Proponent is encouraged to engage the Mi'kmaq of Nova Scotia as referenced in the Nova Scotia Office of Aboriginal Affairs' Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia (2011).

Community Liaison Committee

Include any plans for ongoing community consultation or formation of a community liaison committee (CLC) during construction, operation and decommissioning. The proposed terms of reference of this committee shall be included in the EA Report. These proposed terms of reference shall include at a minimum, details as to the composition of the committee membership, how to become a member of the committee, the type and extent of information that will be provided to the committee, the role and mandate of the committee and how interactions between the committee and the public will take place. The terms of reference for the committee will also set out the types of information about the project and its ongoing operations that will not be provided to the committee and the justification for not providing such information.

16.0 ASSESSMENT SUMMARY AND CONCLUSION

This section of the EA Report shall summarize the overall findings of the EA with emphasis on the main environmental issues identified and predict the significance of adverse environmental effects of the Project.

From:
To: Environment Assessment Web Account
Subject: Northern Pulp
Date: February 7, 2020 3:11:59 PM

Minister Gordon Wilson:

I write today to express my satisfaction with your decision to hold Northern Pulp to our provincial environmental standards, that all industries and residents are held accountable in Nova Scotia. Many previous governments have given a pass on environmental infractions to this kraft pulp mill. Paper Excellence has difficulty adjusting to Premier Stephen McNeil and his environmental Ministers holding them to meet provincial requirements that are not new as claimed, or, that the goal posts have been moved. Northern Pulp could not deliver scientific information that the toxic effluent was not harmful to the fishing industry or adverse affects to our community. N Pulp gained hope in January when permission to extended use of Boat Harbour until April 30/2020. A second hopeful excitement came when Peter MacKay entered the Conservative leadership race. Within days N pulp announced they were filing court action against the Dept. of Environment for ; unrealistic timelines and undefined process. As a resident of Pictou Landing I witnessed daily the abuse of NPulp pollution in our air and waters. Northern Pulp spoke of our poor relations between PLFN's and community by previous mill operators; I attest their relations were just as negatively blatant! The propaganda NPulp put in circulation throughout the province , boycotting Coles Book Store against the book signing of " The Mill" set a higher standard of abuse and disregard for Pictou Co. community second to none. Northern Pulp claims their failure was brought on by our community and government. These letter inserts incites negativity between mill employees and community. In closing I request this polluter be stopped forever. Allow our community to heal and together thrive going forward. With Northern Pulp in our past we will have clean air, water and soil to grow our future in better health. Let the cleanup begin!!! Attached find a cope of N.Pulp letter distributed throughout communities of NS . Thank you for your time. Yours truly; . .

From:
To: [Environment Assessment Web Account]
Subject: Northern Pulp letter.
Date: February 7, 2020 3:13:09 PM

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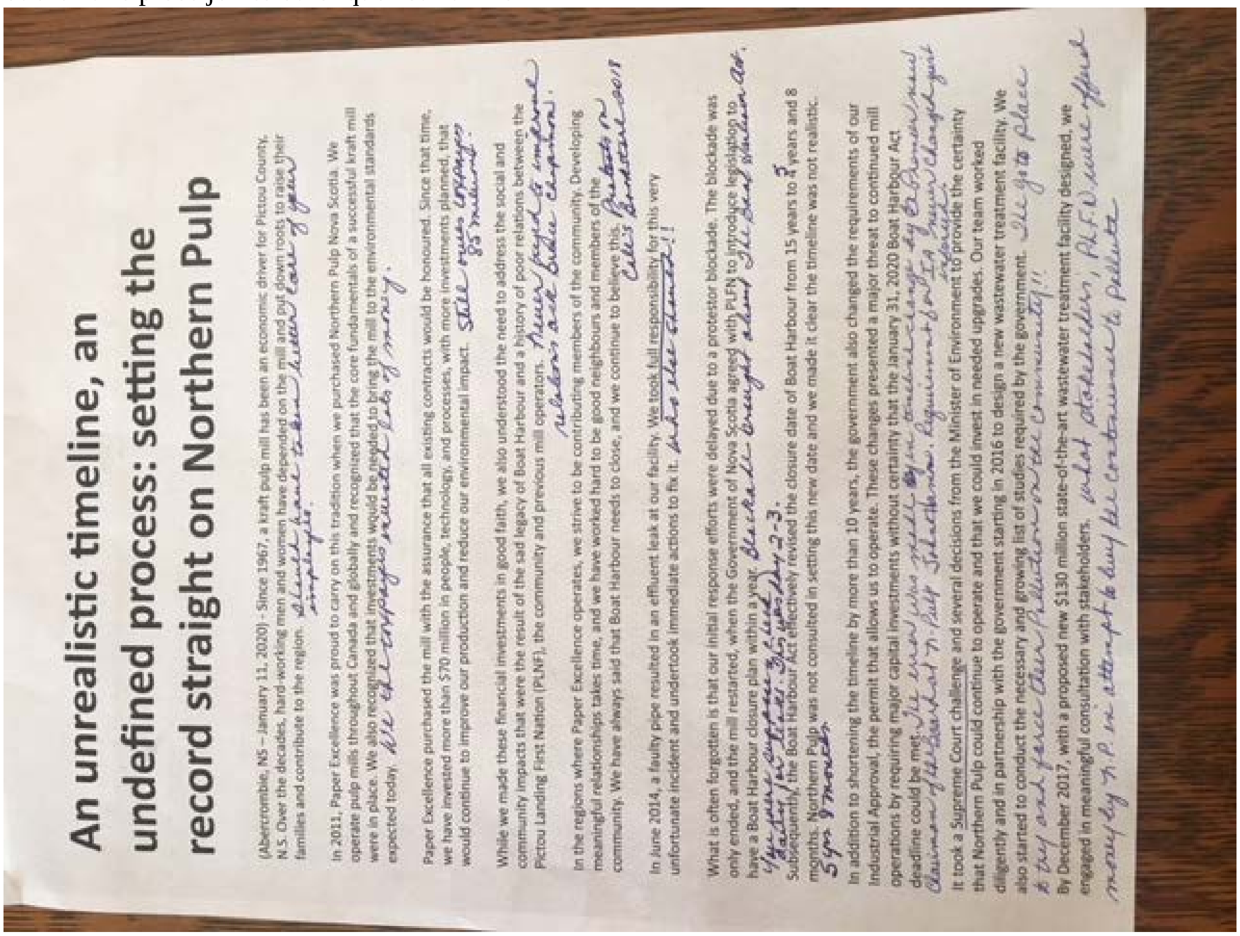


An unrealistic timeline, an undefined process: setting the record straight on Northern Pulp

(Abercrombie, NS – January 11, 2020) - Since 1967, a kraft pulp mill has been an economic driver for Pictou County, N.S. Over the decades, hard-working men and women have depended on the mill and put down roots to raise their families and contribute to the region. Should have taken better care of your employees.

In 2011, Paper Excellence was proud to carry on this tradition when we purchased Northern Pulp Nova Scotia. We operate pulp mills throughout Canada and globally and recognized that the core fundamentals of a successful kraft mill were in place. We also recognized that investments would be needed to bring the mill to the environmental standards expected today. We the taxpayers invested lots of money.

Paper Excellence purchased the mill with the assurance that all existing contracts would be honoured. Since that time, we have invested more than $70 million in people, technology, and processes, with more investments planned, that would continue to improve our production and reduce our environmental impact. Still owes taxpayers 85 millions.

While we made these financial investments in good faith, we also understood the need to address the social and community impacts that were the result of the sad legacy of Boat Harbour and a history of poor relations between the Pictou Landing First Nation (PLNF), the community and previous mill operators. Never tried to improve relations ask Bruce Chapman.

In the regions where Paper Excellence operates, we strive to be contributing members of the community. Developing meaningful relationships takes time, and we have worked hard to be good neighbours and members of the community. We have always said that Boat Harbour needs to close, and we continue to believe this. Protests on Cole's Bookstore 2018

In June 2014, a faulty pipe resulted in an effluent leak at our facility. We took full responsibility for this very unfortunate incident and undertook immediate actions to fix it. who else cleaned!!

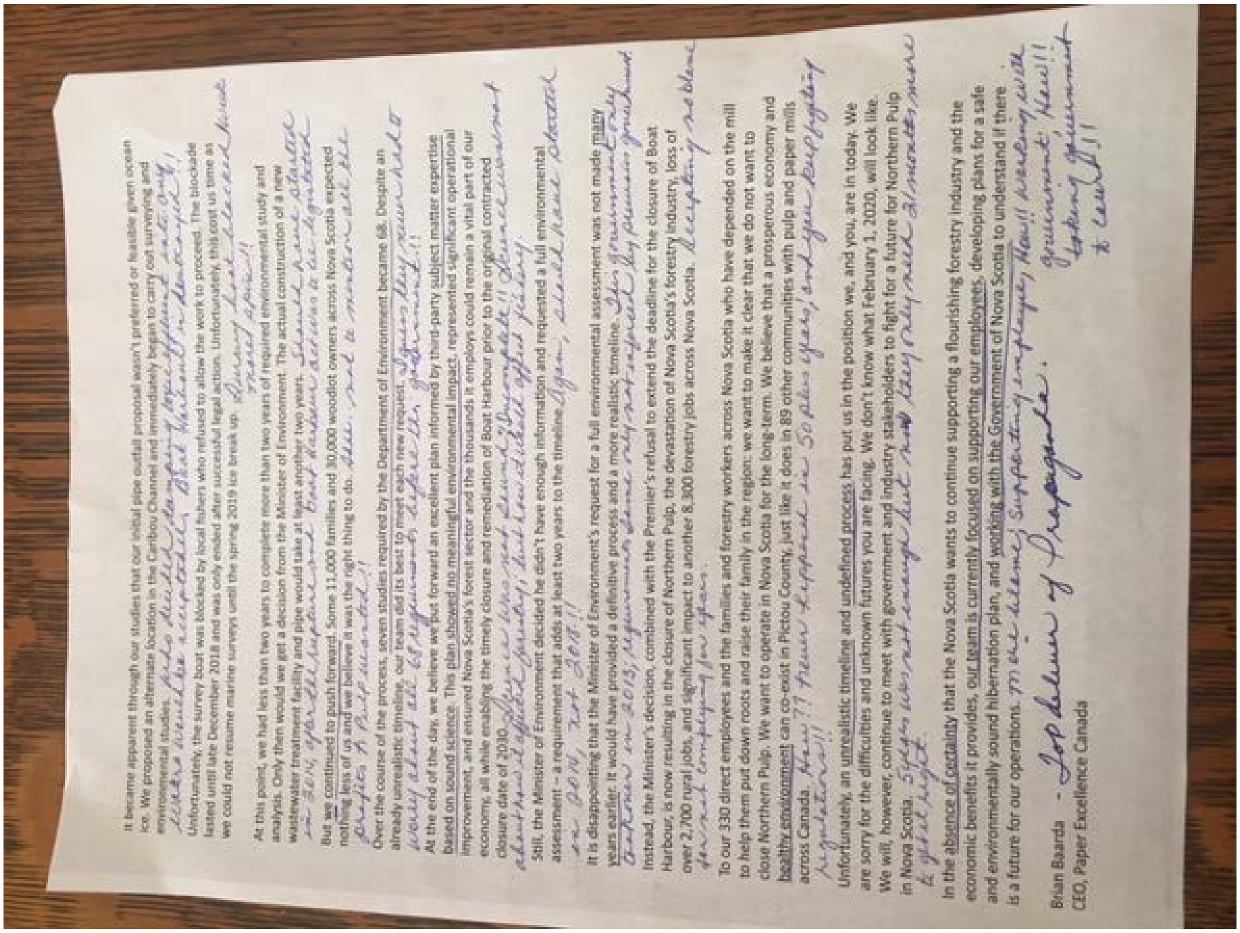
What is often forgotten is that our initial response efforts were delayed due to a protestor blockade. The blockade was only ended, and the mill restarted, when the Government of Nova Scotia agreed with PLFN to introduce legislation to have a Boat Harbour closure plan within a year. Blockade brought about The Boat Harbour Act. You were supposed to clean water for leaks. This was day 2-3.

Subsequently, the Boat Harbour Act effectively revised the closure date of Boat Harbour from 15 years to ~~4~~ 5 years and 8 months. Northern Pulp was not consulted in setting this new date and we made it clear the timeline was not realistic. 5 yrs 8 months

In addition to shortening the timeline by more than 10 years, the government also changed the requirements of our Industrial Approval, the permit that allows us to operate. These changes presented a major threat to continued mill operations by requiring major capital investments without certainty that the January 31, 2020 Boat Harbour Act deadline could be met. The error was made by in timeline change by Ex Premier/now Chairman of the Board at N. Pulp John Hamm. Requirement for IA never changed just enforced.

It took a Supreme Court challenge and several decisions from the Minister of Environment to provide the certainty that Northern Pulp could continue to operate and that we could invest in needed upgrades. Our team worked diligently and in partnership with the government starting in 2016 to design a new wastewater treatment facility. We also started to conduct the necessary and growing list of studies required by the government. The go to place to try and force their Pollution on the Community!!

By December 2017, with a proposed new $130 million state-of-the-art wastewater treatment facility designed, we engaged in meaningful consultation with stakeholders. what stakeholders, PLF.N. were offered money by N.P. in attempt to buy the continuance to pollute



It became apparent through our studies that our initial pipe outfall proposal wasn't preferred or feasible given ocean ice. We proposed an alternate location in the Caribou Channel and immediately began to carry out surveying and environmental studies. Who decided dumping toxic effluent into any waters would be acceptable. Boat Harbour is destroyed!!

Unfortunately, the survey boat was blocked by local fishers who refused to allow the work to proceed. The blockade lasted until late December 2018 and was only ended after successful legal action. Unfortunately, this cost us time as we could not resume marine surveys until the spring 2019 ice break up. Survey boat blocked [illegible] travel again!!

At this point, we had less than two years to complete more than two years of required environmental study and analysis. Only then would we get a decision from the Minister of Environment. The actual construction of a new wastewater treatment facility and pipe would take at least another two years. Should have started in 2014, after the rupture and Boat Harbour act was to be legislated

But we continued to push forward. Some 11,000 families and 30,000 woodlot owners across Nova Scotia expected nothing less of us and we believe it was the right thing to do. Also, not to mention all the profits N Pulp wanted!!

Over the course of the process, seven studies required by the Department of Environment became 68. Despite an already unrealistic timeline, our team did its best to meet each new request. I guess they never had to worry about all 68 requirements before this government!!

At the end of the day, we believe we put forward an excellent plan informed by third-party subject matter expertise based on sound science. This plan showed no meaningful environmental impact, represented significant operational improvement, and ensured Nova Scotia's forest sector and the thousands it employs could remain a vital part of our economy, all while enabling the timely closure and remediation of Boat Harbour prior to the original contracted closure date of 2030. Science was not sound; Incomplete!! Science was not about how it affected forestry, but how it would affect fishery.

Still, the Minister of Environment decided he didn't have enough information and requested a full environmental assessment – a requirement that adds at least two years to the timeline. Again, should have started in 2014, not 2018!!

It is disappointing that the Minister of Environment's request for a full environmental assessment was not made many years earlier. It would have provided a definitive process and a more realistic timeline. This government only took over in 2013; requirements same only not enforced by previous government.

Instead, the Minister's decision, combined with the Premier's refusal to extend the deadline for the closure of Boat Harbour, is now resulting in the closure of Northern Pulp, the devastation of Nova Scotia's forestry industry, loss of over 2,700 rural jobs, and significant impact to another 8,300 forestry jobs across Nova Scotia. Accepting no blame for not complying for years.

To our 330 direct employees and the families and forestry workers across Nova Scotia who have depended on the mill to help them put down roots and raise their family in the region: we want to make it clear that we do not want to close Northern Pulp. We want to operate in Nova Scotia for the long-term. We believe that a prosperous economy and healthy environment can co-exist in Pictou County, just like it does in 89 other communities with pulp and paper mills across Canada. How?? Never happened in 50 plus years, and you keep fighting regulations!!

Unfortunately, an unrealistic timeline and undefined process has put us in the position we, and you, are in today. We are sorry for the difficulties and unknown futures you are facing. We don't know what February 1, 2020, will look like. We will, however, continue to meet with government and industry stakeholders to fight for a future for Northern Pulp in Nova Scotia. 5 years was not enough but now they only need 21 months more to get it right.

In the absence of certainty that the Nova Scotia wants to continue supporting a flourishing forestry industry and the economic benefits it provides, our team is currently focused on supporting our employees, developing plans for a safe and environmentally sound hibernation plan, and working with the Government of Nova Scotia to understand if there is a future for our operations. More blame; Supporting employees, How!! Working with government, How!! taking government to court!!

Brian Baarda - Top deliver of Propaganda.
CEO, Paper Excellence Canada

Sent from my iPhone

From:
To: Environment Assessment Web Account
Subject: Draft terms of reference for Northern Pulp
Date: February 7, 2020 4:31:47 PM

To whom it may concern,
I believe an ombudsman should be appointed to oversee the EA for Northern Pulp. This would allow for an independent moderator facilitate the process.
I also believe the province should hire an independent engineering firm, familiar with effluent treatment systems, to evaluate the EA submitted by Northern Pulp, and follow their recommendation.
Lastly the province should not be allowed to add additional studies required once they have provided the terms of reference to Northern Pulp

From:
To: Environment Assessment Web Account
Cc:
Subject: Terms of Reference for the Environmental Assessment Report for Northern Pulp
Date: February 7, 2020 6:06:09 PM

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Dear Sir or Madame,

Terms of Reference for the Environmental Assessment Report for Northern Pulp

This e-mail is in response to the Terms of Reference wherein the public can provide feedback for the Environmental Assessment Report for Northern Pulp.

. Since 2014 I have closely followed all media and social media information on Northern Pulp. I have been a member of the Clean Up the Pictou County Pulp Mill Facebook group since 2014. This group currently has 6,100 members. I also attended Northern Pulp open houses in 2014 and 2017. I read and responded to the EA and the focus report. Unless you live in the town of Pictou it is difficult to understand how relieved we are that the Mill is closed as of January 31, 2020. We can breath clean air and do not have noise pollution at night from the drone and clanging of the Mill. I am totally opposed to an Effluent Treatment Facility being built by Northern Pulp and the effluent pipe going out in to the prime fishing grounds of the Northumberland Strait. I commend the decisions of the Nova Scotia Department of Environment on the EA and Focus Report submitted by Northern Pulp. There was much incorrect and missing information in both their submissions. For someone such as myself who has university degrees but did not take science past high school, it was very disorganized and difficult to read. It took me two weeks just to read the EA submitted by Northern Pulp in 2019.

Here are my comments for the Terms of Reference:

1. Pipe route through the watershed for potable water for Pictou and Caribou.Mayor Jim Ryan of Pictou was very clear in a letter to Northern Pulp and responses to the EA and Focus report that the company cannot go through the watersheds for drinking water. Alternate route(s) must be provided. Margaret Miller had suggested doubling the pipe through the
watershed.
In Northern Pulp's focus report they proposed slightly thickening the pipe not doubling it. There was no alternate route(s) This is not acceptable to the Mayor and the town residents. We will not allow Northern Pulp to go through watersheds for our drinking water. Mayor Ryan also provided an engineer's letter that a leak from a pipe anywhere along route 106 to the Ferry would impact our water supply. To mitigate this risk the pipe must be double walled along route 106.

2. Delays or cancellation of the Ferry to and from PEI and Caribou.
Specific information needs to be provided as this will impact the tourist economy of the town of Pictou. How long will delays be and details on Ferry cancellations need to be provided. When will this occur and for how many days or partial days, weeks or partial weeks or months? The town of Pictou depends very much on the Ferry from PEI for business in it's downtown core. Will compensation be offered by Northern Pulp to the Ferry, Town of Pictou businesses or PEI?

3. Sewage disposal at the Northern Pulp Plant.
On February 6, 2020 I spoke to an inspector for the Department of Environment about sewage disposal from Northern Pulp. Two methods were used for sewage disposal.

(i) Raw sewage went in to Boat Harbour until January 31, 2020
(ii)Sewage also went to holding tanks that were pumped out.
When I asked the inspector about the percentage that went in to Boat Harbour he said he did not know and I should contact Northern Pulp. I do not plan on contacting Northern Pulp. I have sent questions to them in the past and never received answers . Also, members of the publiccould not contact the Northern Pulp Citizen's Committee as the names of members of the committee or contact information were never published in the minutes.
Sewage disposal is not addressed in the Terms of Reference. Raw sewage should not be going in to the proposed Effluent Treatment Facility and through a pipe in to the Northumberland Strait. Other alternatives are available or can be constructed. You need to address this issue in the TOR that all sewage go in to holding tanks. It needs to be made clear to Northern Pulp that they can no longer put raw sewage in the effluent.

4. Smell from the proposed new Effluent Treatment Facility
We know the smell from Boat Harbour was overpowering. In 2014 when the pipe leak was blockaded at Pictou Landing First Nation, I attempted to walk to the Boat Harbour site accompanied by a native person. I could only go about 20 feet from the bridge and had to turn back due to the smell. If this same smell or worse is going to be carried over to the Town of Pictou it will harm our tourism on the waterfront and our downtown businesses. Northern Pulp has not addressed this.

5. Oxygenators
There was no mention in the EA or the Focus report submitted by Northern Pulp of using oxygenators as part of the proposed Treatment Facility. I am not sure if sxygenators is the correct term but it is the method that was used at Boat Harbour to add oxygen to the effluent treatment. It is mentioned in the Terms of Reference but it is not mentioned as requirement for Northern Pulp. The DOE should require oxygenators as part of the proposed Effluent Treatment Facility. If this is not done a larger dead zone will be created where the effluent enters the ocean.

6. Public Consultation by Northern Pulp
For the EAR it is not enough to state that Northern Pulp needs to consult with the public. Colourful brochures and flyers sent to households through the mail as done with their EA and Focus Report does not constitute consultation. The company should be required to hold open houses in key communities such as Pictou and New Glasgow. Members of the public must be afforded the opportunity to ask questions at the open houses. Furthermore only members of the company that are presenting and key managers should be there. At the last public open house in 2017 all Northern Pulp employees were required to let their supervisor which of the two nights they would be attending in Abercrombie or New Glasgow. The letter they received from the company was published. There was nothing held in Pictou. All the employees that were there resulted in overcrowding and difficulty asking questions and getting answers. While I was speaking with a presenter after their presentation I was interrupted by a Northern Pulp employee sharing how fish are thriving in the river in Pennsylvania. This information was distracting and totally irrelevant to what was being discussed.

Thank you for your consideration of these issues for the Terms of Reference.

From: UA Local 244
To: Environment Assessment Web Account
Subject: Northern Pulp
Date: February 7, 2020 9:20:15 PM
Attachments: npeafeb2020scanned copy20200207221347595.pdf

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Please see attached

UNITED ASSOCIATION
of Journeymen and Apprentices of the
Plumbing and Pipe Fitting Industry of
the United States and Canada

Founded 1889

Letters should be confined to one subject

UA Local Union:

Subject:

244, P.O. Box 40, St. Andrews
Antigonish County, Nova Scotia, B0H-1X0
Phone Fax 902-386-2006
Email: @ns.sympatico.ca

Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442
Halifax, NS, B3J 2P8
Fax: (902) 424-6925
EA@novascotia.ca

February 7/2020

I am writing this letter to express my concerns on the way that Northern Pulp was treated in this Environmental Assessment Process.

In reality an Environmental Assessment should be a balance between the Economy , Industry & Employment all of which enhance socio economic conditions.
Vs.
The issues that need to be addressed for each particular project to protect and conserve the Environment, during the life of the Project.

Given what happened to Northern Pulp I don't think the principals of how an EA Process should be conducted were met.

An Environmental Assessment is suppose to be a legal process with defined goals.

It is not suppose to be a process where all the Political Party Leaders gang up on a particular Industry and pressure the EA Board and the Minister into pretending they couldn't understand the professional documentation supplied by Northern Pulp.

Both Federal and Provincial EA Legislation refer to "promote sustainable development" by protecting and conserving the Environment.

The federal Assessment Basics refers to the EA bringing "informed decisions that contribute to responsible development of Natural Resources.
A Federal Assessment process also refers to completing as Assessment in a "timely manner".
It goes on to say "Encourage Federal Authority's to take action in a manner that promotes sustainable development".
If I read this correctly the Federal Environmental Process sets the standards that the Provinces are to emulate or the Federal System can overrule.

The Atlantic Chamber of Commerce spells it out in pretty clear terms "with the closure of Northern Pulp, environmental issues may have been resolved locally, but from a global perspective they will simply shift to another jurisdiction with Forestry Operations while impoverishing People, Businesses and Communities across Nova Scotia"
.
I really cannot understand how Premier McNeil could intimidate the Opposition Party's into complete silence while he is destroying the Rural Economy.

I see Conflict of Interest mentioned a lot in Social Media.
Others will decide on the legal terminology before the next Election.

That will be about the time Employment Insurance Claims will be running out and Bankruptcy's will be happening.

The reality of the situation is that this Mill has been in operation since 1967 without dire consequences described in this EA. The Fishing Industry has never been better.

The Board would be well aware of the linkage between the Forest Industry and how important it is to the Economy.
The Construction Industry has not been included in the estimated job loss but we are looking forward to building the new Effluent Treatment Plant. Actually we have enough unemployed Members to do the job in half the time if material and equipment were available.
This would be several hundred jobs in a Province that does not have one Industrial Project under Construction. Actually we have Native Trades Members who also are waiting for a year or two's work at home.

It beats me how the EA Board cannot understand that Veolia Water Technologies Equipment Northern Pulp is planning to use is the World Standard in Effluent Plants that is currently going to clean up the effluent to a better standard than Boat Harbour ever did.

The solution to the Caribou Pipeline and the Fisherman situation is to put in the new effluent Diffuser in the same location as it is now.
That is where the biggest lobsters in Pictou Harbour are being caught.

The solution to this assault on the Economy, the Mill, Jobs, Families and the overall Socio Economic good of the Province is to grant Northern Pulp permits to proceed with the Construction of the new state of the artBiological Activated Sludge Process from Veolia Water Technologies.

Let the science prevail.....not Politics
Thank you.

Sincerely.

UA Local 244
Plumbers, Pipefitters,
Welders, Instrument
Techs and Apprentices

From:
To: Environment Assessment Web Account
Subject: Comments on the Draft Terms of Reference For Northern Pulp"s Treatment Facility
Date: February 7, 2020 9:25:25 PM

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To Whom it may Concern,

I perhaps do not understand completely on what is required for me to put my questions and concerns forward on this project for the Effluent Treatment Plant for Northern Pulp at Abercombie Point. None the less I would still like to put forth some things I feel are very important about this project and what is in the terms of reference.

1)

I see no request for soil testing for contamination at the location where the treatment facility will be constructed. My concern is that it will be built on lands that were once part of the Canso Chemical Plant and there has been information available about past issues with Canso Chemical and there loses of mercury at their site. I feel soil testing is important before construction so that further contamination of the area will not occur.

2)

I see no request as to the scientific and chemical contents of the Effluent from Northern Pulp. If we do not have a baseline to start with, how can we possibly say if the new effluent coming out of a newly constructed system is any better or worse than what was coming out of the pipe before.

3)

I see no request for emergency measures for an under sea Pipe rupture, doing winter when ice covers the Northumberland Strait. Will the whole plant shut down until the ice in the Northumberland Strait clears in the spring and the pipe can be repaired ? Or will it continue to run and pump into the Strait until an ice free time window is in place to repair the Pipe.

4)

Finally with the possibilities of the dried sludge from the treatment plant being burned in the power boiler system, what guarantees do we have that serious contamination will not be coming from the stacks.
Given Northern Pulps past records of failed stack tests and unhealthy emission being spread all over Pictou County. Since according to the Canadian Environmental Protection Act for Effluents from Mills Using Bleaching… Document of 1991 which is still in use today. Where it tells us that “It should be noted, however, that wastewater treatment leads to the generation of sludges which contain large

amounts of chlorinated organic
compounds for which as yet no monitoring or disposal strategy has been developed."

I have lived in the Town of Pictou the whole 65 years of my life and I am a very concerned citizen who worries about my future here and that of my children and grand children. We cannot rest until every avenue of this project can be explored and proven to be absolutely safe for not only the environment, but also for all the people who reside here.

I thank you for your time in reviewing my remarks and I hope it is helpful and also beneficial to finding the right answers for this very large and complicated project. The fate of our environment and all the people surrounding this Mill are in your hands.

If you require any information or have any questions for me, please do not hesitate to contact me at any time.

Most Sincerely,

Sent from Mail for Windows 10

NORTHERN PULP
NOVA SCOTIA CORPORATION
A PAPER EXCELLENCE COMPANY

March 27, 2020

NOVA SCOTIA ENVIRONMENT
1903 Barrington Street, Suite 2085
Halifax, NS B3J 2P8

Attn: Ms. Lorrie Roberts
Environmental Assessment Branch, Nova Scotia Environment

RE: Northern Pulp Nova Scotia Effluent Treatment Facility Environmental Assessment Report – Draft Terms of Reference

Summary

The following summary provides a high-level overview of Northern Pulp Nova Scotia's (Northern Pulp) position on the Terms of Reference (TOR) for the Environmental Assessment Report (EAR). This is followed by further detailed comments, with supporting attachments where deemed necessary.

Northern Pulp is committed to operating in Nova Scotia in an environmentally sustainable manner and contributing to the much-needed economic benefits of a healthy and prosperous forestry sector. This is only possible with a timely, well-defined, outcome based and achievable EAR process.

For more than 50 years, the pulp mill has discharged effluent into Boat Harbour and treated effluent into the Northumberland Strait. Since acquiring Northern Pulp in 2011, Paper Excellence Canada has supported and worked with the Province of Nova Scotia on Boat Harbour's timely closure. With the expedited closure of Boat Harbour now finalized and its provincially-led remediation underway, there is an opportunity to focus solely on what Northern Pulp's new Effluent Treatment Facility (ETF) will ultimately achieve—an environmental improvement to an existing operation. An environmental improvement that is consistent with the operations of 88 other pulp and paper mills across Canada.

Northern Pulp has participated in two lengthy environmental processes that grew significantly in scope yet resulted in Ministers concluding they lacked the information necessary for a decision. Northern Pulp needs assurance that this EAR process will not continue down the path of previous processes that failed to balance an ever-growing list of desired new information with the risk of actual adverse environmental effects from environmental improvements to an existing mill.

As you will see below, Northern Pulp is looking for a clear risk-based EAR process with agreed to outcomes and valued-ecosystem components (VECs). The EAR process must be ultimately achievable within an 18 to 24-month window. Without a clear understanding of what is required from regulators and what Northern Pulp will be measured against, Northern Pulp is doubtful this process will have a different outcome from the previous two processes.

Specifically, Northern Pulp is requesting the following EAR processes and guidelines be implemented for the proposed ETF:

- The Minister of Environment refer the EAR to a provincially led EAR Panel of individuals with experience in and understanding of the environmental impacts of pulp and paper mill operations in Canada and Canada's Pulp and Paper Effluent Regulations (PPER).
- The scope of the EAR is limited to the proposed ETF as a modification of an existing facility as outlined in the chosen Class I process. The EAR is not for a new mill. This approach aligns with how a new ETF at the 88 other pulp and paper mills operating throughout Canada would be managed.
- The EAR accepts the pre-hibernation operating conditions and ambient environmental data as baseline information.
- The EAR will accept a level of engineering design detail consistent with Environmental Assessments and not those normally reserved for permitting processes.
- The EAR TOR clearly define the list of specific VECs to be assessed, the accepted assessment methodologies, and the adverse effects and significant environmental effects to be considered for each VEC.
- The EAR factors in and accepts the wealth of existing information on:
    - mill data and effluent treatment operations,
    - environmental effects monitoring (EEM) that has been collected to ensure compliance with federal and provincial regulatory requirements,
    - recently published independent scientific analysis on baseline environmental conditions in the Northumberland Strait for the Boat Harbour remediation project.
- The EAR TOR clearly lays out a process that is achievable within an 18- to 24-month timeframe.

Background

In January 2019, Northern Pulp submitted an Environmental Assessment Registration Document (EARD) for the approval to replace the Boat Harbour Effluent Treatment Facility (BHETF) with an on-site ETF. Following the submission of the EARD, Nova Scotia Environment (NSE) requested additional information to support a final decision regarding the approval of the environmental assessment. The request for additional information was provided as a Terms of Reference (TOR) for a Focus Report.

The Focus Report, provided a science-based review including additional data beyond what was in Northern Pulp's EARD submission in January 2019. Over 20 different science-based investigations and analyses were conducted to provide additional evidence in describing the potential environmental impacts and their mitigation measures for the new proposed ETF. These scientific analyses included environmental baseline studies, archaeological investigations, receiving water modeling, engineering designs, Mi'kmaq Ecological Knowledge Studies, and many more. Additionally, as requested in the Focus Report TOR, a re-aligned treated effluent pipeline route was also determined, and subject to science-based analyses. The impact assessment conducted for the EARD was updated based on the revised project description presented in the Focus Report. Similar to the EARD, through appropriate mitigation, no significant adverse residual environmental impacts were predicted.

Following submission and review of the Focus Report in October 2019, NSE, pursuant to Section 18(b) of the Environmental Assessment Regulations, determined that an Environmental Assessment Report (EAR) was required. Reviewers and Pictou Landing First Nation (PLFN) identified several aspects of the Project where they disagreed with information put forward by NP and/or requested additional study. It was determined that the Minister did not have enough information to properly assess whether there may be adverse effects or significant environmental effects on fish, air, water resources, and human health. NSE developed a draft TOR for the EAR for public review and comment.

We respectfully submit the following comments and evidence, in accordance with Section 19(5) b of the Environmental Assessment Regulations, to provide the Environmental Assessment Branch of NSE with any comments to the Draft TOR for the preparation of an EAR for the Replacement ETF Project.

EA Report Process

With respect to the EAR process, we recommend that the Minister ultimately refer the EAR to a provincially led Environmental Assessment Review Panel (Review Panel). We believe the panel should be populated with a number of Canadian experts on the environmental impacts of pulp and paper mill operations in Canada. Canada's pulp and paper industry is unique in a number of aspects as is its receiving environment. Experts familiar with these realities are better equipped to assess the EAR. We believe such experts can be sourced from other provinces like Ontario and Quebec, as well as from the Government of Canada. Northern Pulp recommends a specific time review period of four months post submission of the final EAR to ensure decisions are made in a timely and focused manner.

Northern Pulp recommends this approach because it provides the public with an opportunity to express their concerns in a non-judicial, informal and non-adversarial format and a venue to address questions to the proponent during the hearings. It gives the proponent the opportunity to present the undertaking, explain how the EAR addresses any issues that were raised, cross examine participants that present to the Panel, and the option of making a final presentation to the Review Panel. The process also allows the Review Panel to request one or more meetings with the proponent and to visit the site of the undertaking. The continued involvement of the panel throughout the process will ensure that the final report contains the information required to make a timely recommendation to the Minister.

Northern Pulp also requests that the Minister appoint a pulp and paper effluent scientific expert with significant regulatory background to the Panel to ensure the EAR review is situated within the broader Canadian regulatory context.

Given the public interest surrounding this project and the lengthy comments received from members of the public, various interest groups, First Nations, and government departments, Northern Pulp feels strongly that a Panel Review is the best process to lower tensions, separate fact from fiction, position the project in the broader environmental context and ultimately assess the environmental impacts of the project and recommendations to mitigate any determined effects.

EA Report Scope

Northern Pulp is concerned the proposed scope of the EAR is expanding beyond the original intent of reviewing the proposed ETF (modification of an existing facility) and into a review of the entire mill as if it were a new facility. Although Northern Pulp has ceased pulp production, there is clear rationale that the EAR should continue to use the pre-hibernation operating conditions and ambient environmental data as the baseline.

In multiple sections of the draft TOR, there is a request for the use of current effluent for various testing and analysis. This is impossible due to the cessation of pulp production. A clear understanding and agreement on reasonable expectations is required for these requests.

The EAR is also requesting a level of detailed engineering information that is normally reserved for permitting processes. As NSE outlines in the *Proponents Guide to Environmental Assessments*[1], environmental assessments are tools to predict environmental effects at the early stages of project development. They typically do not require detailed engineering design as this is both costly and time consuming and can shift based on terms and conditions of an eventual approval. Northern Pulp requests the scope of the EAR TOR reflect this reality.

Northern Pulp is a strong supporter of receiving clear direction from federal and provincial regulators on the specific VECs for the EAR as well as clarity on the assessment methodology and instruction to develop a clear definition of adverse effects and significant environmental effects for each VEC.

An important consideration that should be factored into EAR scoping is the fact that there has been an ETF operating for decades at Boat Harbour that released treated effluent into the Northumberland Strait. Consideration should also be given to the abundance of mill data and effluent treatment operating experience that should remove much of the operating uncertainty in comparison to a new green field project approval.

As part of the EAR process, consideration should be given to the significant environmental effects monitoring (EEM) information that has been collected to ensure ongoing compliance with federal and provincial regulatory requirements. Also, as part of the Boat Harbour remediation project, significant and recently published independent scientific analysis has been conducted on the baseline environmental conditions of the land, water and aquatic species directly adjacent to the existing effluent outflow in the Northumberland Strait. Northern Pulp recommends that this wealth of information be considered in drafting the final TOR for the EAR of the new ETF.

Northern Pulp requests that all specific effluent discharge limits be set by Nova Scotia Environment within the TOR. The specific criteria need to be established to guide the EAR moving forward. There are 22 other kraft pulp mills operating across Canada with many discharging into a marine receiving environment that can be used for reference. There are also current and future Environment and Climate Change Canada PPER that should be considered. A harmonized approach between Nova Scotia Environment and Environment and Climate Change Canada would be most welcomed by Northern Pulp.

[1] https://www.novascotia.ca/nse/ea/docs/EA.Guide-Proponents.pdf

EA Report Timelines

Although significant time and investment has been made engaging with nearby stakeholders and First Nations communities in preparation of the original Environmental Assessment submission and the subsequent Focus Report, Northern Pulp has concerns the two-year window may not be met given the significantly expanded scope of the EAR. In particular, the draft EAR TOR indicate the area of potential impact is expanding to include multiple provinces and First Nations communities and Northern Pulp has concerns that the two-year window may not be sufficient to adequately consult the necessary parties and address new issues and concerns raised. In order to meet the stated deadlines, Northern Pulp requests the government provide an ombudsman who can ensure third party consultations are timely and do not inadvertently prolong the process.

Also, there appears to be a discrepancy between the regulated timelines for submission of the EAR and comments raised by government and the public. For example, some federal and public reviewers are requesting over two years of baseline information to account for yearly variation in the marine environment. It is unclear how this would be possible within a maximum two-year EAR process and when the Northumberland Strait is not accessible during the winter due to ice coverage. We would ask that the ombudsman and Review Panel would take a position to clarify this discrepancy.

Conclusion

Northern Pulp is committed to operating in Nova Scotia in an environmentally sustainable manner, to investing in Nova Scotia, and contributing to the much-needed economic benefits of a healthy and prosperous forestry sector. To do this a clearly defined and timely EAR process is a necessity.

Northern Pulp needs a clear understanding of the level and types of additional detail that is expected from regulators within an outcome-based process that is achievable within the two-year window and is focused on the specific proposed environmental improvements.

I welcome the opportunity to discuss this with you in more detail and work toward a mutually acceptable EAR process.

Sincerely,

General Manager
Northern Pulp Nova Scotia Corporation

cc: Frances Martin, Deputy Minister of Environment
Nova Scotia Environment
Paper Excellence Canada
Northern Pulp Nova Scotia Corporation
, Northern Pulp Nova Scotia Corporation

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DRAFT TERMS OF REFERENCE FOR THE PREPARATION OF AN ENVIRONMENTAL ASSESSMENT REPORT FOR PUBLIC REVIEW AND COMMENT

Regarding the Replacement Effluent Treatment Facility Project Proposed by Northern Pulp Nova Scotia Corporation

Northern Pulp Comments March 13, 2020

NOVA SCOTIA ENVIRONMENT
January 8, 2020

FOREWARD

Current Context

On December 17, 2019, following an environmental assessment review of the Northern Pulp Effluent Treatment Facility Focus Report, the Minister of Environment decided that an Environmental Assessment Report was required to address deficiencies in the information provided. On December 20, 2019, Northern Pulp announced its intent to cease operations at the Northern Pulp Mill. Notwithstanding that announcement, on January 2, 2020, Northern Pulp informed Nova Scotia Environment of its intent to continue with the Environmental Assessment Report process. Since the company has chosen to continue with the process, Nova Scotia Environment is required to release this draft Terms of Reference in accordance with the Environmental Assessment Regulations.

This Draft Terms of Reference is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document and in the subsequent October 2019 Focus Report.

The *Boat Harbour Act* sets out a deadline of January 31, 2020. Further to the above, Nova Scotia Environment expects Northern Pulp to provide information as part of its input on this draft Terms of Reference about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes may affect the Terms of Reference.

Environmental Assessment Process to Date/Next Steps

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an Environmental Assessment Report) to be provided to address gaps or deficiencies in the required information.

Northern Pulp registered it Effluent Treatment Facility for environmental assessment on February 7, 2019. A thorough environmental assessment review concluded that the Registration Document did not provide enough information to determine if adverse effects or significant environmental effects would result from the Project. On March 29, 2019, the Minister determined that the company would have up to one year to submit a Focus Report to address identified information gaps in the Registration Document.

On October 2, 2019, the company submitted a Focus Report. A thorough environmental assessment review of this information concluded that the company failed to provide enough information to properly assess whether there may be adverse effects or significant environmental effects as a result of the Project and, on December 17, 2019, the Minister decided an Environmental Assessment Report was required. Through the environmental assessment review process, concerns were raised about incorrect and incomplete baseline information; assumptions and methodology used in the analysis; and the absence of mitigation measures related to the potential environmental effects. Further specifics regarding these deficiencies are outlined in comments provided during the consultation period, which are posted on our website and reflected in this Draft Terms of Reference, for the preparation of an Environmental Assessment Report.

Northern Pulp is expected to prepare an Environmental Assessment Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that are likely to arise from the Project, including any not explicitly identified in the Terms of Reference.

Regulations require that Draft Terms of Reference for the Environmental Assessment Report be prepared by the Environmental Assessment Administrator and subsequently be made available for public review and comment prior to being finalized and provided to the Proponent (Northern Pulp).

This document presents the Draft Terms of Reference for public review and comment. The Minister of Environment invites interested Nova Scotians to examine the Draft Terms of Reference and provide comments on their adequacy and suggestions for their modification. **Only those comments related to specifics of the Terms of Reference will be used to inform the finalization of the Terms of Reference through this process. As required by the Environmental Assessment Regulations, the company must be advised of comments received through this process.**

Comments should be submitted in writing through the EA website at https://novascotia.ca/nse/ea/comments.asp, by email at EA@novascotia.ca or by mail to the following address on or before **February 7, 2020**, and addressed to:

Environmental Assessment Branch
Nova Scotia Environment
P.O. Box 442, Halifax, Nova Scotia B3J 2P8
EA@novascotia.ca

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1.0 INTRODUCTION

1.1 Background

The Replacement Effluent Treatment Facility Project (the Project or undertaking) proposed by Northern Pulp Nova Scotia Corporation (Northern Pulp or the Proponent) was registered for environmental assessment (EA) as a Class 1 undertaking pursuant to Part IV of the *Environment Act* on February 7, 2019.

On March 29, 2019, the Minister of Environment determined that the registration information was insufficient to make a decision on the Project, and a Focus Report was required in accordance with clause 13(1)c of the Environmental Assessment Regulations, pursuant to Part IV of the *Environment Act*.

On October 2, 2019, Northern Pulp submitted the Focus Report for EA, in accordance with Part IV of the Environment Act. Public comments on the Focus Report were accepted until November 8, 2019.

On December 17, 2019, the Minister of Environment concluded that Northern Pulp would be required to complete an EA Report on this Project.

1.2 Purpose of the Terms of Reference

An Environmental Assessment is a planning tool that allows sustainable development to occur while protecting the environment. When a company registers its project for an environmental assessment, government's expectation is that the company provide a complete and comprehensive assessment of the Project's potential risks and related mitigations. Based on the environmental assessment review, the Minister of Environment has a number of decision options: If the Minister is of the opinion that any adverse effects or significant environmental effects related to the project can be mitigated, then the project is able to proceed. If such effects cannot be mitigated, a project may be rejected. In cases where not enough evidence is provided to determine whether or not there may be adverse effects or significant environmental effects related to a project, the Minister may require more information (in the form of a more information decision, a Focus Report or an Environmental Assessment Report) to be provided to address gaps or deficiencies in the required information.

The purpose of this document is to identify for Northern Pulp the information requirements for the preparation of an EA Report. Northern Pulp is expected to prepare an Environmental Assessment Report that addresses the deficiencies in the information provided to date through the environmental assessment process and which fulfills the intent of the Terms of Reference. The Environmental Assessment Report must consider all the effects that are likely to arise from the Project, including any not explicitly identified in the Terms of Reference. The EA Report will be used to meet the requirements of a provincial Class I Undertaking.

Northern Pulp must include in its EA Report all the information requested within the Terms of Reference, as a minimum, in accordance with the Environmental Assessment Regulations pursuant to Part IV of the *Environment Act*. The Terms of Reference include Valued Ecosystem Components (VECs) which must be adequately addressed in the EA Report. While the Terms of Reference provide a framework for preparing a complete EA Report, it is the responsibility of the Proponent to provide sufficient data and analysis on any potential environmental effects of the Project to permit a proper evaluation by governments, the Mi'kmaq of Nova Scotia and the public.

The EA Report is expected to provide a comprehensive and complete assessment of the potential effects of the Project, presented in a clear format that can easily be reviewed by the Minister, governments, the

Mi'kmaq of Nova Scotia and the public. If the Minister decides to refer the EA Report to an EA Review Panel for review, the EA Report will serve as the cornerstone of the Panel's review and evaluation of the potential effects of the Project and thus must be a stand-alone document. The EA Report will also allow governments, the Mi'kmaq of Nova Scotia and members of the public to understand the Project, the existing environment, and the potential environmental effects of the Project.

1.3 Proposed Project

This Section is based on the proposed Project as described in the February 2019 Environmental Assessment Registration Document (EARD). In response to this Draft Terms of Reference, Northern Pulp is required to provide information on any changes to the Project as a result of the *Boat Harbour Act* deadline. The Northern Pulp Northern Bleached Softwood Kraft pulp mill is located at Abercrombie Point adjacent to Pictou Harbour in Pictou County, Nova Scotia (NS). The proposed Project consists of the development of a new effluent (wastewater) treatment facility (ETF) constructed on Northern Pulp property, and a transmission pipeline that will carry treated effluent overland and in the marine environment and discharge via an engineered diffuser (marine outfall).

The ETF is proposed to employ the AnoxKaldnes BAS™ Biological Activated Sludge process purchased from Veolia Water Technologies, which combines Moving Bed Biofilm Reactor (MBBR) technology with conventional activated sludge. Once treated onsite at Northern Pulp's facility, effluent is proposed to be sent through an approximately 15 km long pipeline, of which approximately 8.7 km is included in the overland section. An additional land-based section of effluent pipeline, less than 1 km will be installed on mill property as a part of the ETF design by KSH Solutions. Approximately 1.5 km of the treated effluent pipeline will follow a marine crossing in Pictou Harbour adjacent to the Pictou Causeway. The land-based section of the pipeline begins on the north side of Pictou Harbour where it enters the Nova Scotia Department of Transportation and Infrastructure Renewal's (TIR's) Highway 106 right-of-way (ROW) and runs generally north, parallel to Highway 106, along the outermost eastern portion of the ROW toward Caribou, NS. The pipeline will then travel through the marine environment to the proposed outfall location approximately 4.0 km offshore within the Northumberland Strait. **NPNS Comment: The AnoxKaldnes BAS™ Biological Activated Sludge was purchased in 2018 as it was required to complete the detailed engineering design. NPNS still does not have clarity on discharge limits that will be imposed by the province or if they will be different than the current and future Pulp and Paper Effluent Regulations (PPER). In absence of limits, comparison to the draft PPER regulations was undertaken at the request of NSE in the Focus Report. Clarity on whether there will be additional provincial regulations applied to the treated effluent are necessary to provide transparency in this process.**

1.4 Environmental Assessment Requirements

The Project is a Class I Undertaking pursuant to Schedule A of the Environmental Assessment Regulations made under Section 49 of the *Environment Act*. In accordance with Section 18(b) of the Environmental Assessment Regulations, the Minister of Environment has determined that an EA Report is required.

The Environmental Assessment Regulations require that the proposed Terms of Reference for the EA Report be prepared by the EA Administrator (Administrator) and made available for public review. Public comments on the Draft Terms of Reference will be accepted from January 8 – February 7, 2020.

All comments will be provided to Northern Pulp within 5 days of the end of the comment period. Northern Pulp will then have 21 days to respond in writing to the comments. Within 14 days from the final date for written response from Northern Pulp, the Final Terms of Reference for the EA Report shall be provided to Northern Pulp.

The Proponent is required to submit the EA Report within 2 years of receipt of the Final Terms of Reference. If the EA Report does not meet the Terms of Reference, Northern Pulp will be required to include further information before the EA Report can be accepted. Upon acceptance of the EA Report, Nova Scotia Environment (NSE) has 14 days to publish a notice advising the public where the EA Report can be accessed for review and comment.

Once the EA Report has been accepted, the Minister has the option to refer the EA Report to an EA Review Panel for review. At the conclusion of this process, the Minister has 3 decision options: a) the undertaking is approved with conditions; b) the undertaking is approved without conditions; or c) the undertaking is rejected.

1.5 Access to Information for the Environmental Assessment Process

Copies of the Draft Terms of Reference for the Preparation of the EA Report may be examined at the following locations:

- Pictou Library, 40 Water Street, Pictou, NS
- New Glasgow Library, 182 Dalhousie Street, New Glasgow NS
- EA website https://www.novascotia.ca/nse/ea/

All information pertaining to this portion of the EA review will be posted to the EA website as it becomes available.

2.0 PREPARATION AND PRESENTATION OF THE ENVIRONMENTAL ASSESSMENT REPORT

Pursuant to the Environmental Assessment Regulations, the EA Report must include, but not be limited to, the following information:

- a description of the proposed undertaking;
- the reason for the undertaking;
- other methods of carrying out the undertaking;
- a description of alternatives to the undertaking;
- a description of the environment that might reasonably be affected by the undertaking;
- the environmental effects of the undertaking, including identifying any effects on species at risk, species of conservation concern and their habitats;
- an evaluation of advantages and disadvantages to the environment of the undertaking;
- measures that may be taken to prevent, mitigate or remedy negative environmental effects and maximize the positive environmental effects on the environment;
- a discussion of adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technology;
- a program to monitor environmental effects produced by the undertaking during its construction, operation and abandonment phases;
- a program of public information to explain the undertaking; and
- information obtained under subsection 19(2) which the Administrator considers relevant.

The information obtained under subsection 19(2) shall be prepared taking into consideration comments from:

- the public;
- departments of Government;
- the Government of Canada and its agencies;
- municipalities in the vicinity of the undertaking or in which the undertaking is located;
- an affected aboriginal people or cultural community; and
- neighbouring jurisdictions to Nova Scotia in the vicinity of the undertaking.

In preparing the EA Report, Northern Pulp shall refer to comments from the above-noted parties during the EA review of both the EARD and the Focus Report submitted by Northern Pulp to NSE, to identify and include the supplementary information required to provide a comprehensive and complete assessment of the potential effects of the Project. The EA Report must be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence-based and supported by credible sources of information. This report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report. Northern Pulp is expected to prepare an EA Report that fulfils the intent of the Terms of Reference and considers all the effects that are likely to arise from the Project, including those not explicitly identified in the Terms of Reference.

The order in which information is presented is at the discretion of the Proponent; however, a concordance table will be required to indicate where the information can be found. In the event that the Minister has decided to refer the EA Report to an EA Review Panel for review, the Proponent may provide additional information to assist the EA Panel in making their recommendation to the Minister and assist the Minister in making the decision for the Project.

Since the EA Report is intended for public review, the information should include an Executive Summary presented non-technical language. The Proponent will be required to submit an electronic copy of the EA Report in accordance with the EA Branch Bulletin on Requirements for Submitting Electronic Copies of Environmental Assessment (EA) Documents for publication on the Department's website.

The EA Report must include, but not be limited to, the following information, as identified under the corresponding sections.

3.0 PROJECT DESCRIPTION

Nova Scotia Environment expects Northern Pulp to provide information, as part of its comment on the draft Terms of Reference, about any anticipated changes to the proposed Project as a result of the *Boat Harbour Act*. Nova Scotia Environment further expects this information to include how these changes, if any, may affect the Terms of Reference. NPNS Comment: Information gathering with respect to the operating mill (air, water, noise, etc.) is impossible with the cessation of pulp production.

Describe each component of the Project as it is planned through its full life cycle, including site preparation, construction, commissioning, operation, maintenance, and decommissioning:

- changes to existing mill infrastructure and in-mill improvements; **NPNS Comment: Based on comments received, commissioning of the mill following the hibernation period should not be**

deemed as part of the Project and therefore should not to be included in the EA Report.

- effluent treatment facility (ETF);
- land-based sections of pipeline; and
- marine based sections of pipeline and the diffuser.

Where final decisions have not been made in regard to an element of Project design, or several options exist for a particular component or activity, the assessment of effects of that element of the Project on the environment should be conducted at the same level of detail for all available options.

3.1 The Proponent

Outline the Proponent's corporate commitment to sustainable development and environmental protection goals and principles including pertinent corporate policies, programs, plans, strategies, protocols, guidelines, codes, and environmental management systems (EMS). **NPNS Comment: Based on comments received, NPNS's environmental record, including any enforcement actions taken under federal or provincial environmental legislation, is not relevant to the Project and should not be required in the EA Report.**

Provide summary information on the nature of the management structure and organizational accountability for designing, constructing, operating and modifying the Project; implementing environmental mitigation measures and environmental monitoring; and managing potential adverse environmental effects.

Provide details on relevant corporate experience (the Proponent and related companies) and experience in building and operating other similar facilities. Provide a record of the environmental performance and capability of the Proponent in conducting this type of Project.

3.2 Project Location

Provide a concise description of the geographical setting in which the Project is to be constructed/operated. Describe how the Project site was chosen, including a discussion of the specific environmental considerations used in site selection of all Project components, and the advantages of the proposed site. Describe the Project's compatibility with existing local and regional land-use policies and plans, and opportunities to integrate Project planning into regional scale development efforts. Discuss compatibility of the Project location in relation to people and their community and traditional activities and land uses by the Mi'kmaq of Nova Scotia.

Describe the ultimate boundaries of the Project in a regional context including existing and proposed land uses and infrastructure such as road networks, highway realignment, railways, power lines, pipelines, proximity to permanent and seasonal residences, individual and community water supplies, wetlands, water bodies, streams, ecologically sensitive areas, and archaeological sites. Include mapping at an appropriate scale. **NPNS Comment: What is the definition of the "ultimate" boundary? Is it different than the project boundaries used to date?**

Provide details on ownership of property within the Project footprint including lands owned by the Proponent, the Crown, or private lands. Provide details of existing agreements to develop the Project on lands not owned by the Proponent. Provide detailed plans for the required acquisition or use of private lands and Crown Lands and discuss any contingencies should these lands not be available for Project development.

Provide a list and map of communities in the region, including Mi'kmaq communities, potentially affected by the Project and indicate the distance between those communities and the specific Project components as appropriate. Identify proposed local shipping routes for importing and exporting products.

3.3 Project Design and Components

Describe the design plans and appropriate design standards for all Project components, associated and ancillary works, and other characteristics that will assist in understanding the Project, including: changes to existing mill infrastructure and in-mill improvements, ETF, land-based sections of pipeline, and marine based sections of pipeline and the diffuser. All associated infrastructure and components must be detailed. Also discuss environmental controls planned for the Project and how environmental protection, conservation, best management practices (BMPs), and best available technology have been considered in the design.

Provide potential design variations and implications (including advantages or disadvantages to the environment) of those variations. Describe any assumptions which underlie the details of the Project design. Where specific codes of practice, guidelines and policies apply to items to be addressed, those documents shall be cited.

For the EA Report, all site-specific data must be collected using equipment installed, operated, maintained and calibrated as specified by the manufacturer's instructions. All samples are to be collected, preserved and analyzed, by qualified personnel, in accordance with recognized industry standards and procedures and at accredited laboratories. Data shall undergo quality assurance and quality control (QA/QC) processes.

In addition to the above, this section will include, but not be limited to information on the following Project design components:

Changes to Existing Mill Infrastructure and In-Mill Improvements

- Preliminary design overview for any in-mill improvement projects necessary to achieve the design assumptions for the Project (e.g., in-mill cooling towers);
- Preliminary design overview of other projects that interact with the performance of the ETF (e.g., oxygen delignification) and a schedule for these projects relative to the proposed ETF construction schedule; and **NPNS Comment: The ETF has been designed, and equipment purchased, for the case without the Oxygen Delignification Project in operation. The addition of an Oxygen Delignification system will not interact negatively with the performance of the ETF. Projects considered under this bullet point should be limited to those that will be completed prior to or in conjunction with commissioning of the new facility. The Oxygen Delignification project should not be highlighted as an example in this context.**
- A waste dangerous goods management plan to accommodate for worst case scenario within design of the proposed ETF. It is important to note that the ETF is not proposed to treat waste dangerous goods based on the information provided in the EARD and in accordance with requirements of NSE. **NPNS Comment: What is the definition of the worst case scenario in this context?**

Effluent Treatment Facility (ETF)

- Footprint, location and preliminary designs for the ETF;

- Equipment description and specifications, including appropriate diagrams and flow charts for the proposed ETF and infrastructure components;

- Details (including characteristics and toxicities) and quantities of all products produced, stored, and imported to and exported from the facility (including by-products and chemical intermediaries); **NPNS Comment: Please define in more detail what NSE is looking for with this condition. It is unclear what this means. Is this referring to the facility as the ETF? The Proponent has already identified chemicals that will be used in relation to the Project in the EARD.**

- Justification of spill basin size and appropriateness of multi-purpose usage. Consider worst-case scenarios and requirements under the Dangerous Goods Management Regulations; **NPNS Comment: Clarification required to determine the definition of "worst-case" as this could be construed differently by the regulators and the Proponent. The justification for the size of the spill basin was already described in the Focus Report.**

- Proposed design for the spill basin, including but not limited to, management and disposal of contaminated material that may be present at the site, liner details, secondary containment features, clean-out access and connection to the mill infrastructure and ETF; **NPNS Comment: Design details of the spill basin have been described in both the EARD and in further detail in the Focus Report. NPNS requests more detail in outlining what additional information is required.**

- Submit additional data regarding the complete physical and chemical characterization of NPNS' raw wastewater at Point A (as defined in EARD and Focus Report), to support the assessment of the appropriateness of the proposed treatment technology. The sampling data for complete characterization (i.e., broad chemical analysis) must be statistically relevant and adequately represent ETF influent for various operating conditions that may exist at the mill (e.g., seasonality, flow rates, changes in sources of fibre or production, start-up and shut-down cycles, etc.); **NPNS Comment: For clarity, all prior effluent testing for the purpose of Industrial Approvals, the EARD and the Focus Report has been conducted at the Total Mill Effluent (TME) pump house location, not Point A. The two terms have at times been used interchangeably. There is no actual representative effluent flow at the TME, or Point A, due to the cessation of Kraft pulping activities in early January 2020.**

  There are 22 stand-alone kraft mills in Canada that are regulated under the Federal Pulp and Paper regulations. These mills, including NPNS, all successfully operate under the same regulations over a wide range of flow rates, wood species and production rates during all four seasons. NPNS is not unique, in fact, it is quite average in terms of effluent quality.

  Veolia Water Technologies, the ETF chosen vendor, has studied the effluent at NPNS and was comfortable in providing effluent quality guarantees. Veolia supplies both municipal and industrial treatment facilities in every corner of the world, including systems all over Canada.

  In our opinion, additional characterization of normally-occurring operating variations in raw effluent will not provide more certainty to this project. If additional testing is deemed necessary, there should be provision to use an approved surrogate effluent to conduct any necessary bench scale testing and broad chemical analysis and the term "statistically relevant"

should be clearly defined.

- Using NPNS' raw wastewater characterization results, evaluate all contaminants of potential concern (COPCs) with respect to the effluent discharge quality following treatment using the proposed technology. This statistically relevant assessment shall include, but not be limited to, bench-scale testing of the mill's actual Point A effluent. Provide results of all expected COPCs influent and effluent concentration ranges. Include chemical oxygen demand (COD) fractionation (soluble and total) concentrations in the assessment; **NPNS Comment: There is no actual representative effluent flow at the TME, or Point A, due to the cessation of Kraft pulping activities in early January 2020. If additional testing is deemed necessary, there should be provision to use an approved surrogate effluent to conduct any necessary bench scale testing.**

- Comparison of the effluent characterization results from the above assessment with appropriate regulations and/or guidelines, including the draft Pulp and Paper Effluent Regulations (PPER) daily and monthly average limits; **NPNS Comment: To address comments submitted by others, NSE Tier 1 EQS for both marine and freshwater discharge limits should not apply for pulp and paper mill effluent discharges in Nova Scotia, as the PPER regulations would be obligatory.**

- Effluent flow data to support the proposed peak treatment capacity of 85,000 m^3 flow of effluent per day using actual daily flow data from Point A over a minimum 1-year period; **NPNS Comment: The Focus Report outlined the rationale and justification for choosing 85,000 m^3/day as the design flow for the new facility. Accurate Point A data does not exist and is not necessary to design a new plant.**

- Information regarding how the facility will achieve compliance with COD influent limits once the in-mill changes and ETF are operational; and **NPNS Comment: NPNS does not believe that a COD influent limit should be applied to the project. NPNS has met the benchmark condition outlined in the 2015 Industrial Approval for 50% COD reduction and followed the clarification letter of November 24, 2015 from NSE for compliance and reporting requirements until operations ceased in January 2020. NPNS still contends that COD compliance at the <u>inlet</u> of an effluent treatment system is highly unusual and quite possibly a first for a pulp and paper facility in Canada. Inlet COD is an operational parameter for an ETF and has no direct effect on the receiving environment.**

- Evaluation of sludge disposal options and management plans, including the rationale for the preferred option. If the preferred option uses the biomass boiler, provide a secondary disposal option.

<u>Land-Based Sections of Pipeline Route</u>

- Information on corridor width requirements, accounting for minimal possible corridor width requested by TIR;

- Appropriate, intrusive geotechnical survey results to support proposed pipeline construction methods;

- Risk assessment of pipeline design, including the following:

    - An evaluation of the probability of a potential leak, spill or release from the pipeline installation and its operation, based on a literature review and on comparable design.

- Identification of points of the system that are susceptible to failure.
- Based on the risk assessment, a suitable secondary containment system (e.g., a double-walled pipeline system) and proposed locations. Secondary containment is at a minimum required within the Town of Pictou's water supply protection area; **NPNS Comment: NPNS believes that in all areas of the land based pipeline that containment requirements should be based on a risk assessment. Please provide the rationale/regulation for secondary containment requirements.**

- Preferred option(s) for both external and internal leak detection technologies for all sections of the on-land pipeline, with specific consideration to any section of the pipeline located in the Town of Pictou's water supply protection area and near private supply wells. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline;
- Maps, at an appropriate scale of the Project location and pipeline route that show Project components, boundaries with UTM coordinates, major existing infrastructure, important environmental features, and adjacent land uses that will intersect with the pipeline route (e.g., road networks, railways, power lines, pipelines, proximity to settled areas, individual and community water supplies, watercourses, wetlands, ecologically sensitive areas, priority flora and fauna and archaeological sites); and
- A list of all properties (i.e., Parcel Identification Numbers) that will intersect with the pipeline route.

Marine Based Sections of Pipeline Route

- Selected options for both external and internal leak detection technologies for marine sections of the pipeline. Identify the corresponding sensitivity of instruments, maintenance and staff training plan, inspection frequencies, methodologies and response protocols to leaks detected in any part of the pipeline; and **NPNS Comments: NPNS will endeavor to evaluate available options for leak detection, but systems may not exist to detect leaks in all portions of the pipeline. In addition, there is limited precedent of leak detection on treated effluent pipelines.**
- Maps, at an appropriate scale, detailing: the Project location, the Project components (e.g., confirmed locations of marine sections of the proposed pipeline including diffuser), boundaries of the proposed site with UTM coordinates, the major existing infrastructure, adjacent land uses that will intersect with the pipeline route, and important environmental features (e.g., spatial and temporal marine habitat distribution, marine refuge (Scallop Buffer Zone 24), etc.).

3.4 Construction

Describe the construction of all Project components and supporting infrastructure. This will include but not be limited to: **NPNS Comments: Some of the details requested in this section will not be known until engineering pipeline design is complete, bid packages are evaluated and contracts are awarded. Some items relate to future permitting after an approved EA. Modifications to this plan will be required.**

- Proposed construction schedule for all Project components (including those mentioned in Section 3.3 of the Terms of Reference), including days of the week, times of the day, seasonal schedules and anticipated commencement and completion dates;

- All physical works and activities carried out during the construction phase are to be identified and described by location. This, includes but is not limited to: clearing and grubbing; blasting; site access and roadways; marine construction methods; road construction methods; dangerous goods storage areas; disposal at sea; watercourse crossings or diversions; utilities; and description of equipment used for construction activities, both terrestrial and marine;

- Dredge management/disposal plans that characterize and quantify marine sediments to be dredged and disposed (or re-used) in accordance with Environment and Climate Change Canada (ECCC) standards and in consultation with relevant government departments. Identify areas where dredging activities will occur and identify the location, quantity and chemistry of any dredge materials that are expected to require land-based disposal;

- Evaluation of pipe jacking feasibility where crossing roads or structure locations that includes addressing limitations associated with practical pipe length at crossings and available space for thrust/reception pits on either side of crossings;

- Evaluation of the effects of excavating and replacing large rock fill along the alignment route near Harvey A. Veniot Pictou Causeway;

- Storage areas for fuels, explosives and dangerous goods; and

- Waste disposal plans (types of waste, methods of disposal, quantity).

3.5 Operation

Describe the operation of all Project components and supporting infrastructure to all components. The description of the operation shall include but not be limited to the following:

- Routine and maintenance operations for all Project components;

- Environmental controls and BMPs, including pollution prevention techniques in addition to traditional treatment and disposal practices;

- A spill basin management plan that proactively addresses the management of different types of materials, including compatible and non-compatible waste dangerous goods, sequential spills/leaks/releases, clean-out and liquid/solid removal procedures for the different types of collected materials, and appropriate final disposal procedures that observe applicable provincial and federal regulations; and

- A plan to ensure adequate staffing and operation oversight of ETF by trained personnel at all times.

3.6 Decommissioning and Reclamation

Describe the proposed plans for decommissioning the Project, including all infrastructure and reclamation of any impacted site. The EA Report shall also discuss the post-decommissioning land use options of the property.

4.0 REGULATORY ENVIRONMENT

Describe the existing regulatory environment (Federal, Provincial and Municipal) including all permitting, licensing and regulatory requirements that apply to all phases of the Project and associated infrastructure. Provide a schedule indicating anticipated dates for required regulatory approvals.

Significant portions of the proposed Project to be evaluated by the EA Report are located on federal lands; therefore, federal authorities have indicated that they must make a determination as to whether the Project is likely to cause significant adverse effects and/or in the case of Public Services and Procurement Canada (PSPC) seek an Order in Council prior to providing authorizations, licenses, or leases. To ensure potential environmental effects are addressed to the satisfaction of federal authorities under Section 82 of the *Impact Assessment Act*, provide all necessary authorizations, licenses, or leases for all applicable federal authorities.

Describe applicable guidelines and standards that would apply to the Project. Those applicable standards or guidelines shall also be referenced in the appropriate sections of the EA Report and linked to environmental protection objectives.

5.0 NEED FOR AND PURPOSE OF THE PROJECT

The need for and purpose of the Project should be established from the perspective of the Proponent. The Project is being designed to meet specific objectives and these objectives should be discussed. If the objectives of the Project are related to or contribute to a larger private or public sector policy, program or plan, this information should be included.

6.0 DESCRIPTION OF ALTERNATIVES TO THE PROJECT

Include an analysis of alternative means of carrying out the Project; describing functionally different ways to meet the Project need and achieve the Project purpose.

7.0 OTHER METHODS FOR CARRYING OUT THE PROJECT

Discuss other methods for meeting the need for the Project, including but not limited to, pipelines and treatment technologies. This section shall also discuss alternate locations for the Project.

The rationale for rejecting other described methods of carrying out the Project must be provided, including a discussion of how environmental sustainability and impact avoidance criteria were applied.

8.0 ASSESSMENT METHODOLOGY

Include the study strategy, methodology and boundaries used for preparing the EA Report. The following must be clearly defined:

- Temporal boundaries (i.e., duration of specific Project activities and potential impacts) for construction and operation through to decommissioning and post-decommissioning;

- Study boundaries or Project area and all space that will be potentially impacted, by the Project as proposed, or subject to subsequent modifications, and the methodology used to identify the study boundaries;

- Valued Ecosystem Components (VECs) within the study boundaries and the methodology used to identify the VECs. The methodology used for VEC identification shall include input from members of the public, government departments and agencies, other experts, and other interested parties, as well as direct engagement with the Mi'kmaq of Nova Scotia; **NPNS Comment: NPNS agrees with the Fisheries & Oceans comment that the ToR needs to provide clarity to the proponent with regard to the assessment methodology and instruction to develop a clear definition of adverse effects and significant environmental effects for each Valued Component.**

- Where appropriate, identify environmental protection objectives (including those contained in applicable legislation or guidelines) associated with each VEC;

- Strategy for investigating the interactions between the Project and each VEC and how that strategy was used to coordinate the individual studies undertaken; and

- Method for predicting and evaluating Project impacts upon the environment; determining necessary avoidance, mitigation, remediation and/or compensation (in this order of consideration); and determining the significance of any residual impacts.

The EA Report is to be prepared using an accepted and proven EA methodology and a qualified person should predict and evaluate Project impacts upon the environment. If there are no predicted effects to a specific VEC, provide reasons to support that claim. A complete discussion and analysis of predicted effects (direct and indirect effects) should be provided that is qualitative and quantitative, evidence-based and supported by credible sources of information. Provide a list of literature and sources used in the preparation of the EA Report.

The following sections outline specific concerns and requirements related to the existing environment, adverse effects and environmental effects assessment, proposed mitigation, residual environmental impacts, proposed compliance and effects monitoring, and the public information program that are to be addressed in the EA Report for the proposed Project.

9.0 EXISTING ENVIRONMENT

Provide a baseline description of the environment in the vicinity of the Project and all other areas that could be impacted by the Project. This description must include the components of the existing environment and environmental processes, their interrelations and interactions, as well as variability in these components, processes and interactions over time scales appropriate to the effects assessment. The Proponent's description of the existing environment shall be in sufficient detail to permit the identification, assessment and evaluation of the significance of potentially adverse environmental effects that may be caused by the Project.

The EA Report shall build upon, where appropriate, the science and evidence outlined in the EARD and in the Focus Report, considering comments on those documents during their respective EA review processes. The EA Report shall be a stand-alone document that presents a complete discussion and analysis of predicted effects (direct and indirect effects) that is qualitative and quantitative, evidence-based and supported by credible sources of information. Supplementary information shall be included to provide a comprehensive and complete assessment of the potential effects and may provide additional information to assist the EA Panel in making their recommendation to the Minister in the case of a panel review and to assist the Minister in making the decision for the Project.

The EA Report shall clearly indicate baseline data/information which is not available or where existing data cannot accurately represent environmental conditions in the Project area. If the background data have been extrapolated or otherwise manipulated to depict environmental conditions in the Project area, modelling methods and equations shall be described and shall include calculations of margins of error.

For the EA Report, the spatial boundaries must include the Project footprint and relevant receiving environments such as airsheds and watersheds. Temporal boundaries must address applicable guidelines, standards and regulatory requirements and include Project construction, operation, decommissioning and post-decommissioning.

The Proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. Where technical reports are included or referenced, they must be finalized and signed by the qualified individual(s). Also provide the name and credentials of the person(s) conducting baseline studies/surveys. Mapping clearly indicating the extent of studies/surveys, sampling points, and illustrating key findings should also be included and presented logically within the EA Report in a location that allows for ease of review. Wherever possible, mapping should be presented at common scales and datum to allow for comparison and overlap of mapped features.

The components of the environment to be discussed shall include identified VECs and those indicated within Sections 9.1 – 9.8.

9.1 Geophysical Environment

9.1.1 Topography, Geomorphology and Geology

Topographical maps should be provided locating the Project in both regional and local contexts. Describe the physical geography of the Project study area including post-glaciated landforms, coastal features, and marine features.

9.1.2 Geology

Include a description of bedrock geology, surficial geology and soils. The results of the geotechnical survey referenced in Section 3 of the Terms of Reference should be included. Geological properties of all Project sites in the study area which may influence stability, occupational health and safety, rehabilitation programs, or the quality of discharge water leaving any area disturbed by the Project should be described. The EA Report must consider the potential for Acid Rock Drainage/Metal Leaching (ARD/ML) where new bedrock may be exposed and/or excavated.

The marine component of the Project should also include a discussion pertaining to surficial sediment characteristics and mobility under present and future environmental conditions. This section should also identify any mineral resources that may be impacted by the Project.

9.2 Water Resources

Include a description of groundwater, surface water, marine water and wetland resources potentially affected by the Project.

9.2.1 Groundwater

Provide a description of the regional and local hydrogeology of the study area. A discussion of groundwater use in the study area, including both current and likely potential future uses must be provided. Provide a map showing all water supply wells locations and potentially affected watercourses within 500 metres of the pipeline route.

9.2.2 Surface Water

Provide a general hydrologic, hydraulic and water quality description of all surface water bodies in the study area, including upstream and downstream to all Project components. Existing uses, withdrawal capacities, and users of the watercourses shall be identified, including use by the Mi'kmaq of Nova Scotia.

9.2.3 Marine Water

Provide baseline studies that characterize environmental conditions for the four seasons over a minimum of one year for the marine environment, including: climate, water quantity (e.g., current profiles, wave height, tide levels), water quality (e.g., temperature, salinity, chemical and physical water quality), and marine sediment chemical characterization in the vicinity of proposed marine outfall location. These studies must be to the satisfaction of relevant government departments and are to be used to support modeling activities.

NPNS Comments:

PSPC comment on marine water and sediment: "Provide a minimum of two years of baseline information to account for yearly variations." This requirement is not in line with the fixed term of 2 years for the submission of the EA Report.

In both government and others comments, there was significant discussion about baseline conditions, receiving water uniformity and the modelling method (2D Cormix) used to predict future impacts. Please refer to the Stantec letter (*let_121416276_Stantec_RWS_Focus_Rpt_responses to ECCC comments_20191210*) attached which speaks to comments from federal reviewers on the Focus Report. Of particular note, on page 4, Stantec speaks to the differences between 2D and 3D modelling and confirms that "based on temperature differential the water column profile is uniform", which satisfies the CORMIX modelling requirements for 2D modelling. Stantec goes on to say "Depending on modelling conditions, a 3D model is not always more accurate than a 2D model for far-field predictions. Typical application of 3D far-field hydrodynamic models are for estuaries, tidal rivers, and localized highly stratified areas in lakes. For open-ocean, large area applications a 2D far-field modelling approach is the most common."

NPNS suggests that one additional season (fall data set) be collected to supplement the spring data already gathered. If that data continues to suggest minimal stratification is present and 2D modelling is still deemed appropriate based on modelling criteria in the area of the outfall, it is unlikely that these additional studies will provide more certainty or result in less risk to the project. We say this especially given the poor effluent mixing conditions that were present for over five decades at the Boat Harbour dam with no adverse impacts identified in the receiving waters near the outfall. These studies are outlined in further detail below.

Some reviewers called for an expanded model study area. The model area used for the receiving water study was approximately 2500 km^2. Given the large modelling area already selected and more than five decades of effluent entering that same study area, a larger study area is not warranted in our view.

Whatever the decision, NPNS needs very clear definition of what is required (and coordinated agreement from all relevant government departments) – this level of scrutiny doesn't seem to exist in other projects.

Provide marine sediment chemical characterization along the proposed marine based pipeline section routes. Marine sampling locations must be clearly identified.

Conduct an intrusive marine geotechnical investigation in the areas identified to have potential bedrock of uncertain depth and along proposed route near base of Harvey A. Veniot Pictou Causeway. **NPNS Comment: There are sections in both the Pictou Harbour and Caribou marine pipelines that the geotechnical survey concluded may contain bedrock within the trenched volume (Identified in Enclosures 8 and 9 of the CSR survey). Additional intrusive investigation should only be required in these areas of uncertainty, not the entire length of the Pictou Causeway as the wording currently suggests.**

Provide an ice scour baseline study for at least two winter seasons. **NPNS comment: NPNS assumes this means one additional season in consideration of the 2019 season already collected.**

9.2.4 Wetlands

Identify the location, size and class(es) of any wetland and/or wetland complexes within the predicted zone of influence and conduct a wetland evaluation. Evaluation of the wetlands shall include wildlife habitat potential (including rare and endangered species), groundwater recharge potential, role of the wetland in surface water regulation (stormwater retention and flood control) and the role of the wetland in watershed health. Based on the results of the evaluation, the EA Report must specifically identify wetlands that:

- Support a significant species or species assemblages;
- Support high wildlife value; and/or
- Have high social or cultural importance.

Describe all work activities and predict the effects (direct and indirect), with supporting rationale, on impacted wetland and wetland functions.

Wetland evaluations shall include additional assessment of adjacent wetland areas and anticipated extent of impacts associated with construction activities. The wetland evaluation must include identification of assessment areas and catchment areas used in the evaluation and include any associated outputs or assessment scoring outputs.

Baseline studies must describe and document pre-construction conditions, including, but not limited to, wetland class distribution, vegetation community structure, soil characteristics, and hydrology trends.

9.3 Atmospheric Resources

Atmospheric resources will include ambient air quality, the acoustic environment, greenhouse gas emissions, and impacts on climate.

9.3.1 Climate

Include a discussion of regional climate conditions and meteorology in the vicinity of the Project as well as expected changes over the next 50 years due to climate change. This section should include climate norms, extreme conditions, as well as trends in these conditions and climate change impacts, as well as the effect these changes may have on the Project and plans to mitigate against those impacts.

In addition to historical and projected climate data, the climate sub-section of the existing environment should include a summary of greenhouse gas emission projections for the Project, including plans to mitigate those emissions in both the design and operation.

Please follow the EA guidance documents when completing this section: https://novascotia.ca/nse/ea/docs/Development.Climate.Change.Guide.pdf.

9.3.2 Air Quality

For the study area, provide a review of baseline ambient air quality and meteorological data, including annual and seasonal climatic conditions for the region.

Provide a description of existing ambient air quality conditions for the study area, with particular attention to ambient and peak levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O3), particulate matter (total suspended particulate (TSP), fine particulate matter (diameter less than 2.5 microns) ($PM_{2.5}$) and coarse particulate matter (diameter less than 10 microns) (PM_{10}), total reduced sulphur (TRS) and volatile organic compounds (VOCs) levels. **NPNS Comments: NPNS understands this refers to data already collected during normal operation of the mill facility under production.**

Discuss the influence of local and regional emission sources and the influence of climate and weather conditions. The data should be used for the development of an appropriate model(s) for the study area to be provided in the EA Report. Also describe any potentially sensitive receptors and/or locations. **NPNS Comments: Some public comments called for a modelling change from AERMOD to CALPUFF. The AERMOD model used in the EARD and Focus Report is currently designated as the preferred model by U.S. EPA. This model yields a good match between modeled and observed results in the near-field because meteorological conditions are typically fairly uniform over short distance (<50 km) and time scales. Nova Scotia Environment (NSE) has accepted using the Ontario Guidance (MECP 2017) approach in the past which approves the usage of AERMOD. AERMOD is the model that has been approved by Nova Scotia Environment for all Northern Pulp's historical regulatory work and previous approved permits. In addition, the AERMOD program was the approved model used for the Class II Goldboro LNG Project Environmental Assessment.**

9.3.3 Ambient Noise and Light Levels

Describe the existing ambient acoustical environment at the Project site (including the marine environment), and in any other areas where Project activities could be expected to have an environmental effect. **NPNS Comments: NPNS understands this refers to data already collected during normal operation of the mill facility under production.**

Provide the spatial boundaries of existing noise and vibration levels, as well as locations of recording stations and length of record for any acoustic or vibration data presented. Consider the effects of different meteorological conditions on noise propagation. Provide information on any existing relevant standards, guidelines or objectives with respect to noise and vibration levels.

Describe existing ambient light levels at the Project site and at any other areas where Project activities could have an environmental effect on light levels. Describe night-time illumination levels during different weather conditions and seasons.

9.4 Flora and Fauna

Identify flora, fauna, and habitat types that will be intersected by all components of the Project. Appropriate field surveys agreed to by Nova Scotia Lands and Forestry (NSLAF) – Wildlife Division, shall be conducted as part of the evaluation. Surveys should be described by results, methodology, and spatial and temporal boundaries.

9.4.1 Terrestrial Environment

This section must include, but not be limited to the following:

- Identification of typical species of flora, sensitive flora, flora species-at-risk, and potential habitat for flora species-at-risk in the study area;

- Identification of areas of old growth forest. Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; the Nova Scotia Museum of Natural History, and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed in a manner that is acceptable to NSLAF – Wildlife Division. Available data, survey results, and detailed mitigation measures that demonstrate a special emphasis on avoidance of impacts shall be included in the EA Report;

- Identification of any existing or planned wildlife management areas, ecological reserves or wilderness areas as well as managed wetlands and significant wildlife habitat;

- Identify and delineate on a map 'roadless areas' and discuss their potential value to Nova Scotia's protected areas network. Include areas with high wildlife concentrations, wildlife corridors or habitats rare/unique to Nova Scotia;

- Identification of typical species of fauna (including invertebrate species), sensitive fauna, fauna species-at-risk, and potential habitat for fauna species-at-risk in the study area. Current information shall be obtained from NSLAF – Wildlife Division; the Atlantic Canada Conservation Data Center; ECCC; Nova Scotia Communities, Culture and Heritage; the latest Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list; the Atlas of Breeding Birds of the Maritime Provinces; and local naturalists and relevant interest groups. Field surveys and investigations required to supplement the available data shall be completed by professional biologists in a manner that is acceptable to NSLAF – Wildlife Division and Canadian Wildlife Service**;** **NPNS Comments: NPNS agrees with NS Department of Lands and Forestry that definitions of sensitive fauna and species-at-risk should be provided for clarity in the process.**

- Additional migratory bird surveys at representative survey points along the pipeline route;

- Bird surveys transects to provide a complete view of bird species distribution and habitat use along the pipeline route, including transect bird surveys and fall migratory bird survey. Identification of nests of bird species, which are protected under the *Wildlife Act*, regardless of whether they are active or not must also be considered;

- Bird baseline survey for common nighthawk (*Chordeiles minor*), including rationale for survey point selection to the satisfaction of NSLAF;

- Raptor nest survey to identify nest locations for the entire Project area including the pipeline route;

- Herptile survey for the Project area, which includes the pipeline route, to include both spring and fall survey information. Prior to conducting survey, develop survey methodology in consultation with NSLAF; and

- When surveys are necessary to supplement the available data and adequately describe the use of the area by migratory birds during different times of the year (breeding season, migration, winter), emphasis will be placed on determining whether any bird species-at-risk, colonial nesting species, species particularly vulnerable to habitat fragmentation, etcetera, occur or breed in or near the study area.

9.4.2 Freshwater Aquatic and Marine Environment

This section must include, but not be limited to the following:

- Fish and fish habitat baseline surveys for the marine environment;

- Description of any freshwater fish or fish habitat that exists in any identified watercourse or any other receiving watercourse that may be impacted by the development. The description of these species and habitat should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish;

- Description the relative distribution and abundance of valued fish resource components within the predicted zone of influence. Fish species, age, health, and diversity shall be described;

- Description of any seasonal variation in the location, abundance and activities of aquatic species should be included. Describe and identify key habitat features, such as spawning, rearing, nursery, feeding, migration and overwintering areas, as they occur within the Project area. Also describe the criteria utilized for determining the zone of influence this Project has on the fish habitat;

- Description of the marine habitat and species of fish, including pelagic and demersal finfish, shellfish, crustaceans, and marine mammals, likely to be present within the surrounding marine environment. The description of these species and habitats should identify any species-at-risk and ecologically sensitive or critical habitat and migratory routes of fish and marine mammals;

- Baseline data for existing mercury concentrations in fish tissue that are adequate to be used for comparison purposes for impact monitoring programs. Provide data on total mercury in whole fillets accompanied by fish species and size data; and **NPNS Comment: It is unclear to NPNS why this condition exists. As outlined in the Focus Report, NPNS untreated effluent was non-detect for mercury. Mercury is not generated through a treatment facility if it is not present in the influent. The mercury contamination in the Boat Harbour Basin is historic. Further, several very recent studies have been completed by Nova Scotia universities for the NS Lands Boat Harbour Remediation Project that have assessed mercury and other contaminants in fish in the area of the Boat Harbour Effluent Treatment Facility (BHETF) outfall against the Canadian Food Inspection Agency (CFIA) guidelines. Results of two such studies (attached) are summarized below:**

  Chaudhary, M. (December, 2019). Baseline Assessment of Contaminants in Sediments and

Marine Biota of Northumberland Strait, Nova Scotia, Canada. *https://dalspace.libray.dal.ca*

"This study evaluated concentration of metals, dioxins and furans and methyl mercury in surficial sediments and marine biota (*i.e*. American lobster (*Homarus americanus*), rock crabs (*Cancer irroratus*), and blue mussels (*Mytilus edulis*) of Northumberland Strait."

"…our results provide no evidence of any significant impact on sediments or biota of the Northumberland Strait that is attributable to the industrial effluents. In sediments, all the contaminants (*i.e*. metals, dioxins and furans, mercury) were below the ISQGs and some even below the detection limit. It was interesting to note that the concentrations of metals in sediments were not only found below the CCME ISQGs (CCME, 2019a) but were also below the background concentration range in coastal sediments of Nova Scotia (Loring et al., 2016)."

Maltby, E. (November 11, 2019). American lobster (*Homarus americanus*) tissue sampling for trace metal(loid)s and organic contaminants: baseline report for Boat Harbour remediation project. Report to NS Lands Inc.

"This report is intended to establish a baseline of the contaminant levels in lobster tissues prior to remediation of Boat Harbour. Three additional objectives were to 1) determine if contaminants in lobsters exceed any guideline values 2) record the differences in contamination between sites and 3) test for any bioaccumulation effect in lobsters. In the summer of 2018, three age classes of lobsters (adults, subadults, and juveniles) were collected from three different sites; Ballantynes Cove (~45 km from Boat Harbour outfall), Merigomish (~15 km from Boat Harbour outfall), and Pictou Road (>1 km from Boat Harbour outfall)."

"There was also no one site that was found to have higher contamination than the others; it varied depending on the contaminant. Pictou Road was expected to have higher levels of contaminants, but occasionally levels at Ballantynes and Merigomish exceeded those at Pictou Road. Contaminants were mostly below regulatory guideline levels and within the contaminant ranges reported by reference studies, with a few exceptions. Notably, arsenic concentrations from all sites exceeded the CFIA action level for fish tissues. However, arsenic levels are known to be generally elevated in Nova Scotia due to natural and anthropogenic sources."

- Baseline study for fish and shellfish tissue with chemical analysis that includes COPCs of representative key marine species important for commercial, recreational and Aboriginal fisheries (food, social and ceremonial) in the vicinity of the proposed effluent pipeline and diffuser location. The locations of samples must be clearly identified. **NPNS Comments: Baseline fish and shellfish tissue analysis was conducted for species that could be caught in the study area including American Lobster, Rock Crab and Quahogs. Clarity is required for the specific additional species that are required under this condition. NPNS suggests that the species be consistent with those approved for the Boat Harbour Remediation Project given it is the same body of water.**

9.5 Agriculture, Aquaculture and Forestry Resources

Identify and describe agricultural resources in the study area. Identify agricultural operations in the study area and describe crop types, growing seasons and growing methods.

Describe all commercial, recreational and Aboriginal fisheries (including food social ceremonial (FSC) as well as commercial), aquaculture, and harvesting (e.g., marine plants, shellfish) in the study area. Describe the commercial and recreational species, caught, grown or harvested, and their economic importance. Identify fishing, aquaculture and harvesting locations, the amount caught, and methods used.

Identify and describe forestry activities in the study area.

9.6 Socio-Economic Conditions

Describe the current socio-economic conditions of the study area, including population demographics and economic conditions (including Aboriginal Peoples). Provide details of employment rates and trends at the municipal and regional level. The spatial boundaries of this analysis should include areas within which employees of the Project are expected to reside. Identify key industries in the region (both land-based and marine-based) and describe their contribution to the local and regional economies. Provide details of residential and commercial property values. Describe any local and regional economic development goals and objectives identified through community consultation, or existing economic development plans and strategies.

9.7 Existing and Planned Land Uses

Describe the patterns of current and planned land use and settlement in the study area including residential, industrial, agricultural, parks, and protected areas. Provide details of areas under existing mineral exploration licenses as well as areas licensed for pulpwood harvesting. Identify locations of abandoned mine workings, mine tailings and waste rock disposal areas, as well as contaminated sites. This section shall include map(s) to illustrate land uses and provide distances to significant settlements.

The EA Report must also identify lands and resources of special social, cultural or spiritual value to the Mi'kmaq of Nova Scotia, with particular emphasis on any current use of land for traditional purposes. A Mi'kmaq Ecological Knowledge Study (MEKS) should be used to identify land and resource use that have and/or continue to be pursued by the Mi'kmaq of Nova Scotia. **NPNS Comments: NPNS has completed the MEKS for the Project area and has included the local Indigenous community in the study. The study currently sits with KMKNO for final review.**

9.8 Archaeological Resources

Identify any areas containing features of historical, paleontological, cultural or archaeological importance in a manner acceptable to the Nova Scotia Communities, Culture and Heritage (CCH). Describe the nature of the features located in those areas. Particular attention shall be given to Mi'kmaq of Nova Scotia archaeological sites and burial sites. All heritage research permits acquired, and engagement with the Mi'kmaq of Nova Scotia during this analysis should be identified in the document. Results of the Archaeological Resource Impact Assessment reports related to Indigenous land use and known archaeological sites of interest to the Mi'kmaq, should be provided to the Office of Aboriginal Affairs and PLFN.

10.0 ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS ASSESSMENT

Describe the effects of the Project on the environment during all phases of the Project (construction, operation, and decommissioning and reclamation), including any environmental change on health, socio-economic conditions, archaeology, and the current use of land for traditional purposes by the Mi'kmaq of Nova Scotia. The EA Report shall identify and describe the accidents and/or malfunctions that may occur during all phases of the Project and assess the effects on VECs.

Provide a detailed contingency plan that considers site-specific conditions and sensitivities, the lifespan of different components and includes, but is not limited to:

- Full hazard identification and qualitative risk assessment associated with Project construction and operation, including those which have or may have an environmental impact (directly or indirectly);

- Prevention, mitigation and contingency measures to mitigate potential Project impacts;

- Discussion of measures to mitigate potential impacts or damages on the environment, properties and human health (e.g., liability insurance, financial security, etc.);

- Emergency response procedures;

- Description and quantification of releases that could occur under both normal conditions and a 'worst-case scenario'; **NPNS Comments: Clarification required to determine the definition of "worst-case" as this could be construed differently by the regulators and the Proponent.**

- Description the types, fate and distribution of contaminants within the study area under normal and worst-case scenarios during construction, operations and post-reclamation; **NPNS Comments: Clarification required to determine the definition of the three "worst-case's" as this could be construed differently by the regulators and the Proponent.**

- Discussion of potential Project impacts on emergency and health services in communities near the Project area, and associated mitigation and contingency measures in the events of major Project related accidents and malfunctions;

- Description of the cumulative effects of Project activities; and

- The effects assessment shall also consider impacts of the environment (including weather and climate) on the Project, including a discussion of how potential climate change will impact all components of the Project.

10.1 Geophysical Environment

Potential effects of the Project on the geophysical environment must be discussed in the EA Report.

The EA Report must also discuss the potential cumulative and residual effects of the Project on the geophysical environment and the significance of these effects. **NPNS Comments: It is unclear what is**

being requested under cumulative geophysical effects as most geophysical effects would be short-term construction-related effects.

10.2 Water Resources

In conducting the effects assessment on water resources, the EA Report must identify and evaluate:

- Changes in groundwater and surface water quality as a result of effluent discharges from the Project site;

- Potential effects on groundwater quality and quantity and associated impacts to users of groundwater;

- Potential cumulative and residual effects of the Project on water resources and the significance of these effects including ecosystem integrity and changes in hydrology to areas immediately adjacent to the Project area;

- Where wetland avoidance is not possible, the EA Report must discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function. **NPNS Comments: These items can be discussed in generalities, but final pipeline design with bid contracts awarded and input from contractors are all required to definitively respond to this condition. This level of detail seems unusual in an EA and seems more related to future permitting requirements.**

- The Canadian Council for Ministers of the Environment (CCME) Water Quality Guidelines with background water quality results shall be used to ensure the protection of relevant water uses (aquatic life, recreational use, agricultural use, and drinking water supply) and shall be used as the basis for evaluating the significance of the predicted impacts; and

- It is recommended Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Water Quality, be reviewed and applied in the evaluation where relevant.

10.2.1 Groundwater

Provide an assessment of the potential risk to groundwater resources associated with the construction and operation of the pipeline. The assessment shall include but is not limited to quantitative calculation of time of travel between the pipeline and water supply wells and watercourses, delineation of well capture zones and determination of groundwater flow directions. The results of this assessment shall be considered in the final pipeline design in terms of providing for greater protection in areas of greatest risk.

The groundwater assessment results need to be discussed with the Town of Pictou to establish confidence that the risk of negative impacts to the Town water supply has been reduced to an acceptable level. **NPNS Comment: NPNS seeks clarification of the definition of "an acceptable level".**

10.2.2 Surface Water

In conducting the effects assessment on surface water resources, the EA Report must identify and evaluate:

- Potential effects to surface water quality on fish and fish habitat, community water supplies (protected and unprotected), and recreational and agricultural users.

10.2.3 Marine

The proponent is encouraged to consult with relevant government departments when determining the need for, extent, methods, and timing of site-specific studies/surveys. In conducting the effects assessment on marine resources, the EA Report must identify and evaluate, to the satisfaction of relevant government departments:

- Marine pipeline construction methods along the full route and construction requirements (e.g., blasting), using results from geotechnical investigations;

- Adequacy of proposed pipeline burial depths with respect to ice scour;

- Geotechnical assessment of stability of underwater excavation works near base of Causeway with respect to causeway embankment and structures;

- Potential risk of impacts to the marine environment resulting from leaks from marine based sections of pipeline;

- Receiving water study that assesses fate and transport of COPCs in the receiving water environment for a range of scenarios reflective of conditions possible at the chosen site. This study shall identify potential short and long-term impacts. This study is to be completed using modelling techniques and scenarios for all COPCs in the receiving environment, based on the results of the effluent characterization in Section 3.6 of the Terms of Reference and other relevant studies, such as Human Health Risk Assessment. All baseline climate and marine water quantity and quality data should be applied to this study for model setup, calibration and validation. Results shall include, but not be limit to, discharge plume dimensions and dilution ratios; **NPNS Comment: In the focus report, NPNS was asked to run various scenarios of differing effluent quality and also to determine the assimilative capacity (that included COPCs) of the receiving water to meet CCME water quality guidelines as the worst case scenario. The back-calculation of assimilative capacity concluded that the outfall area had "substantial assimilative capacity". The term "range of scenarios reflective of conditions possible at the chosen site" should be well-defined, especially if deemed different from the last receiving water study scenarios. The past receiving water studies were conducted with normal modelling time frames – a precise definition of short term and long term and how those impacts should be evaluated should be provided so there is no confusion in the model requirements going forward.**

- Goodness of Fit statistical procedures are to be applied to evaluate model adequacy in representing the receiving water environment for the calibration and validation periods. Assessment must be provided on the adequacy of the seasonal variation and lengths of observed datasets used in model setup and calibration/validation. A summary of model confidence in adequately representing multi-year effluent discharge transportation of COPCs and accretion/build-up within the receiving water environment is to be included; **NPNS Comment: In the Focus Report, Stantec provided a model based on standard time frames, a month of field data collection, and calibration. Much of the above condition is highly unusual and outside of normal modelling requirements on other Canadian projects. As this request is outside of the norm for project modelling, our consultants were unable to provide clear advice on a path forward. Clearly defined methodologies need to be provided.**

- Potential build-up of COPCs resulting from the proposed activity (e.g., shoreline accumulation). Provide the estimated dilution potentials at various distances from the diffusers based on calibrated model results as appropriate;

- In conjunction with the above, provide sediment transport modelling, including model(s) and scenarios to assess the impacts of sediment transport within near-field and far-field model areas. The results of the modelling activities are to be assessed with respect to chemical and physical characterization of the distributed solids, interaction with marine sediments and waters, and effects within the marine environment, particularly to marine organisms; and **NPNS Comment: Please refer to the Stantec letter (*let_121416276_Stantec_RWS_Focus_Rpt_responses to ECCC comments_20191210*) attached which speaks to comments from federal reviewers on the Focus Report. We stand by the appropriateness of our model in meeting the requirements/recommendations of 2D modelling for this offshore outfall.**

  Regardless of feedback received with respect to the Caribou outfall location modelling, there appears to be consensus that the effluent mixing will be a significant improvement over the mixing that was provided at the overflow of the BHETF for five decades. As part of the Boat Harbour Remediation Project baseline studies, an evaluation of Sitmu'k, also known as Moodie's Cove was undertaken. Sitmu'k is a shallow salt water lagoon system with tidal influence near the Boat Harbour tidal estuary which, depending on the tides, and verified by both visual observation and modeling predictions, regularly received pulp mill effluent. The study was undertaken in part to determine if the cove has been influenced by local industrial activity.

  Wyles, D.G. (April 2019). A paleolimnological assessment of sediment in Sitmu'k Lagoon, Pictou Landing, Nova Scotia to determine the influence of geogenic and anthropogenic activity on water quality change through time. *https://scholar.acadiau.ca*

  "The purpose of this study is to determine the legacy of environmental change that has been preserved in Sitmu'k sediments by conducting an applied paleolimnological assessment of the sediment archive from the lagoon. A comparison of metal concentrations to previous studies done in the area will establish whether the changes are unique and if they can be related to

local industrial activity. An assessment of the present environmental conditions in the lagoon was achieved through applied water chemistry analysis."

"There is strong evidence for natural environmental change at Sitmu'k. … XRF analysis of the lagoon sediment archives does not provide evidence for sequestered contaminants or extensive change. There are two events in the sediment archive that change metal concentrations, both are likely due to sudden rapid sedimentation rates caused by breaches in the barrier beach. Evidence for anthropogenic impact on-site is found in the water quality data. E. coli bacteria is likely coming from a source of fecal contamination. High phosphorus concentrations may be related to septic influence. Total carbon, total nitrogen, and stable isotope analysis indicated that organic material is of marine origin, reducing the likelihood that pulp effluent impacted the site."

This study should be considered relevant and speaks to lack of impacts of NPNS effluent in the marine environment, especially in an area with much greater mixing due to the diffused outfall and the presence of significant ocean currents. Given the lack of any adverse impacts identified in both fish tissues and sediment and in light of the larger body of evidence present from other kraft mill outfalls, NPNS does not feel additional assessment of sediment transport and environmental effects is warranted.

- Based on the results of the receiving water study, evaluate whether colour is expected to be visible at the ocean surface above the diffuser site, including influence of in-water reactions (e.g., potential stratification of the water column) on colour levels. Assess impact of colour and its interaction and effect on the marine sediments and associated marine life.

10.2.4 Wetlands

In conducting the effects assessment on wetlands, the EA Report must identify and evaluate:

- Potential direct and indirect impacts to wetlands and how Project development will adhere to the Nova Scotia Wetland Conservation Policy; and
- Where wetland avoidance is not possible, discuss wetland specific construction activities (including trench dewatering, surface water diversions and maintenance of hydrologic connection of wetland complexes), proposed mitigations and anticipated impact on wetland area and function.

10.3 Atmospheric Resources

Describe the sources, types and estimated quantities of air emissions from the mill facility for all potential air contaminants of concern related to the Project under routine conditions and in the case of malfunctions and accidental events on a seasonal and annual basis. Air contaminants to be evaluated should include but not be limited to, impacts of CO, hydrogen sulphide (H_2S), nitrogen oxides (expressed as nitrogen dioxide)(NO_2), O_3, SO_2, TSP, $PM_{2.5}$, PM_{10}, TRS, speciated VOCs, semivolatile VOCs, polycyclic aromatic hydrocarbons (PAHs) and metals. The description shall include appropriate models based on known or measured atmospheric conditions throughout the year.

For all Project phases, construction, operation and decommissioning, estimate the GHG emissions and provide an inventory of GHG emissions from all Project components. This includes carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), sulfur hexafluoride (SF6), nitrogen trifluoride (NF3) and conversion of these emissions to an equivalent amount of CO2. Also include an inventory of the precursors or tropospheric ozone (CO, NOx, and VOCs).

Where possible, include a comparison of the above information with estimates of total GHG contributions from NS, and from similar facilities in Canada. The EA Report must also include a discussion of measures that have been considered and/or are proposed to reduce air emissions and reduce or offset GHG emissions.

While considering the effects on air quality, the EA Report must discuss the potential impacts of predicted increases in noise and light levels during all phases of the Project, on surrounding residential, commercial, recreational and institutional areas, and marine and terrestrial habitats.

It is recommended Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air and Noise, be reviewed and applied in the evaluation where relevant.

In addition, based on concerns raised by government reviewers, the EA Report must also include, but not be limited to the following additional items:

Revised air dispersion modelling including the following:

- Consideration of the effects of fumigation and coastal interaction in the modelling;
- Modelling based on the operating scenario for the occasion when the highest concentration of an air contaminant occurs at ground level. The operating condition that corresponds to the maximum air contaminant concentration at ground level may occur when the facility is at the maximum production level or running at a lower production level or when the process is in transition. The report shall include a description of the operating conditions that result in the maximum ground level concentration of an air contaminant;
- Identification of individual emission rates as measured or estimated and include the reference and justification for values used;
- Comparison of the maximum predicted ground level concentrations of all contaminants with relevant ambient air quality criteria. In the absence of NS adopted ambient air quality criteria, the Proponent shall utilize criteria from Federal or other Provincial jurisdictions; **NPNS Comments: It is NPNS's understanding that the applicable regulatory air quality criteria are provincial standards (i.e. Nova Scotia Air Quality Regulations [NS Reg. 510/2017]) and the federal standards (i.e. Canadian Ambient Air Quality Standards, CAAQS).**
- Comparison of the maximum predicted ground level concentrations of all contaminants with their relevant upper risk thresholds; **NPNS Comments: In the absence of provincial regulations, Upper Risk Threshold (URT) criteria found in the Ontario Air Pollution – Local Air Quality Regulation (O. Reg, 419/05) will be used.**
- Risk assessment and mitigation plan for contaminants that demonstrate a predicted exceedance of a relevant upper risk threshold;
- Inclusion of isopleth mapping for all contaminants predicted to exceed relevant ambient air quality criteria;
- Identification of discrete receptors on all isopleth mapping;

- Mitigation options to address any predicted exceedances of relevant ambient air quality criteria used in the modelling. The model shall be rerun incorporating the mitigation projects to demonstrate no predicted exceedances; and
- Implementation schedule for potential mitigation options.

10.4 Flora and Fauna

10.4.1 Terrestrial Environment

Identify and evaluate the potential effects on flora and fauna and avifauna species/communities during all phases of the Project. Include a full account of impacts on species at risk or of concern, significant habitats and protected areas or areas of potential value to Nova Scotia's protected areas network that may be potentially disturbed, altered or removed. The effects assessment must also consider the potential for effects to flora and fauna associated with landscape fragmentation and sensory disturbances.

10.4.2 Freshwater Aquatic and Marine Environment

Evaluate the potential effects on aquatic environments, including fish and fish habitat.

While considering the effects that the Project may have on freshwater and marine species, include a full account species at risk or of concern and significant habitats. This section must include activities that may affect avifauna in the aquatic environments. Also consider potential effects to marine species from blasting, dredging and other marine construction, as well as vessel traffic and Project operation. Where impacts to fish habitat cannot be avoided or mitigated, discuss compensation measures to ensure impacts are offset.

Assessment of COPCs in the baseline fish and shellfish populations and potential effects due to expected discharge quality.

Include a summary of the potential effects on flora/fauna known to be important to the Mi'kmaq of Nova Scotia.

10.5 Agriculture, Aquaculture and Forestry Resources

Include an effects assessment of the Project on existing and future agriculture activity within the study area.

Assess the impacts on commercial/recreational fishing, aquaculture or other marine harvesting which may be impacted by the proposed Project. The effects assessment should consider changes in commercial/recreational fishing, aquaculture or other marine harvesting species, including contamination of species consumed by people as a result of increased erosion, sedimentation and from effluent discharges from the Project, displacement, mortality or loss and/or alteration of habitat. Also discuss navigation restrictions and loss of traditional fishing areas of the Mi'kmaq of Nova Scotia.

Conduct an impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon information, studies and an understanding of expected movement of contaminants according to the revised receiving water study. Based on the assessment of applicability of Point C representing Project ETF effluent quality, chronic and acute toxicity testing of non-diluted treated effluent is to be conducted through a series of controlled laboratory experiments. Species used in the assessment should be applicable to the receiving water environment. Consideration should be given to using either the plant's current effluent or another acceptable and representative substitute. The selection of information sources, representative marine species and assessment methodology must first be agreed upon by relevant government departments.

Undertake a model-based evaluation of the chronic effects of thermal cooling water discharge on fish and fish habitat in the receiving water. Based on the results of the evaluation, develop appropriate mitigation measures and/or project changes. **NPNS Comments: There is no actual representative effluent flow at Point C, due to the cessation of Kraft pulping activities in early January 2020. If additional testing is deemed necessary, there should be provision to use an approved surrogate effluent to conduct any necessary bench scale testing.**

The EA Report must include a discussion on the potential effects on any forestry resources within the Project area.

10.6 Human Health

Provide the completed Human Health Risk Assessment (HHRA) in accordance with Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk Assessment and other Guidance for Evaluating Human Health Impacts in Environmental Assessment documents for noise, air quality, drinking and recreational water, etc. as applicable. Federal contaminated sites guidance documents such as the Detailed Quantitative Risk Assessment (DQRA) may be used to supplement the EA Guidance documents where appropriate. The risk assessment must consider human consumption of fish and other seafood, consumption of potentially contaminated drinking water, exposure to recreational water and sediment, outdoor air inhalation, and any other potential exposure pathways. The analysis must inform the identification of contaminants of concern and updating of the receiving water study.

The HHRA must consider baseline data and represent all marine species which are harvested and consumed in the area with respect to the marine component of the Project and in all types of fisheries-commercial, food, social and ceremonial. In addition, information for these species should be included in the baseline studies for COPCs in marine organism tissues where possible. The HHRA must consider bioaccumulation and the potential for biomagnification in the food chain. The exposure route associated with consumption of seaweed and sea vegetables must also be included.

The HHRA is to include appropriate receiving water study and associated modelling activity results (e.g., contaminant fate and transport) as to accurately assess the potential risk to human health.

Include monitoring and mitigation measures for elevated COPCs in air emissions in HHRA problem formulation.

Screen COPCs in Project effluent discharge according to guidance from Health Canada. Incorporate findings from receiving water study. Discuss the potential for interactive effects from similarly acting chemicals. Include an evaluation of the risk associated with exposure to chemical mixtures. Provide calculation of Hazard Quotients (HQ) and Incremental Lifetime Cancer Risk (ILCR) which account for additivity.

Ensure any screening values used from the EPA are adjusted to be consistent with the health protection endpoints prescribed by Health Canada and CCME.

Provide clarification on methodology applied to selection of COPCs for seafood ingestion in consultation with Health Canada.

10.7 Socio-Economic Conditions

Identify potential impacts of the Project on economic conditions, populations and employment.

Identify potential impacts of the proposed Project on residential property values and property demand during all phases of the Project (including temporary accommodation required during construction).

Describe the effect of the proposed Project on present and future commercial, residential, institutional, recreational and resource land uses within the study area, including impacts to areas under mineral exploration licenses or forestry licenses.

Identify the potential impact on recreational opportunities, including the effects on aesthetics from areas surrounding the Project area. This analysis should be supported by visual impact assessments from both the land and water.

Identify the potential impact on the current use of land and resources for traditional purposes and any Aboriginal specific land claims within the study area.

While considering the effects on economic conditions and employment, include a discussion on expenditures and the anticipated direct and indirect employment positions that will be created during all phases of the Project.

10.8 Existing and Planned Land Uses

The EA Report must consider the effects that may restrict the ability of people to use and enjoy adjacent lands and marine area presently, and in the future. Describe the potential impacts from existing or planned land uses in the study area. This shall include a discussion of Project interactions with any rural planning initiatives, parks, protected areas, contaminated sites, former mine workings, and mine disposal areas.

Identify and evaluate potential effects on traditional and current recreational and commercial use by the Mi'kmaq of Nova Scotia.

Discuss the anticipated changes in traffic density and patterns during all phases of the Project including the effects on transportation.

While assessing the effects on navigation and navigable waters, consider navigation patterns of all waters that may be impacted by the Project. Potential effects on traditional and current recreational and commercial use must be identified and evaluated.

10.9 Archaeological Resources

Evaluate the potential effects of any changes in the environment as a result of Project activities on physical and cultural resources, structures and/or sites of historic, archaeological, or paleontological significance.

In conducting the effects assessment on archaeological resources, it is recommended that the Proponent consult with CCH and with the Archaeology Research Division of KMKNO.

11.0 PROPOSED MITIGATION

Describe all measures that have, or will be, taken to avoid or mitigate negative impacts, and maximize the positive environmental effects of the Project (as described in Section 9.0 of the Terms of Reference). Mitigation includes the elimination, reduction or control of the adverse effects or the significant environmental effects of the Project and may include restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

Describe proposed compensation that will be provided when environmental damage is unavoidable or cannot be adequately mitigated by any other means.

In considering mitigation measures to be employed, the EA Report must describe any legislation, regulations, guidelines, policies, BMPs, and specifications that will be adhered to during construction and operation of the facility that will lead to mitigation of environmental impacts.

11.1 Geophysical Environment

If applicable, describe alternatives to disrupting net acid producing bedrock. When no practical alternative to exposing acid producing bedrock exists, mitigation plans shall be developed for minimizing the impacts on the aquatic environment. Discuss commitments to provide contingency and remediation plans for watercourses that have been degraded due to the disturbance of net acid producing bedrock or tills.

If contaminated soils are to be disturbed, discuss methods to minimize adverse impacts.

Provide applicable mitigation measures and preliminary agreements and plans that meet Provincial regulatory disposal and transportation requirements for potential dredge materials. **NPNS Comments: NPNS agree with comment from Fisheries and Oceans that clarification should be provided in this section in relation to offsetting impacts to fish and fish habitat, financial compensation, or other accommodations.**

11.2 Water Resources

11.2.1 Groundwater Quality and Quantity

Describe actions that will be taken to mitigate any negative impacts on groundwater quality and quantity.

Provide a Groundwater Protection Plan based on the assessment of risks to local water supplies (municipal and private) and the environment. This plan should include management/contingency response actions and reference the groundwater monitoring plan as well.

Describe measures to be employed in the event of accidental contamination or dewatering of any water supply wells as a result of the construction or operation of the Project, including compensation for loss or degradation of water supplies. Describe mitigation measures planned to prevent and remediate contamination of groundwater from the accidental release of a hazardous substance.

Discuss commitments to provide contingency and remediation plans for any contamination of groundwater resources, including decrease of water quality.

11.2.2 Surface Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to surface water resources, including but not limited to erosion and run-off control features and storm drainage management.

Discuss all mitigation measures planned to prevent the release of hazardous substances into local surface waters.

Discuss commitments to provide contingency and remediation plans for any impact to surface water resources, including decrease of water quality or quantity.

11.2.3 Marine Water Quality and Quantity

Describe all mitigation measures that will be used in construction, operation and decommissioning phases of the Project to reduce impacts to marine water resources.

Discuss all mitigation measures planned to prevent the release of hazardous substances into marine waters.

Discuss commitments to provide contingency and remediation plans for any impact to marine water resources, including decrease of water quality or quantity.

11.2.4 Wetland Resources

Describe measures to avoid, minimize or otherwise mitigate effects on wetland resources within the Project area. Specifically, the EA Report must describe measures to maintain ecological and hydrological integrity of any wetlands in the area. Where avoidance is not possible, provide wetland specific mitigations proposed to lessen impacts of the Project at all stages and describe commitments to monitoring and compensation for any loss of wetland habitat. Also provide discussion and commitment regarding remediation/rehabilitation of aquatic habitat as a result of incidental releases of treated effluent in wetlands.

11.3 Atmospheric Resources

Describe measures to avoid, minimize or otherwise mitigate effects on biological receptors during all phases of the Project (vegetation, fish, wildlife, and human health).

Specifically, describe measures that will be taken to control emissions including but not limited to CO, H_2S, nitrogen oxides expressed as NO_2, O_3, SO_2, TSP, $PM_{2.5}$ and PM_{10}, TRS, speciated VOCs, semivolatile VOCs, PAHs and metals. Describe any GHG mitigation plans.

Describe all measures that will be taken to mitigate any potential increase in noise and light levels during construction and operation.

11.4 Flora and Fauna

11.4.1 Terrestrial Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on flora species. Include any landscaping plans for preservation of existing vegetation.

Describe the measures that will be taken to minimize the impacts of the Project at all stages on terrestrial fauna and avifauna. Include any plans for preservation of existing habitat and compensation for loss or degradation of terrestrial habitat (i.e., habitat rehabilitation/replacement). Measures to comply with wildlife legislation (e.g., *Migratory Birds Convention Act* and regulations) should also be provided.

Discuss commitments to provide contingency and remediation plans for impacts to terrestrial habitat as a result of accidental events.

In addition, based on concerns raised by government reviewers during the review of the EARD and the Focus Report, the EA Report must also include, but not be limited to the following additional items:

- Mitigation plan developed in consultation with NSLAF that includes additional details to protect wildlife and wildlife habitat, including birds, mammals, herptiles, raptors, and species and risk. The plan must include but not be limited to the following:

a) mitigation measures that will be taken to avoid destroying rare priority species detected in the 2019 floristic surveys;

b) mitigation and monitoring plan for the Eastern Wood-Pewee (*Contopus virens*, SARA Special Concern, NSESA Vulnerable) and Barn Swallow (*Hirundo rustica*, SARA Threatened, NSESA Endangered) found during the course of field surveys and Kildeer (*Charadrius vociferous*) identified to likely be breeding in the Project area, in consultation with both ECCC and NSLAF;

c) additional details on how impacts to the Double-Crested Cormorant (*Phalacrocorax auratus*) colony located along the east side of Highway 106 causeway will be mitigated during installation of the pipeline across Pictou Harbour. Identify appropriate mitigation measures to protect Double-crested Cormorant nests in the event of a pipeline rupture;

d) specific measures to be developed to discourage waterfowl from accessing the spill basin and other open ETF components;

e) specific measure to be developed to control of spread of invasive species;

f) specific measures to be developed to address potential foraging and overwintering habitat for turtles; and

g) a training program for field staff to enable them to recognize the potential for species occurrences and procedures to follow.

11.4.2 Freshwater Aquatic and Marine Environment

Discuss measures that will be taken to minimize the impacts of the Project construction and operation on marine and freshwater aquatic species, avifauna and their habitats. Include any plans for preservation of existing habitat and compensation for loss or degradation of aquatic habitat.

Describe the measures that will be taken to minimize the introduction of non-native species to the area.

Discuss commitments to provide contingency and remediation plans for impacts to aquatic habitat as a result of accidental events.

11.5 Agriculture, Aquaculture and Forestry Resources

Discuss measures that will be taken to minimize the impacts of the Project on agriculture, fishing, aquaculture, marine harvesting, and forestry.

11.6 Human Health [New Subsection]

Provide suitable avoidance and/or mitigation measures to prevent and minimize potential Project impacts on human health.

11.6 Socio-Economic Conditions

Describe actions that will be taken to mitigate adverse impacts on private and commercial property, existing industry and businesses, planned land use, recreation and other human activities, including traditional activities and land uses by the Mi'kmaq of Nova Scotia.

Provide a dispute resolution policy for addressing Project related complaints and concerns that may be received throughout construction, operation, decommissioning and reclamation, and post-decommissioning.

11.7 Existing and Planned Land Uses

Describe the measures planned to minimize the potential impacts of the Project on existing and planned land uses.

Discuss the mitigation measures planned to address anticipated impacts from any predicted changes in traffic speed, traffic routes, marine navigation, exclusion zones and density in adjacent residential and commercial areas.

11.8 Archaeological Resources

Describe mitigation measures to preserve, protect, or recover any resources of cultural or archaeological value that are identified in the study area.

12.0 RESIDUAL EFFECTS AND ENVIRONMENTAL EFFECTS

This section of EA Report shall list and contain a detailed discussion and evaluation of the residual impacts for each VEC, including the criteria for determining significance. Residual impacts are those adverse effects or significant environmental effects which cannot or will not be avoided or mitigated through the application of environmental control technologies or other acceptable means. Those impacts that can be mitigated or avoided shall be clearly distinguished from those impacts that will not be mitigated or avoided.

These impacts become important in the evaluation of a proposed Project as they represent the environmental cost of the Project.

13.0 EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

Present an overall evaluation of the advantages and disadvantages to the environment, including the VECs, during the construction, operation and decommissioning phases of the Project. The evaluation of the disadvantages shall include an examination and justification of each disadvantage.

14.0 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

Include a framework upon which compliance and effects monitoring will be based throughout the life of the proposed Project, including decommissioning and post-decommissioning activities. Monitoring programs must be designed to determine the effectiveness of the implemented mitigation measures. The EA Report shall describe the compliance reporting methods to be used, including reporting frequency, duration, methods, parameters, comparison standards or guidelines, format, and receiving agencies. Mapping clearly illustrating baseline and proposed monitoring locations should also be included.

Recognizing that the effectiveness of compliance and effects monitoring depends on a workforce that can identify and address potential impacts during construction and operation of the Project, the framework shall include procedures for providing training and orientation to on site employees during construction and operation of the Project.

The description of the compliance and effects monitoring program shall also include any procedures/plans for addressing potential exceedances of environmental protection standards, guidelines or approvals.

The discussion of compliance monitoring shall include, but not be limited to Sections 14.1 – 14.4.

14.1 Geophysical Environment

Describe plans and procedures for assessing ARD potential and associated monitoring in the event of disturbance or exposure.

14.2 Water Resources

Wetland specific post construction monitoring and comparison to baseline condition must be provided to identify post-construction wetland indicator performance and adaptive management to address impacts at all project stages. The report should address compensation measures that may be required to ensure no net loss of wetland area and functions.

Submit a groundwater quality and level monitoring plan for the construction, operation and decommissioning phases of the Project, including the pipeline route and mill site location. This is to include the location of monitoring wells, monitoring sampling frequency and monitoring parameters. The plan must consider the final pipeline design as well as the potential risk to the environment and local water supplies as a result of pipeline construction and possible pipeline leak. The plan must address, as a minimum, sensitive areas along the pipeline route, such as shallow water table intersecting surface water features, proximity to water supply wells and areas along the pipeline more susceptible to failure. Locations where the pipeline may be constructed below the seasonal high-water table shall be identified.

Discuss plans for a survey of structures if blasting is planned, to include wells, building foundations, etcetera, which may experience damage or impact due to seismic vibrations or air concussion.

Discuss any surface water monitoring plans for the construction, operation and decommissioning phases of the Project, including both water quality and quantity aspects.

Develop a marine discharge plume delineation monitoring program to confirm plume dimensions, and effluent concentrations and characteristics in support of the Environmental Effects Monitoring program.

14.3 Fish and Fish Habitat

Submit an Environmental Effects Monitoring program that includes water quality, sediment and tissue sampling and is based on the results of various relevant baseline studies and receiving water study. The program should at a minimum be designed based on applicable regulatory requirements. **NPNS Comments: NPNS will design a program as based on current and future PPER EEM requirements. These programs always undergo scrutiny and approval by Environment Canada before commencement.**

14.4 Atmospheric Resources

Complete an ambient air quality monitoring plan, acceptable to the Department, based on the results of the air dispersion modelling. This plan must include but not be limited to sampling locations, parameters, monitoring methods, protocols and frequency. The plan shall ensure adequate monitoring coverage of areas where predicted levels of air contaminants are elevated.

Describe plans for GHG monitoring, reduction targets and reduction plans.

Discuss the plans for monitoring baseline, construction and operational noise levels at the site, and at any residential or commercial areas near the Project.

14.5 Human Health

Provide suitable monitoring measures to confirm impact predictions. Where monitoring is proposed, include a plan for reporting/communicating reporting exceedances of relevant guidelines/thresholds.

14.5 Other Monitoring Plans **(14.6)**

Include any other monitoring plan which may include an Environmental Protection Plan or other guidelines, polices or plans, proposed for the construction, operation and decommissioning of the Project.

15.0 CONSULTATION PROGRAM

A Notice regarding the Draft Terms of Reference for Preparation of an Environmental Assessment Report pursuant to the Nova Scotia *Environment Act* was published in the Chronicle Herald and Royal Gazette on January 8, 2020 and posted on the NSE internet site (www.gov.ns.ca/nse/ea/). Information pertaining to this EA will be available on this site.

The Class I EA process for the Project includes the following opportunities to participate (specifically government departments/agencies, the Mi'kmaq of Nova Scotia and the general public will be invited to provide comments):

- the Draft Terms of Reference; and
- the Environmental Assessment (EA) Report.

15.1 Public Consultation

For any consultation undertaken with the general public, the EA Report must describe ongoing and proposed consultation and information sessions.

Describe all steps taken by the Proponent to identify the concerns of the public about the adverse effects or environmental effects of the Project. It shall provide a summary of all concerns expressed by the public and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the general public.

15.2 Consultation with the Mi'kmaq of Nova Scotia

To assist the provincial Government in their consultation process with the Mi'kmaq of Nova Scotia, the EA Report must describe all steps taken by the Proponent to identify the concerns of Mi'kmaq of Nova Scotia about the adverse effects or environmental effects of the Project. It shall provide a summary of all concerns expressed by the Mi'kmaq of Nova Scotia and all steps taken by the Proponent to address these concerns. Moreover, the EA Report must describe any outstanding concerns.

During the EA process, NSE will serve as the provincial Crown consultation coordinator.

The EA Report will also provide details of efforts made to distribute Project information and provide a description of the information and materials distributed to inform the Mi'kmaq of Nova Scotia.

In parallel to Proponent engagement with the Mi'kmaq of Nova Scotia, the Government of Nova Scotia will undertake continued consultation directly with the Mi'kmaq of Nova Scotia pursuant to the Mi'kmaq-Nova Scotia-Canada Consultation Process (2010).

The Proponent is encouraged to engage the Mi'kmaq of Nova Scotia as referenced in the Nova Scotia Office of Aboriginal Affairs' Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia (2011).

Include any plans for ongoing community consultation or formation of a community liaison committee

(CLC) during construction, operation and decommissioning.

16.0 ASSESSMENT SUMMARY AND CONCLUSION

This section of the EA Report shall summarize the overall findings of the EA with emphasis on the main environmental issues identified and predict the significance of adverse environmental effects of the Project.

BASELINE ASSESSMENT OF CONTAMINANTS IN SEDIMENTS AND MARINE BIOTA OF NORTHUMBERLAND STRAIT, NOVA SCOTIA, CANADA

by

Meenakshi Chaudhary

Submitted in partial fulfilment of the requirements
for the degree of Master of Environmental Studies

at

Dalhousie University
Halifax, Nova Scotia
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ABSTRACT

A bleached kraft pulp mill operating in Pictou County, Nova Scotia has discharged effluent into former tidal estuary known as Boat Harbour since 1967. After treatment in Boat Harbour, effluent is discharged into Northumberland Strait. Effluents will no longer be discharged after January 31, 2020 and remediation will start thereafter. A previous review of historical documents to identify contaminants in marine biota of Northumberland Strait found that data was insufficient to properly evaluate the baseline conditions prior to remediation. This study evaluated concentration of metals, dioxins and furans and methyl mercury in surficial sediments and marine biota (*i.e*. American lobster (*Homarus americanus*), rock crabs (*Cancer irroratus*), and blue mussels (*Mytilus edulis*) of Northumberland Strait. Results were compared to Canadian Council of Minsters of Environment and Canadian Food Inspection Agency guidelines showed limited contamination signature in sediments and marine biota of Northumberland Strait. Recommendations to have long-term monitoring is provided for remediation.

LIST OF ABBREVIATIONS USED

2,3,7,8 - TCDD- 2,3,7,8-tetrachlorodibenzo-p-dioxin
2,3,7,8 - TCDF- 2,3,7,8-tetrachlorodibenzofuran
As - Arsenic
AOX - Absorbable Organic Halide
BH - Boat Harbour
BHTF - Boat Harbour Treatment Facility
BOD - Biochemical Oxygen Demand
BCR - Bureau of Reference
CCME - Canadian Council of Ministers of Environment
Cd - Cadmium
CEPA - Canadian Environmental Protection Agency
CFIA - Canadian Food Inspection Agency
COD - Chemical Oxygen Demand
Cr - Chromium
Cu - Copper
D/F - Dioxin and Furan
DFO - Department of Fisheries and Oceans
DL - Detection Limit
DGT - Diffusive Gradient in Thin Films
EEM - Environmental Effects Monitoring
ERL - Effects Range Low
ERM - Effects Range Median
FA – Fisheries Act
Hg - Mercury
ISQG - Interim Sediment Quality Guideline
MeHg - Methyl Mercury
MFS- 3-Mercaptopropyl-Functionalized Silica
N - North
NE - North East
NS – Northumberland Strait
NOAA - National Oceanic and Atmospheric Administration
Pb - Lead
PCDD - Polychlorinated Dibenzodioxins
PCDD - Polychlorinated Dibenzofurans
PEL - Probable Effects Level
PPI - Pulp and Paper Industry
PPER - Pulp and Paper Effluents Regulation
PLFN - Pictou Landing First Nation
POP - Persistent Organic Pollutants
SQGs - Sediment Quality Guidelines
TSS - Total Suspended Solids

TOC - Total Organic Carbon
TEF - Toxic Equivalency Factor
TEQ - Toxic Equivalency
VOC - Volatile Organic Compound
VSC - Volatile Sulphur Compound
USEPA - United States Environmental Protection Agency
Zn - Zinc

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CHAPTER 1 - INTRODUCTION

1.1 Industrial Effluents and Environmental Effects

Industrial wastewater effluents are major sources of contamination for aquatic environments via regulated and unregulated discharges (Ali and Sreekrishnan, 2001; Chaudhary and Walker, 2019). A major threat to aquatic ecosystems is untreated or partially treated industrial wastewater discharges to aquatic receiving environments (Singh and Chandra, 2019). The pulp and paper industry (PPI) are a major industry contributing to environmental pollution after oil, cement, leather, textile, and steel industries (Ali and Sreekrishnan, 2001). It is the world's sixth most polluting industry, discharging a variety of atmospheric, liquid, and solid waste pollutants into the environment (Ugurlu et al., 2008). The PPI has been expanding in South America but started declining in the beginning of 2000 in North America with widespread mill closures (Bogdanski, 2014). However, despite increasing trends of switching from print to electronic media, increasing market demands for paper products continue within North America, Asia, and Europe collectively consuming 90% of global paper production (Szabo et al., 2009). Canada is the world's largest exporter of pulp and newsprint thus; the PPI remains a fundamental pillar of the economy and natural resource sector (Environment Canada, 2013). However, effluents from paper and pulp mills can be highly toxic and are a major contributor to aquatic pollution. More than 250 chemicals have been identified in effluents derived from different stages of paper production. PPI also generates large volumes of wastewater for each metric ton of paper produced depending on the raw material and process being used (Ali and Sreekrishnan, 2001; Kamali and Khodaparast, 2015).

Pulping, the separation of cellulose and hemicellulose wood fibers from lignin, can be achieved by either mechanical and chemical processes (Ali and Sreekrishnan, 2001). In the mechanical process, force is applied with minimum use of chemical to release usable wood fiber (Owens, 1991). Whereas, during chemical processes depolymerization and dissolving of lignin is done to produce purified cellulose fiber. There is 55-60% discharge of lignocellulosic waste from raw material (wood chips), while only 40-45% of pulp is obtained during the chemical pulping process. The lignocellulosic waste consists of various complexes of organic and inorganic pollutants, which if released untreated, may cause considerable damage to the receiving water (Pokhrel and Viraraghavan, 2004).

The wastewater from the PPI have a high biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorinated compounds (measured as absorbable organic halide, AOX), suspended solids, fatty acids, tannins, resin acids, lignin, and its derivatives, sulfur and sulfurous compounds (Ali and Sreekrishnan, 2001). Pollutants from PPI comprise naturally occurring wood extractives (tannins, resin acids, lignin) and xenobiotic compounds (e.g., chlorinated lignins, resin acids, and phenol, dioxins and furans).

1.2 Project Background

1.2.1 Study Site

A'se'k, "the other room" commonly known as Boat Harbour (BH) is a former tidal estuary located within Mi'kmaq Pictou Landing First Nation (PLFN) on the Northumberland Strait (NS) in Nova Scotia, Canada (Pictou Landing Native Women's Group et al., 2016). For the last 50 years, a bleached kraft pulp mill located at Abercrombie Point in Pictou County has been discharging its effluent in BH before its final discharge to NS (Fig. 1).

Fig. 1. Location of Boat Harbour in Pictou County relative to the pulp mill, communities of Pictou Landing First Nation, and the town of Pictou and final discharge point of Northumberland Strait. (Adapted from Romo et al. (2019).

Historically, BH was used by PLFN community for fishing, hunting, spiritual, and ceremonial purposes. However, in order to improve the economy of Nova Scotia in the 1960s, the provincial government offered raw water supply and BH as an effluent treatment facility to many industries including this kraft mill (Hoffman et al., 2017a). In 1967, the mill-initiated operations and began discharging its raw effluent to BH. From 1967 until present the mill has been operated by different mill owners. It was first owned and operated by Scott Paper Company. In 1996, responsibility for operating the mill was transferred to Kimberly Clark, then subsequently to Neenah Paper in 2004 and finally to Northern Pulp in 2008 which is the current owner of the mill (Dillon Consulting Limited, 2000; Pictou Landing Native Women's Group et al., 2016).

After two years of mill operation in 1969, the Boat Harbour Treatment Facility (BHTF) was constructed to treat wastewater effluents before their discharge to Northumberland Strait (Romo et al., 2019). Furthermore, in 1972 a dam was built at the estuary outlet and BH was transformed into a freshwater pond. The BHTF was also upgraded in 1972 consisting of twin settling ponds and an aerated stabilization basin. Effluent from the mill is piped beneath East River and discharged to settling ponds for sedimentation. After sedimentation, effluents flow to an aerated stabilization basin for the oxidation of wastewater. After 5-6 days of aerated treatment, effluent is then discharged to a stabilization lagoon, that is BH. Effluents remain here for 20-30 days before final discharge to the Northumberland Strait through a dammed estuary mouth (Fig.1 and Fig. 2) (Hoffman et al., 2017a). Along with mill effluents, BH also used to receive wastewater from a local chlor-alkali plant known as Canso Chemicals Ltd. which operated in the area from 1971-1992 (Seakem Oceanography Ltd., 1990; SeaTech Ltd., 1996; Andrews and Parker, 1999; St-Jean et al., 2003).

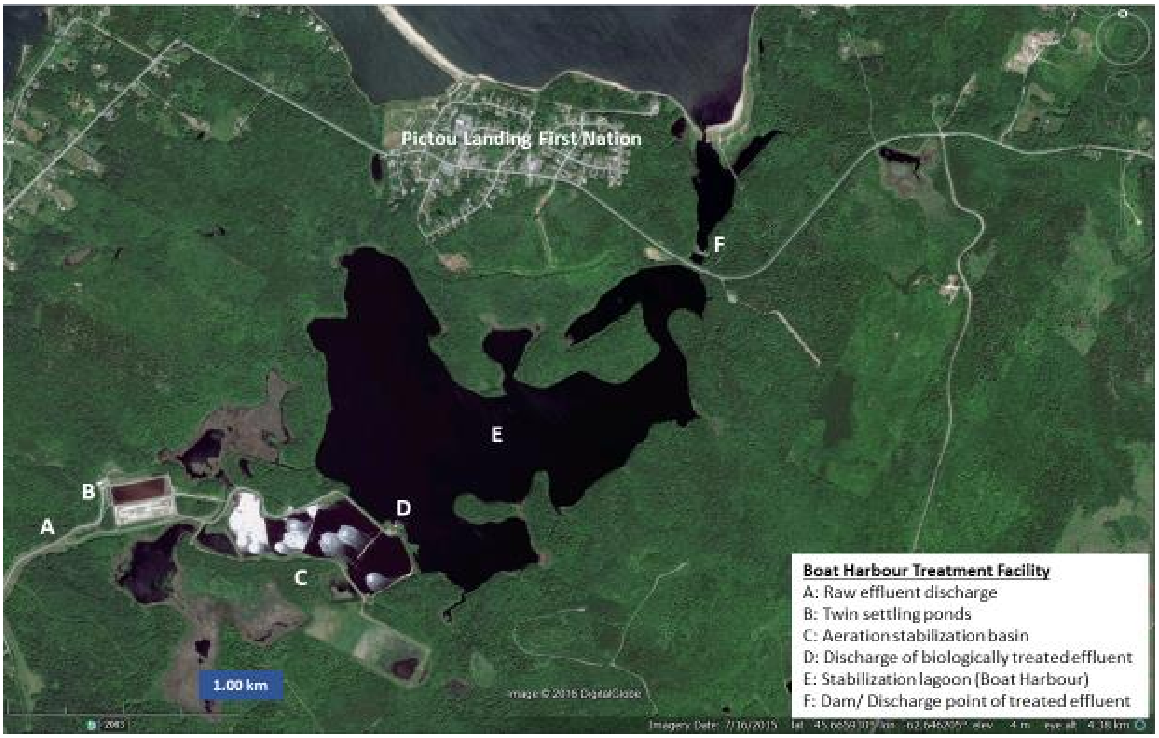

Fig. 2. Components of Boat Harbour Treatment Facility (BHTF) (from Hoffman et al. (2017a).

1.2.2 Public Concerns and *Boat Harbour Act*

Fifty-years of effluent discharge from the pulp mill and former chlor-alkali plant into BH has created large volumes of unconsolidated sediments impacted by inorganic and organic contaminants. The PLFN community (population <500) is located in the North-East direction (2 km) and the Town of Pictou (population 3500) in the North West direction (5 km) of BHTF (Fig. 1). Over the years, significant concern has been raised by both communities (Hoffman et al., 2015; Hoffman et al., 2017b). The adverse environmental impacts including poor air and water quality, soil contamination, and negative impacts on recreational activities have been the main concern of the PLFN community. Reid (1989) reported potential adverse human health effects linked to the mill and found that Pictou had significantly higher proportions of respiratory disease compared to provincial averages for three consecutive years. This research recommended an epidemiological study related to the mill should be conducted to confirm these findings (Reid, 1989). Although communities have long advocated for closure of the mill, public attention gained momentum in 2014 following an unprecedented effluent leak, and after, a broken stack precipitator (air quality equipment) (Hoffman et al., 2015). The mill was fined $225,000 CAD as the magnitude of the mill's effluent leak was found deleterious to fish under the federal *Fisheries Act* (1985) (Pictou Landing Native Women's Group et al., 2016). After years of public protest, the *Boat Harbour Act* 2015 was passed (Boat Harbour Act, 2015). According to this act, BH will be closed for effluent treatment by January 31, 2020. Remediation of contaminated sediments will begin in 2020 by the province of Nova Scotia and Nova Scotia Lands is the proponent of the remediation project. The aim of this remediation project is to return BH to its pre-tidal estuary state.

Contaminants from industries near BH have significantly impacted the environment of the area. Numerous ongoing studies have characterized the impacted wetlands, soils, and groundwater prior to remediation. According to Hoffman et al. (2017a), over the past 25 years, BH sediments metal(loid) concentrations were up to 20 times higher than samples collected from other un-impacted reference sites. Concentrations of contaminants in sediment were found to be above the Canadian Council of Ministers of Environment (CCME) Sediment Quality Guidelines (SQGs) posing a potential risk to aquatic ecosystems. Sediment mercury concentrations also exceeded CCME freshwater and marine SQGs (Hoffman et al., 2017a).

Despite numerous studies documenting effluent impacts on sediments in BH to assist remediation decisions, comparable baseline data related to contaminants in the marine environment of Northumberland Strait was lacking (Romo et al., 2019). To achieve the ultimate aim of *Boat Harbour Act* to bring BH to pre-tidal form, it is important to establish baseline data on contaminants in sediments and biota of the marine receiving environment of the Northumberland Strait. Baseline data is required to determine historical impacts and to assist future environmental effects monitoring during remediation of BH sediments, which will commence in 2020.

1.3 Research Objectives

The two main objectives of this research are to:

1) Assess levels of contamination of metals, total mercury, methyl mercury, and dioxins and furans in sediments and biota of the marine receiving environment of Northumberland Strait.

2) Prepare baseline pre-remediation data which can be used for environmental effects monitoring during and post-remediation to assess the effectiveness of remediation activities.

CHAPTER– 2 LITERATURE REVIEW

2.1 The Canadian Pulp and Paper Industry

Canada has been producing paper for 200 years and is one of the largest exporters of pulp and paper in the world since the beginning of the 20th century. The Canadian pulp and paper industry (PPI) had produced almost 10.5 million tonnes of pulp, 8.2 million tonnes of newsprint, and 6.9 tonnes of printing and writing paper in the year 2004 (Martel et al., 2005). From this production, only 17% was shipped domestically within Canada and the rest was mainly exported to the U.S., Asia, and Western Europe. These exports were worth $20.5 billion CAD which represents a 70% export intensity (Bender et al., 1981; Arntzen et al., 1995). Furthermore, according to Natural Resources Canada, Forest Fact Book 2018-2019, Canada is still the second-largest exporter of wood pulp after Brazil with 17% of world value. It also is leading global producer and exporter of newsprint worth $1.98 billion CAD (Natural Resources Canada, 2019). This makes PPI highest in the Canadian manufacturing sector and therefore the industry remains a fundamental pillar of the economy and natural resource sector (Environment Canada, 2013). Canada accounts for almost 10% of the world's total forest coverage. Historically, it also made PPI in Canada one of the country's most vital industries in terms of value of production and total wages paid (Sinclair, 1990).

Although PPI plays an important role in generating revenue for the country, its contribution to environmental pollution cannot be ignored. It is a resource-intensive industry that uses a large amount of energy, water, and forestry resources (Murray, 1992; Toczylowska, 2017). These industries generate large volumes of wastewater for each metric ton of paper production. It has been estimated that the PPI industry is responsible for 50% all waste dumped in Canadian aquatic ecosystems (Sinclair, 1990). Effluents from PPI industries generate large amounts of toxic substances in water which may lead to zooplankton and fish mortality and negatively impact aquatic ecosystems (Hewitt et al., 2008; Singh and Chandra, 2019) They also create problems such as slime growth, thermal impacts, scum formation, and colour problems which affect the aesthetic quality of water (Pokhrel and Viraraghavan, 2004).

2.1.1 The Pulp Industry Process

To understand the nature of pollutants from the pulp industry it is necessary to review the composition of primary substrate, wood, and different processes that it must undergo to produce pulp needed for papermaking (Murray, 1992; Singh and Chandra, 2019). The pulp and paper making process consists of five steps and each step can be carried out using a variety of methods (Fig. 3). Different effluents are released during different stages of papermaking (Chandra et al., 2018).

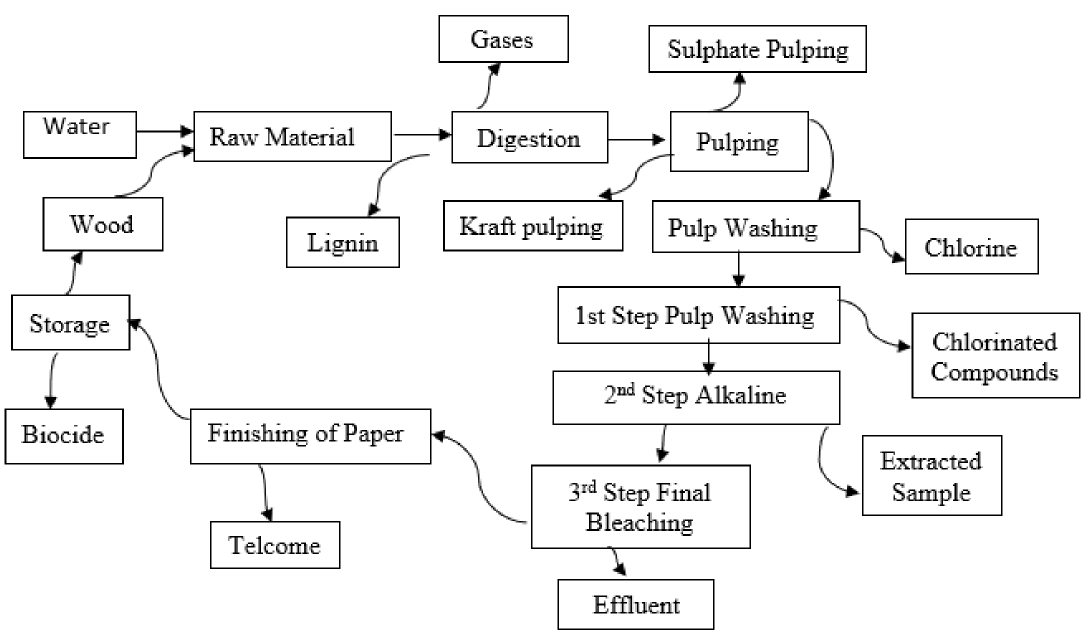

Fig. 3. Schematic illustration of a paper pulp manufacturing process (from Chandra et al., 2018).

Following are the major steps in the pulp making process:

i) Debarking (raw material preparation) - In this step, plant fiber is converted into smaller pieces called chips and removal of bark is done. The bark is removed by tumbling in large steel drums and wash water is applied (Smook, 1992). In this step, the nature of the raw material used, (i.e., hardwood, softwood, agro residues) results in the transfer of tannins and resin acids present in the bark to process waters (Ali and Sreekrishnan, 2001).

ii) Pulping – During pulping wood chips are converted into pulp. This removes most of the lignin and hemicellulose from raw material, resulting in a cellulose-rich pulp. Pulping can be done by two processes mechanical and chemical (Ali and Sreekrishnan, 2001). In the mechanical process, force is applied with minimum use of chemicals to release usable wood fiber (Owens, 1991). Whereas, during chemical processes depolymerization and dissolving of lignin are done to produce purified cellulose fiber. The chemical process can be executed in two ways that are by kraft (sulfate) and sulfite.

During the early half of the twentieth century, sulfite pulping predominated in Canada, until it was replaced by kraft pulping. Today kraft mills account for a very large share of total pulp production (Murray, 1992). The pulp mill at Abercrombie Point (discussed in Chapter-1) also uses the kraft pulping process. In the kraft pulping process, woods logs are digested at high temperatures (160-170°C) and pressure using mixture of sodium hydroxide (NaOH) and sodium sulfide (Na_2S). Whereas, in sulfite pulping mixture of sulfurous acid (H_2SO_3) and bisulfite ions (HSO_3^-) is used (Saltman, 1978). During this step, long-chain fatty acids and resins are transferred to process water.

iii) Bleaching - In this step brown pulp obtained is changed into the desired color. Several bleaching agents are used depending on the mill. The most common agents used in bleaching are chlorine, chlorine dioxide, hydrogen peroxide, oxygen, and ozone (Martin et al., 2000; Ali and Sreekrishnan, 2001). In Canada, it was estimated that 47 mills used chlorine in their bleaching process prior to 1992 (Minister of Supply and Services Canada, 1991). During this process lignin, phenols, resin acids get chlorinated and transformed into potentially toxic organochlorine compounds. Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzo-p-furans (PCDFs) are mainly produced during pulp bleaching process, where they are formed from chlorinated phenols, and particularly from chlorinated 2-phenoxyphenols (Murray, 1992).

iv) Washing- Here bleaching agents are removed from pulp by using alkali (caustic soda) and hence also known as alkali extraction stage.

v) Paper and paper products - To produce the final product, the pulp is washed with appropriate filters (clay, titanium dioxide, calcium carbonate) and resin or starch which behaves as sizing agents. After the manufacturing process wastewater is generated which contains cellulose, hemicellulose, lignin, resins, fatty acids, and other phenolic compounds. These compounds are finally washed out as black liquor (Biermann, 1996; Kincaid, 1998).

2.1.2 Contaminants of Concern

It is well known that contaminants from PPI are acute or even chronic toxins (Sunito et al., 1988; Ali and Sreekrishnan, 2001; Singh and Chandra, 2019). Contaminants released from PPI are mainly classified as gaseous pollutants, inorganic metallic, and inorganic non-metallic and organic pollutants.

i. Gaseous Pollutants

The PPI generates large quantities of atmospheric and effluents emissions which may lead to environmental degradation (Hewitt et al., 2002; Hoffman et al., 2017b). Emissions from different industries vary depending on its pulping methods, wood species, and technology used (Soskolne and Sieswerda, 2010). During the papermaking process, various volatile sulfur compounds (VSCs) and volatile organic compounds (VOCs) are produced. These VSCs and VOCs eventually lead to the production of reduced sulfur compounds including methyl mercaptan (CH_3SH), dimethyl disulfide (CH_3SSCH_3), and hydrogen sulfide (H_2S) (Higgins et al., 2006). Other gaseous compounds released in PPI are sulfur dioxide (SO_2), sodium oxide (Na_2O), chlorine (Cl_2), chlorine dioxide (ClO_2), and hydrogen peroxide (H_2O_2) (Singh and Chandra, 2019).

ii. Inorganic Metallic and Non-Metallic Pollutants

The major metals released by the PPI are arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), manganese (Mn), mercury (Hg), lead (Pb), and zinc (Zn) (Sunito et al., 1988; Ali and Sreekrishnan, 2001; Hakeem and Smita, 2010; Singh and Chandra, 2019) Out of the metals, Hg is most toxic. When it reaches to sediments via different sources it may get converted into methyl mercury (MeHg) under anaerobic conditions. Bacteria that process sulfate ($SO^{2-}{}_4$) in the environment play an important role in methylation. These bacteria take up mercury in its inorganic form and convert it to methylmercury through metabolic processes after which it enters the food chain (United States Geological Survey, 2000). When humans get exposed to MeHg, it may cause sensory and mental disturbances, visual problems, renal, pulmonary, digestive and immune problems. Furthermore, PPI also produces and releases some non-metallic compounds such as chlorine (Cl^-), sulfates (SO^{2-}), phosphates (PO^{3-}) (Chandra and Abhishek, 2011; Yadav and Chandra, 2018).

iii. Organic Pollutants

Chlorinated organic compounds such as dioxins and furans (D/F) are major contaminants of concern coming out from industrial wastewaters. They are persistent in nature and are recalcitrant to degradation and therefore known as persistent organic pollutants (POPs) (Ali and Sreekrishnan, 2001). They have been classified as 'priority pollutants' by the United States Environmental Protection Agency (USEPA, 1998), listed in Priority Substances List 1 (PSL-1) in *Canadian Environmental Protection Act* (CEPA) (Canadian Environmental Protection Act, 1999), and came into 'dirty dozen' group of POPs identified by United Nations Environment Program (UNEP, 1995).

These POPs are often toxic to aquatic species and have the potential to migrate throughout the ecosystem and ultimately accumulate in fatty tissues of a variety of organisms (Sunito et al., 1988). They have the ability to induce genetic changes in exposed organisms and thus named as 'known human carcinogens' by the World Health Organization (World Health Organization, 1997). Because of acute toxicity of two congeners of dioxins and furans, that is, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and 2,3,7,8 tetrachlorodibenzofuran (2,3,7,8-TCDF), discharge of these contaminants are prohibited at "measurable concentrations" according to *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* under the *Canadian Environmental Protection Act* (Canadian Environmental Protection Act*,* 1999). Of many pollutants from PPI, only dioxins and furans have been evaluated by Health and Welfare Canada as "priority substances" (Murray, 1992).

2.1.3 Environmental Effects Monitoring (EEM) in Canada

In the 1980s, discharges from Canadian mills were regulated federally by *Pulp and Paper Effluents Regulations* (PPER) that was passed under the *Fisheries Act* (FA) in 1971. Under this regulation, there was set daily and monthly mass-based limits for BOD and total suspended solids (TSS) and also the requirement that effluents are not acutely lethal to rainbow trout (McMaster et al., 2006; Barrett et al., 2010). Furthermore, these limits were only legal binding on mills which were constructed after the announcement of legislation in November 1971 which covered only less than 10% of mills in Canada (McMaster et al., 2006). As the regulation only covered the small part of PPI industry effluents were still high in fiber and BOD which resulted in habitat degradation and acute lethality of fish (McLeay and Associates, 1987; Folke, 1996).

Before the 1980s the regulations did not consider any dioxins and furans and organochlorine discharges, but in the late 1980s, aquatic discharges from the PPI became an area of environmental concern as dioxins and furans were found in effluents and paper products (Kringstad and Lindstrom, 1984). In early 1980s studies conducted by Sweden under the Environment Cellulose project provided the first evidence of the toxicity of effluents to fish even at very low concentrations in the receiving environment (Sandstrom et al., 1988; Sodergen, 1989).

The change in growth, biochemistry, and deformities in fish were detected in the large area of 8-10 km downstream from the pulp mill, with a dilution of the effluent by more than 1000 times (Sodergren, 1992). Along with this, some other studies were also conducted at an unbleached kraft mill which showed fewer effects compared to bleached kraft mills (Sodergren, 1992).

During the same time of these studies, Ministers of the Environment in Canada announced plans to revise the federal regulatory framework in March 1989 to address the deficiencies in the 1971 regulations. The initial studies were conducted at Jackfish Bay on Lake Superior, which received effluent from a bleached kraft mill located in Terrace Bay, Ontario, Canada. This bay received no other effluents and had no permanent human residents. The results found that fish exposed to primary treated effluents from bleached kraft mill displayed similar reproductive effects to those found in Sweden study (Munkitrick et al., 2013).

Fish exposed to pulp mill effluent showed an increased age to sexual maturation, reduced gonadal development, and expression of secondary sexual characteristics, and reductions in circulating reproductive steroid hormone levels (McMaster et al., 1991; Munkittrick et al., 1991; Oakes et al. 2005; McMaster et al., 2006). Furthermore, in mid-to-late 1980s polychlorinated dioxins and furans were detected in effluents as a by-product of chlorine bleaching (Luthe et al., 1988; Allen et al., 1989). After these studies, a worldwide public campaign by Greenpeace was started against the use of molecular chlorine. However, there was no clear evidence linking chlorinated compounds (used in bleaching pulp) to effects in fish (Thornton 1991; Amato, 1993; Carey et al., 1993).

It was documented that initial studies in Jackfish Bay were done prior to the construction of a secondary effluent treatment plant (McMaster et al., 1991; Munkittrick et al., 1991; Munkittrick et al., 2013). Therefore, in the spring of 1990 samples of spawning fish were collected again and results showed the impact remained in the population despite the implementation of secondary treatment. These results were not surprising at the time as it was assumed that persistent organochlorines are responsible for the changes seen in fish and it will take several years for these persistent compounds to level in contaminated sediments (Munkrittrick et al., 1998; Munkittrick et al. 1992; Branson et al., 1985).

Furthermore, sampling was conducted again in the fall of 1990 following a scheduled mill maintenance shutdown. Results from this sampling showed the rapid recovery of liver mixed-function oxygenase (MFO) enzymes in longnose sucker (*Catostomus catostomus*), and steroid hormone in male white sucker (*Catostomus commersoni*) (Munkittrick et al., 1992). These results suggested that contaminated sediments were not a large contributor to responses at Jackfish Bay, chemical impacts were short-lived, the compounds responsible for biochemical changes were present in the secondary effluent, and if the responsible compounds were identified and removed, recovery of fish populations might take place quickly (Munkittrick et al., 1998).

After the intense public pressure globally and within Canada, new regulations for pulp and paper mills in Canada were developed in the early 1990s and were implemented in May 1992 (Munkittrick et al., 1998; Munkittrick et al., 2013). PPER was passed under the *Canadian Environmental Protection Act* in 1992 to control the release of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). The existing PPER under *Fisheries Act* were also updated with strict limits on BOD and TSS while maintaining the similar non acute lethality requirement as in the 1971 regulations.

Unlike the earlier requirements, this regulation became the legal binding to all the mills across Canada (McMaster et al., 2006). Additionally, while re-analyzing the PPER, regulators realized that uniform limits for a few parameters in the effluent may not necessarily protect the health of all aquatic receiving bodies across Canada (Walker et al., 2002). In order to address these issues, environmental effects monitoring is included in new regulations which are the requirement at all mill's sites (McMaster et al., 2006).

2.1.4 Environmental Effects Monitoring (EEM)- *Pulp and Paper Effluent Regulations, 1992*

EEM is a science-based tool that can detect and assess the changes in aquatic ecosystems potentially affected by pulp mill effluent discharges. EEM is a repetitive system of monitoring and interpretation phases that can be used to measure the effectiveness of environmental management measure to protect the ecosystem (Walker et al., 2002). It is an assessment tool used to help determine the sustainability of human activities on ecosystem health. EEM goes beyond end-of-pipe measurement of chemicals in effluent to analyze the effectiveness of environmental protection measures (Environment Canada, 2010; McMaster et al., 2006).

In EEM, long-term effects are measured using regular cyclical monitoring and interpretation phases designed to assess and investigate the impacts on the same parameters and locations. This helps in the spatial and temporal characterization of potential effects to assess changes in receiving environments (Environment Canada, 2010).

The pulp and paper program are structured into a defined cycle, such that a mill must conduct an EEM study once every three years (Walker et al., 2002). The first cycle conducted in this program was aimed to provide baseline data for future cycles to compare against and determine components required for subsequent EEM programs. The typical EEM for PPI consists of some or all the following components: an adult fish population survey, a benthic invertebrate community survey, a study of dioxins and furans in fish tissues, a tainting study, effluent toxicity testing, and an assessment of water and sediment with their specific purpose (Table. 1).

Table 1. Required monitoring components for pulp and paper EEM programs (Adapted from Walker et al., 2002).

PPER	**Purpose**
Fish survey	Indicator of fish population
Benthic invertebrate community survey	Indicator of effects on fish habitat
Fish tissue analysis for dioxins and furans, for mills using chlorine bleaching	Indicator of effects on the usability of fisheries resources by humans
Supporting Environmental measurements • Water quality • Sediment variables	Interpretation and assessment of cause-effect linkages Interpretation of benthic invertebrate data
Sublethal Toxicity Testing • Fish • Invertebrate • Algae	Examine sublethal changes in effluent quality

2.2 Impacts of Industrial Effluents on Sediments

2.2.1 Importance of Estuaries

Coastal zones, including estuaries and bays, are the regions of active land-sea interaction.

Estuaries are one of the most productive ecosystems on earth (Maanan et al., 2015). They are defined as the water bodies that connect land and ocean and extend from fully marine conditions to the effective limit of tidal influence, and where seawater is diluted by freshwater inflow (Hobbie, 2000).

Estuaries provide a number of ecosystem services such as fisheries, climate regulations, coastal protection, and waste treatment (Millennium Ecosystem Assessment, 2005; De Souza et al., 2016). Estuaries also serve as habitat for a high diversity of species for the whole or part of their life cycle and are characterized by high biological productivity (Kennish, 1991; Spencer et al., 2006). By virtue of their nature and position between marine and terrestrial environments, estuaries are the hub of variety of human activities and have become sites of major industrial developments (Ridgway and Shimmield, 2002). The disposal of waste from industries makes estuaries the ultimate receptacle of pollutants and has led to a significant increase in metal contamination.

2.2.2 Estuary Sediments as Sink and Source of Contaminants

Estuaries sediment contamination is a major source of ecosystem health stress and thus getting increasing attention from the scientific community (Riba et al., 2002; Ganugapenta et al., 2018). According to Forstner and Wittmann (1979), the world’s six most heavily polluted aquatic environments by metals are estuaries. In countries with long historic industrialization such as United Kingdom, Germany, and the Netherlands, thousands of tons of metals were deposited in the estuaries and coastal areas (Forstner and Wittmann, 1979).

Limited freshwater inputs in such enclosed and semi-enclosed ecosystems, may cause enhanced accumulation of pollutants leading to potential threats to the ecosystem (Hahladakis et al., 2013; Qiu, 2015). Estuaries have also been used for dilution and disposal of waste which contributes to their deterioration. Metals and other contaminants like dioxins and furans, as well as total mercury, are gradually being concentrated in these water bodies and, at higher concentrations, they have proven toxic to marine biota and ultimately to humans (Maanan, 2008).

Sediments in estuaries are complex systems affected by the interaction of geological, hydrological, physiochemical, and biological factors and thus may act as a reservoir for heavy metals discharged into the marine environment (Fujito et al., 2014; Machado et al., 2016). They have a large capacity to retain heavy metals from various sources and thus act as a sink for contaminants from different industrial discharges (Gibbs, 1977; Menon et al., 1998; Barcena et al., 2017).Metals are deposited within sediments and sorb to organic-rich fine-grained particulate matter or incorporate in inorganic matter compounds when they enter marine environment (Jamshidi and Bastami, 2016; Zhang et al., 2019).

There are certain properties of sediments such as texture, pH, Eh, organic matter, salinity, sulfide contents, iron (Fe), aluminum (Al), and others which can influence biogeochemical behavior and mobility of metals in aquatic systems (Zhuang and Gao, 2014; Cipullo et al., 2018). It is very important to identify these processes in order to identify the key contaminants and sediment characteristics that can affect the bioavailability and toxicity of metals (Vezzone et al., 2019).

Under certain physiochemical conditions (current, pH, DO, redox potentials, and temperature changes), heavy metals trapped in sediments may migrate upward to the sediment-water interface. For example, if there is a decrease in redox at the interface between solid and liquid phases it would accelerate reductive dissolution of iron (Fe) and manganese (Mn) oxides which leads to the release of metals bound to them (Mukwaturi and Lin, 2015; Gao et al., 2018). In case of low pH, negative surface charges of sediment particles and Fe and Al oxides reduces, which promotes the mobility and bioavailability of metals which are co-precipitated with carbonates and sulfides (Du Laing et al., 2009).

When these metals are released to dissolved phase from sediments, bioavailability is increased leading to threats to aquatic organisms (Zhao et al., 2013; Dhanakumar et al., 2015; Machado et al., 2016; Chen et al., 2016). Therefore, sediments are not only sink for many pollutants but can also be the sources of pollutants. Furthermore, the release of metals in sediments depends on their different chemical forms, which shows different physical and chemical behaviours in terms of chemical interaction, potential toxicity, bioavailability and mobility (Sun et al., 2016; Gabarron et al., 2017; Kang et al., 2017; Liu et al., 2018).

Bioavailability is an important factor in metal toxicity assessment. It is defined as the metal fraction available for organisms from all possible uptake sources (Morel and Hering, 1993; Campbell, 1994; Ehlers and Luthy, 2003). Bioavailable metal fraction, mainly metal ions, represents the toxic metal fraction instead of total concentrations of metals (Morel and Hering, 1993). Heavy metals are area of concern for marine organisms and their consumers due to their toxicity, persistence, and bioaccumulation (La Colla et al., 2018).

According to the European “Community Bureau of Reference” (BCR) sequential extraction procedure, chemical forms of heavy metals in sediments are divided into four parts, that is, the exchangeable, reducible, oxidizable and residual parts (Quevauviller et al., 1997). The bioavailable fraction is usually composed of the former three parts which could be released into the overlying water. Therefore, the chemical fractions of heavy metals with high bioavailability should be assessed for evaluation of ecological risk in sediments (Cheng and Yap, 2015; Kang et al., 2017; Liu et al., 2018).

2.2.3 Sediment as an Indicator of Contamination

Marine sediments represent, quantitatively, the major compartment for metal storage in aquatic environments (Chapman et al., 1998). Therefore, they act as a useful indicator of metals contamination in aquatic environments, metal toxicity and hazard in sediments (Saher and Siddiqui, 2019). Due to their trapping capacity, the evolution of metals in sediments reflect the geochemical history of the region (Barcena et al., 2017). They provide both short- and long-term memory of contaminant loading to a water body. Continuous monitoring of sediment quality is very essential in determining the state of pollution of the marine environment. Survey of metal concentrations in sediments and comparison between these concentrations and non-polluted baselines are an important step in understanding the transport and deposition of metals in the environment (Wang et al., 2012). Characterizing distribution and concentration of metal contaminants within sediments is necessary in order to quantify pollution levels (Santos et al., 2005; Walker et al., 2013a, 2013b, 2013c; Zhang et al., 2019).

There are several factors which should be considered while conducting an assessment of contaminated sediments. For instance, particle size plays an important role in controlling the pollutant concentrations in sediments. It is generally believed that metals are associated with smaller particle sizes (Whitney, 1975; Gibbs, 1977; Martincic, 1990; Biksham et al., 1991). This trend is attributed to sorption, co-precipitation, and complexing of metals on particle surface.

Smaller particles have larger surface area and therefore can potentially be associated with a higher concentration of metals (Parizanganeh, 2008). Therefore, it is important to consider the effect of particle size by using geochemical methods (Paramasivam et al., 2015).

The toxicity of contaminated sediments is usually measured by using a weight-of-evidence approach, comprising chemical, ecotoxicological, and ecological analysis (Marziali et al., 2017). In recent years different indices have been developed which can be used in estuaries for metal assessment. Each of indices aggregates the concentration of metal contaminants and can be classified as following three types (Caeiro et al., 2005):

a) *Contamination indices*- It compares the contaminants with non-polluted and/or polluted stations measured in the study area or simply aggregate metal concentrations

b) *Background enrichment indices*- It compares the results for the contaminants with different baseline levels, available in the literature, relevant for the study area.

c) *Ecological risk indices*- It compares the results for the contaminants with Sediment Quality Guidelines (SQGs) values developed by different institutions.

2.2.4 Sediment Quality Guidelines (SQGs)

SQGs are important empirical tools for the protection and conservation of marine and freshwater environments (Birch, 2018). These guidelines evaluate the extent to which the sediment-bound chemical status might adversely affect marine organisms and are designed to help in the interpretation of sediment quality (Maanan et al., 2015). Long and Morgan (1990) and MacDonald et al., (1996) outlined these SQGs and described the derivation of low- and high-level guideline values for each contaminant. United States National Oceanic and

Atmospheric Administration's (NOAA) defines effects range low (ERL) and effects range median (ERM) guideline values, which is used to measure potential risk of pollutants in sediments to the marine ecosystem. According to guidelines, if the metal concentrations are below ERL, this indicates adverse effects are rarely present. If concentrations of exceed ERMs, negative effects on benthic communities are expected with at least a 50% frequency. In the case of concentrations values greater than ERLs, but less than ERMs, chronic or acute biological effects may occur occasionally (Macdonald et al., 1996; Birch, 2018; Zhang et al., 2019; National Oceanic and Atmospheric Administration, 2019).

In Canada, the Canadian Council of Ministers of the Environment (CCME) has developed interim sediment quality guidelines (ISQGs) and probable effect levels (PELs) for the protection of marine and freshwater aquatic life. ISQGs indicates the threshold-level effects below which negative biological effects are unlikely to be observed. Similarly, PELs indicate the concentrations above which adverse biological effects are expected to be common (CCME, 2019).

2.3 Impact of Industrial Effluents on Biota

2.3.1 Importance of Benthic Invertebrates

Benthic macroinvertebrates hold an important position in aquatic food webs. They are a key component of the aquatic ecosystem as they play an important role in detritus decomposition, nutrient cycling, and energy flow to higher trophic levels (Gray and Elliot, 2009). These macroinvertebrates are either attached to or intimately linked with the benthic substrate

(Vannote et al., 1980; Rosi-Marshall and Wallace, 2002; Runck, 2007). They are the primary material exchangers across the sediment-water interface.

As benthic organisms are in direct contact with sediments, therefore levels of contamination in sediments can have a great impact on their survival (Hussain and Pandit, 2012; Maharaj and Alkins-Koo, 2007). When metal concentrations increase in the environment, it affects metal accumulation in organisms which may exceed natural levels. It may also trigger biomagnification of metals which leads to a progressive increase in chemical concentration with increasing trophic level (Luoma and Rainbow, 2008; Pinherio et al., 2012; Saher and Siddiqui, 2019).

Some metals such as Pb, Cd, Cr, and Cu can be bioconcentrated through direct uptake across the gill surface and other external body parts (Bere et al., 2016). Furthermore, ingestion of contaminated food by benthic organisms can also lead to bioaccumulation of metals in tissue of biota which may eventually biomagnify up the food chain (Chen et al., 2007; Siddique et al., 2009; Varol, 2011; Wang et al., 2012).

Bioaccumulation in organisms depends on a number of factors such as level of contamination in the environment, biotic factors such as diet and trophic position of the organism. Therefore, it reflects the amount of the elements that have been ingested, excreted, and retained. Thus, benthic invertebrates are excellent bioindicators which due to their short lifespans can provide accurate near real-time reflections of contaminant dynamics under fluctuating aquatic conditions (Stankovic et al., 2014). Bioindicators refers to any aquatic organism that can accumulate contaminants in its tissues from the surrounding environment. Therefore, a change in a bioindicator species tissue metal burden reflects varying metal concentrations in the surrounding environment (Rainbow, 1995; Al-Farsi et al., 2015).

2.3.2 Benthic Invertebrates as Bioindicators

Although total metal concentrations in sediments indicate varying degrees of metal contamination, it does not necessarily predict the toxicity of contaminants to aquatic organisms. The ecotoxicological risk induced by contaminated sediments depends on metal availability, uptake kinetics as well as the ability of organisms to assimilate them. This makes it very important to assess levels of contaminants in aquatic organisms as well as characterizing bulk sediment chemistry (Amiard et al., 2007; Campana et al., 2012). Different species have different sensitivities to chemical stress; therefore, it is recommended to use combination of species from different organizational and trophic levels for better understanding of sediment ecotoxicity (Maltby et al., 2005; Tuikka et al., 2011). Organisms used as metal pollution bioindicators must meet certain criteria in order to reflect the biotic and /or abiotic levels of contamination of an environment (Hodkinson and Jackson, 2005). The following are criteria for good bioindicators:

- Ability for organisms to bioaccumulate inorganic or organic contaminants (e.g., including organisms exhibiting chronic or acute impacts from contamination accumulation).
- Bioindicator organisms must be relatively easy to collect, identify, and handle.
- Must have sufficient tissue to make chemical analysis easy and accurate.
- Life span of the organism must be long enough to reflect contaminant bioaccumulation over longer temporal periods (Stankovic et al., 2014).

Various benthic organisms are being widely used as an indicator for metal pollution in aquatic ecosystems, such as insects, polychaetes, gastropods, bivalves, and decapod crustaceans (Walker et al., 2013c; Fan et al., 2014; Duysak and Ersoy, 2014; Velez et al., 2015; Walker and Grant, 2015; Alvaro et al., 2016). Some of the most popular bioindicators for long term monitoring are bivalve molluscs, particularly oyster, mussels, and clams that have been used in the monitoring of marine water and sediments (Zhou et al., 2008; Liu et al., 2017).

Blue mussels (*Mytilus edulis*) has been widely used in monitoring of the marine environment due to their unique characteristics (Walker et al., 2013d; Walker and Macaskill, 2014). Mussels were also among the first animals used by researchers for assessing the environmental quality of seawater (Beyer et al., 2017). Blue mussels are sessile which helps in getting location-specific information. They are medium sized which provide enough tissue material for chemical analysis. They are easy to collect as they form a mussel bed in shallow waters. Mussels are also filter-feeders which makes them efficient to accumulate pollutant chemicals from water. They have limited ability to metabolize contaminants and tend to accumulate them to the levels exceeding those found in the ambient seawater, where the concentration of many contaminants in water are often below instrument detection limits (Walker and MacAskill, 2014). All these qualities of mussels make them a good fit for environmental monitoring (Beyer et al., 2017; Walker et al., 2015). Mussels are also being used in NOAA's Mussel Watch Program which was designed to monitor the status and trends of chemical contamination of U.S. coastal waters, including the Great Lakes (Kimbrough et al., 2008).

Furthermore, some decapods such as crabs and lobsters are used for measuring heavy metal contamination in surface sediments (Ololade et al., 2011). These species are ubiquitous and live in close contact with rocky substrates. They are bottom scavengers and their diet consists of organisms from different trophic levels including clams, mussels, polychaetes, and small crustaceans. Contaminants are stored in fat-rich digestive gland, the hepatopancreas (Boudet et al., 2015; Verma and Sharma, 2017). Their limited ability to metabolize contaminants in sediments makes them a suitable bioindicator for assessing the health of marine environment (Garron et al., 2005; Walker et al., 2013c). Finfish can also be bioindicators to estimate heavy metal levels in water, but their mobility makes them potentially less reflective of the local environment relative to shellfish (Zhou et al., 2018). There are certain known factors which can influence the metal accumulation in these organisms which includes metal bioavailability, season of sampling, hydrodynamics of the environment, size, sex, changes in tissue composition and reproductive cycle (Szefer et al., 2004; El Nemr et al., 2016).

2.4 Human Health Implications of Metals in Aquatic Biota

Humans can be exposed to metals via the ingestion of aquatic biota. The elements of highest concern from a human health perspective are: As, Cd, Co, Cr, Cu, Hg, Mn, Fe, Zn, Ni, and Pb which are commonly present in effluents from different industries (Rai and Pal, 2002; Lavery et al., 2009). Heavy metals in the tissues of marine organisms may transfer to humans through aquatic organism consumption. Seafood consumption, in particular, is increasing rapidly due to their beneficial nutritional values (Guerin et al., 2011). Marine organisms such as mollusks, crustaceans, and fish contain essential amino acids for humans and are a great source of minerals, vitamins, and polyunsaturated fatty acids (Raknuzzaman et al., 2016). Therefore, it is important to monitor environmental contaminants in marine organisms, as increasing seafood consumption can result in potential health risks for humans, particularly in coastal communities who rely on seafood as their primary source of animal protein (Chien et al., 2002; Raknuzzaman et al., 2016).

2.5 Importance of Baseline Data

Canada has an abundance of aquatic resources, including nearly 20% of the world's freshwater and a land mass bordering three oceans. In this era of industrialization, robust aquatic monitoring is required to protect these ecosystems from any harmful damage (Kilgour et al., 2007; Roach and Walker, 2017). Aquatic monitoring programs are designed to identify any potential environmental effects through biological, chemical, and physical changes and analyze the degree of harmful effects (Servos, 1996; Kilgour et al., 2007). For any successful monitoring program, obtaining accurate and precise baseline data is very important and a critical precondition for remediating any contaminated site (Jain, 2015). It can provide perspective on the appropriateness of remedial objectives that are derived for an impacted area. As it represents the current condition of the site before remediation, baseline data can help the managers of the project to plan remediation strategies according to site-specific conditions (Wills et al., 2003).

In Canada, monitoring comes in different forms which may include fish surveys, toxicology testing, benthic invertebrate surveys, and water quality measurements (Walker et al., 2013a, b; Walker and MacAskill, 2014; Roach and Walker, 2017). There are different federally mandated EEM programs used to measure impacts of industrial effluents such as pulp and paper (as discussed above) and metal mining effluents on receiving waters.

2.6. Gaps and Inconsistencies in Marine Biota Data from Estuary and Northumberland Strait

As per the *Boat Harbour Act* (2015) (as discussed in chapter 1), the remediation of Boat Harbour will commence after January 31, 2020. For this purpose, there is a need for current pre-remediation baseline data which can be used for comparing the effectiveness of remediation program during and post remediation. Romo et al. (2019) reviewed >200 government reports and peer-reviewed articles for relevant marine/aquatic biota data from Boat Harbour, Pictou Harbour, Northumberland Strait or reference locations. The aim of the study was to assess historical qualitative and quantitative contaminant data in marine biota (e.g., blue mussels, American lobster, and rock crabs) (Romo et al., 2019). This data was reviewed and consolidated so it could be used to help inform future monitoring for the Boat Harbour remediation project to compare against. These historical data would be useful for baseline (pre-remediation) monitoring data to be compared against, along with environmental monitoring conducted during and post-remediation.

In this study it was found there are significant gaps and inconsistencies in marine biota data. EEM became mandatory in 1992, and there are reports available only for four EEM cycles (JWEL, 1996; Stantec, 2004; Ecometrix Inc., 2007; Ecometrix Inc., 2016). As the second, fifth and sixth EEM cycle data were unavailable, second cycle results were summarized in subsequent reports using data derived from Andrews and Parker (1999) and fifth and sixth cycle results were inferred from the seventh cycle (Romo et al., 2019).

In the available reports, there were lots of inconsistencies between different cycles, which reflected differing regulatory and technical requirements for the different cycles. For instance, to assess impacts on fish and shellfish, the first cycle chose winter flounder (*Pseudopleuronectes americanus*) and rock crab for analyzing resin and fatty acids and contrasting morphological characteristics with reference samples from Merigomish Harbour (Fig. 4) (Romo et al., 2019). Blue mussels were analyzed for 10 dioxins and furans congeners, with reference sites from Caribou Island (JWEL, 1996). In contrast, the third cycle analyzed blue mussel and mummichog (*Fundulus heteroclitus)* for immunological and morphological endpoints relative to reference sites from Merigomish Harbour and Logan's Point (Fig. 4).

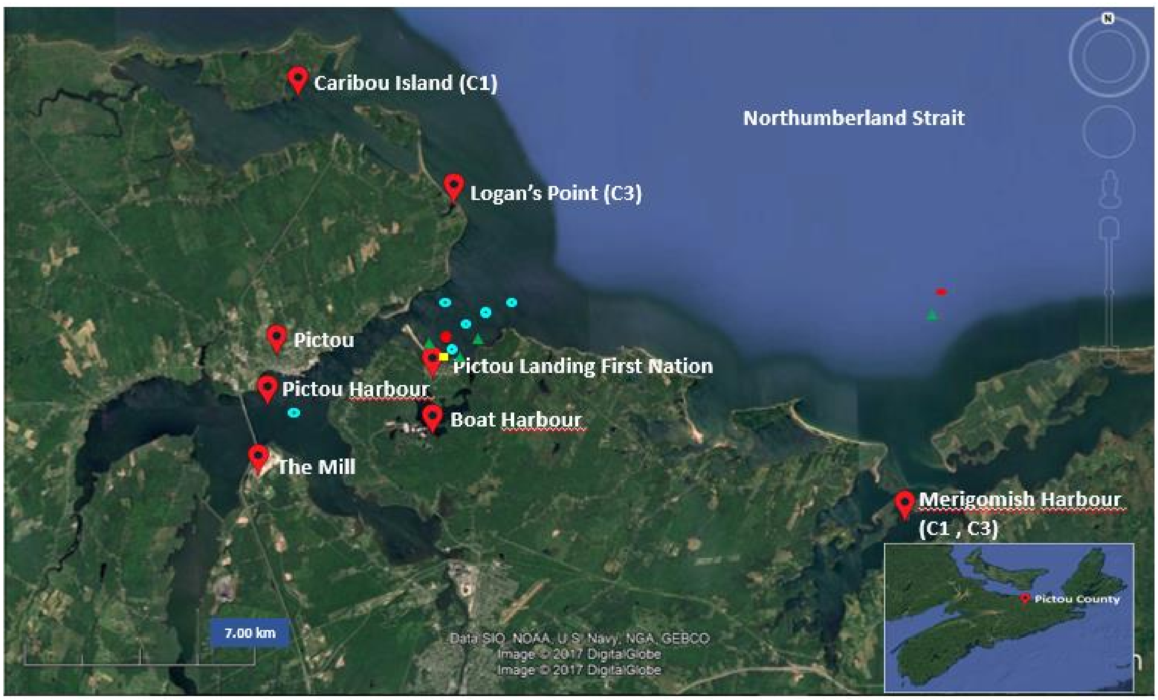

Fig. 4. Location of Boat Harbour in Pictou County, Nova Scotia. Blue circles represent blue mussel (*Mytilus edulis*) sampling locations, green triangles represent rock crab (*Cancer irroratus*) sampling locations, red circles represent American lobster (*Homarus americanus*) sampling locations and yellow squares represent soft shell clams (*Mya arenaria*) sampling locations. C1, C2 and C3 represent reference locations used in EEM cycles 1, 2 and 3, respectively (from Romo et al., 2019).

Taint testing in cycle one (JWEL, 1996), used LEM Laboratory (1994) data, but taint testing was omitted from subsequent cycles, due to a lack of significant effects. All available EEM reports noted limited impacts on marine biota (Fig.4).

In addition, despite the presence of a former chlor-alkali facility, which operated for 20 years (1972-1992) and discharged effluent into Boat Harbour, Hg has never been analyzed in the marine environment, nor Me-Hg which is susceptible to bioaccumulation. Furthermore, two dioxins and furans congeners (2,3,7,8- TCDD and 2,3,7,8-TCDF) were not analyzed in the first EEM cycle, despite claims to the contrary (Romo et al., 2019). Overall, there was a marked lack of consistency in analyses, sentinel species used across different cycles, and limited georeferenced sites, making it difficult to use this data for future reference.

To help develop useful baseline data for remediation programs, selection of suitable biota, consistency in analysis of different contaminants, and periodic monitoring are all important components (Romo et al., 2019). To establish robust baseline data, it was important to assess current conditions of the estuary and the marine environment which can be used as a benchmark during and after remediation. In order to fill this baseline data gap described in Chapter 1, the objective of this thesis is to assess the level of contamination of metals and dioxin and furans in sediments and biota of the Northumberland Strait.

Chapter-3 Assessment of historical and current baseline contaminants in sediments and marine biota near an industrial effluent discharge in Northumberland Strait, Nova Scotia, Canada

3.1 Introduction

For decades, the pulp and paper industry (PPI) in Canada has been responsible for generating large volumes of effluent wastewater. Pulp mill effluents contain organic (e.g., dioxins and furans) and inorganic contaminants including metals which can have detrimental impacts on aquatic ecosystem health (Sunito et al., 1988; Colodey and Wells, 1992; Hoffman et al., 2019). These mills generate large volumes of wastewater for each metric ton of paper produced. More than 250 chemical contaminants have been identified in effluents produced during different stages of the pulping process (Pokhrel and Viraraghavan, 2004). Wastewater from the PPI has a high biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorinated compounds, metals, suspended solids, fatty acids, tannins, resin acids, lignin, and its derivatives, sulfur and sulfur compounds (Ali and Sreekrishnan, 2001). The pulping process can employ either mechanical or kraft pulping. In mechanical pulping, force is used to generate heat and torsional forces to isolate wood fibres with limited use of chemicals, whereas kraft pulping uses sulfate or sulfite to chemically degrade lignin to isolate cellulose and hemicellulose fibres.

A bleached kraft pulp mill in Pictou County, Nova Scotia has been discharging wastewater effluent into Boat Harbour and subsequently into the Northumberland Strait since 1967 (Hoffman et al., 2017a, 2019) (Fig. 5). Prior to 1967, A’se’k, a waterbody commonly known as Boat Harbour (BH) is a former tidal estuary connected to the Northumberland Strait. Boat

Harbour lies within the Mi'kmaq Pictou Landing First Nation (PLFN) and was traditionally used by the community for hunting, fishing, and ceremonial purposes (Fig. 5).

Fig. 5. Location of Boat Harbour in Pictou County relative to the pulp mill, communities of Pictou Landing First Nation, and the town of Pictou and final discharge point into the Northumberland Strait. (Adapted from Romo et al. (2019).

In 1969, the Boat Harbour Treatment Facility (BHTF) was built and operated by the province to treat wastewater effluent from the mill and a nearby chlor-alkali plant owned by Canso Chemicals Ltd. which operated from 1972 to 1992. Further, in 1972 a dam was built at the BH outlet preventing seawater incursion while transforming BH into a freshwater pond. Canso Chemicals Ltd. operated the chlor-alkali electrolysis facility that generated sodium hydroxide and chlorine (used in the kraft pulp mill bleaching process) as well as hydrogen using mercury cell process and brine solution. The mill has undergone several owners and process changes since 1967 (Hoffman et al., 2017a; 2019).

Currently, the mill is operated by Northern Pulp and the use of elemental chlorine previously used in the bleaching process by previous owners was changed to chlorine dioxide in 1997 to meet new federal *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* (Northern Pulp, 2019). Effluent from the mill (approximately 87,000 m^3/day) is piped beneath East River and discharged into one of two settling ponds to promote sedimentation (Fig. 5). After coarse sediment is precipitated, effluent is discharged into an aerated stabilization basin for atmospheric agitated pump aeration for 5-6 d prior to its discharge to a stabilization lagoon (*i.e.,* Boat Harbour). Effluents remain in Boat Harbour for a 20-30 d hydraulic residency before final discharge to the Northumberland Strait through the impoundment upstream of the estuary (Fig. 5).

Effluent discharge over the last 50 years has resulted in the deposition of approximately 577,000 m^3 of unconsolidated contaminated sediments impacted by inorganic and organic contaminants in BH (Hoffman et al., 2017a, 2019; Alimohammadi et al., 2019).

Since 1967, the environmental and human health impacts of the pulp mill and chlor alkali plant effluents on water quality, soil, and sediment contamination have been a major concern (Hoffman et al., 2017a). In 2014, an effluent pipe leak and broken stack precipitator increased the concern and intensity of protests by the PLFN community. This mounting political pressure resulted in the passing of the *Boat Harbour Act* (2015), which mandated that the discharge of mill effluents into the BHTF will cease on January 31, 2020. Following the cessation of effluent discharges, contaminated sediments in BH will be remediated (Hoffman et al., 2017a, 2019; Romo et al., 2019). The goal of the *Act* is to return Boat Harbour to its pre-effluent tidal estuary condition as requested by the PLFN community. However, a detailed characterization of contaminants in sediment and biota in Northumberland Strait are required before remediation begins.

To track the effectiveness of remediation, baseline data is required to predict potential ecological impacts and risks associated with the contaminated sediments in BH and marine environments of the Northumberland Strait. After the *Boat Harbour Act* was passed in 2015, numerous studies have been conducted in and around BH to characterize contaminants in sediments, groundwater, and nearby wetlands. Despite numerous historical studies documenting the impact of effluents on sediments in BH, there is a lack of recent information on the potential impacts on marine sediments and biota of the Northumberland Strait (Romo et al., 2019). The ultimate goal of the *Boat Harbour Act* (2015) is to return BH to its former tidal condition and to hydraulically connect it to the Northumberland Strait. Therefore, it is important to establish current baseline data for marine sediments and biota in Northumberland Strait which can be used for comparison during future monitoring. A key aim of this study was to conduct a baseline assessment of level of contamination in sediments and marine biota of Northumberland Strait.

3.2 Materials and Methods

3.2.1 Review of Secondary Data

In order to determine if contaminants from BH migrated into the marine receiving environment of Northumberland Strait, it is important to gather background information on historical contaminants of BH and the surrounding area for comparison.

Although many historical studies have been conducted in and around BH, there have been few summaries describing spatio-temporal organic and inorganic contaminant characterization. Hoffman et al. (2017a, 2019) conducted a holistic characterization of metal and organic contaminants in BH sediments. These studies reviewed >200 documents (including government reports and peer-reviewed journals) for sediment quality data (JWEL and Beak Consultants, 1992 and 1993; JWEL, 1999, 2001, 2005; Stantec 2013, 2016; Hoffman et al. 2017a, 2019). It was reported in the study that out of all previous sampling events (from 1992-2015), approximately 38% of samples were grabs and the rest (62%) were cores (Hoffman et al. 2017a, 2019) (Fig. 6).

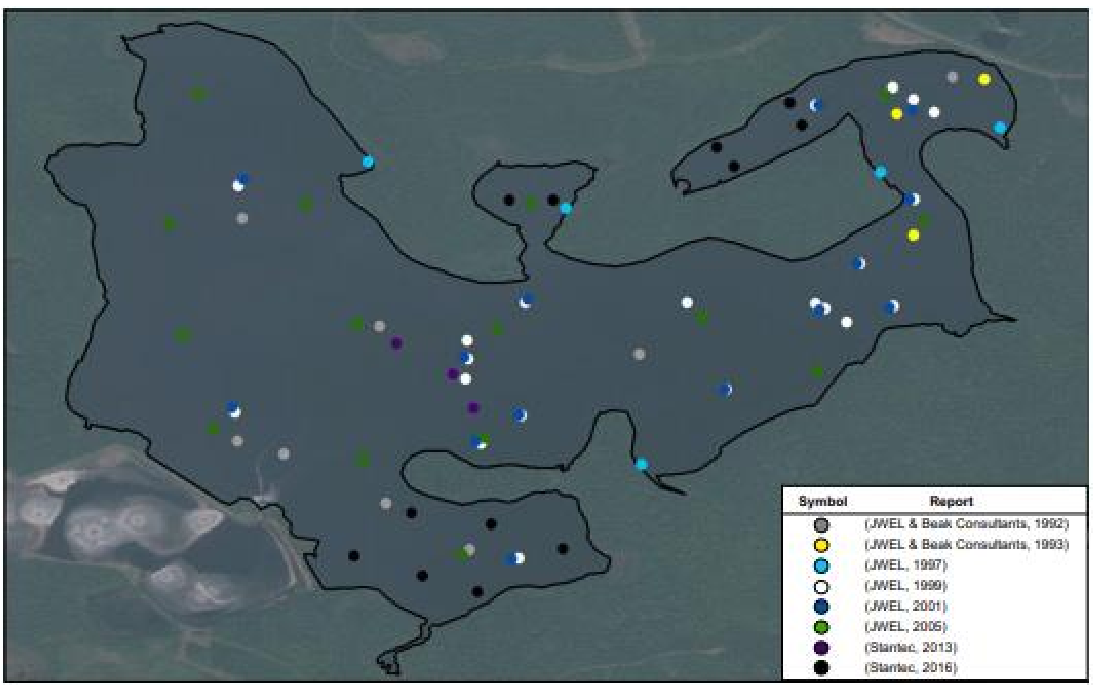

Fig. 6. Spatiotemporal coverage (1992–2015) of sediment sampling sites in Boat Harbour. Colored circles indicate when samples were collected/analyzed (from Hoffman et al., 2017a).

Further, toxic equivalency quotient (TEQ) concentrations for polychlorinated dibenzodioxins and furans (PCDD/F) of 60 samples from 48 stations were also calculated (Hoffman et al., 2017a, 2019). It was reported that six metals: As, Cd, Cr, Pb, Hg, and Zn exceeded freshwater

Probable Effects Levels (PELs) and four: Cd, Cu, Hg, and Zn exceeded marine PELs (Hoffman et al., 2017a).

Sediments across BH were found to be highly organic with mean total organic carbon values ranging from 4 to 27%. Furthermore, all PCDD/F TEQs exceeded the low -effect CCME interim sediment quality guidelines (ISQGs), 66.6% exceeded CCME PELs, and 93.3% exceeded the CCME soil quality guideline for human health. In addition, percent contributions of PCDD/F congeners indicate higher proportions of 2,3,7,8-tetrachlorodibenzofuran (68.6-97.3%) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (10.7-63.8%) in the sediment of Boat Harbour for all TEF categories (Hoffman et al., 2019).

Ferguson's Pond located 2.5 km NE of BH was selected as reference site for this study (Fig. 7) and it was found that BH sediment concentrations of the chemicals of concern were 20 times higher than at this reference site (Hoffman et al., 2017a).

Fig. 7. Location of reference site Fergusons Ponds relative to Boat Harbour (from Hoffman et al., 2017a).

According to Hoffman et al. (2017a, 2019), to return BH to pre-tidal conditions, more local baseline data of sediments and marine biota in the Northumberland Strait marine receiving environment is required. This data is necessary to determine potential ecological impacts to aquatic life (St-Jean et al., 2003; Romo et al., 2019).

To assess quantitative and qualitative data on marine biota from BH, Pictou Harbour, Northumberland Strait, and reference sites, Romo et al. (2019) reviewed government reports and peer-reviewed articles. The review included contaminant concentrations (metals, dioxins and furans, chlorophenols, resins and fatty acids) and sample locations (x, y coordinates in decimal degrees). Romo et al. (2019) reported that many species such as American eels (*Anguilla rostrata*), soft-shell clams *(Mya arenaria*) and quahogs (*Mercenaria mercenaria*), suffered widespread mortality due to early effluent exposure (Seakem Oceanography, 1990).

Since 1992, pulp mill effluents in Canada have been regulated under the *Pulp and Paper Effluent Regulations* (PPER) under the *Fisheries Act* (PPER, 1992). Pulp mills are obliged to conduct an Environmental Effects Monitoring (EEM) cycle every 3 years to measure the effects of effluents on fish and fish habitat. After reviewing all available EEM cycles from 1996 until 2016, Romo et al. (2019) reported many inconsistencies in EEM reporting. Although EEM became mandatory in 1992, only four EEM cycles out of seven had reports that were available (JWEL, 1996; Stantec, 2004; Ecometrix Inc., 2007; Ecometrix Inc., 2016). The second, fifth and sixth EEM cycles were unavailable, but results from the second cycle were summarized in subsequent reports using data derived from Andrews and Parker (1999) and the fifth and sixth cycle results were inferred from the seventh EEM cycle report (Ecometrix Inc., 2016).

In the available reports, there were inconsistencies between different EEM cycles. For instance, to assess impacts on fish and shellfish, the first EEM cycle selected winter flounders and rock crabs for analyzing resin and fatty acids and morphological characteristics with reference samples collected from Merigomish Harbour. Blue mussels were analyzed for 10 dioxins and furans congeners, with reference sites selected from Caribou Island (JWEL, 1996). In contrast, the third EEM cycle analyzed blue mussel (*Mytilus edulis)* and mummichog (*Fundulus heteroclitus)* for immunological and morphological endpoints with reference sites from Merigomish Harbour and Logan's Point (Fig. 8).

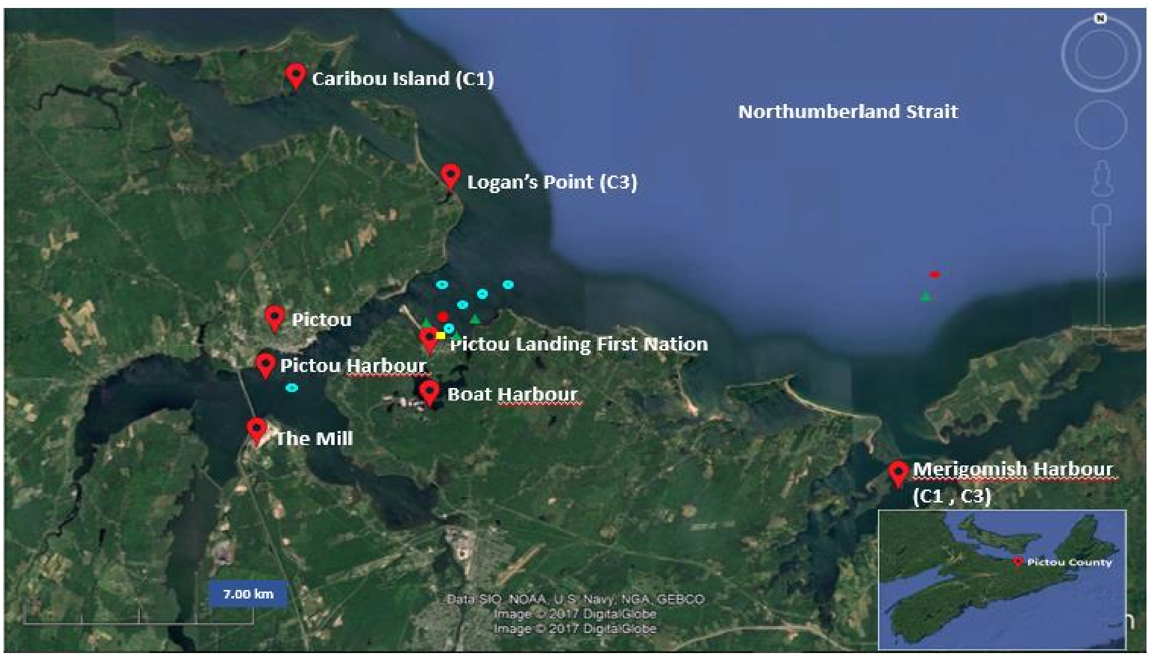

Fig. 8. Location of Boat Harbour in Pictou County, Nova Scotia. Blue circles represent Blue mussel (*Mytilus edulis*) sampling stations, green triangles represent Rock crabs (*Cancer irroratus*) sampling stations, red circles represent American lobsters (*Homarus americanus*) sampling stations and yellow squares represent soft shell clams (*Mya arenaria*) sampling locations. C1, C2 and C3 represent reference locations used in EEM cycles 1, 2 and 3 cycles, respectively (from Romo et al., 2019).

All EEM cycles reported limited impacts on marine biota, despite there being a lack of contaminant guidelines for biota tissue and limited local reference data (Romo et al., 2019) (Fig.

8). In addition, despite a chlor-alkali facility which operated for 21 years and discharged effluent into Boat Harbour, mercury (Hg) has never been analyzed, nor has methyl mercury (Me-Hg). Chlor-alkali facilities are potentially a major source of mercury as they generate sodium hydroxide, chlorine, and hydrogen by using mercury as a catalyst (Walker, 2016; Dillon Consulting Limited, 2019).

Furthermore, two dioxin and furan congeners 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) and 2,3,7,8 tetrachlorodibenzofuran (2,3,7,8-TCDF) were not analyzed in the first EEM cycle contradicting the claims made in the reports (JWEL, 1996; Romo et al., 2019). Overall, there was a lack of consistency in analyses, species used in different cycles, and limited reference sites, which make it difficult to use this data for future reference.

Although numerous studies have reviewed sediment quality and characterized contaminants in BH (Hoffman et al., 2017a, 2019; Romo et al., 2019) current assessment of contaminants in marine sediments and biota in Northumberland Strait is required. This baseline data can be used to compare against potential future monitoring programs in the area. Studies in and around BH (Hoffman et al., 2017a, 2019; Romo et al., 2019) have recommended to prepare a baseline dataset for sediments and marine biota for the marine receiving environment of Northumberland Strait.

The aim of this study as stated in chapter 1 is to:

1) Assess levels of contamination of metals, total mercury, methyl mercury, dioxins and furans in sediments and biota of the marine environment of Northumberland Strait; and

2) Prepare the baseline pre-remediation data which can be used during and after remediation for monitoring purposes.

3.3 Sampling

Research objectives were achieved by using multiple lines of evidence to measure contaminant concentrations in marine sediments and in marine biota at different trophic levels. The first line of evidence was bulk sediment sampling (0-15 cm). The second line of evidence was marine biota sampling using multiple species including: American lobster (*Homarus americanus*), Rock crab (*Cancer irroratus*), and Blue mussel (*Mytilus edulis*). The third line of evidence was passive sampling by diffusive gradient thin films (DGTs).

3.3.1 Sampling Stations

Sixteen sampling stations were selected to achieve the 7-8 km spatial coverage from the mouth of the estuary (where effluents get discharged after final treatment) to offshore areas in the marine environment of Northumberland Strait. Another eight stations were selected for blue mussels along the coastline of Pictou Harbour in Northumberland Strait. Stations in Northumberland Strait were then divided along two transects (North East (NE) and North (N)) from the estuary mouth into Northumberland Strait. NE and N Transects extended approximately 7 and 8 km, respectively into the Northumberland Strait (Fig. 9) (Table 2). Following is the cumulative distance of sampling station from BH.

Table 2. Distance of sampling stations from BH

Stations	Cumulative distance from BH
N1-N3	0.80-2.00 km
N4-N6	3.80-5.00 km
N7-N8	6.00-7.00 km
NE1-NE6	1.00-3.00 km
NE7-NE8	6.50-8.00 km
M1-M2	2.50-3.00 km
M3-M4	0.50-1.00 km
M5-M6	1.50-3.00 km
M7-M8	6.50-7.50 km

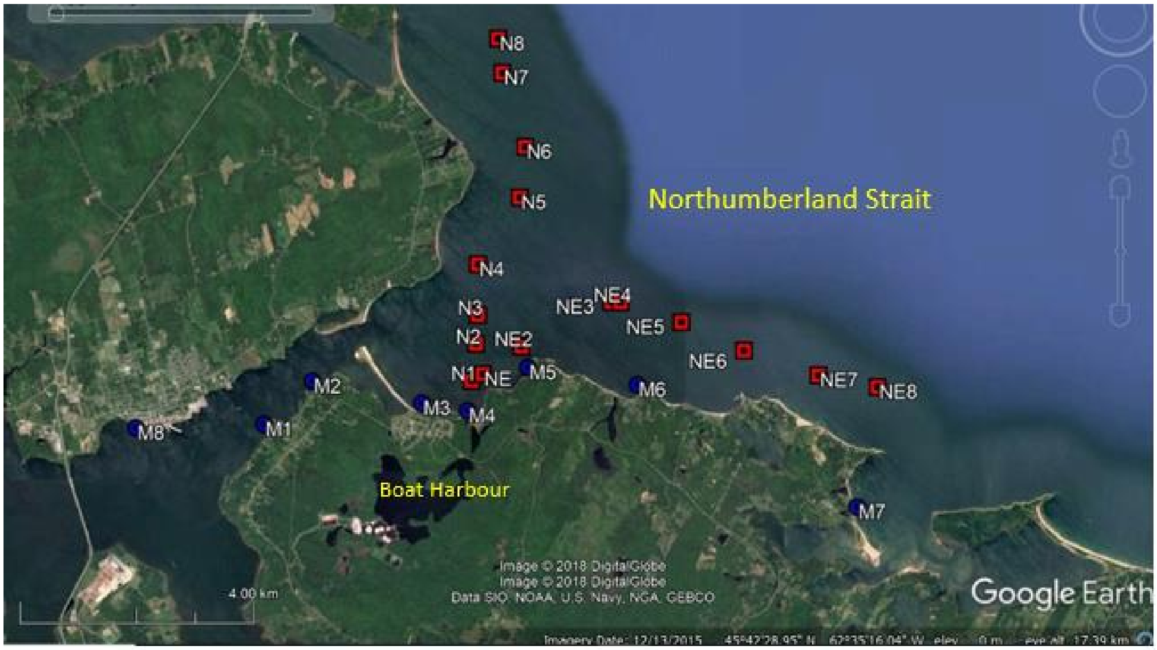

Fig. 9. Sediment and marine biota sampling stations. Red squares represent sediment sampling stations, American lobster (*Homarus americanus)*, and Rock crab (*Cancer irroratus)* sampling stations. Blue circles represent blue mussel (*Mytilus edulis)* sampling stations.

Sampling stations were divided into three areas: near-field area (1-3), mid-field area (4-6), and far-field area (7-8) along each transect to get a wide representation of samples (Table 2). Sampling stations were selected to obtain two duplicate samples in the near-field area (i.e., N1-N3 and NE1-NE3), considered contaminated *a priori*. Blue mussel stations were selected to get a spatial coverage over approximately 8 km along the shoreline of Pictou Harbour. Stations M3, M4, and M5 were considered near- field, M1, M2, and M6 as mid -field and stations M7 and M8 as far- field. Sediment sampling was completed during two field seasons. The first in May 2018 and second in July 2019. Sampling positions were recorded using hand-held and boat Garmin Global Positioning System (GPS) units (Appendix A Image 1).

Ten sampling stations were selected near the estuary mouth for the deployment of DGTs and ten stations were selected in BH. Ten chelex binding gel DGTs disc for metals (As, Cd, Cr, Cu, Pb, and Zn) and ten 3-mercaptopropyl-functionalized silica (MFS) binding gel for total mercury (THg) were deployed at each site.

3.3.2 Sediment Sampling and Analysis

Twelve sediment samples were collected during two field sampling seasons in 2018 and 2019. Six samples were collected in July 2018, including five samples from NE transect (NE4- NE8) and one sample from N transect (N4). Long gravity corer (approximately 1.25 m) 2416 B45 (Wildco®) was used to collect samples in 2018 (Appendix A Image 2). Surface sediment samples from 0-15 cm depth were collected as this horizon is the most biologically active (Walker and Grant, 2015; US EPA, 2019). Rocky substrate in Northumberland Strait prevented sediment samples using the gravity corer at stations N5-N8 in 2018. Six samples in 2018 were collected on a lobster fishing boat (*JB & Stephanie*) (Appendix A Image. 3).

In May 2019, the second round of sediment sampling was completed from the near- field stations. Sediment samples were collected from six stations in the N transect (*i.e.,* N1-N6). All the samples were collected by using 316 Stainless Steel, 152 x 152 mm ponar grab (Wildco®) from the 0-15 cm horizon. To avoid disturbance of surface sediment care was taken to allow surface seawater in the grab to drain away (Walker and Grant, 2009; Walker et al., 2013). Near-field samples were collected from shallow water on small aluminium motorboat (Appendix A Image. 4). Sediment sub-samples were then transferred to individual clean glass jars; 250 mL jars were used for metals, and dioxins and furans, and 120 mL jars were used for total organic carbon (TOC).

All sediment samples were analyzed by AGAT laboratories, accredited by the Standards Council of Canada. Samples were analyzed for grain size, TOC, 25 metals (Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Li, THg, Mn, Mo, Ni, Se, Ag, Sr, Tl, Sn, U, V, Zn), total mercury (THg), and dioxin and furans. Although 25 metals were analyzed, this study focussed on the priority metals (i.e., As, Cd, Cr, Cu Pb, Zn, Hg). These metals exceeded CCME PEL thresholds in BH sediments (Hoffman et al., 2017a). Samples for grain size were analyzed by sieve and a pipette based on the ASTM D-422-63 (ASTM, 2007). TOC was determined by using titration based on MA 405-C 1.1. Metals were analyzed by using multi-element inductively coupled plasma-mass spectrometry (ICP-MS) based on US-EPA SW 846 6020A/3050B and SM 3125 (Center of Expertise in Environmental Analysis of Quebec, 2014; USEPA, 1998a). Analysis of dioxins and furans was conducted using high-resolution mass spectrometry (HRMS) in accordance with EPA 1613 (USEPA, 1994). All sediment concentrations were expressed in dry weight (dw).

3.3.3 Marine Biota Sampling and Analysis

Thirteen adult American lobster (*Homarus americanus*) with carapace length (CL) between 80-125 mm and thirteen composite Rock crab (*Cancer irroratus*) samples (comprising 6-8 individuals per station) between 102-113 mm CL were collected from stations along the N and NE transects (Fig. 9). Lobsters and rock crabs were collected from the same stations as sediment samples (Appendix A Image 5 and 6). All samples were collected from a lobster fishing boat (*JB & Stephanie*) in July 2018.

Traps with Department of Fisheries and Ocean (DFO) scientific tags for lobsters and rock crabs were deployed on July 9, 2018 and retrieved on July 11, 2018 (Appendix A Image 7) (Fig. 9). Eight blue mussels (*Mytilus edulis)* composite samples of 50-65 mm shell length (comprising 6-30 individuals per station) were collected along the shoreline of Pictou Harbour from eight stations (Fig. 9). Blue mussels were collected on July 10, 2018 by hand from inter-tidal stations during low tide (Appendix A Image 8). DFO scientific licenses were obtained prior to sampling (License No.: SG-RHQ-18-071) (Appendix A Image 9). The number of species collected during sampling was in accordance with licenses issued. After collection, all the samples were transferred into a -20^{o}C freezer overnight and delivered to AGAT laboratories on July 12, 2018. American lobster, rock crab, and blue mussel whole body tissues were analyzed for metals (As, Cu, Cd, Pb, Zn, THg), and dioxins and furans by AGAT laboratories. Two samples from near-field stations and one sample from far-field stations of each species were also analyzed for MeHg. Metals were analyzed based on US-EPA 350 with ICP/MS and mercury was analyzed with CV/AA based on US-EPA 248.6 (USEPA, 2019). HRMS was used for dioxins and furans analysis based on US-EPA 1613 in whole tissue (USEPA, 1994). MeHg was analyzed based on M-10220 with digestion, aqueous ethylation, purge, trap, and CVAFS with an automated system (USEPA, 1998). All tissue concentrations were expressed as wet weight.

3.3.4 Passive Sampling Using DGTs disc and Analysis

Passing sampling is the use of an abiotic device to monitor contaminants in an environmental medium, which obtains a measurement without active media transport (Alvarez, 2010). Passive samplers based on DGTs technique was used in this study.

DGT® was originally developed by Davison and Zhang from Lancaster University in order to measure free ion concentrations (bioavailability) in bulk seawater and sediment porewater (Davison and Zhang, 1994, 2012). DGTs measure porewater concentrations using Fick's first law of diffusion and relies on an ion-exchange resin layer, which is separated from the bulk solution by an ion-permeable hydrogel (Zhang et al., 1998). A typical DGT disc consists of a binding gel layer, an ion-permeable diffusive gel layer, a filter member and plastic cap and base (Fig. 10).

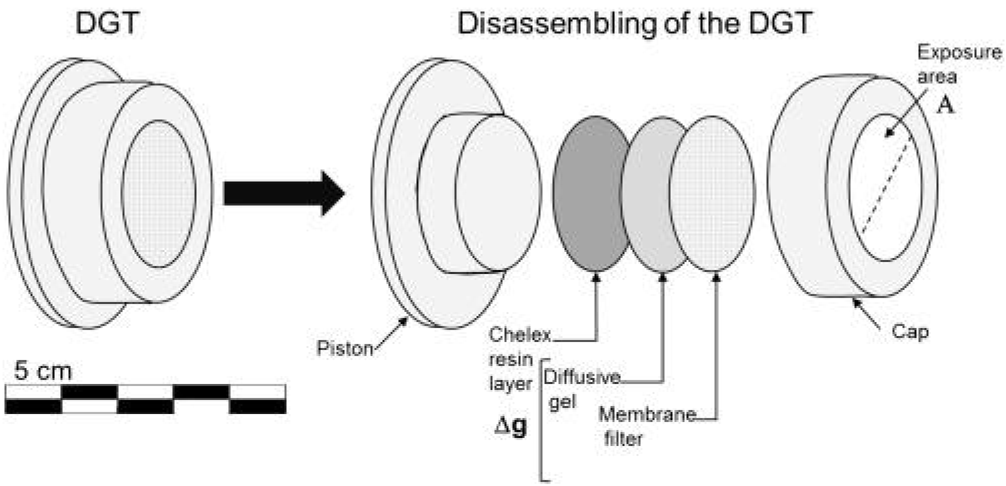

Fig. 10. Schematic representation of a DGT unit assembled and disassembled, A is the exposure surface area of the membrane, Δg is the thickness of the diffusion layer (diffusive gel +filter membrane) (from Desaulty et al., 2017).

When DGT discs are deployed in an environmental media, a diffusive gradient is created across the bulk solution and the resin gel. The resin gel acts as a sink, inducing the flux of ions from sediments through the diffusive layer (Zhang and Davison, 1995; Ruello et al., 2008). Metal ions then pass through a gel diffusion layer and bind to the chelating or ion exchange resin. Two results which can be obtained from DGT analyses are mass accumulated by DGT resin and time weighted estimated water concentration (Zhang and Davison, 1995).

Contaminants taken up by organisms accumulate in tissues, organs, or throughout the whole body. Bioaccumulation of contaminants occurs when the rate of uptake exceeds that of excretion. In theory, such a time integrated characteristic is also represented by the DGTs technique, where the resin gel in DGTs behaves like a tissue (Guan, 2019). Therefore, DGTs can be used to mimic contaminants uptake and bioaccumulation processes similar to fish (Alvarez, 2010; Guan, 2019). The resin (adsorptive) gels used in DGTs are selective towards certain metal species; for instance, chelex resin is used for As, Cd, Cr, Cu, Pb, and Zn and MFS are used for THg. Therefore, it can be used to measure a variety of analytes with suitable adsorbents.

To assess the level of metals and THg in sediment pore water of BH and the downstream estuary, forty DGT discs (twenty in BH and twenty in estuary) were deployed.

Forty piston sediment probe DGTs were purchased from DGT® Research, Lancaster UK. The discs had plastic base (2.5 cm diameter) with 0.4 mm resin gel layer, 0.8 mm diffusive gel layer, and 0.135 mm filter (Appendix A Image 10). Out of forty discs, twenty were with chelex binding gel (used for metal As, Cd, Cr, Cu, Pb, and Zn) and twenty with MFS binding gel were used for THg analysis. Chelex and MFS disc were deployed at the same station (*i.e.* two discs at each station). DGTs disc with chelex gel (metals) were labelled as ESM1-10(for estuary) and BHM1-10(for BH) and MFS gel disc (THg) were labelled as ESHG1-10, (for estuary) and BHHG1-10 (for BH). DGTs disc were tied to cinder blocks with plastic cable to avoid any cross contamination (Appendix A Image 11).

The equilibrium time required by the DGTs disc is different for freshwater and marine environments. Therefore, DGTs disc were deployed for one week in the marine environment of the estuary (May 21-28, 2019). As the equilibrium time for DGT discs in freshwater is one month, (personal communication, Lord, Heather, April 30, 2019) DGTs in BH were deployed May 21-June 18, 2019.

All the discs were shipped to Bureau Veritas (accredited by the Standards Council of Canada). Metals were analyzed by ICPMS digestion by using EPA 6020b R2 m (USEPA, 2014) and THg was analyzed by CV based on BCMOE BCLM Oct2013 m (Austin, 2015).

3.4 Quality Control

Nitrile gloves were used during each sample collection to minimize potential cross-contamination. Samples were collected in laboratory supplied glass jars in order to minimize contamination (Appendix Image 12). Samples were uniquely labelled, and control was maintained using chain of custody forms. All samples were stored in freezers at -20°C and transported to laboratory in coolers using ice packs. Blind field duplicate for lobsters were collected for every 10 samples. In this study 13 lobsters were collected which includes two field duplicates. Method blanks, spike blanks, and matrix spikes were analyzed for of each batch samples by AGAT laboratory. Spike blanks results were control charted and met specific acceptance criteria (Appendix B).

3.5 Data Analysis

SPSS statistical package (version 25), Microsoft Excel™, Minitab®, and Sigma Plot™ were used for data analysis. One sample t-test was performed by using SPSS™ on each metal (with the exception of Cd, Hg) to determine whether sample means were statistically different from background means. Mean sediment metal background concentrations from Nova Scotia harbours and inlets studied by Loring et al. (1996) were used in this study (Table 6). Background values represent concentrations of metals from relatively pristine environments without anthropogenic impacts (Loring et al., 1996). A Pearson correlation was performed using SPSS™ to assess the correlation between metals, grain size and TOC. In this study, the geoaccumulation index (Igeo) was also calculated to assess the metal pollution in sediments compared to background levels (Admano et al., 2005). The geoaccumulation index was introduced by Muller (1969) and is sometimes used in ecological risk assessment by using equation (Eq. 1):

$$Igeo = \log2.\ Cn/\ 1.5\ Bn$$

Where Cn is sediment metal concentration and Bn is background sediment metal concentration. Factor 1.5 is introduced to minimise the effect of possible variations in the background values which may be attributed to lithologic variations in the sediments (Muller 1969; Stoffers et al., 1986). The descriptive classes for increasing Igeo values developed by Muller (1969) are described in (Table 5). Box plots and graphs for metals were developed using Sigma Plot™.

For metals, Canadian Council of Ministers of Environment (CCME) marine sediment quality guidelines (SQGs) were used to compare against sediment contaminant burdens. Two SQGs exist for marine sediments; 1) Probable Effect Level (PEL) and 2) Interim Sediment Quality Guidelines (ISQGs) (Canadian Council of Ministers of the Environment, 2019a). Sediment concentrations above PEL are often considered heavily contaminated and likely to impair aquatic biota, concentrations between PELs and ISQGs are considered moderately contaminated, and concentrations below ISQGs are considered uncontaminated (Canadian Council of Ministers of the Environment, 2019a). For dioxins and furans, toxic equivalency (TEQ) concentrations of samples were calculated by multiplying individual PCDD/F congener concentrations with associated toxic equivalency factors (TEFs) for each congener (Canadian Council of Ministers of the Environment, 2019). TEQ concentrations were determined using the World Health Organization (WHO) established TEFs for fish, birds, and humans (World Health Organization, 2006).

For metals in tissue samples, Canadian Food Inspection Agency (CFIA) guidelines for chemical contaminants and toxins in fish and fish products were used (Canadian Food Inspection Agency, 2019). Only As, Pb, and Hg tissue data were able to be compared against the CFIA guidelines as there are no guidelines available for other metals. For methyl mercury in biota tissue, Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota (2019) was used for comparison (Canadian Council of Ministers of the Environment, 2019b). If metal and dioxins and furans concentrations were below detection limits (DL), then a 1/2DL concentration was used in calculations (MacAskill et al., 2016; Zhang et al., 2019).

3.6 Result and Discussion

3.6.1 Sediment Contaminant Concentrations

Sediments collected were light brown in color. Grain size of most sediments were coarse, ranging from 60-100 % (>75µm). Out of 12 samples, two mid field samples (N4, NE4) and 1 far-field (NE8) were found to be fine grain sizes with values 42%, 34%, and 46% above the sieve size of >75µm respectively. TOC content was low in all the sediment samples with a range of <0.3-1.5%.

Sediment metal concentrations (As, Cd, Cr, Cu, Hg, Pb, Zn) were detected below marine sediment interim sediment quality guidelines (ISQGs) (Fig. 11). Results from the one-sample t-test showed a significant difference ($p \leq 0.001$) between means of each metal (As, Cr, Cu, Pb, Zn) relative to mean background metal concentrations. Arsenic was detected below the ISQGs ranging between 3-7 mg/kg (DL=1 mg/kg). Sediment Cr, Cu, Pb, and Zn concentrations were also below ISQGs ranging from 13-19 mg/kg (DL=2 mg/kg), 1-11 mg/kg (DL=2 mg/kg), 1.9-12.4 mg/kg (DL=0.5 mg/kg), and 18-59 mg/kg (DL=5 mg/kg), respectively (Table 3). Sediment Cd and Hg concentrations were below DLs (0.3 mg/kg and 0.05 mg/kg, respectively) across all sampling stations, so are not presented. Dioxins and furans in all samples were detected below CCME ISQGs.

Table 3. Descriptive statistics of sediment metal concentrations from sampling stations mg/kg(dw) (n=12).

Metals	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
As	3.00	7.00	5.08	1.16
Cr	3.00	19.00	10.83	6.32
Cu	1.00	11.00	5.33	3.62
Pb	1.90	12.40	6.58	4.09
Zn	18.0	59.00	38.50	15.41

*dw- dry weight

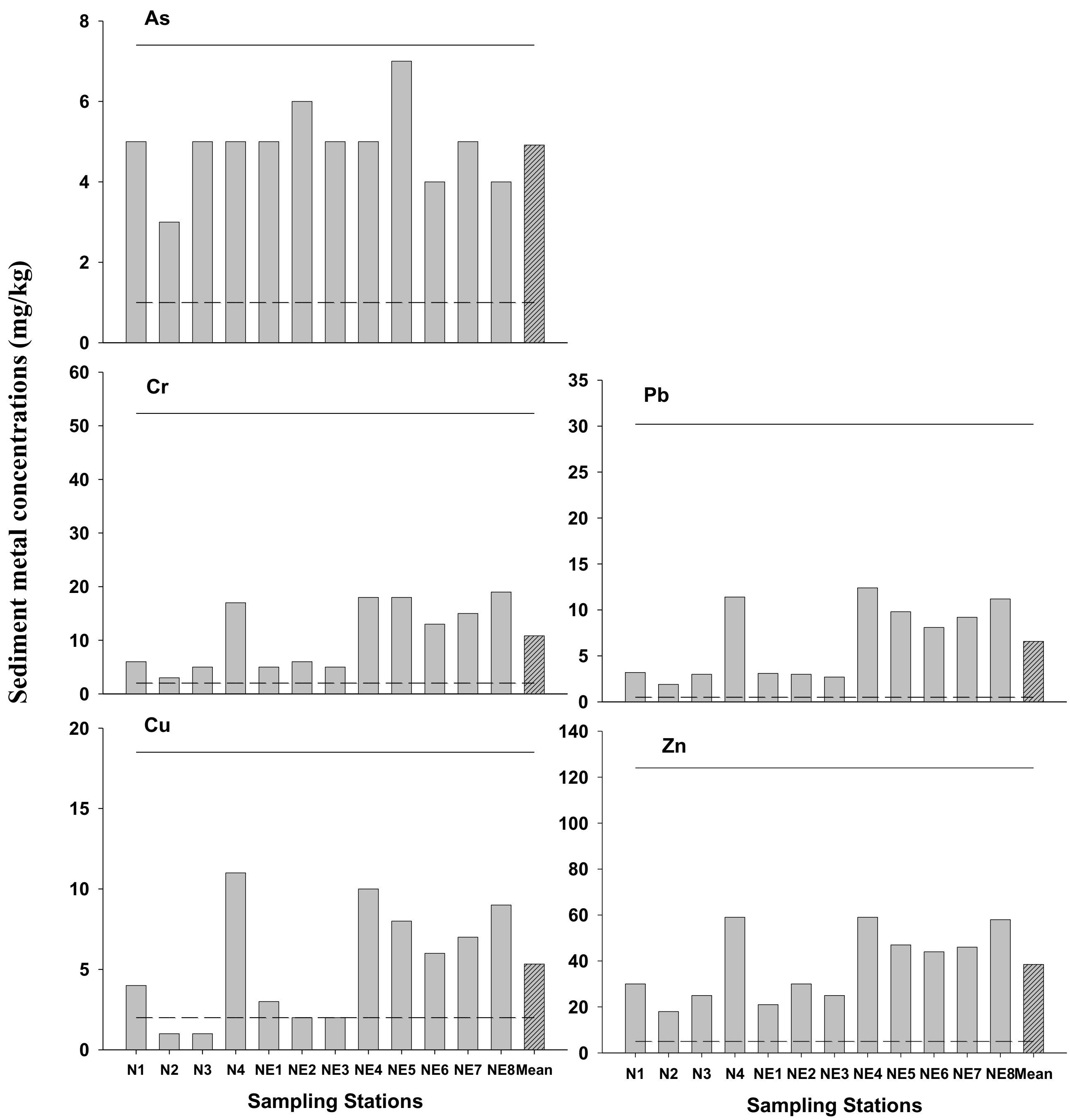

Fig. 11. Sediment metal concentrations across all sampling stations (*n*=12). Solid horizontal line represents ISQG and dotted horizontal line indicates detection limit. Concentration in sediments expressed in dry weight.

Pearson correlation analysis indicated that there is a strong positive significant relation of As (*r*=0.61 and *p*=0.03) ,Cr (*r*=0.71, *p*=0.01), Cu (*r*=0.64 *p*=0.02), Pb (*r*=0.65 *p*=0.02), and Zn (*r*=0.71, *p*=0.03) with TOC (Table 4).

Table 4. Pearson's correlation matrix for sediment metal concentration, TOC and grain size from sampling stations in Northumberland Strait.

Parameters	As	Cr	Cu	Pb	Zn	TOC	Grain size
As	1.00						
Cr	0.36	1.00					
Cu	0.34	0.95**	1.00				
Pb	0.34	0.99**	0.97**	1.00			
Zn	0.33	0.97**	0.97**	0.98**	1.00		
TOC	0.61*	0.71**	0.64*	0.65*	0.62*	1.00	
Grain size	-0.37	-0.98	-0.97	-0.99	-0.97	-0.70	1.00

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Note: *r* value $\leq$ 0.30 is considered weak, r > 0.30 and r <0.70 is considered moderate and r $\geq$ 0.70 is considered a strong relationship.

The positive correlation of metals with TOC indicated that organic content plays an important role in metal ion adsorption in sediments. In previous studies, it has been documented that organic matter in water sorbs metals (Rule, 1986; Lin and Chen, 1998; Bartoli et al., 2012. A strong negative significant relation was observed between Cr (*r*=-0.98, *p*<0.01), Cu (*r*=0.97, *p*<0.01), Pb (*r*=-0.97, *p*<0.01), and Zn (*r*=-0.70, *p*<0.01) with grain size (Table 4). It has been documented that fine grain particles tend to have relatively higher metal content due to high specific surface areas of particles (Rubino et al., 2000; Bartoli et al., 2012). Most of the grain sizes were coarse across sampling stations, leading to less adsorption of contaminants. Three sampling stations (N4, NE4, N8) which exhibited finer grain size showed a higher concentration of metals compared to other stations (Fig. 11).

Igeo for each metal was calculated using (Eq. 1) for quantitative measurement of pollution at each site. Results indicated that the sites are unpolluted with values below 0 (*i.e.* As (-2.64), Cr (-3.18), Cu (-3.64), (-3.32) and Zn (-3.24). Classification of degree of pollution was done according to Igeo values indicated in Table 5.

Table 5. Classification of geo-accumulation and pollution level (adapted from Abrahim and Parker, 2008).

Igeo	Classification	Pollution status
<0	0	Unpolluted
0-1	1	Unpolluted to moderately polluted
1-2	2	Moderately polluted
2-3	3	Moderately to heavily polluted
3-4	4	Heavily polluted
4-5	5	Heavily to severely polluted
>5	6	Severely polluted

After the *Boat Harbour Act* (2015) was passed, Nova Scotia Lands retained GHD to conduct a baseline assessment to characterize contaminants in and around Boat Harbour. In 2017, GHD collected sediment samples for metals and dioxin/furan contamination assessment of the estuary mouth and Northumberland Strait. Four sediment samples were collected from the 0-15 cm depth horizon (Fig. 12) (GHD, 2018). Sediment metal concentrations from GHD were compared to those of the present study using a one-way ANOVA. A Ryan-Joiner normality test and Bartlett's Test for homogeneity of group variances were run in *Minitab® 18.1* (Minitab Inc., 2017) to validate parametric test assumptions. Heterogeneous or non-normal data ($\alpha \leq 0.05$)

were log-transformed and retested using the above tests, and if still failing to meet parametric assumptions, were analyzed non-parametrically by Mann-Whitney analyses with differences considered significant if $p \leq 0.05$.

The sediment metal concentrations of the present study did not significantly differ from those previously sampled by GHD for As (p=0.17), Cr (p=0.19), Cu (p=0.7), Pb (p=0.8), and Zn (p=0.17). Sediment concentrations in the present study s ranged as follows: As: 1-7.8 mg/kg, Cr: 2.5-23 mg/kg, Cu: 1-43 mg/kg, Pb: 1.9-28 mg/kg, and Zn: 10-46 mg/kg (Fig. 13). Results from GHD sampling showed the same pattern as the present study with all sediment metal concentrations below the ISQGs. GHD data demonstrated decreasing sediment concentrations as distance from the estuary increased. Northumberland Strait sediment metal concentrations showed a sharp decrease, suggesting dilution of or attenuation of contaminants migrating from Boat Harbour.

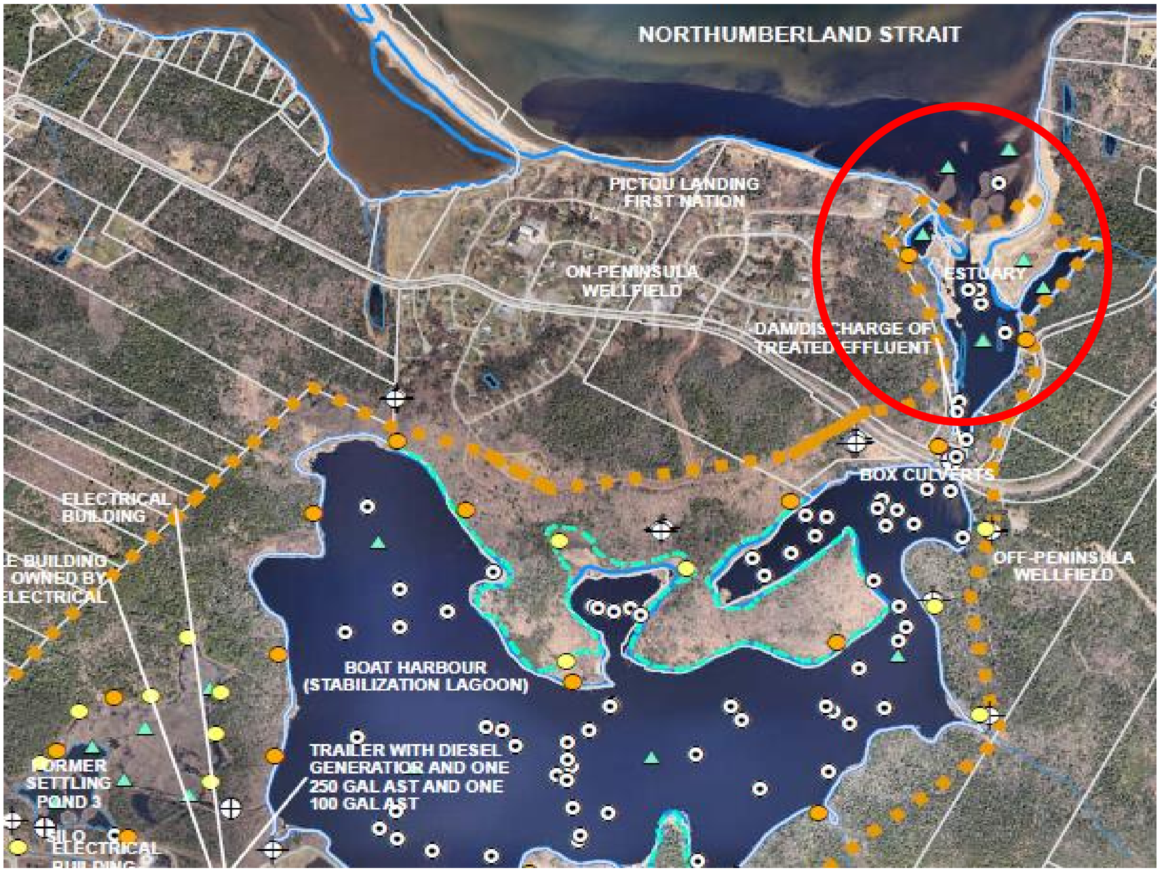

Fig. 12. GHD sediment sampling stations from the estuary (red circle). Blue triangles represent sediment sampling stations (adapted from GHD, 2018).

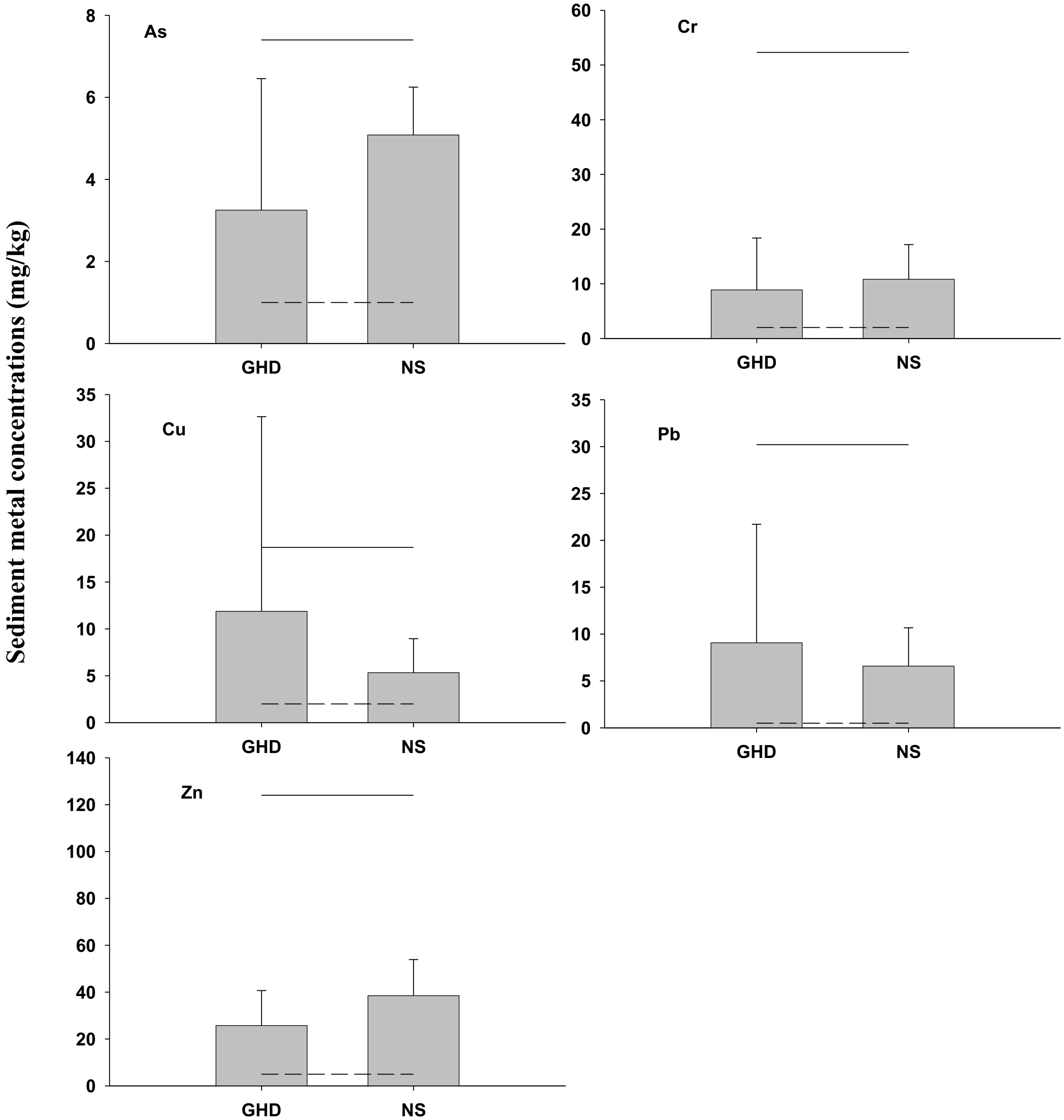

Fig.13. Mean metal concentration in sediments from Northumberland Strait in July 2018 and May 2019 (NS18/19) (*n*=12) and sediments collected by GHD in 2018 (*n*=4). Horizontal straight line represents ISQGs (CCME, 2019) and dotted horizontal line represents DL.

Sediments of many coastal regions adjacent to industrial areas in Nova Scotia are large sinks for metallic contaminants (Loring et al., 1996; Zhang et al., 2019a, b). To understand the broader picture of metal contamination in the marine environment, the concentration of metals in this study is compared with different studies from harbours and inlets across Nova Scotia. These studies include contamination from industrial effluents, municipal and residential sewage, agricultural discharge, marine transportation, fish and fishing process, and coastal residences (Stewart et al., 2019).

In general, the concentration of metals (As, Cd, Cr, Cu, Hg, Pb, and Zn) in this present study were relatively low compared to other Nova Scotian studies. As the metal concentrations were generally lower than in other studies across Nova Scotia and the Maritimes, marine sediment metal concentrations do not exhibit a pollution signature from effluents derived from BH (Table 6). However, results from this present study can be used as a baseline for future monitoring studies conducted during and post-remediation.

Northumberland Strait sediment metal concentrations were low, suggesting that the objective of using BH as sedimentation lagoon worked effectively to contain contaminants in pulp mill effluent. Most contaminants reported by Hoffman et al. (2017a, 2019) appear to have been retained in Boat Harbour sediments. There was no signature of migration of contaminants from the BHTF to the Northumberland Strait receiving environment. The other possible reason that this study found no impact on marine sediment could be a distance of sampling sites from BH. The sampling stations that were selected were approximately 0.5-8 km away from the Boat Harbour treatment facility. As the Northumberland Strait is a high energy dispersive receiving environment, contaminants released from BH may have undergone dilution and attenuation.

***Table 6.** Comparison of metals concentrations (mg/kg) in sediment, mussel and lobster tissue by study (adapted from Walker and Grant, 2015).

Location	As	Cd	Cu	Hg	Pb	Zn	Reference
Sediment							
Northumberland Strait, NS, Canada (DL) (dw)	3.0-7.0 (1.0)	<0.3 (0.3)	2.0-11.0 (2.0)	<0.05 (0.05)	1.9-12.4 (0.5)	18-59 (5.0)	Present study
Isaacs and Country Harbours, NS, Canada (dw)	5.0-40.0	<0.3-0.9	3.0-25.0	<0.05-0.16	2.3-26.0	18-80	Walker and Grant (2015)
Isaacs Harbour, NS, Canada (dw)	2.2-278	0.06-1.53	4.3-179	<0.05-16.0	2.2-126	19.3-142	Walker and Grant (2015)
Wine Harbour, NS, Canada	4-568	0.09-0.91	6.8-30.3	<0.05-74.3	5.4-53.4	26.1-77.6	Little et al. (2015) *
Seal Harbour, NS, Canada	1.2-445	0.02-0.96	1.5-25.2	<0.05-1.30	1.6-33.9	16-90.3	Walker and Grant (2015) *
Sydney Harbour, NS, Canada (dw)	4.0-33.0	0.3-1.10	2.2-71.0	0.10-0.49	4-120	31-210	Walker et al. (2013a, b)
Outer Lunenberg Harbour, NS, Canada	10-20	ND	12-34	ND	52-10	17-24	Envirosphere Consultants (1996) *
Halifax Harbour, Shipyard, NS, Canada	17-34	ND-1.3	64-533	ND	67-555	179-1429	Carter et al. (2004) *
Bay of Fundy, NS, Canada	ND	0.02-0.04	9.3-17.0	ND	ND	35.1-65.5	Chou et al. (2003) *
Background in coastal sediments, NS, Canada (dw)	20	0.4	40	0.10	40	150	Loring et al. (1996)
CCME ISQG	7.24	0.7	18.7	0.13	30.2	124	CCME (2019)
CCME PEL	41.6	4.2	108	0.70	112	271	CCME (2019)

Note-DL- detection limit for present study presented in parentheses; nv- no guideline value; * data reported did not specify whether wet weight or dry weight; ND- not determined; dw-dry weight; CCME, ISQG, and PEL- Canadian Council of Ministers of the Environment, Interim Sediment Quality guideline, and Probable Effects Levels (CCME, 2019a).

3.6.2 Biota Tissue Contaminant Concentrations

American lobster (*Homarus americanus)* (*n*=13)*,* rock crab (*Cancer irroratus)* (*n*=13), and blue mussel (*n*=8) whole-body tissues were analyzed for metals (As, Cu, Cr, Cd, THg, Pb and Zn), dioxins and furans, and methyl mercury (MeHg). Only As and Pb concentrations were compared to CFIA guidelines, as CFIA guidelines do not exist for other metals (Cu, Cr, Cd, and Zn) (CFIA, 2019). Arsenic concentrations in lobster and crabs exceeded CFIA guidelines (3.5 mg/kg) in all stations ranging from 4-10 mg/kg (lobster) and 2-5 mg/kg (rock crabs) (Fig. 14). Pb concentrations in all stations were below DLs (0.4 mg/kg) in lobster, and also rock crab except at station N3, where concentrations were above the CFIA limit of 0.5 mg/kg. Although Cr has no CFIA guidelines it was also below DLs (2 mg/kg) across all sampling stations in lobster and crab tissue (Fig. 14). Zn was detected above the DL (5 mg/kg) ranging between 18-37 mg/kg and 24-42 mg/kg in lobsters and crabs, respectively.

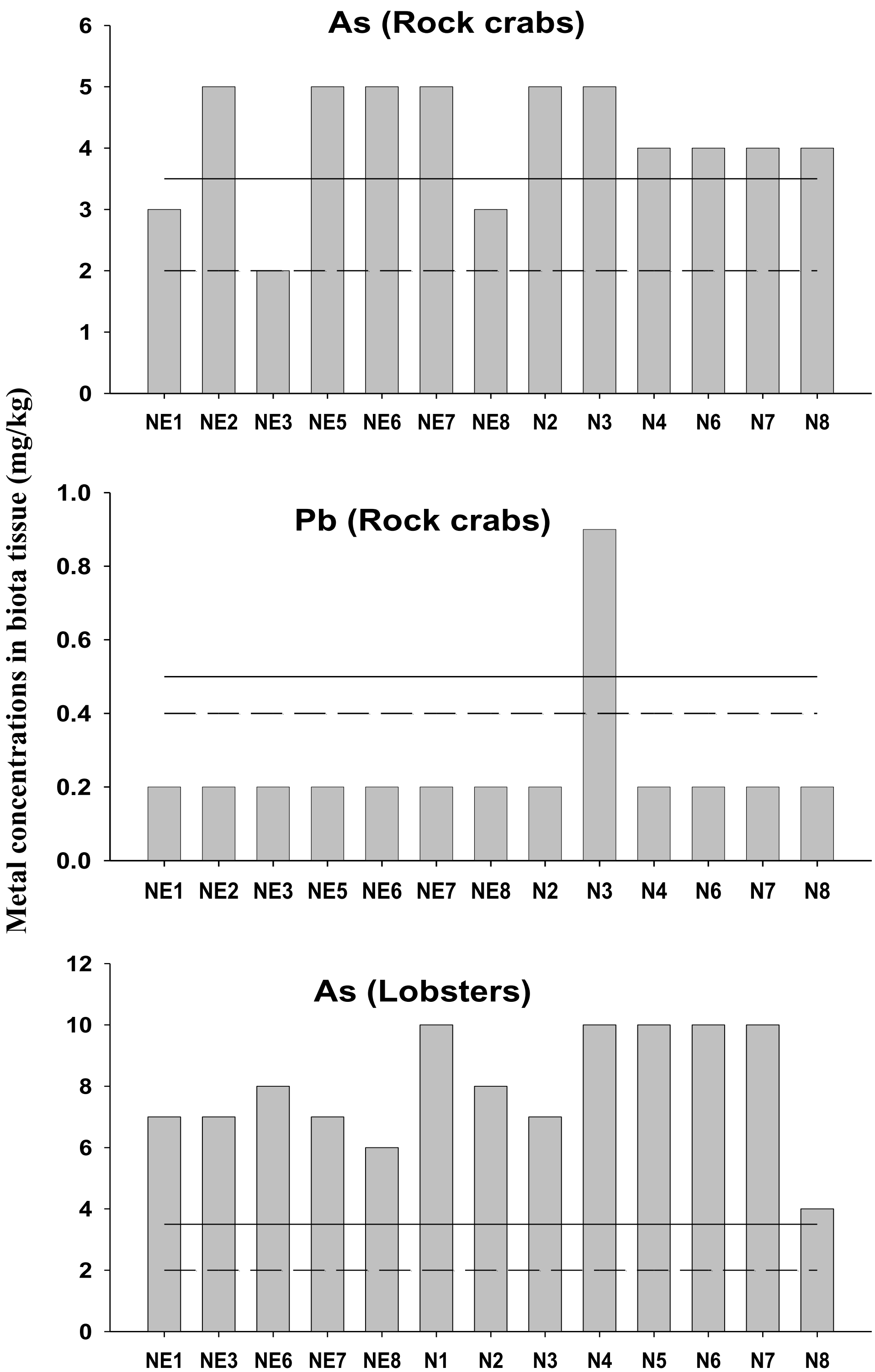

Fig. 14. Metal concentrations in rock crab (*Cancer irroratus*) (n=13) and lobster (n=13) (*Homarus americanus)* tissue. Horizontal straight line indicates CFIA guideline and dotted horizontal line indicates DL. Concentration of tissue expressed in wet weight

All metal concentrations were below DLs in blue mussel (*Mytilus edulis*), except Zn with measured tissue concentrations between 7-19 mg/kg (DL=5 mg/kg). Mercury which has a CFIA guideline of 0.5 mg/kg was not quantified above the DL of 0.05 mg/kg in all three biota species. For dioxins and furans, there are CFIA guidelines for 2,3,7,8 TCDD (dioxin), which represents the TEQ of the PCDD/F mixture, and which is 0.02 ng/kg (under review, CFIA, 2019). All tissue samples were below DLs in all three marine biota species for dioxins and furans. All three species were also analyzed for MeHg.

There is a paucity of background metal concentration data in the Maritime region for marine biota. To determine if arsenic concentrations detected in lobster tissue samples in the present study were representative, results were compared to those of a similar study conducted by Maltby et al. (2018 unpublished data) in the Northumberland Strait. Maltby et al. (2018) collected samples of adults, sub-adults, and juvenile American lobster from three different sites in Northumberland Strait, Ballantynes Cove (~45 km from Boat Harbour outfall), Merigomish (~15 km from Boat Harbour outfall), and Pictou Road (>1 km from Boat Harbour outfall). Results from Maltby et al. (2018) showed a similar pattern of metal concentrations to the present study, reporting some exceedances in As concentrations in adult lobsters from all stations. Arsenic concentrations across all stations ranged from below DL to 23 mg/kg, results comparable to this study. Lead was also undetected in all stations assessed by Maltby et al. (2018). The results for the metals lacking CFIA guidelines (Cd, Cr, Cu, Zn) were also comparable (Table 7).

To determine if elevated As concentrations in marine biota were only limited to Northumberland Strait or was a broader regional issue, results were also compared with other regional studies in Nova Scotia and the Maritimes. American lobster and rock crab samples collected by Walker and Grant (2015) from Issacs and Country harbour (adjacent historical gold mining tailings site) and Sydney Harbour (contaminated by coking and steel manufacturing) in Nova Scotia also reported As exceedances (Table 7). However, a study conducted by Chou et al. (2003) in the Bay of Fundy did not detect As and Pb concentrations in American lobster (Table 7).

Presumably, elevated As in American lobster and rock crabs is due to the natural presence of As in rock, soil, and sediments across Nova Scotia (Meunier et al., 2010; Walker and Grant, 2015). These biota species live in direct contact with sediments so contamination in the sediments has a great impact on them (Maharaj and Alkins-Koo, 2007; Hussain and Pandit, 2012). While As in biota tissues could be bioaccumulated over time, the elevated Pb concentrations in rock crab tissues at station N3 was unclear (Fig. 14).

Furthermore, contaminant concentrations (i.e., metals, dioxins and furans, THg) did not exceeded CFIA in blue mussels. Similar patterns were observed in different studies across Nova Scotia, New Brunswick, Gulf of Maine (near the south shore of Nova Scotia) in the United States (Table 7), where metals in mussels were below CFIA guidelines and in some cases were below DLs. Blue mussels are good filter feeders and can filter particles from 2 -5 µm in size (Pruell et al., 1986; Boening, 1999). Low detection of contaminants (i.e., metals, dioxins and furans, THg) in blue mussels collected from along the shoreline of Pictou Harbour indicates that there is limited or negligible contaminant concentrations in seawater.

***Table 7.** Comparison of metals concentrations (mg/kg) in mussel, rock crabs, and lobster tissue by study (adapted from Walker and Grant, 2015).

Location	**As**	**Cd**	**Cu**	**Hg**	**Pb**	**Zn**	**Reference**
American lobster tissue (*H. americanus)*							
Northumberland Strait, NS, Canada (DL)(wb) (ww)	4.0-10.0 (2)	0.9-1.4 (0.3)	13-28 (2)	<0.05 (0.05)	<0.4 (0.4)	18-34 (5.0)	Present study
Northumberland Strait, NS, Canada (wb) (ww)	ND-23	ND-0.63	ND-27	ND	ND	ND-42	Maltby et al. (2018 unpublished data)
Isaacs and Country Harbours, NS, Canada (hep)(ww)	5.0-10.0	<0.3	ND	0.06-0.12	<0.5	24.35	Walker and Grant (2015)
Bay of Fundy, NS, Canada	ND	5.1-22.9	10.4-896	ND	ND	27-129	Chou et al. (2000, 2003) *
CFIA	3.5	Nv	nv	0.5	0.5	nv	CFIA (2019)
Rock crab tissue *(C. irroratus)*							
Northumberland Strait, NS, Canada (DL) (wb) (ww)	2.0-5.0 (2)	0.6-3.9 (0.3)	12-36 (2)	<0.05 (0.05)	<0.4-0.9 (0.4)	24-42 (5.0)	Present study
Sydney Harbour, NS, Canada (hep) (ww)	3.6-15.3	0.5-6.9	9.8-28	<0.01-0.04	<0.18	11.7-28.9	Walker et al. (2013c)
CFIA	3.5	Nv	nv	0.5	0.5	nv	CFIA (2019)
Blue mussel tissue *(M. edulis)*							
Northumberland Strait, NS, Canada (DL) (ww)	<2.0 (2.0)	<0.3 (0.3)	<2-2 (2.0)	<0.05 (0.05)	<0.4 (0.4)	7-20 (5.0)	Present study
Isaacs and Country Harbours, NS, Canada (ww)	1.3-2.0	0.16-0.19	0.8-6.7	0.02-0.05	0.15-1.31	7.4-11	Walker and Grant (2015)
Seal Harbour, NS, Canada	60-109	ND	ND	ND	ND	ND	Whaley-Martin et al. (2012) *
Sydney Harbour, NS, Canada (ww)	1.5-3.9	0.14-0.29	0.8-1.9	<0.01-0.03	<0.18-0.43	10-24	Walker and MacAskill (2014)
Halifax Harbour, NS, Canada(ww)	1.9-2.5	0.10-0.44	1.5-2.4	0.01-0.04	0.1-2.4	17-41	McCullough et al. (2005)
Dalhousie, NB, Canada (ww)	ND	ND	ND	0.02-1.40	ND	ND	Garron et al. (2005)
Baie des Chaleurs, NB, Canada (ww)	ND	0.55-4.2	0.5-1.1	ND	<2.5-31	4.8-42	Fraser et al. (2011)
Gulf of Maine, United States	ND	1.10-1.31	4.5-9.3	0.11-1.31	1.0-8.3	54-153	McCullough et al. (2005) *
Gulf of Maine, United States	ND	0.10-0.20	0.7-1.3	ND	0.08-0.78	7-13	GMCME (2013) *
CFIA	3.5	Nv	nv	0.5	0.5	nv	CFIA (2019)

Note-*DL- detection limit for present study presented in parentheses; nv- no guideline value; ND- not determined; * data reported did not specify whether wet weight or dry weight ;wb- whole body tissue; hep- hepatopancreases tissue; ww- wet weight; CFIA- Canadian Food Inspection Agency (CFIA, 2019).

Whole-body tissue homogenates of all three species (American lobsters, rock crabs, and blue mussels) were also analyzed for MeHg. There is currently no CFIA guideline for MeHg in fish tissue. For this study, Canadian tissue residue methyl mercury guidelines for the protection of wildlife consumers of aquatic biota (2019) were used for comparison (CCME, 2019b). These MeHg tissue residue guidelines (TRGs) refer to the maximum concentration of chemical substance in the tissues of aquatic biota that is not expected to result in adverse effects to wildlife consumers of the aquatic biota. They are developed to protect wildlife species which are not in direct contact with sediments and usually feed on aquatic animals and plants.

A total of six lobsters (N1, N2, NE1, NE3, N8, NE 8) and four rock crabs (N2, N3, NE1, N2, N8, NE8) were analyzed for MeHg. Four composite samples of blue mussels (from M3, M4, M7, M8) were also analyzed for MeHg. Samples from N1 (37.3 ng/kg), N2 (53.4 ng/kg), NE1 (41.8 ng/kg), NE3 (47.2ng/kg), NE1 (57.5), and N3 (39.5 ng/kg) exceeded the CCME MeHg tissue residue guideline (33.3 ng/kg) (Fig. 15).

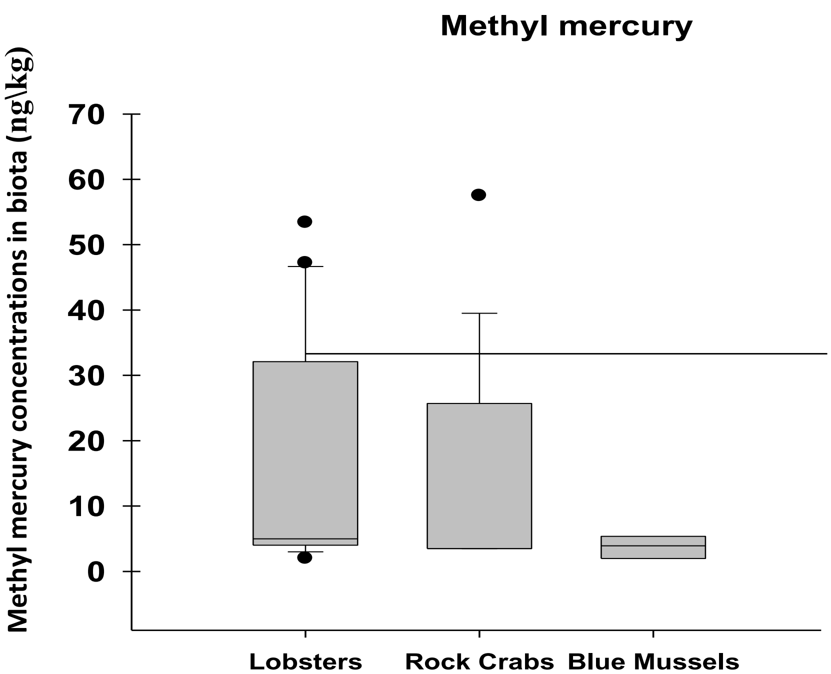

Fig. 15. Box plot representing whole tissue methyl mercury concentrations in lobster (*Homarus americanus)* (*n*=7), rock crabs (*Cancer irroratus)* (*n*=6) and blue mussels (*Mytilus edulis)* (*n*=4). Tissue concentration were expressed in wet weight. Horizontal line represents the methyl mercury guideline by Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota (CCME, 2019b).

A number of studies have been conducted to understand the influence of metals, including THg, on exposed biota, but there is a lack of research data on MeHg concentrations in Nova Scotian biota (Stewart, 2019). Further, MeHg has not been tested in BH biota, water, or sediment samples, making it difficult to predict whether the elevation of MeHg is due to migration of contaminants from BH. In the environment, inorganic mercury is regularly methylated into its organic form (MeHg) which can readily bioaccumulate in organisms and is also known to biomagnify through the food chain (Hammerschmidt and Fitzgerald, 2006). Presence of mercury in the environment adjacent to Boat Harbour can possibly have arisen from different sources, for instance the weathering of mercury bearing rocks, fossil fuels, industrial effluents (such as from chlor-akali plants), and atmospheric emissions (UNEP, 2002; Walker, 2016). It is often difficult to attribute environmental MeHg to one or more-point sources. A similar study on Hg near a chlor-alkali plant in Chaleur Bay in New Brunswick, Canada was conducted by Walker (2016), which suggested that there was natural recovery by deposition of new uncontaminated sediments over contaminated strata in the area (Walker, 2016). It is possible that a similar deposition of sediments low in Hg and MeHg could have covered contaminated sediments in this study also. Therefore, it is necessary to have long term monitoring plans in and around BH to examine the effects of remediation activities on concentration of MeHg in the area.

3.6.3 DGTs Metal and THg Concentrations

DGT chelex disc binding gels were analyzed for metals and MFS binding gels were analyzed for THg. DGT chelex disc from station 10 (ESM 10) and MFS disc from station 8 (ESHG 8) were damaged during retrieval and were not analyzed. There are no CCME guidelines for sediment porewater metal concentrations. Therefore, metal concentrations in DGTs from BH were compared to DGTs downstream in the estuary. The concentration of As in the estuary was found to be slightly higher than those in BH with a range of 2.90-4.33 µg/l (Tables 7 and 8). Cd in BH was not detected and was also very low in the estuary. Cu, Cr, Pb and Zn were also found in low concentrations in BH relative to the estuary (Tables 7 and 8). Concentrations of THg in MFX DGTs discs from both BH and the estuary were very low and <DLs at some stations (Table 7 and 8). DGT results indicated that sediment porewater metal concentrations in BH were likely lower than downstream estuary concentrations. Since Cd and THg were not detected in the DGTs, it would appear that these metals are not readily bioavailable for species exposed to sediment porewater.

Table 7. Descriptive statistics of DGT and MFS disc (which represent sediment porewater) metal concentrations (µg/l) from BH (*n*=10).

Metals	Minimum	Maximum	Mean	Std. Deviation	DL
As	1.070	1.600	1.360	0.164	0.200
Cd	0.025	0.025	0.025	0.000	0.050
Cr	1.200	2.000	1.440	0.236	1.000
Cu	0.500	1.300	0.580	0.252	1.000
Hg	0.010	0.030	0.015	0.008	0.020
Pb	0.810	1.65	1.142	0.257	0.200
Zn	5.000	25.000	11.400	8.408	10.000

Table 8. Descriptive statistics of DGT and MFS disc (which represent sediment porewater) metal concentrations (µg/l) from ES (*n*=9).

Metals	Minimum	Maximum	Mean	Std. Deviation	DL
As	2.90	4.33	3.65	0.538	0.200
Cd	0.07	0.12	0.096	0.017	0.050
Cr	1.70	2.10	1.877	0.148	1.000
Cu	0.50	2.10	0.900	0.572	1.000
Hg	0.01	0.01	0.009	0.000	0.020
Pb	1.20	2.15	1.610	0.316	0.200
Zn	5.00	16.00	12.000	3.240	10.000

3.7 Limitations

There are some limitations in this study which should be considered:

1) Due to limited funding and high cost of analysis, only 12 bulk sediment samples were collected and analyzed. In addition, due to rocky substrate, samples from 4 stations (i.e., N5, N6, N7, N8) could not be collected. More samples would have strengthened the statistical power of the study.

2) Only one sample of lobster was collected per station due to restrictions imposed under the DFO scientific fishing licence. More lobster samples would have provided better information on the potential impact of pulp mill effluent on biota and would have also strengthened the statistical power of the study.

3) Lack of CFIA guidelines for some metals (i.e., Cr, Cd, Cu, MeHg) for aquatic biota tissues made it difficult to understand what the detected concentrations of these metals in marine biota mean with respect to human health. In addition, there are a limited number of local studies conducted on metal concentrations in marine biota which made it difficult to get a broader picture of the region.

3.8 Conclusion

The primary objective of this study was to assess the level of contamination in marine sediments and biota of the Northumberland Strait. Therefore, to assess the broader picture of contaminant concentrations across the Northumberland Strait, this study used sediments and three marine species (American lobsters, rock crabs, and blue mussels) from different trophic levels to provide an ecosystem approach. Due to proximity of the Northumberland Strait to the effluent discharge point (estuary), it was expected that the study would find a higher concentration of contaminants in near field stations (N, NE 1-3) relative to far-field stations (N, NE6-8). However, our results provide no evidence of any significant impact on sediments or biota of the Northumberland Strait that is attributable to the industrial effluents. In sediments, all the contaminants (*i.e*. metals, dioxins and furans, mercury) were below the ISQGs and some even below the detection limit. It was interesting to note that the concentrations of metals in sediments were not only found below the CCME ISQGs (CCME, 2019a) but were also below the background concentration range in coastal sediments of Nova Scotia (Loring et al., 2016).

Further, it was assumed that marine biota would be impacted by effluents due to bioaccumulation and biomagnification at different trophic levels. Our results indicate there is no significant impact on Northumberland Strait biota with the exception of As exceedances in lobsters and crab. The source of these As exceedances in the environment is not due to point source releases or industrial activities, but rather, is most likely due to underlying bedrock geology resulting in naturally high As levels in water, sediments and soil across Nova Scotia. MeHg in lobsters and rock crabs were found to be above the prescribed Canadian tissue residue guideline for the protection of wildlife consumers of aquatic biota and are of potential concern. In addition, MeHg can become bioavailable to aquatic biota under certain conditions and may bioaccumulate and biomagnify in marine aquatic food webs. The present study was the first to assess baseline MeHg concentrations in marine biota after 50 years of Boat Harbour effluent discharge.

The final objective of the *Boat Harbour Act* (2015) is to connect Boat Harbour with Northumberland Strait by removing the dam above the estuary. While the volume and surface area of BH will decrease in the absence of the impoundment, there will be an incursion of marine water from Northumberland Strait to Boat Harbour. This incursion may potentially lead to a remobilisation of any mercury present in contaminated sediments that are not removed from Boat Harbour. It has been documented in different studies that flooding changes can lead to remobilisation of THg, and thus increase MeHg in aquatic ecosystem (St Louis et al., 2001, 2004; Roy et al., 2009; Teisserence et al., 2014). Usually, flooding events modify the organic matter dynamics in sediments resulting in sharp increases of TOC in surface sediments which may lead to mobilisation of Hg (Louchouarn et al., 1993). Therefore, it is highly recommended that more detailed investigation of THg and MeHg in and around BH should be conducted.

A strong baseline dataset will help to inform remediation decisions and the monitoring regime during and after remediation activities. Our results clearly indicate that, at present, the Northumberland Strait adjacent to Boat Harbour has similar or less contamination than comparable areas not influenced by Boat Harbour and is therefore not requiring any remediation. However, monitoring should be implemented throughout Boat Harbour remediation to ensure clean-up activities do not inadvertently introduce contaminants known to be resident in the Boat Harbour settling basin. Periodic sediment and same species (American lobsters, rock crabs, and blue mussels) biota sampling are recommended to enable tracking of potential future contamination of the Northumberland Strait, which may occur during or following BH remediation.

Chapter - 4 Conclusions and Recommendation

4.1 Summary of Research

According to the *Boat Harbour Act* (2015), remediation of Boat Harbour (BH) will start after January 31, 2020 (Boat Harbour Act, 2015). The main objective of the *Boat Harbour Act* (2015) is to remediate and return BH to pre-tidal conditions by re-connecting it to the Northumberland Strait (Hoffman et al., 2017a, 2019). In order to have an effective remediation plan, baseline data in BH, its estuary, and the Northumberland Strait receiving environment was necessary. The two objectives of this research were:

1) To assess the level of contamination of metals, dioxins and furans and methyl mercury in sediments and biota of the marine environment of Northumberland Strait; and

2) To prepare the baseline pre-remediation data, which can be used during and after remediation for monitoring purposes.

To achieve these objectives, sediment and American lobsters (*Homarus americanus)*, rock crab (*Cancer irroratus*), and blue mussel (*Mytilus edulis*) sampling was done in May 2018 and July 2019. The samples were analyzed for metals and dioxins and furans (as discussed in chapter- 3). This Chapter provides the summary of key findings and some management-specific recommendations which will help the current and future planning of the BH remediation project.

4.2 Key Findings

1) Sediment concentrations of metals (As, Cd, Cr, THg, Pb, and Zn) and dioxins and furans were below the Canadian Council of Ministers of Environment (CCME) interim sediment quality guidelines. Cd and THg were not detected in sediment samples. These findings were corroborated with results of sediment sampling done by the private consulting firm contracted to perform the site assessment for the Boat Harbour remediation project. Interestingly, sediment metal concentrations in the Northumberland Strait were lower than the background values of sediment metal concentrations at un-impacted sites across Nova Scotia.

2) Concentrations of metals (Cd, Cr, THg, Pb, and Zn) and dioxins and furans in three biota species were below the Canadian Food Inspection Agency guidelines for fish tissue. Arsenic concentrations in lobsters and rock crabs were found to be above the CFIA guidelines. In addition, methyl mercury concentrations in some samples of American lobsters and rock crabs exceeded tissue residue guidelines for the protection of wildlife consumers of aquatic biota.

4.3 Management Implications and Recommendations

4.3.1 Long Term Monitoring Plans

Chemical concentrations (i.e. metals, dioxins and furans and THg) measured in Northumberland Strait sediments in this study were lower than CCME guidelines and BH sediments, demonstrating that the Boat Harbour Treatment Facility achieved its designed objectives of retaining contaminants in BH. The results of the present study will help delineate the boundaries of the BH remediation programs by providing baseline contaminants data during and after remediation.

Additionally, this data will also be helpful if the new effluent pipeline plan proposed by Northern Pulp gets approval (Dillon Consulting Limited, 2019).

The end goal of the Boat Harbour Act is to return the waterbody to a tidally influenced estuary condition by re-connecting it hydraulically to the Northumberland Strait. Therefore, it is very important to have long term monitoring plans for the study area. Currently, the remediation plan for BH has not been definitively addressed, and it is not yet known whether it will be *ex-situ* or *in situ* (dredging, capping). It has been documented that dredging and infilling operations at contaminated sites sometimes lead to major negative sediment disturbances such as resuspension, remobilization and enhanced bioavailability of historical contaminants (Walker et al., 2013a).

Therefore, any negative sediment disturbance in BH during remediation could lead to the migration of contaminants to the Northumberland Strait. Thus, it is recommended that a regular monitoring plan should be developed during and after remediation. Regular water sampling every 2-3 months and annual sediment sampling is recommended during remediation. This will help to measure effectiveness (both positive and negative) of remediation techniques in the area. Long term monitoring is also recommended after remediation which should include periodic sampling of water, sediments, and biota tissue of the area every three years.

4.3.2 More Studies on Metals and MeHg Concentration in Biota in Atlantic Region

Concentrations of metals (except As) and dioxins and furans were found lower than CFIA guidelines. This data is not only useful for remediation plans, but also for the fishing industry of the region. Fishing is the important industry sector for Atlantic Canada. The export of Nova Scotia fish and seafood is valued at $1 billion CAD annually (DFO, 2018; Zhang et al., 2019). The key stakeholder community of this remediation project, Pictou Landing First Nation, are also dependent on the fishing sector. Any exceedance of MeHg in any commercially harvested species in the region could potentially harm the local seafood market, which has a reputation for clean, safe products. In this context, there is a considerable lack of research in the Atlantic region on MeHg concentrations in biota, leading to the recommendation to conduct further studies on biota, particularly focussing on MeHg concentrations to better understand the broader regional picture. Passive techniques like diffusive gradient thin films (DGTs) can be used to estimate the level of contamination in biota, a particularly useful technique in a region where actual biota sampling is not always possible or feasible. DGTs behave as a fish surrogate in water (Ferreira et al., 2013; Bireta, 2015). These studies will help in understanding any potential ecological or human health risk that may be associated with MeHg contamination.

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APPENDIX -A

Image.1. Garmin GPS unit for recording waypoints of sampling stations.

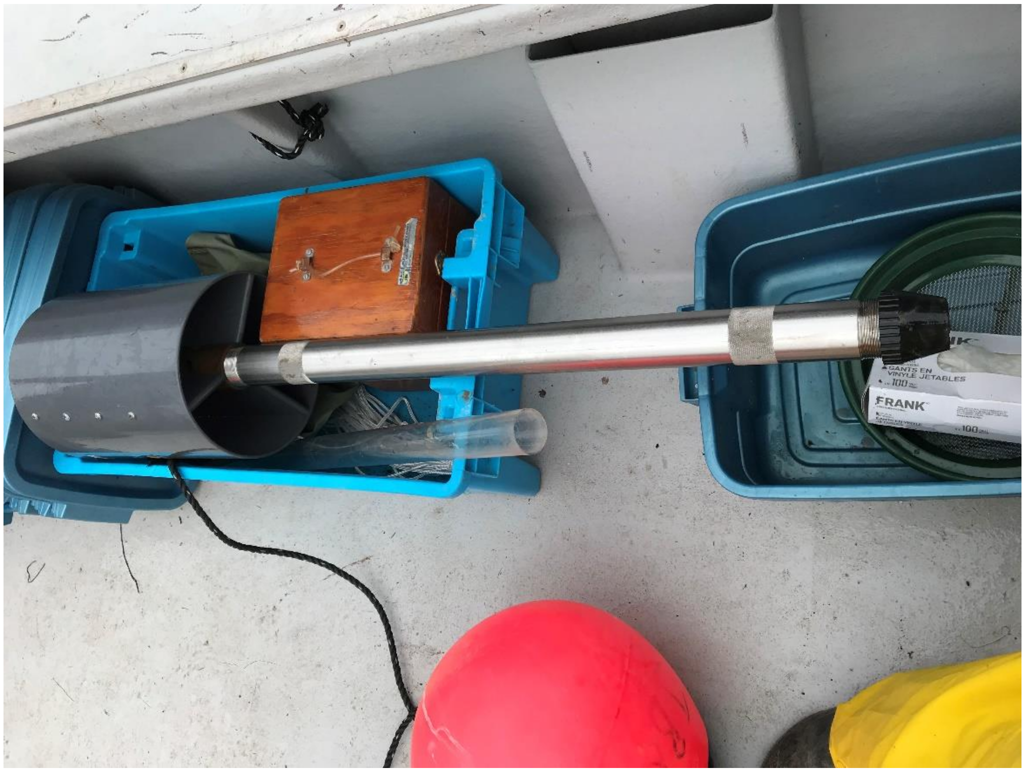

Image.2. Long gravity corer 2416 B45 (Wildco®) used for sediment sampling.

Image.3. Lobsters fishing boat used for sediment and biota sampling in July 2018.

Image.4. Small aluminium boat used for sediment sampling in May 2019.

Image.5. Adult lobster (*Homarus americanus)*, of CL (180-125 mm) collected in July 2018.

Image.6. Rock crabs (*Cancer irroratus)* CL (103-113mm) collected in July 2018.

Image.7. Lobsters (*Homarus americanus)* and rock crabs' (*Cancer irroratus)* traps with DFO scientific tags.

Image.8. Blue mussels *(Mytilus edulis)* (56-60mm) shell length collected in July 2018.

VESSEL IDENTIFICATION

Activities carried out under the authority of this licence shall only be conducted using the following fishing vessel:

Vessel Name	VRN
Jason Rene	160576

PERIOD OF ACTIVITY

This licence is valid from July **9, 2018** to **July 13, 2018**.

NOTIFICATION REQUIREMENTS

Prior to commencing activities authorized under the authority of this licence, the licence holder or delegate must provide the Field Supervisor at the nearest Conservation and Protection office with the time and the location the activities are to be carried out and the details of the activities. Annex 'A' is a list of all Conservation and Protection offices in the Gulf Region.

REPORT REQUIREMENTS

A summary report on the project activities must be submitted to the Chief, Licensing, Fisheries and Oceans Canada, P.O. Box 5030, Moncton, NB, E1C 9B6 within 4 weeks of the expiry date of this licence.

ISSUED AT MONCTON, NB

Signature of Licence Holder

Licence not valid unless signed by DFO Authorized Person and Licence Holder.

Image.9. Department of Fisheries and Ocean (DFO) Scientific license.

Image 10. Diffusive gradient in thin films sediment probe disc.

Image. 11 DGT disc tied to cinder block and plastic cable ties.

Image. 12. Laboratory provided glass jars used for storing sediment samples.

APPENDIX B

AGAT Laboratories

11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
CANADA B3B 1M2
TEL (902)468-8718

CLIENT NAME: NOVA SCOTIA LANDS INC PO BOX 430, STATION A
SYDNEY , NS B1P6H2
(902) 564-7933

ATTENTION TO: Tony Walker
PROJECT:
AGAT WORK ORDER: 18X361396
SOIL ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter
ULTRA TRACE REVIEWED BY: Philippe Morneau, chimiste
DATE REPORTED: Jul 31, 2018
PAGES (INCLUDING COVER): 18
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOT

Certificate of Analysis

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FAX (902)468-8924
http://www.agatlabs.com

AGAT WORK ORDER: 18X361396
PROJECT:

CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Available Metals in Soil

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-07-31**

Parameter	Unit	G / S	RDL	N4	NE 4	NE 5	NE 6	NE 7	NE 8
			SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
				9388054	9388059	9388060	9388061	9388062	9388063
Aluminum	mg/kg		10	7950	8350	8310	5880	7090	8930
Antimony	mg/kg		1	<1	<1	<1	<1	<1	<1
Arsenic	mg/kg		1	5	5	7	4	5	4
Barium	mg/kg		5	120	173	159	114	152	188
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2
Boron	mg/kg		2	14	14	17	10	13	18
Cadmium	mg/kg		0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium	mg/kg		2	17	18	18	13	15	19
Cobalt	mg/kg		1	9	9	9	6	8	9
Copper	mg/kg		2	11	10	8	6	7	9
Iron	mg/kg		50	17200	17100	17600	12300	15300	17600
Lead	mg/kg		0.5	11.4	12.4	9.8	8.1	9.2	11.2
Lithium	mg/kg		5	24	24	23	16	20	25
Manganese	mg/kg		2	311	269	292	199	376	300
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	20	21	20	13	17	21
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	20	17	20	13	16	21
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	3	3	3	3	3	3
Uranium	mg/kg		0.1	0.7	1.0	1.6	0.9	1.2	0.9
Vanadium	mg/kg		2	23	26	26	19	24	27
Zinc	mg/kg		5	59	59	47	44	46	58

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9388054-9388063 Results are based on the dry weight of the sample.

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AGAT WORK ORDER: 18X361396
PROJECT:

CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Grain Size Analysis - Coarse/Fine Classification

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-07-31**

Parameter	Unit	G / S	RDL	N4	NE 4	NE 5	NE 6	NE 7	NE 8
			SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
				9388054	9388059	9388060	9388061	9388062	9388063
Particles >75um	%		1	42	34	51	71	62	46
Classification	Coarse/Fine			Fine	Fine	Coarse	Coarse	Coarse	Fine

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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AGAT WORK ORDER: 18X361396
PROJECT:

CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Inorganics (Soil)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-07-31**

						SAMPLE DESCRIPTION:	N4	NE 4	NE 5	NE 6	NE 7
						SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment
						DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	RDL	8388054	8388059	8388060	8388061	8388062
Total Organic Carbon	%					0.3	0.9	0.8	1.5	0.4	0.6
Moisture Content	%					0.1	40.7	28.7	45.3	21.8	26.0

						SAMPLE DESCRIPTION:	NE 8
						SAMPLE TYPE:	Sediment
						DATE SAMPLED:	2018-07-11
Parameter	Unit	G / S: A	G / S: B	G / S: C	G / S: D	RDL	8388063
Total Organic Carbon	%					0.3	0.6
Moisture Content	%					0.1	26.9

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: A Refers to Basses-Terres du St-Laurent, B Refers to QC PTC 2016 B, C Refers to QC PTC 2016 C, D Refers to QC RESC (Annexe 1)
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

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AGAT WORK ORDER: 18X361396
PROJECT:

CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Mercury Analysis in Soil

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-07-31**

			SAMPLE DESCRIPTION:	N4	NE 4	NE 5	NE 6	NE 7	NE 8
			SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	Unit	G / S	RDL	8388054	8388059	8388060	8388061	8388062	8388063
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
8388054-8388063 Results are based on the dry weight of the soil.

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CLIENT NAME: NOVA SCOTIA LANDS INC

ATTENTION TO: Tony Walker

SAMPLING SITE:

SAMPLED BY:

Dioxins and Furans (Sediment, WHO 1998, Fish)

DATE RECEIVED: 2018-07-12

DATE REPORTED: 2018-07-31

			SAMPLE DESCRIPTION:	N4		NE 4		NE 5		NE 6
			SAMPLE TYPE:	Sediment		Sediment		Sediment		Sediment
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9388054	RDL	9388059	RDL	9388060	RDL	9388061
1,2,3,6,7,8-Hexa CDD (TEF 0.01)	TEQ			0.00674		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.001)	TEQ			0.00221		0		0.00282		0.00131
Octa CDD (TEF 0.0001)	TEQ			0.00250		0.00372		0.00540		0.00282
2,3,7,8-Tetra CDF (TEF 0.5)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDF (TEF 0.5)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.5)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0.126		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0.00718		0		0.0172		0.00672
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0001)	TEQ			0.000221		0		0.000324		0.000371
Total PCDDs & PCDFs (TEQ)	TEQ			0.0189		0.00372		0.152		0.0112

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CLIENT NAME: NOVA SCOTIA LANDS INC **ATTENTION TO: Tony Walker**

SAMPLING SITE: **SAMPLED BY:**

Dioxins and Furans (Sediment, WHO 1998, Fish)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-07-31

		SAMPLE DESCRIPTION:	N4	NE 4	NE 5	NE 6
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	9398054	9398059	9398060	9398061
13C-2378-TCDF	%	30-140	64	64	68	66
13C-12378-PeCDF	%	30-140	58	57	47	62
13C-23478-PeCDF	%	30-140	59	62	47	65
13C-123478-HxCDF	%	30-140	57	63	49	63
13C-123678-HxCDF	%	30-140	64	65	55	65
13C-234678-HxCDF	%	30-140	69	73	53	69
13C-123789-HxCDF	%	30-140	68	68	73	69
13C-1234678-HpCDF	%	30-140	49	49	48	50
13C-1234789-HpCDF	%	30-140	48	46	46	50
13C-2378-TCDD	%	30-140	74	74	98	77
13C-12378-PeCDD	%	30-140	64	64	58	67
13C-123478-HxCDD	%	30-140	67	74	44	69
13C-123678-HxCDD	%	30-140	68	70	67	71
13C-1234678-HpCDD	%	30-140	50	52	52	51
13C-OCDD	%	30-140	36	38	31	37

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CLIENT NAME: NOVA SCOTIA LANDS INC **ATTENTION TO: Tony Walker**
SAMPLING SITE: **SAMPLED BY:**

Dioxins and Furans (Sediment, WHO 1998, Fish)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-07-31**

			SAMPLE DESCRIPTION:	NE 7		NE 8
			SAMPLE TYPE:	Sediment		Sediment
			DATE SAMPLED:	2018-07-11		2018-07-11
Parameter	**Unit**	**G / S**	**RDL**	**9398062**	**RDL**	**9398063**
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2	0.1	<0.1
1,2,3,7,8-Penta CDD	ng/kg		0.6	<0.6	0.2	<0.2
1,2,3,4,7,8-Hexa CDD	ng/kg		0.7	<0.7	0.7	<0.7
1,2,3,6,7,8-Hexa CDD	ng/kg		0.7	<0.7	0.7	<0.7
1,2,3,7,8,9-Hexa CDD	ng/kg		0.7	<0.7	0.7	<0.7
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	0.7	0.6	<0.6
Octa CDD	ng/kg		2	14	1	14
2,3,7,8-Tetra CDF	ng/kg		0.3	<0.3	0.2	0.4
1,2,3,7,8-Penta CDF	ng/kg		0.5	<0.5	0.4	<0.4
2,3,4,7,8-Penta CDF	ng/kg		0.4	0.5	0.4	<0.4
1,2,3,4,7,8-Hexa CDF	ng/kg		0.6	0.7	0.4	0.6
1,2,3,6,7,8-Hexa CDF	ng/kg		0.6	<0.6	0.2	<0.2
2,3,4,6,7,8-Hexa CDF	ng/kg		0.7	<0.7	0.5	<0.5
1,2,3,7,8,9-Hexa CDF	ng/kg		0.9	<0.9	0.6	<0.6
1,2,3,4,6,7,8-Hepta CDF	ng/kg		1	1	0.5	0.5
1,2,3,4,7,8,9-Hepta CDF	ng/kg		2	<2	0.9	<0.9
Octa CDF	ng/kg		1	2	0.7	1.4
Total Tetrachlorodibenzodioxins	ng/kg		0.2	0.8	0.1	0.2
Total Pentachlorodibenzodioxins	ng/kg		0.6	1.4	0.2	0.6
Total Hexachlorodibenzodioxins	ng/kg		0.7	3.2	0.7	1.8
Total Heptachlorodibenzodioxins	ng/kg		0.6	4.5	0.6	1.6
Total PCDDs	ng/kg		2	24	1	18
Total Tetrachlorodibenzofurans	ng/kg		0.3	2.8	0.2	1.8
Total Pentachlorodibenzofurans	ng/kg		0.5	3.2	0.4	0.9
Total Hexachlorodibenzofurans	ng/kg		0.9	3.9	0.6	1.1
Total Heptachlorodibenzofurans	ng/kg		2	4	0.9	1.0
Total PCDFs	ng/kg		2	15	0.9	6.3
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.5)	TEQ			0		0

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AGAT WORK ORDER: 18X361396
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CLIENT NAME: NOVA SCOTIA LANDS INC
ATTENTION TO: Tony Walker
SAMPLING SITE:
SAMPLED BY:

Dioxins and Furans (Sediment, WHO 1998, Fish)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-07-31**

Surrogate	Unit	SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: Acceptable Limits	NE 7 Sediment 2018-07-11 9398062	NE 8 Sediment 2018-07-11 9398063
13C-2378-TCDF	%	30-140	63	67
13C-12378-PeCDF	%	30-140	61	60
13C-23478-PeCDF	%	30-140	69	74
13C-123478-HxCDF	%	30-140	65	70
13C-123678-HxCDF	%	30-140	65	70
13C-234678-HxCDF	%	30-140	68	65
13C-123789-HxCDF	%	30-140	71	67
13C-1234678-HpCDF	%	30-140	55	61
13C-1234789-HpCDF	%	30-140	53	55
13C-2378-TCDD	%	30-140	79	80
13C-12378-PeCDD	%	30-140	72	72
13C-123478-HxCDD	%	30-140	70	67
13C-123678-HxCDD	%	30-140	76	83
13C-1234678-HpCDD	%	30-140	58	59
13C-OCDD	%	30-140	38	37

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9398054-9398063 The results were corrected based on the surrogate percent recoveries.

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Certificate of Analysis

AGAT WORK ORDER: 18X361396
PROJECT:

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Sediment, WHO 1998, Fish)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-07-31**

			SAMPLE DESCRIPTION:	NE 7		NE 8
			SAMPLE TYPE:	Sediment		Sediment
			DATE SAMPLED:	2018-07-11		2018-07-11
Parameter	**Unit**	**G / S**	**RDL**	**9388082**	**RDL**	**9388083**
1,2,3,6,7,8-Hexa CDD (TEF 0.01)	TEQ			0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.01)	TEQ			0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.001)	TEQ			0.000692		0
Octa CDD (TEF 0.0001)	TEQ			0.00137		0.00142
2,3,7,8-Tetra CDF (TEF 0.5)	TEQ			0		0.0209
1,2,3,7,8-Penta CDF (TEF 0.5)	TEQ			0		0
2,3,4,7,8-Penta CDF (TEF 0.5)	TEQ			0.255		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0.0663		0.0588
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0.0118		0.00527
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0
Octa CDF (TEF 0.0001)	TEQ			0.000198		0.000141
Total PCDDs & PCDFs (TEQ)	TEQ			0.335		0.0866

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC | AGAT WORK ORDER: 18X361396
PROJECT: | ATTENTION TO: Tony Walker
SAMPLING SITE: | SAMPLED BY:

Soil Analysis

RPT Date: Jul 31, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Available Metals in Soil															
Aluminum	9398063	9398063	9780	9830	0.5%	< 10	113%	80%	120%	111%	80%	120%	125%	70%	130%
Antimony	9398063	9398063	<1	<1	NA	< 1	97%	80%	120%	108%	80%	120%	NA	70%	130%
Arsenic	9398063	9398063	4	5	NA	< 1	97%	80%	120%	95%	80%	120%	96%	70%	130%
Barium	9398063	9398063	188	183	2.3%	< 5	96%	80%	120%	98%	80%	120%	96%	70%	130%
Beryllium	9398063	9398063	<2	<2	NA	< 2	108%	80%	120%	107%	80%	120%	107%	70%	130%
Boron	9398063	9398063	18	16	9.2%	< 2	108%	80%	120%	105%	80%	120%	109%	70%	130%
Cadmium	9398063	9398063	<0.3	<0.3	NA	< 0.3	95%	80%	120%	98%	80%	120%	101%	70%	130%
Chromium	9398063	9398063	19	19	0.0%	< 2	100%	80%	120%	105%	80%	120%	113%	70%	130%
Cobalt	9398063	9398063	9	9	1.9%	< 1	100%	80%	120%	101%	80%	120%	107%	70%	130%
Copper	9398063	9398063	9	9	NA	< 2	109%	80%	120%	105%	80%	120%	105%	70%	130%
Iron	9398063	9398063	18300	18400	0.2%	< 50	105%	80%	120%	114%	80%	120%	101%	70%	130%
Lead	9398063	9398063	11.2	11.2	0.2%	< 0.5	102%	80%	120%	103%	80%	120%	104%	70%	130%
Lithium	9398063	9398063	25	25	0.1%	< 5	108%	70%	130%	107%	70%	130%	110%	70%	130%
Manganese	9398063	9398063	328	346	5.3%	< 2	113%	80%	120%	108%	80%	120%	101%	70%	130%
Molybdenum	9398063	9398063	<2	<2	NA	< 2	96%	80%	120%	102%	80%	120%	99%	70%	130%
Nickel	9398063	9398063	21	21	0.2%	< 2	101%	80%	120%	107%	80%	120%	109%	70%	130%
Selenium	9398063	9398063	<1	<1	NA	< 1	97%	80%	120%	93%	80%	120%	89%	70%	130%
Silver	9398063	9398063	<0.5	<0.5	NA	< 0.5	86%	80%	120%	100%	80%	120%	90%	70%	130%
Strontium	9398063	9398063	21	21	NA	< 5	102%	80%	120%	104%	80%	120%	113%	70%	130%
Thallium	9398063	9398063	<0.1	<0.1	NA	< 0.1	100%	80%	120%	101%	80%	120%	NA	70%	130%
Tin	9398063	9398063	3	3	NA	< 2	97%	80%	120%	99%	80%	120%	102%	70%	130%
Uranium	9398063	9398063	0.9	1.0	5.6%	< 0.1	97%	80%	120%	98%	80%	120%	108%	70%	130%
Vanadium	9398063	9398063	27	27	0.4%	< 2	96%	80%	120%	98%	80%	120%	111%	70%	130%
Zinc	9398063	9398063	58	57	1.3%	< 5	99%	80%	120%	101%	80%	120%	103%	70%	130%
Mercury Analysis in Soil															
Mercury	1	9341958	1500	1490	0.7%	< 0.05	95%	70%	130%	NA	70%	130%	100%	70%	130%
Inorganics (Soil)															
Total Organic Carbon	9394454		11.2	11.0	1.8%	< 0.3	NA	80%	120%	NA	80%	120%	NA	80%	120%

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC | AGAT WORK ORDER: 18X361396
PROJECT: | ATTENTION TO: Tony Walker
SAMPLING SITE: | SAMPLED BY:

Ultra Trace Analysis

RPT Date: Jul 31, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Dioxins and Furans (Sediment, WHO 1998, Fish)															
2,3,7,8-Tetra CDD	1	NA	< 0.2	< 0.2	NA	< 0.1	98%	40%	130%	NA	40%	130%	94%	40%	130%
1,2,3,7,8-Penta CDD	1	NA	< 0.4	< 0.5	NA	< 0.2	106%	40%	130%	NA	40%	130%	100%	40%	130%
1,2,3,4,7,8-Hexa CDD	1	NA	< 0.7	< 0.7	NA	< 0.7	104%	40%	130%	NA	40%	130%	105%	40%	130%
1,2,3,6,7,8-Hexa CDD	1	NA	< 0.7	< 0.7	NA	< 0.7	110%	40%	130%	NA	40%	130%	105%	40%	130%
1,2,3,7,8,9-Hexa CDD	1	NA	< 0.7	0.8	NA	< 0.7	103%	40%	130%	NA	40%	130%	107%	40%	130%
1,2,3,4,6,7,8-Hepta CDD	1	NA	1.3	1.4	NA	< 0.2	101%	40%	130%	NA	40%	130%	105%	40%	130%
Octa CDD	1	NA	9	10	10.5%	< 0.5	101%	40%	130%	NA	40%	130%	102%	40%	130%
2,3,7,8-Tetra CDF	1	NA	< 0.3	< 0.5	NA	< 0.1	109%	40%	130%	NA	40%	130%	103%	40%	130%
1,2,3,7,8-Penta CDF	1	NA	0.7	< 2	NA	< 0.4	113%	40%	130%	NA	40%	130%	110%	40%	130%
2,3,4,7,8-Penta CDF	1	NA	< 0.4	< 0.9	NA	< 0.4	117%	40%	130%	NA	40%	130%	113%	40%	130%
1,2,3,4,7,8-Hexa CDF	1	NA	0.4	< 1	NA	< 0.4	111%	40%	130%	NA	40%	130%	111%	40%	130%
1,2,3,6,7,8-Hexa CDF	1	NA	< 0.4	< 0.9	NA	< 0.1	112%	40%	130%	NA	40%	130%	111%	40%	130%
2,3,4,6,7,8-Hexa CDF	1	NA	< 0.6	< 1	NA	< 0.5	111%	40%	130%	NA	40%	130%	111%	40%	130%
1,2,3,7,8,9-Hexa CDF	1	NA	< 0.8	< 1	NA	< 0.8	103%	40%	130%	NA	40%	130%	105%	40%	130%
1,2,3,4,6,7,8-Hepta CDF	1	NA	0.5	< 1	NA	< 0.5	109%	40%	130%	NA	40%	130%	112%	40%	130%
1,2,3,4,7,8,9-Hepta CDF	1	NA	< 0.9	< 2	NA	< 0.9	105%	40%	130%	NA	40%	130%	104%	40%	130%
Octa CDF	1	NA	< 2	< 2	NA	< 0.7	100%	40%	130%	NA	40%	130%	107%	40%	130%

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Method Summary

CLIENT NAME: NOVA SCOTIA LANDS INC
PROJECT:
SAMPLING SITE:

AGAT WORK ORDER: 18X361396
ATTENTION TO: Tony Walker
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Particles >75um	INOR-121-6031, INOR-121-6034	ASTM D-422-63	Sieve
Classification	INOR-121-6031, INOR-121-6031	Atlantic RBCA	Sieve
Total Organic Carbon	INOR-101-6057F	MA. 405-C 1.1	TITRAGE
Moisture Content	LAB-111-4040F	MA.100-ST 1.1	BALANCE

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Method Summary

CLIENT NAME: NOVA SCOTIA LANDS INC

AGAT WORK ORDER: 18X361396

PROJECT:

ATTENTION TO: Tony Walker

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Ultra Trace Analysis			
2,3,7,8-Tetra CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDD	HR-151-5400	EPA 1613	HRMS
Octa CDD	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDF	HR-151-5400	EPA 1613	HRMS
2,3,4,7,8-Penta CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
2,3,4,6,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8,9-Hepta CDF	HR-151-5400	EPA 1613	HRMS
Octa CDF	HR-151-5400	EPA 1613	HRMS
Total Tetrachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Pentachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Hexachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Heptachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total PCDDs	HR-151-5400	EPA 1613	HRMS
Total Tetrachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Pentachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Hexachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Heptachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total PCDFs	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDD (TEF 1.0)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDD (TEF 1.0)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDD (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDD (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDD (TEF 0.001)	HR-151-5400	EPA 1613	HRMS
Octa CDD (TEF 0.0001)	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDF (TEF 0.5)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDF (TEF 0.5)	HR-151-5400	EPA 1613	HRMS
2,3,4,7,8-Penta CDF (TEF 0.5)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	HR_151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
Octa CDF (TEF 0.0001)	HR-151-5400	EPA 1613	HRMS
Total PCDDs & PCDFs (TEQ)	HR-151-5400	EPA 1613	HRMS
13C-2378-TCDF	HR-151-5400	EPA 1613	HRMS
13C-12378-PeCDF	HR-151-5400	EPA 1613	HRMS
13C-23478-PeCDF	HR-151-5400	EPA 1613	HRMS
13C-123478-HxCDF	HR-151-5400	EPA 1613	HRMS

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Method Summary

CLIENT NAME: NOVA SCOTIA LANDS INC

PROJECT:

SAMPLING SITE:

AGAT WORK ORDER: 18X361396

ATTENTION TO: Tony Walker

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
13C-123678-HxCDF	HR-151-5400	EPA 1613	HRMS
13C-234678-HxCDF	HR-151-5400	EPA 1613	HRMS
13C-123789-HxCDF	HR-151-5400	EPA 1613	HRMS
13C-1234678-HpCDF	HR-151-5400	EPA 1613	HRMS
13C-1234789-HpCDF	HR-151-5400	EPA 1613	HRMS
13C-2378-TCDD	HR-151-5400	EPA 1613	HRMS
13C-12378-PeCDD	HR-151-5400	EPA 1613	HRMS
13C-123478-HxCDD	HR-151-5400	EPA 1613	HRMS
13C-123678-HxCDD	HR-151-5400	EPA 1613	HRMS
13C-1234678-HpCDD	HR-151-5400	EPA 1613	HRMS
13C-OCDD	HR-151-5400	EPA 1613	HRMS

Certificate of Analysis

AGAT Laboratories

AGAT WORK ORDER: 19X470398
PROJECT:

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:

ATTENTION TO: Heather Daurie
SAMPLED BY:

Mercury in Soil

DATE RECEIVED: 2019-05-23

DATE REPORTED: 2019-06-18

			SAMPLE DESCRIPTION:	N1	N2	N3	NE1	NE2	NE3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21
Parameter	Unit	G / S	RDL	216578	216581	216582	216583	216584	216586
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

216578-216586 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

Certificate of Analysis

AGAT Laboratories

AGAT WORK ORDER: 19X470398
PROJECT:

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:

ATTENTION TO: Heather Daurie
SAMPLED BY:

Grain Size Analysis - Coarse/Fine Classification

DATE RECEIVED: 2019-05-23

DATE REPORTED: 2019-06-18

			SAMPLE DESCRIPTION:	N1	N2	N3	NE1	NE2	NE3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21
Parameter	Unit	G / S	RDL	216578	216581	216582	216583	216584	216586
Particles >75um	%		1	99	100	99	100	96	99
Classification	Coarse/Fine			Coarse	Coarse	Coarse	Coarse	Coarse	Coarse

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Halifax (unless marked by *)

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Certificate of Analysis

AGAT WORK ORDER: 19X470398

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES | **ATTENTION TO: Heather Daurie**

SAMPLING SITE: | **SAMPLED BY:**

Available Metals in Soil

DATE RECEIVED: 2019-05-23 | **DATE REPORTED: 2019-06-18**

			SAMPLE DESCRIPTION:	N1	N2	N3	NE1	NE2	NE3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21
Parameter	Unit	G / S	RDL	215578	215581	215582	215583	215584	215586
Aluminum	mg/kg		10	4150	2360	3570	2790	3480	2940
Antimony	mg/kg		1	<1	<1	<1	<1	<1	<1
Arsenic	mg/kg		1	5	3	5	5	6	5
Barium	mg/kg		5	90	21	36	59	42	42
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2
Boron	mg/kg		2	4	4	4	2	5	4
Cadmium	mg/kg		0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium	mg/kg		2	6	3	5	5	6	5
Cobalt	mg/kg		1	4	2	3	3	4	3
Copper	mg/kg		2	4	<2	<2	3	2	2
Iron	mg/kg		50	6740	4060	6320	3870	5770	5450
Lead	mg/kg		0.5	3.2	1.9	3.0	3.1	3.0	2.7
Lithium	mg/kg		5	12	7	11	10	12	9
Manganese	mg/kg		2	706	283	455	495	524	585
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	8	4	6	6	7	6
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	9	6	6	5	8	8
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	4	4	4	3	4	4
Uranium	mg/kg		0.1	0.2	0.1	0.2	0.2	0.2	0.2
Vanadium	mg/kg		2	11	7	11	9	11	11
Zinc	mg/kg		5	30	18	25	21	30	25

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

215578-215586 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certificate of Analysis

AGAT WORK ORDER: 19X470398
PROJECT:

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:
ATTENTION TO: Heather Daurie
SAMPLED BY:

Grain Size Analysis - Coarse/Fine Classification

DATE RECEIVED: 2019-05-23 DATE REPORTED: 2019-06-18

			SAMPLE DESCRIPTION:	N1	N2	N3	NE1	NE2	NE3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21
Parameter	Unit	G / S	RDL	215578	215581	215582	215583	215584	215586
Particles >75um	%		1	99	100	99	100	96	99
Classification	Coarse/Fine			Coarse	Coarse	Coarse	Coarse	Coarse	Coarse

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Halifax (unless marked by *)

Certificate of Analysis

AGAT WORK ORDER: 19X470398
PROJECT:

11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:
ATTENTION TO: Heather Daurie
SAMPLED BY:

Mercury in Soil

DATE RECEIVED: 2019-05-23 DATE REPORTED: 2019-06-18

			SAMPLE DESCRIPTION:	N1	N2	N3	NE1	NE2	NE3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21
Parameter	Unit	G / S	RDL	215578	215581	215582	215583	215584	215586
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
215578-215586 Results are based on the dry weight of the soil.
Analysis performed at AGAT Halifax (unless marked by *)

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:
ATTENTION TO: Heather Daurie
SAMPLED BY:

Methylmercury in Soil

DATE RECEIVED: 2019-05-23 DATE REPORTED: 2019-06-18

			SAMPLE DESCRIPTION:	N1	N2	N3	NE1	NE2	NE3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21	2019-05-21
Parameter	Unit	G / S	RDL	215578	215581	215582	215583	215584	215586
Methyl Mercury	ng/g		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Halifax (unless marked by *)

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES | **ATTENTION TO: Heather Daurie**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Soil, WHO 2005)

DATE RECEIVED: 2019-05-23 | **DATE REPORTED: 2019-06-18**

			SAMPLE DESCRIPTION:	N1		N2		N3		NE1
			SAMPLE TYPE:	Soil		Soil		Soil		Soil
			DATE SAMPLED:	2019-05-21		2019-05-21		2019-05-21		2019-05-21
Parameter	Unit	G / S	RDL	215578	RDL	215581	RDL	215582	RDL	215583
2,3,7,8-Tetra CDD	ng/kg		0.1	<0.1	0.1	<0.1	0.2	<0.2	0.1	<0.1
1,2,3,7,8-Penta CDD	ng/kg		0.1	<0.1	0.2	<0.2	0.2	<0.2	0.1	<0.1
1,2,3,4,7,8-Hexa CDD	ng/kg		0.3	<0.3	0.2	<0.2	0.9	<0.9	0.6	<0.6
1,2,3,6,7,8-Hexa CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.9	<0.9	0.5	<0.5
1,2,3,7,8,9-Hexa CDD	ng/kg		0.3	<0.3	0.3	<0.3	1	<1	0.6	<0.6
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	<0.6	0.2	<0.2	0.4	<0.4	1	<1
Octa CDD	ng/kg		4	14	2	3	2	<2	4	18
2,3,7,8-Tetra CDF	ng/kg		0.2	<0.2	0.1	<0.1	0.2	<0.2	0.1	<0.1
1,2,3,7,8-Penta CDF	ng/kg		0.2	<0.2	0.1	<0.1	0.1	<0.1	0.2	<0.2
2,3,4,7,8-Penta CDF	ng/kg		0.2	<0.2	0.1	<0.1	0.1	<0.1	0.1	<0.1
1,2,3,4,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.2	<0.2	0.2	<0.2
1,2,3,6,7,8-Hexa CDF	ng/kg		0.2	<0.2	0.3	<0.3	0.1	<0.1	0.2	<0.2
2,3,4,6,7,8-Hexa CDF	ng/kg		0.2	<0.2	0.3	<0.3	0.1	<0.1	0.2	<0.2
1,2,3,7,8,9-Hexa CDF	ng/kg		0.4	<0.4	0.5	<0.5	0.2	<0.2	0.3	<0.3
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.5	<0.5	0.2	<0.2	0.9	<0.9	0.8	<0.8
1,2,3,4,7,8,9-Hepta CDF	ng/kg		1	<1	0.4	<0.4	2	<2	2	<2
Octa CDF	ng/kg		2	<2	2	<2	3	<3	3	<3
Total Tetrachlorodibenzodioxins	ng/kg		0.1	0.4	0.1	<0.1	0.2	1.2	0.1	<0.1
Total Pentachlorodibenzodioxins	ng/kg		0.1	0.4	0.2	0.2	0.2	<0.2	0.1	0.6
Total Hexachlorodibenzodioxins	ng/kg		0.3	<0.3	0.2	<0.2	0.9	<0.9	0.6	<0.6
Total Heptachlorodibenzodioxins	ng/kg		0.6	<0.6	0.2	<0.2	0.4	<0.4	1	<1
Total PCDDs	ng/kg		4	14	2	<2	2	<2	4	18
Total Tetrachlorodibenzofurans	ng/kg		0.2	<0.2	0.1	<0.1	0.2	<0.2	0.1	<0.1
Total Pentachlorodibenzofurans	ng/kg		0.2	<0.2	0.1	<0.1	0.1	<0.1	0.2	0.2
Total Hexachlorodibenzofurans	ng/kg		0.4	0.6	0.5	<0.5	0.2	<0.2	0.3	<0.3
Total Heptachlorodibenzofurans	ng/kg		1	<1	0.4	<0.4	2	<2	2	<2
Total PCDFs	ng/kg		2	<2	2	<2	3	<3	3	<3
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES | ATTENTION TO: Heather Daurie
SAMPLING SITE: | SAMPLED BY:

Dioxins and Furans (Soil, WHO 2005)

DATE RECEIVED: 2019-05-23 | DATE REPORTED: 2019-06-18

			SAMPLE DESCRIPTION:	N1		N2		N3		NE1
			SAMPLE TYPE:	Soil		Soil		Soil		Soil
			DATE SAMPLED:	2019-05-21		2019-05-21		2019-05-21		2019-05-21
Parameter	Unit	G / S	RDL	215578	RDL	215581	RDL	215582	RDL	215583
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0.00408		0.00103		0		0.00537
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	ng/kg TEQ			0.00408		0.00103		0		0.00537

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES

ATTENTION TO: Heather Daurie

SAMPLING SITE:

SAMPLED BY:

Dioxins and Furans (Soil, WHO 2005)

DATE RECEIVED: 2019-05-23 **DATE REPORTED: 2019-06-18**

Surrogate	Unit	Acceptable Limits	N1	N2	N3	NE1
		SAMPLE TYPE:	Soil	Soil	Soil	Soil
		DATE SAMPLED:	2019-05-21	2019-05-21	2019-05-21	2019-05-21
			215578	215581	215582	215583
13C-2378-TCDF	%	30-140	62	63	45	58
13C-12378-PeCDF	%	30-140	58	59	38	47
13C-23478-PeCDF	%	30-140	78	81	46	68
13C-123478-HxCDF	%	30-140	81	85	63	61
13C-123678-HxCDF	%	30-140	78	73	66	61
13C-234678-HxCDF	%	30-140	94	85	85	59
13C-123789-HxCDF	%	30-140	95	84	79	66
13C-1234678-HpCDF	%	30-140	63	61	48	44
13C-1234789-HpCDF	%	30-140	54	53	35	43
13C-2378-TCDD	%	30-140	68	74	49	70
13C-12378-PeCDD	%	30-140	77	78	51	70
13C-123478-HxCDD	%	30-140	88	91	84	76
13C-123678-HxCDD	%	30-140	92	88	82	73
13C-1234678-HpCDD	%	30-140	58	59	43	45
13C-OCDD	%	30-140	33	30	28	21

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ATTENTION TO: Heather Daurie

SAMPLING SITE:

SAMPLED BY:

Dioxins and Furans (Soil, WHO 2005)

DATE RECEIVED: 2019-05-23 **DATE REPORTED: 2019-06-18**

Parameter	Unit	G / S	RDL	NE2	RDL	NE3
			SAMPLE TYPE:	Soil		Soil
			DATE SAMPLED:	2019-05-21		2019-05-21
				215584		215585
2,3,7,8-Tetra CDD	ng/kg		0.5	<0.5	0.1	<0.1
1,2,3,7,8-Penta CDD	ng/kg		0.1	<0.1	0.2	<0.2
1,2,3,4,7,8-Hexa CDD	ng/kg		0.4	<0.4	0.3	<0.3
1,2,3,6,7,8-Hexa CDD	ng/kg		0.4	<0.4	0.3	<0.3
1,2,3,7,8,9-Hexa CDD	ng/kg		0.4	<0.4	0.3	<0.3
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	<0.6	0.8	<0.8
Octa CDD	ng/kg		6	23	4	17
2,3,7,8-Tetra CDF	ng/kg		0.2	<0.2	0.4	<0.4
1,2,3,7,8-Penta CDF	ng/kg		0.2	<0.2	0.3	<0.3
2,3,4,7,8-Penta CDF	ng/kg		0.1	<0.1	0.2	<0.2
1,2,3,4,7,8-Hexa CDF	ng/kg		0.1	<0.1	0.2	<0.2
1,2,3,6,7,8-Hexa CDF	ng/kg		0.1	<0.1	0.2	<0.2
2,3,4,6,7,8-Hexa CDF	ng/kg		0.1	<0.1	0.2	<0.2
1,2,3,7,8,9-Hexa CDF	ng/kg		0.2	<0.2	0.4	<0.4
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.1	<0.1	0.3	<0.3
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.4	<0.4	0.7	<0.7
Octa CDF	ng/kg		2	<2	2	<2
Total Tetrachlorodibenzodioxins	ng/kg		0.5	1.8	0.1	0.3
Total Pentachlorodibenzodioxins	ng/kg		0.1	0.3	0.2	0.6
Total Hexachlorodibenzodioxins	ng/kg		0.4	<0.4	0.3	<0.3
Total Heptachlorodibenzodioxins	ng/kg		0.6	<0.6	0.8	<0.8
Total PCDDs	ng/kg		6	25	4	19
Total Tetrachlorodibenzofurans	ng/kg		0.2	0.5	0.4	<0.4
Total Pentachlorodibenzofurans	ng/kg		0.2	<0.2	0.3	<0.3
Total Hexachlorodibenzofurans	ng/kg		0.2	<0.2	0.4	<0.4
Total Heptachlorodibenzofurans	ng/kg		0.4	<0.4	0.7	<0.7
Total PCDFs	ng/kg		2	<2	2	<2
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:

ATTENTION TO: Heather Daurie
SAMPLED BY:

Dioxins and Furans (Soil, WHO 2005)

DATE RECEIVED: 2019-05-23 | **DATE REPORTED: 2019-06-18**

			SAMPLE DESCRIPTION:	NE2		NE3
			SAMPLE TYPE:	Soil		Soil
			DATE SAMPLED:	2019-05-21		2019-05-21
Parameter	Unit	G / S	RDL	215584	RDL	215585
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0
Octa CDD (TEF 0.0003)	TEQ			0.00683		0.00521
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0		0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0
Octa CDF (TEF 0.0003)	TEQ			0		0
Total PCDDs and PCDFs (TEQ)	ng/kg TEQ			0.00683		0.00521

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CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
SAMPLING SITE:

ATTENTION TO: Heather Daurie
SAMPLED BY:

Dioxins and Furans (Soil, WHO 2005)

DATE RECEIVED: 2019-05-23 | **DATE REPORTED: 2019-06-18**

		SAMPLE DESCRIPTION:	NE2	NE3
		SAMPLE TYPE:	Soil	Soil
		DATE SAMPLED:	2019-05-21	2019-05-21
Surrogate	Unit	Acceptable Limits	215584	215585
13C-2378-TCDF	%	30-140	46	71
13C-12378-PeCDF	%	30-140	59	62
13C-23478-PeCDF	%	30-140	81	76
13C-123478-HxCDF	%	30-140	77	90
13C-123678-HxCDF	%	30-140	74	77
13C-234678-HxCDF	%	30-140	81	91
13C-123789-HxCDF	%	30-140	81	89
13C-1234678-HpCDF	%	30-140	59	64
13C-1234789-HpCDF	%	30-140	54	57
13C-2378-TCDD	%	30-140	72	80
13C-12378-PeCDD	%	30-140	78	84
13C-123478-HxCDD	%	30-140	89	90
13C-123678-HxCDD	%	30-140	81	90
13C-1234678-HpCDD	%	30-140	60	61
13C-OCDD	%	30-140	30	33

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

215578-215581 The results were corrected based on the surrogate percent recoveries.

215582-215583 The results were corrected based on the surrogate percent recoveries.
The percent recovery of 13C-OCDD is outside of acceptable range due to matrix interferences.

215584-215585 The results were corrected based on the surrogate percent recoveries.

AGAT Laboratories

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Quality Assurance

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES | **AGAT WORK ORDER: 19X470398**

PROJECT: | **ATTENTION TO: Heather Daurie**

SAMPLING SITE: | **SAMPLED BY:**

Soil Analysis

RPT Date: Jun 18, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	214867		8290	7340	12.2%	< 10	120%	80%	120%	120%	80%	120%	NA	70%	130%
Antimony	214867		<1	<1	NA	< 1	84%	80%	120%	120%	80%	120%	70%	70%	130%
Arsenic	214867		5	4	NA	< 1	120%	80%	120%	110%	80%	120%	111%	70%	130%
Barium	214867		30	27	7.8%	< 5	120%	80%	120%	115%	80%	120%	NA	70%	130%
Beryllium	214867		<2	<2	NA	< 2	111%	80%	120%	104%	80%	120%	102%	70%	130%
Boron	214867		6	5	NA	< 2	120%	80%	120%	119%	80%	120%	113%	70%	130%
Cadmium	214867		<0.3	<0.3	NA	< 0.3	118%	80%	120%	113%	80%	120%	110%	70%	130%
Chromium	214867		15	15	2.4%	< 2	120%	80%	120%	120%	80%	120%	NA	70%	130%
Cobalt	214867		7	7	2.7%	< 1	113%	80%	120%	110%	80%	120%	NA	70%	130%
Copper	214867		11	11	5.7%	< 2	120%	80%	120%	110%	80%	120%	NA	70%	130%
Iron	214867		10600	14600	NA	< 50	120%	80%	120%	118%	80%	120%	NA	70%	130%
Lead	214867		14.7	15.5	5.2%	< 0.5	111%	80%	120%	107%	80%	120%	NA	70%	130%
Lithium	214867		28	27	4.8%	< 5	130%	70%	130%	118%	70%	130%	NA	70%	130%
Manganese	214867		310	395	NA	< 2	116%	80%	120%	114%	80%	120%	NA	70%	130%
Molybdenum	214867		<2	<2	NA	< 2	98%	80%	120%	98%	80%	120%	110%	70%	130%
Nickel	214867		18	18	1.5%	< 2	116%	80%	120%	113%	80%	120%	NA	70%	130%
Selenium	214867		<1	<1	NA	< 1	120%	80%	120%	113%	80%	120%	72%	70%	130%
Silver	214867		<0.5	<0.5	NA	< 0.5	104%	80%	120%	103%	80%	120%	113%	70%	130%
Strontium	214867		7	8	NA	< 5	106%	80%	120%	105%	80%	120%	121%	70%	130%
Thallium	214867		<0.1	<0.1	NA	< 0.1	112%	80%	120%	106%	80%	120%	70%	70%	130%
Tin	214867		4	4	NA	< 2	114%	80%	120%	116%	80%	120%	106%	70%	130%
Uranium	214867		0.5	0.5	5.1%	< 0.1	106%	80%	120%	103%	80%	120%	117%	70%	130%
Vanadium	214867		19	18	3.7%	< 2	114%	80%	120%	110%	80%	120%	NA	70%	130%
Zinc	214867		65	58	10.6%	< 5	113%	80%	120%	107%	80%	120%	NA	70%	130%
Mercury in Soil															
Mercury	215585	215585	<0.05	<0.05	NA	< 0.05	110%	70%	130%	NA	70%	130%	100%	70%	130%
Methylmercury in Soil															
Methyl Mercury	1	215578	<0.4	<0.4	NA	< 0.4	89%	65%	135%	110%	65%	135%	78%	65%	135%
Grain Size Analysis - Coarse/Fine Classification															
Classification	1	215578				<									
Analyses Inorganiques (sol)															
Carbone organique total	258268		0.6	0.5	NA	< 0.3	116%	80%	120%	NA	80%	120%	119%	80%	120%

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Quality Assurance

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES **AGAT WORK ORDER: 19X470398**

PROJECT: **ATTENTION TO: Heather Daurie**

SAMPLING SITE: **SAMPLED BY:**

Soil Analysis (Continued)

RPT Date: Jun 18, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper

Comments: NA : Non applicable

NA dans l'écart du duplicata indique que l'écart n'a pu être calculé car l'un ou les deux résultats sont < 5x LDR.

NA dans le pourcentage de récupération de l'échantillon fortifié indique que le résultat n'est pas fourni en raison de l'hétérogénéité de l'échantillon ou de la concentration trop élevée par rapport à l'ajout.

NA dans le blanc fortifié ou le MRC indique qu'il n'est pas requis par la procédure.

Le pourcentage de récupération du MRC peut être en dehors du critère d'acceptabilité de 80-120%, s'il est conforme à l'écart du certificat du matériau de référence.

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Quality Assurance

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES **AGAT WORK ORDER: 19X470398**

PROJECT: **ATTENTION TO: Heather Daurie**

SAMPLING SITE: **SAMPLED BY:**

Ultra Trace Analysis

RPT Date: Jun 18, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Dioxins and Furans (Soil, WHO 2005)															
2,3,7,8-Tetra CDD	1	215578	< 0.1	< 0.1	NA	< 0.1	107%	30%	140%	NA	30%	140%	122%	30%	140%
1,2,3,7,8-Penta CDD	1	215578	< 0.1	< 0.3	NA	< 0.1	113%	30%	140%	NA	30%	140%	128%	30%	140%
1,2,3,4,7,8-Hexa CDD	1	215578	< 0.3	< 0.3	NA	< 0.1	121%	30%	140%	NA	30%	140%	124%	30%	140%
1,2,3,6,7,8-Hexa CDD	1	215578	< 0.2	< 0.3	NA	< 0.1	121%	30%	140%	NA	30%	140%	122%	30%	140%
1,2,3,7,8,9-Hexa CDD	1	215578	< 0.3	< 0.3	NA	< 0.1	82%	30%	140%	NA	30%	140%	128%	30%	140%
1,2,3,4,6,7,8-Hepta CDD	1	215578	< 0.6	< 0.4	NA	< 0.3	101%	30%	140%	NA	30%	140%	129%	30%	140%
Octa CDD	1	215578	14	12	15.4%	< 2	114%	30%	140%	NA	30%	140%	121%	30%	140%
2,3,7,8-Tetra CDF	1	215578	< 0.2	< 0.1	NA	< 0.1	128%	30%	140%	NA	30%	140%	127%	30%	140%
1,2,3,7,8-Penta CDF	1	215578	< 0.2	< 0.2	NA	< 0.1	104%	30%	140%	NA	30%	140%	120%	30%	140%
2,3,4,7,8-Penta CDF	1	215578	< 0.2	< 0.1	NA	< 0.1	110%	30%	140%	NA	30%	140%	127%	30%	140%
1,2,3,4,7,8-Hexa CDF	1	215578	< 0.3	< 0.2	NA	< 0.1	104%	30%	140%	NA	30%	140%	129%	30%	140%
1,2,3,6,7,8-Hexa CDF	1	215578	< 0.2	< 0.2	NA	< 0.1	121%	30%	140%	NA	30%	140%	117%	30%	140%
2,3,4,6,7,8-Hexa CDF	1	215578	< 0.2	< 0.2	NA	< 0.1	93%	30%	140%	NA	30%	140%	125%	30%	140%
1,2,3,7,8,9-Hexa CDF	1	215578	< 0.4	< 0.3	NA	< 0.2	112%	30%	140%	NA	30%	140%	123%	30%	140%
1,2,3,4,6,7,8-Hepta CDF	1	215578	< 0.5	< 0.1	NA	< 0.3	106%	30%	140%	NA	30%	140%	129%	30%	140%
1,2,3,4,7,8,9-Hepta CDF	1	215578	< 1	< 0.4	NA	< 0.5	128%	30%	140%	NA	30%	140%	128%	30%	140%
Octa CDF	1	215578	< 2	< 2	NA	< 2	113%	30%	140%	NA	30%	140%	119%	30%	140%

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Quality Assurance

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES

AGAT WORK ORDER: 19X470398

PROJECT:

ATTENTION TO: Heather Daurie

SAMPLING SITE:

SAMPLED BY:

Ultra Trace Analysis

RPT Date: Jun 18, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Dioxins and Furans (Soil, WHO 2005)															
2,3,7,8-Tetra CDD	1	215578	< 0.1	< 0.1	NA	< 0.1	107%	30%	140%	NA	30%	140%	122%	30%	140%
1,2,3,7,8-Penta CDD	1	215578	< 0.1	< 0.3	NA	< 0.1	113%	30%	140%	NA	30%	140%	128%	30%	140%
1,2,3,4,7,8-Hexa CDD	1	215578	< 0.3	< 0.3	NA	< 0.1	121%	30%	140%	NA	30%	140%	124%	30%	140%
1,2,3,6,7,8-Hexa CDD	1	215578	< 0.2	< 0.3	NA	< 0.1	121%	30%	140%	NA	30%	140%	122%	30%	140%
1,2,3,7,8,9-Hexa CDD	1	215578	< 0.3	< 0.3	NA	< 0.1	82%	30%	140%	NA	30%	140%	128%	30%	140%
1,2,3,4,6,7,8-Hepta CDD	1	215578	< 0.6	< 0.4	NA	< 0.3	101%	30%	140%	NA	30%	140%	129%	30%	140%
Octa CDD	1	215578	14	12	15.4%	< 2	114%	30%	140%	NA	30%	140%	121%	30%	140%
2,3,7,8-Tetra CDF	1	215578	< 0.2	< 0.1	NA	< 0.1	128%	30%	140%	NA	30%	140%	127%	30%	140%
1,2,3,7,8-Penta CDF	1	215578	< 0.2	< 0.2	NA	< 0.1	104%	30%	140%	NA	30%	140%	120%	30%	140%
2,3,4,7,8-Penta CDF	1	215578	< 0.2	< 0.1	NA	< 0.1	110%	30%	140%	NA	30%	140%	127%	30%	140%
1,2,3,4,7,8-Hexa CDF	1	215578	< 0.3	< 0.2	NA	< 0.1	104%	30%	140%	NA	30%	140%	129%	30%	140%
1,2,3,6,7,8-Hexa CDF	1	215578	< 0.2	< 0.2	NA	< 0.1	121%	30%	140%	NA	30%	140%	117%	30%	140%
2,3,4,6,7,8-Hexa CDF	1	215578	< 0.2	< 0.2	NA	< 0.1	93%	30%	140%	NA	30%	140%	125%	30%	140%
1,2,3,7,8,9-Hexa CDF	1	215578	< 0.4	< 0.3	NA	< 0.2	112%	30%	140%	NA	30%	140%	123%	30%	140%
1,2,3,4,6,7,8-Hepta CDF	1	215578	< 0.5	< 0.1	NA	< 0.3	106%	30%	140%	NA	30%	140%	129%	30%	140%
1,2,3,4,7,8,9-Hepta CDF	1	215578	< 1	< 0.4	NA	< 0.5	128%	30%	140%	NA	30%	140%	128%	30%	140%
Octa CDF	1	215578	< 2	< 2	NA	< 2	113%	30%	140%	NA	30%	140%	119%	30%	140%

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Method Summary

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
AGAT WORK ORDER: 19X470398
PROJECT:
ATTENTION TO: Heather Daurie
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Carbone organique total	INOR-101-6057F	MA. 405-C 1.1	TITRAGE
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Particles >75um	INOR-121-6031, INOR-121-6034	ASTM D-422-63	Sieve
Classification	INOR-121-6031, INOR-121-6031	Atlantic RBCA	Sieve
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CVAA

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Method Summary

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES
AGAT WORK ORDER: 19X470398
PROJECT:
ATTENTION TO: Heather Daurie
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Ultra Trace Analysis			
2,3,7,8-Tetra CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDD	HR-151-5400	EPA 1613	HRMS
Octa CDD	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDF	HR-151-5400	EPA 1613	HRMS
2,3,4,7,8-Penta CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
2,3,4,6,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8,9-Hepta CDF	HR-151-5400	EPA 1613	HRMS
Octa CDF	HR-151-5400	EPA 1613	HRMS
Total Tetrachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Pentachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Hexachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Heptachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total PCDDs	HR-151-5400	EPA 1613	HRMS
Total Tetrachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Pentachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Hexachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Heptachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total PCDFs	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDD (TEF 1.0)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDD (TEF 1.0)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
Octa CDD (TEF 0.0003)	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDF (TEF 0.03)	HR-151-5400	EPA 1613	HRMS
2,3,4,7,8-Penta CDF (TEF 0.3)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	HR_151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
Octa CDF (TEF 0.0003)	HR-151-5400	EPA 1613	HRMS
Total PCDDs and PCDFs (TEQ)	HR-151-5400	EPA 1613	HRMS
13C-2378-TCDF	HR-151-5400	EPA 1613	HRMS
13C-12378-PeCDF	HR-151-5400	EPA 1613	HRMS
13C-23478-PeCDF	HR-151-5400	EPA 1613	HRMS
13C-123478-HxCDF	HR-151-5400	EPA 1613	HRMS

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Method Summary

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES — **AGAT WORK ORDER: 19X470398**
PROJECT: — **ATTENTION TO: Heather Daurie**
SAMPLING SITE: — **SAMPLED BY:**

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Ultra Trace Analysis			
2,3,7,8-Tetra CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDD	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDD	HR-151-5400	EPA 1613	HRMS
Octa CDD	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDF	HR-151-5400	EPA 1613	HRMS
2,3,4,7,8-Penta CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
2,3,4,6,7,8-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDF	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8,9-Hepta CDF	HR-151-5400	EPA 1613	HRMS
Octa CDF	HR-151-5400	EPA 1613	HRMS
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Total Hexachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total Heptachlorodibenzodioxins	HR-151-5400	EPA 1613	HRMS
Total PCDDs	HR-151-5400	EPA 1613	HRMS
Total Tetrachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Pentachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Hexachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total Heptachlorodibenzofurans	HR-151-5400	EPA 1613	HRMS
Total PCDFs	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDD (TEF 1.0)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDD (TEF 1.0)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
Octa CDD (TEF 0.0003)	HR-151-5400	EPA 1613	HRMS
2,3,7,8-Tetra CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8-Penta CDF (TEF 0.03)	HR-151-5400	EPA 1613	HRMS
2,3,4,7,8-Penta CDF (TEF 0.3)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	HR_151-5400	EPA 1613	HRMS
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	HR-151-5400	EPA 1613	HRMS
Octa CDF (TEF 0.0003)	HR-151-5400	EPA 1613	HRMS
Total PCDDs and PCDFs (TEQ)	HR-151-5400	EPA 1613	HRMS
13C-2378-TCDF	HR-151-5400	EPA 1613	HRMS
13C-12378-PeCDF	HR-151-5400	EPA 1613	HRMS
13C-23478-PeCDF	HR-151-5400	EPA 1613	HRMS
13C-123478-HxCDF	HR-151-5400	EPA 1613	HRMS

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Method Summary

CLIENT NAME: DALHOUSIE UNIVERSITY - FINANCIAL SERVICES

AGAT WORK ORDER: 19X470398

PROJECT:

ATTENTION TO: Heather Daurie

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
13C-123678-HxCDF	HR-151-5400	EPA 1613	HRMS
13C-234678-HxCDF	HR-151-5400	EPA 1613	HRMS
13C-123789-HxCDF	HR-151-5400	EPA 1613	HRMS
13C-1234678-HpCDF	HR-151-5400	EPA 1613	HRMS
13C-1234789-HpCDF	HR-151-5400	EPA 1613	HRMS
13C-2378-TCDD	HR-151-5400	EPA 1613	HRMS
13C-12378-PeCDD	HR-151-5400	EPA 1613	HRMS
13C-123478-HxCDD	HR-151-5400	EPA 1613	HRMS
13C-123678-HxCDD	HR-151-5400	EPA 1613	HRMS
13C-1234678-HpCDD	HR-151-5400	EPA 1613	HRMS
13C-OCDD	HR-151-5400	EPA 1613	HRMS

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CLIENT NAME: NOVA SCOTIA LANDS INC
PO BOX 430, STATION A
SYDNEY , NS B1P6H2
(902) 564-7933

ATTENTION TO: Tony Walker

PROJECT: Lobster

AGAT WORK ORDER: 18X361283

MISCELLANEOUS ANALYSIS REVIEWED BY: Kelly Hogue, B.Sc, P.Chem, Operations Manager

SOIL ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

ULTRA TRACE REVIEWED BY: Philippe Morneau, chimiste

DATE REPORTED: Aug 01, 2018

PAGES (INCLUDING COVER): 24

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1) Page 1 of 24

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Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Subcontracted Data Received

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	LOB N1	LOB N2	LOB N8	LOB NE1	LOB NE3	LOB NE8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	Unit	G / S	RDL	9397190	9397210	9397237	9397254	9397258	9397260
Subcontracted Data				Y	Y	Y	Y	Y	Y

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Metals in Tissue

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	LOB N1	LOB N2	LOB N3	LOB N4	LOB N5	LOB N6	LOB N7	LOB N8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
				8387190	8387210	8387222	8387224	8387226	8387228	8387236	8387237
Aluminum	mg/kg		10	<10	<10	<10	<10	<10	<10	<10	<10
Antimony	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg		2	10	8	7	10	10	10	10	4
Barium	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Cadmium	mg/kg		0.3	1.0	0.7	1.1	1.3	1.4	0.7	1.1	0.9
Chromium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg		2	22	20	22	22	28	31	22	13
Iron	mg/kg		50	<50	<50	<50	<50	<50	<50	<50	<50
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Manganese	mg/kg		2	3	8	7	6	17	11	14	6
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg		1	<1	<1	<1	<1	1	1	1	<1
Silver	mg/kg		0.5	0.6	<0.5	0.6	0.6	0.7	0.8	0.6	<0.5
Strontium	mg/kg		5	8	20	17	13	24	37	75	20
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg		5	25	30	32	30	33	34	30	18

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Metals in Tissue

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	LOB NE1	LOB NE3	LOB NE6	LOB NE7	LOB NE8	LOB N3-Dup	LOB NE6-Dup
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
				8387254	8387256	8387257	8387258	8387260	8406935	8406937
Aluminum	mg/kg		10	<10	<10	<10	<10	<10	<10	<10
Antimony	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg		2	7	7	8	7	6	5	6
Barium	mg/kg		5	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg		5	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg		2	<2	<2	3	<2	<2	<2	<2
Cadmium	mg/kg		0.3	1.0	1.2	0.6	1.2	1.1	0.4	1.2
Chromium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg		1	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg		2	14	14	25	22	21	16	19
Iron	mg/kg		50	<50	<50	<50	<50	<50	<50	<50
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Manganese	mg/kg		2	7	11	8	3	6	7	10
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg		1	<1	<1	1	<1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	0.7	0.7	0.5	0.6	<0.5	0.6
Strontium	mg/kg		5	15	26	28	9	14	14	33
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg		5	32	33	31	29	34	37	36

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8387190-8406937 Results are based on the wet weight of the sample.

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12

DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	LOB N1		LOB N2		LOB N3		LOB N4
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9397190	RDL	9397210	RDL	9397222	RDL	9397224
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2	0.5	<0.5	0.2	<0.2	0.4	<0.4
1,2,3,7,8-Penta CDD	ng/kg		0.8	<0.8	0.9	<0.9	0.2	<0.2	0.5	<0.5
1,2,3,4,7,8-Hexa CDD	ng/kg		0.8	<0.8	0.9	<0.9	0.5	<0.5	0.7	<0.7
1,2,3,6,7,8-Hexa CDD	ng/kg		0.7	<0.7	0.9	<0.9	0.4	<0.4	0.6	<0.6
1,2,3,7,8,9-Hexa CDD	ng/kg		0.7	<0.7	0.8	<0.8	0.5	<0.5	0.7	<0.7
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	<0.6	1	<1	0.6	<0.6	1	<1
Octa CDD	ng/kg		2	<2	2	3	0.7	0.7	2	<2
2,3,7,8-Tetra CDF	ng/kg		0.4	0.6	0.2	0.6	0.3	<0.3	0.6	<0.6
1,2,3,7,8-Penta CDF	ng/kg		0.5	<0.5	0.6	<0.6	0.5	<0.5	0.9	<0.9
2,3,4,7,8-Penta CDF	ng/kg		1	<1	0.5	<0.5	0.4	<0.4	0.7	0.9
1,2,3,4,7,8-Hexa CDF	ng/kg		0.2	<0.2	0.8	<0.8	0.5	<0.5	0.5	<0.5
1,2,3,6,7,8-Hexa CDF	ng/kg		0.2	<0.2	0.9	<0.9	0.5	<0.5	0.6	<0.6
2,3,4,6,7,8-Hexa CDF	ng/kg		03	<03	0.8	<0.8	0.5	<0.5	0.6	<0.6
1,2,3,7,8,9-Hexa CDF	ng/kg		0.3	<0.3	1	<1	0.8	<0.8	0.8	<0.8
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.6	<0.6	1	<1	0.2	<0.2	1	<1
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.9	<0.9	1	<1	0.4	<0.4	2	<2
Octa CDF	ng/kg		2	<2	4	<4	2	<2	2	<2
Total Tetrachlorodibenzodioxins	ng/kg		0.2	1.0	0.5	1.2	0.2	0.4	0.4	1.5
Total Pentachlorodibenzodioxins	ng/kg		0.8	2.7	0.9	3.1	0.2	0.4	0.5	<0.5
Total Hexachlorodibenzodioxins	ng/kg		0.8	2.8	0.9	3.7	0.5	1.3	0.7	2.8
Total Heptachlorodibenzodioxins	ng/kg		0.6	1.6	1	6	0.6	0.7	1	<1
Total PCDDs	ng/kg		2	8	2	17	0.7	3.6	2	6
Total Tetrachlorodibenzofurans	ng/kg		0.4	3.9	0.2	5.7	0.3	3.3	0.6	4.0
Total Pentachlorodibenzofurans	ng/kg		1	4	0.6	4.1	0.5	2.5	0.9	4.2
Total Hexachlorodibenzofurans	ng/kg		0.3	1.4	1	2	0.8	1.0	0.8	1.6
Total Heptachlorodibenzofurans	ng/kg		0.9	<0.9	1	2	0.4	<0.4	2	<2
Total PCDFs	ng/kg		2	9	4	14	2	7	2	11
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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FAX (902)468-8924
http://www.agatlabs.com

CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12

DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	LOB N1		LOB N2		LOB N3		LOB N4
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9397190	RDL	9397210	RDL	9397222	RDL	9397224
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0		0.000912		0.000213		0
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0.0557		0.0589		0		0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0.255
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.0557		0.0598		0.000213		0.255

Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:	LOB N1	LOB N2	LOB N3	LOB N4
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	8387190	8387210	8387222	8387224
13C-2378-TCDF	%	30-140	64	41	53	58
13C-12378-PeCDF	%	30-140	57	38	46	54
13C-23478-PeCDF	%	30-140	44	45	56	63
13C-123478-HxCDF	%	30-140	64	49	57	67
13C-123678-HxCDF	%	30-140	74	51	78	74
13C-234678-HxCDF	%	30-140	68	56	75	1
13C-123789-HxCDF	%	30-140	64	50	57	64
13C-1234678-HpCDF	%	30-140	50	40	54	52
13C-1234789-HpCDF	%	30-140	49	42	41	53
13C-2378-TCDD	%	30-140	82	51	61	75
13C-12378-PeCDD	%	30-140	35	48	56	65
13C-123478-HxCDD	%	30-140	69	57	65	73
13C-123678-HxCDD	%	30-140	77	59	98	73
13C-1234678-HpCDD	%	30-140	53	48	50	57
13C-OCDD	%	30-140	38	34	36	41

Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:		LOB N5		LOB N6		LOB N7		LOB N8
		SAMPLE TYPE:		Tissue		Tissue		Tissue		Tissue
		DATE SAMPLED:		2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	8387226	RDL	8387228	RDL	8387235	RDL	8387237
2,3,7,8-Tetra CDD	ng/kg		0.4	<0.4	0.2	<0.2	0.4	<0.4	0.5	<0.5
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4	0.8	<0.8	2	<2	0.6	<0.6
1,2,3,4,7,8-Hexa CDD	ng/kg		0.5	<0.5	1	<1	1	<1	0.8	<0.8
1,2,3,6,7,8-Hexa CDD	ng/kg		0.5	<0.5	0.9	<0.9	1	<1	1	<1
1,2,3,7,8,9-Hexa CDD	ng/kg		0.5	<0.5	1	<1	1	<1	0.8	<0.8
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	<0.6	0.6	<0.6	3	<3	3	<3
Octa CDD	ng/kg		1	<1	2	<2	8	<8	6	<6
2,3,7,8-Tetra CDF	ng/kg		0.5	0.8	0.4	0.9	0.8	2.1	0.8	1.1
1,2,3,7,8-Penta CDF	ng/kg		0.6	<0.6	0.8	<0.8	2	<2	0.9	<0.9
2,3,4,7,8-Penta CDF	ng/kg		0.5	<0.5	0.6	<0.6	2	<2	0.7	<0.7
1,2,3,4,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.9	<0.9	1	<1	1	1
1,2,3,6,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.9	<0.9	1	<1	1	<1
2,3,4,6,7,8-Hexa CDF	ng/kg		0.5	<0.5	1	<1	1	<1	1	<1
1,2,3,7,8,9-Hexa CDF	ng/kg		0.7	<0.7	2	<2	2	<2	1	<1
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.4	0.5	1	<1	2	<2	0.9	1.3
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.6	<0.6	2	<2	3	<3	2	<2
Octa CDF	ng/kg		1	<1	3	<3	2	<2	6	<6
Total Tetrachlorodibenzodioxins	ng/kg		0.4	1.1	0.2	0.2	0.4	1.7	0.5	0.6
Total Pentachlorodibenzodioxins	ng/kg		0.4	1.1	0.8	1.3	2	<2	0.6	0.8
Total Hexachlorodibenzodioxins	ng/kg		0.5	1.9	1	2	1	4	1	3
Total Heptachlorodibenzodioxins	ng/kg		.6	1.8	0.6	0.7	3	<3	3	<3
Total PCDDs	ng/kg		1	6	2	4	8	<8	6	6
Total Tetrachlorodibenzofurans	ng/kg		0.5	5.0	0.4	3.3	0.8	7.1	0.8	2.9
Total Pentachlorodibenzofurans	ng/kg		0.6	2.3	0.8	1.8	2	2	0.9	1.6
Total Hexachlorodibenzofurans	ng/kg		0.7	1.2	2	2	2	2	1	2
Total Heptachlorodibenzofurans	ng/kg		0.6	2.1	2	2	3	4	2	<2
Total PCDFs	ng/kg		1	11	3	9	3	16	6	8
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0

Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

AGAT Laboratories
11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
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TEL (902)468-8718
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http://www.agatlabs.com

CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	LOB N5		LOB N6		LOB N7		LOB N8
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9397226	RDL	9397228	RDL	9397235	RDL	9397237
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0		0		0		0
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0.0760		0.0878		0.205		0.114
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0.119
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0.00478		0		0		0.0133
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.0808		0.0878		0.205		0.246

Certificate of Analysis

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

		SAMPLE DESCRIPTION:	LOB N5	LOB N6	LOB N7	LOB N8
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	9397226	9397228	9397235	9397237
13C-2378-TCDF	%	30-140	49	58	41	44
13C-12378-PeCDF	%	30-140	45	47	39	39
13C-23478-PeCDF	%	30-140	48	63	39	51
13C-123478-HxCDF	%	30-140	62	70	63	58
13C-123678-HxCDF	%	30-140	62	83	65	65
13C-234678-HxCDF	%	30-140	62	74	63	56
13C-123789-HxCDF	%	30-140	58	61	54	40
13C-1234678-HpCDF	%	30-140	50	56	45	44
13C-1234789-HpCDF	%	30-140	50	53	44	37
13C-2378-TCDD	%	30-140	65	75	55	54
13C-12378-PeCDD	%	30-140	58	63	44	48
13C-123478-HxCDD	%	30-140	74	73	60	55
13C-123678-HxCDD	%	30-140	75	86	73	69
13C-1234678-HpCDD	%	30-140	56	61	45	41
13C-OCDD	%	30-140	42	36	39	32

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SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	LOB NE1	RDL	LOB NE3	RDL	LOB NE6	RDL	LOB NE7
		SAMPLE TYPE:		Tissue		Tissue		Tissue		Tissue
		DATE SAMPLED:		2018-07-11		2018-07-11		2018-07-11		2018-07-11
				9387264		9387266		9387267		9387268
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.3	<0.3	0.4	<0.4
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4	0.3	<0.3	2	<2	0.9	<0.9
1,2,3,4,7,8-Hexa CDD	ng/kg		0.4	<0.4	0.4	<0.4	1	1	0.8	<0.8
1,2,3,6,7,8-Hexa CDD	ng/kg		0.4	<0.4	0.4	<0.4	0.9	<0.9	0.6	<0.6
1,2,3,7,8,9-Hexa CDD	ng/kg		0.4	<0.4	0.4	<0.4	1	<1	0.7	<0.7
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	<0.6	0.6	<0.6	2	<2	0.9	<0.9
Octa CDD	ng/kg		2	<2	3	<3	1	2	3	4
2,3,7,8-Tetra CDF	ng/kg		0.3	0.5	0.2	0.4	0.4	<0.4	0.4	1.3
1,2,3,7,8-Penta CDF	ng/kg		0.3	0.4	0.5	<0.5	2	<2	1	<1
2,3,4,7,8-Penta CDF	ng/kg		0.2	0.3	0.4	<0.4	2	<2	1	<1
1,2,3,4,7,8-Hexa CDF	ng/kg		0.4	<0.4	0.5	<0.5	0.8	3.6	1	1
1,2,3,6,7,8-Hexa CDF	ng/kg		0.4	<0.4	0.5	<0.5	0.7	<0.7	0.9	<0.9
2,3,4,6,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.5	<0.5	0.8	<0.8	1	<1
1,2,3,7,8,9-Hexa CDF	ng/kg		0.5	<0.5	0.8	<0.8	1	<1	2	<2
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.5	0.6	0.8	<0.8	0.9	1.6	1	1
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.9	<0.9	1	<1	1	<1	2	<2
Octa CDF	ng/kg		1	<1	2	<2	10	<10	3	5
Total Tetrachlorodibenzodioxins	ng/kg		0.2	0.6	0.2	1.2	0.3	0.7	0.4	1.7
Total Pentachlorodibenzodioxins	ng/kg		0.4	0.5	0.3	0.8	2	<2	0.9	2.2
Total Hexachlorodibenzodioxins	ng/kg		0.4	1.3	0.4	1.3	1	4	0.8	2.7
Total Heptachlorodibenzodioxins	ng/kg		0.6	0.9	0.6	<0.6	2	3	0.9	2.0
Total PCDDs	ng/kg		2	3	3	4	2	10	3	13
Total Tetrachlorodibenzofurans	ng/kg		0.3	2.9	0.2	2.7	0.4	7.1	0.4	6.4
Total Pentachlorodibenzofurans	ng/kg		0.3	2.5	0.5	2.1	2	5	1	7
Total Hexachlorodibenzofurans	ng/kg		0.5	0.6	0.8	0.9	1	6	2	5
Total Heptachlorodibenzofurans	ng/kg		0.9	2.5	1	1	1	4	2	6
Total PCDFs	ng/kg		1	8	2	7	10	21	3	29
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0.101		0

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
CANADA B3B 1M2
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FAX (902)468-8924
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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	LOB NE1	RDL	LOB NE3	RDL	LOB NE6	RDL	LOB NE7
		SAMPLE TYPE:		Tissue		Tissue		Tissue		Tissue
		DATE SAMPLED:		2018-07-11		2018-07-11		2018-07-11		2018-07-11
				9387264		9387266		9387267		9387268
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0		0		0.000709		0.00125
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0.0451		0.0404		0.0662		0.133
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0.0112		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0.0823		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0.360		0.114
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0.00634		0		0.0156		0.0139
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0.00152
Total PCDDs and PCDFs (TEQ)	TEQ			0.145		0.0404		0.544		0.263

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

11 Morris Drive, Unit 122
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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:
ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:	LOB NE1	LOB NE3	LOB NE6	LOB NE7
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	9387254	9387256	9387257	9387258
13C-2378-TCDF	%	30-140	47	48	57	64
13C-12378-PeCDF	%	30-140	43	46	46	60
13C-23478-PeCDF	%	30-140	47	48	66	40
13C-123478-HxCDF	%	30-140	59	59	69	63
13C-123678-HxCDF	%	30-140	65	60	87	80
13C-234678-HxCDF	%	30-140	66	61	74	74
13C-123789-HxCDF	%	30-140	57	53	59	65
13C-1234678-HpCDF	%	30-140	49	45	46	55
13C-1234789-HpCDF	%	30-140	49	44	36	52
13C-2378-TCDD	%	30-140	62	65	69	80
13C-12378-PeCDD	%	30-140	53	54	62	49
13C-123478-HxCDD	%	30-140	68	68	67	70
13C-123678-HxCDD	%	30-140	76	71	92	88
13C-1234678-HpCDD	%	30-140	55	50	47	58
13C-OCDD	%	30-140	41	33	32	35

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Certificate of Analysis

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PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:
ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	LOB NE8		LOB N3-Dup		LOB NE6-Dup
			SAMPLE TYPE:	Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9387260	RDL	9408836	RDL	9408837
2,3,7,8-Tetra CDD	ng/kg		0.3	<0.3	0.5	<0.5	0.4	<0.4
1,2,3,7,8-Penta CDD	ng/kg		0.5	<0.5	1	<1	0.5	<0.5
1,2,3,4,7,8-Hexa CDD	ng/kg		0.5	<0.5	2	<2	1	<1
1,2,3,6,7,8-Hexa CDD	ng/kg		0.5	<0.5	2	<2	0.9	<0.9
1,2,3,7,8,9-Hexa CDD	ng/kg		0.5	<0.5	2	<2	1	<1
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.6	<0.6	1	2	2	<2
Octa CDD	ng/kg		1	1	7	<7	2	<2
2,3,7,8-Tetra CDF	ng/kg		0.4	0.6	0.7	<0.7	0.8	<0.8
1,2,3,7,8-Penta CDF	ng/kg		0.6	<0.6	0.9	<0.9	0.8	<0.8
2,3,4,7,8-Penta CDF	ng/kg		0.5	<0.5	0.7	<0.7	0.6	<0.6
1,2,3,4,7,8-Hexa CDF	ng/kg		0.5	0.6	1	<1	0.7	<0.7
1,2,3,6,7,8-Hexa CDF	ng/kg		0.4	<0.4	0.8	<0.8	0.8	1.0
2,3,4,6,7,8-Hexa CDF	ng/kg		0.5	<0.5	1	<1	0.8	0.9
1,2,3,7,8,9-Hexa CDF	ng/kg		0.7	<0.7	1	<1	1	<1
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.5	<0.5	1	<1	0.8	<0.8
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.6	<0.6	2	<2	1	<1
Octa CDF	ng/kg		2	2	3	<3	10	<10
Total Tetrachlorodibenzodioxins	ng/kg		0.3	0.6	0.5	1.1	0.4	0.6
Total Pentachlorodibenzodioxins	ng/kg		0.5	0.7	1	2	0.5	0.7
Total Hexachlorodibenzodioxins	ng/kg		0.5	2.1	2	<2	1	2
Total Heptachlorodibenzodioxins	ng/kg		0.6	1.3	1	4	2	<2
Total PCDDs	ng/kg		1	6	7	9	2	3
Total Tetrachlorodibenzofurans	ng/kg		0.4	3.2	0.7	5.5	0.8	3.5
Total Pentachlorodibenzofurans	ng/kg		0.6	2.2	0.9	2.0	0.8	1.3
Total Hexachlorodibenzofurans	ng/kg		0.7	1.3	1	4	1	3
Total Heptachlorodibenzofurans	ng/kg		0.6	0.8	2	<2	1	<1
Total PCDFs	ng/kg		2	9	3	14	10	<10
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0

Certificate of Analysis

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AGAT WORK ORDER: 18X361283
PROJECT: Lobster

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CLIENT NAME: NOVA SCOTIA LANDS INC **ATTENTION TO: Tony Walker**
SAMPLING SITE: **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	LOB NE8		LOB N3-Dup		LOB NE8-Dup
			SAMPLE TYPE:	Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11
Parameter	**Unit**	**G / S**	**RDL**	**9397260**	**RDL**	**9408936**	**RDL**	**9408937**
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0.0171		0
Octa CDD (TEF 0.0003)	TEQ			0.000372		0		0
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0.0622		0		0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0.0558		0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0.092
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0.0882
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0
Octa CDF (TEF 0.0003)	TEQ			0.000505		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.119		0.0171		0.187

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Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

		SAMPLE DESCRIPTION:	LOB NE8	LOB N3-Dup	LOB NE8-Dup
		SAMPLE TYPE:	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11
Surrogate	**Unit**	**Acceptable Limits**	**9397260**	**9408936**	**9408937**
13C-2378-TCDF	%	30-140	40	42	50
13C-12378-PeCDF	%	30-140	38	34	45
13C-23478-PeCDF	%	30-140	40	40	57
13C-123478-HxCDF	%	30-140	53	53	65
13C-123678-HxCDF	%	30-140	57	63	77
13C-234678-HxCDF	%	30-140	54	58	65
13C-123789-HxCDF	%	30-140	50	54	57
13C-1234678-HpCDF	%	30-140	42	43	49
13C-1234789-HpCDF	%	30-140	45	50	43
13C-2378-TCDD	%	30-140	53	53	63
13C-12378-PeCDD	%	30-140	46	41	56
13C-123478-HxCDD	%	30-140	61	65	69
13C-123678-HxCDD	%	30-140	67	66	86
13C-1234678-HpCDD	%	30-140	48	54	54
13C-OCDD	%	30-140	33	36	35

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9397190-9408937 The results were corrected based on the surrogate percent recoveries.

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AGAT Laboratories

Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC | AGAT WORK ORDER: 18X361283
PROJECT: Lobster | ATTENTION TO: Tony Walker
SAMPLING SITE: | SAMPLED BY:

Soil Analysis

RPT Date: Aug 01, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Mercury Analysis in Tissue															
Mercury in Tissue	1	9397256	<0.05	<0.05	NA	< 0.05	87%	70%	130%	NA	70%	130%	95%	70%	130%
Metals in Tissue															
Aluminum	9406935	9406935	<10	<10	NA	< 10	104%	70%	130%	102%	70%	130%	NA	70%	130%
Antimony	9406935	9406935	<2	<2	NA	< 2	85%	70%	130%	104%	70%	130%	NA	70%	130%
Arsenic	9406935	9406935	5	5	NA	< 2	95%	70%	130%	94%	70%	130%	NA	70%	130%
Barium	9406935	9406935	<5	<5	NA	< 5	94%	70%	130%	94%	70%	130%	NA	70%	130%
Beryllium	9406935	9406935	<2	<2	NA	< 2	103%	70%	130%	100%	70%	130%	NA	70%	130%
Bismuth	9406935	9406935	<5	<5	NA	< 5	101%	70%	130%	NA	130%	130%	NA	70%	130%
Boron	9406935	9406935	<2	<2	NA	< 2	102%	70%	130%	103%	70%	130%	NA	70%	130%
Cadmium	9406935	9406935	0.4	0.4	NA	< 0.3	93%	70%	130%	95%	70%	130%	NA	70%	130%
Chromium	9406935	9406935	<2	<2	NA	< 2	99%	70%	130%	98%	70%	130%	NA	70%	130%
Cobalt	9406935	9406935	<1	<1	NA	< 1	102%	70%	130%	101%	70%	130%	NA	70%	130%
Copper	9406935	9406935	15	15	2.2%	< 2	102%	70%	130%	101%	70%	130%	NA	70%	130%
Iron	9406935	9406935	<50	<50	NA	< 50	105%	70%	130%	106%	70%	130%	NA	70%	130%
Lead	9406935	9406935	<0.4	<0.4	NA	< 0.4	106%	70%	130%	107%	70%	130%	NA	70%	130%
Manganese	9406935	9406935	7	4	NA	< 2	111%	70%	130%	112%	70%	130%	NA	70%	130%
Molybdenum	9406935	9406935	<2	<2	NA	< 2	96%	90%	110%	97%	90%	110%	NA	70%	130%
Nickel	9406935	9406935	<2	<2	NA	< 2	101%	70%	130%	99%	70%	130%	NA	70%	130%
Selenium	9406935	9406935	<1	<1	NA	< 1	97%	70%	130%	94%	70%	130%	NA	70%	130%
Silver	9406935	9406935	<0.5	<0.5	NA	< 0.5	100%	70%	130%	101%	70%	130%	NA	70%	130%
Strontium	9406935	9406935	14	8	NA	< 5	103%	70%	130%	105%	70%	130%	NA	70%	130%
Thallium	9406935	9406935	<0.1	<0.1	NA	< 0.1	102%	70%	130%	101%	70%	130%	NA	70%	130%
Tin	9406935	9406935	<2	<2	NA	< 2	93%	70%	130%	95%	70%	130%	NA	70%	130%
Uranium	9406935	9406935	<0.1	<0.1	NA	< 0.1	101%	70%	130%	99%	70%	130%	NA	70%	130%
Vanadium	9406935	9406935	<2	<2	NA	< 2	98%	70%	130%	98%	70%	130%	NA	70%	130%
Zinc	9406935	9406935	37	36	4.8%	< 5	99%	70%	130%	102%	70%	130%	NA	70%	130%

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC
PROJECT: Lobster
SAMPLING SITE:

AGAT WORK ORDER: 18X361283
ATTENTION TO: Tony Walker
SAMPLED BY:

Ultra Trace Analysis

RPT Date: Aug 01, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Dioxins and Furans (Tissue, WHO 2005)															
2,3,7,8-Tetra CDD	1	9397224	< 0.4	< 0.3	NA	< 0.1	93%	40%	130%	NA	40%	130%	83%	40%	130%
1,2,3,7,8-Penta CDD	1	9397224	< 0.5	< 0.7	NA	< 0.2	89%	40%	130%	NA	40%	130%	98%	40%	130%
1,2,3,4,7,8-Hexa CDD	1	9397224	< 0.7	< 0.8	NA	< 0.2	93%	40%	130%	NA	40%	130%	94%	40%	130%
1,2,3,6,7,8-Hexa CDD	1	9397224	< 0.6	< 0.8	NA	< 0.1	96%	40%	130%	NA	40%	130%	99%	40%	130%
1,2,3,7,8,9-Hexa CDD	1	9397224	< 0.7	< 0.7	NA	< 0.1	94%	40%	130%	NA	40%	130%	100%	40%	130%
1,2,3,4,6,7,8-Hepta CDD	1	9397224	< 1	< 1	NA	< 0.6	92%	40%	130%	NA	40%	130%	91%	40%	130%
Octa CDD	1	9397224	< 2	< 2	NA	< 0.4	92%	40%	130%	NA	40%	130%	90%	40%	130%
2,3,7,8-Tetra CDF	1	9397224	< 0.6	< 0.5	NA	< 0.1	99%	40%	130%	NA	40%	130%	99%	40%	130%
1,2,3,7,8-Penta CDF	1	9397224	< 0.9	< 1	NA	< 0.2	103%	40%	130%	NA	40%	130%	104%	40%	130%
2,3,4,7,8-Penta CDF	1	9397224	0.9	< 0.8	NA	< 0.1	109%	40%	130%	NA	40%	130%	108%	40%	130%
1,2,3,4,7,8-Hexa CDF	1	9397224	< 0.5	< 0.7	NA	< 0.2	103%	40%	130%	NA	40%	130%	108%	40%	130%
1,2,3,6,7,8-Hexa CDF	1	9397224	< 0.6	< 0.6	NA	< 0.2	96%	40%	130%	NA	40%	130%	104%	40%	130%
2,3,4,6,7,8-Hexa CDF	1	9397224	< 0.6	< 0.6	NA	< 0.2	106%	40%	130%	NA	40%	130%	105%	40%	130%
1,2,3,7,8,9-Hexa CDF	1	9397224	< 0.8	< 0.9	NA	< 0.2	94%	40%	130%	NA	40%	130%	103%	40%	130%
1,2,3,4,6,7,8-Hepta CDF	1	9397224	< 1	< 2	NA	< 0.2	102%	40%	130%	NA	40%	130%	106%	40%	130%
1,2,3,4,7,8,9-Hepta CDF	1	9397224	< 2	< 3	NA	< 0.2	95%	40%	130%	NA	40%	130%	104%	40%	130%
Octa CDF	1	9397224	< 2	< 3	NA	< 0.3	85%	40%	130%	NA	40%	130%	91%	40%	130%

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Certificate of Analysis

AGAT WORK ORDER: 18X361283
PROJECT: Lobster

CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Mercury Analysis in Tissue

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:		LOB N1	LOB N2	LOB N3	LOB N4	LOB N5	LOB N6	LOB N7	LOB N8
		SAMPLE TYPE:		Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:		2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	Unit	G / S	RDL	8387190	8387210	8387222	8387224	8387226	8387228	8387236	8387237
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

		SAMPLE DESCRIPTION:		LOB NE1	LOB NE3	LOB NE6	LOB NE7	LOB NE8	LOB N3-Dup	LOB NE6-Dup
		SAMPLE TYPE:		Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:		2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	Unit	G / S	RDL	8387254	8387256	8387257	8387258	8387260	8406836	8406837
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
8387190-8406837 Results are based on the wet weight of the sample.

Methyl Mercury Results

Flett Research Ltd.

[illegible] Winnipeg, MB [illegible]

[illegible]

E-mail: [illegible] Webpage: [illegible]

[illegible]

Page 1 of 1

CLIENT: AGAT Labs - Dartmouth: 18x361283

Unit 122-11 Morris Drive

Dartmouth, NS B3B 1M2

Date Received: July 24, 2018

Sampling Date: July 11, 2018

Matrix: Tissue (wet)

Transaction ID: 718

PO/Contract No.:

Date Analysed: July 27, 2018

Analyst(s): Xiang W.

Analytical Method: [illegible] Methyl Mercury in Tissue by Digestion, Aqueous Ethylation, Purge & Trap, and CVAFS with an Automated System (Version 2)

Comments: Samples are wet tissues which were homogenized at AGAT.

Detection Limit: 4 ng/g (ML) MDL = 1 ng/g The MDL was determined based on 7 replicates of analytical blanks (99% confidence level) and a 100 mg wet sample size.

For reporting purposes results will be flagged below the ML which is considered a practical quantitation limit.

Estimated Uncertainty: The estimated uncertainty of this method has been determined to be ± 13% at a concentration level of 4470 ng/g (95% confidence)

Results authorized by: Dr. Robert J. Flett, Chief Scientist

QUALITY DATA

Blanks		pg of MeHg in whole ethylation EPA vial	Gross Peak Area	Mean Ethylation Blank (ng/L)
	Ethylation blank (H_2O+Reagent)	0.42	1422	0.01
	Mean Eth. Blank (last 30 runs)	0.30		0.01
		Net pg MeHg in whole Ethylation EPA vial	Gross Peak Area	Equiv. CH_3Hg Conc. based on current batch mean weight (0.0986g) of wet sample, ng/g (Note)
	Method Blank 1	-0.30	387	-0.298
	Method Blank 2	-0.29	437	-0.287
	Method Blank 3	0.01	1448	0.007
	Mean Method Blank	-0.20		-0.195
Standards		MeHg Standard Added to Ethylation EPA Vial (pg CH_3Hg)	Gross Peak Area	Net Corrected MeHg Std Calibration Factor (units / pg)
	Mean Value			3766

Spike Recovery	Sample Identification	Sample Type	Gross Peak Area	% CH_3Hg Recovery Used for Calculations	Wet Sample Mass (g)	Net CH_3Hg as Hg (ng/g Wet Wt)	CH_3Hg Recovery (%)
	[illegible] (LCB N8)	MS	220430	100%	0.101	56	85.7
	[illegible] (LCB N8)	MSD	222613	100%	0.098	67	96.6
	Mean of Recoveries						91.1
QC Samples	Dorm-4 [illegible]		321862	100%	0.025		95.3
	Dorm-4 [illegible]	Repeat Aliquot	313604	100%	0.025		92.9
	Mean of Dorm-4						94.1
[illegible]	A.S.S. [illegible] (1000 ng/L)		186409	100%		[illegible]	106.7

LAB ID	Sampling Details	Sample ID	Date Sampled	Sample Type	Gross Peak Area	% CH_3Hg Recovery Used for Calculations	Weighed Wet Sample Mass (g)	Net CH_3Hg as Hg (ng/g) Wet Wt. [recovery corrected]
92009	[illegible]	LCB N1	July 11, 2018		140111	91.1	0.1008	37.3
92010	[illegible]	LCB N2	July 11, 2018		122080	91.1	0.0844	53.4
92011	[illegible]	LCB N8	July 11, 2018		31886	91.1	0.0959	15.3
92012	[illegible]	LCB N81	July 11, 2018		186242	91.1	0.1102	41.8
92013	[illegible]	LCB N83	July 11, 2018		162158	91.1	0.1064	47.2
92014	[illegible]	LCB N88	July 11, 2018	Dup#1	87510	91.1	0.0907	20.3
92014	[illegible]	LCB N88	July 11, 2018	Dup#2	88560	91.1	0.0844	22.7

* : See 'Comments' section above for discussion.

[illegible]

This test report shall not be reproduced, except in full, without written approval of the laboratory.
Note: Results relate only to the items tested.

Dup : Duplicate - two subsamples of the same sample carried through the analytical procedure in an identical manner.

CALA

[illegible]

[illegible]

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CLIENT NAME: NOVA SCOTIA LANDS INC
PO BOX 430, STATION A
SYDNEY , NS B1P6H2
(902) 564-7933

ATTENTION TO: Tony Walker

PROJECT:

AGAT WORK ORDER: 18X361280

MISCELLANEOUS ANALYSIS REVIEWED BY: Kelly Hogue, B.Sc, P.Chem, Operations Manager

SOIL ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

ULTRA TRACE REVIEWED BY: Philippe Morneau, chimiste

DATE REPORTED: Aug 01, 2018

PAGES (INCLUDING COVER): 25

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 18X361280
PROJECT:

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Subcontracted Data Received

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

Parameter	Unit	G / S	RDL	CNE1	CNE2	CNE8	C N8	C N3	C N2
SAMPLE TYPE:				Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
DATE SAMPLED:				2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
				8387166	8387168	8387180	8387188	8387188	8387189
Subcontracted Data				Y	Y	Y	Y	Y	Y

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certificate of Analysis

AGAT WORK ORDER: 18X361280
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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Mercury Analysis in Tissue

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	CNE1	CNE2	CNE3	CNE5	CNE6	CNE7	CNE8	C N8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	**Unit**	**G / S**	**RDL**	9397166	9397168	9397169	9397172	9397173	9397174	9397180	9397188
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

			SAMPLE DESCRIPTION:	C N7	C N6	C N4	C N3	C N2
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	**Unit**	**G / S**	**RDL**	9397182	9397183	9397184	9397186	9397189
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9397166-9397189 Results are based on the wet weight of the sample.

Certificate of Analysis

AGAT WORK ORDER: 18X361280
PROJECT:

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Metals in Tissue

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	CNE1	CNE2	CNE3	CNE5	CNE6	CNE7	CNE8	C N8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Parameter	**Unit**	**G / S**	**RDL**	9397166	9397168	9397169	9397172	9397173	9397174	9397180	9397188
Aluminum	mg/kg		10	18	<10	10	32	40	<10	33	14
Antimony	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg		2	3	5	2	5	5	5	3	5
Barium	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg		2	<2	<2	2	<2	<2	<2	<2	2
Cadmium	mg/kg		0.3	0.4	0.5	0.9	1.6	0.8	0.7	2.9	3.9
Chromium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg		2	12	18	20	19	16	16	30	23
Iron	mg/kg		50	<50	<50	<50	60	82	<50	63	<50
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Manganese	mg/kg		2	4	4	8	11	8	7	10	6
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg		1	<1	2	<1	2	1	1	1	2
Silver	mg/kg		0.5	<0.5	0.6	<0.5	0.6	0.6	<0.5	0.9	0.8
Strontium	mg/kg		5	25	36	20	61	50	91	25	50
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg		5	24	36	28	39	35	34	27	39

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Certificate of Analysis

AGAT WORK ORDER: 18X361280
PROJECT:

CLIENT NAME: NOVA SCOTIA LANDS INC — **ATTENTION TO: Tony Walker**
SAMPLING SITE: — **SAMPLED BY:**

Metals in Tissue

DATE RECEIVED: 2018-07-12 — **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	C N7	C N8	C N4	C N3	C N2
SAMPLE DESCRIPTION:				C N7	C N8	C N4	C N3	C N2
SAMPLE TYPE:				Tissue	Tissue	Tissue	Tissue	Tissue
DATE SAMPLED:				2018-07-11	2018-07-11	2018-07-11	2018-07-11	2018-07-11
				8387192	8387193	8387194	8387198	8387199
Aluminum	mg/kg		10	10	20	50	17	<10
Antimony	mg/kg		2	<2	<2	<2	<2	<2
Arsenic	mg/kg		2	5	4	4	4	4
Barium	mg/kg		5	<5	<5	<5	<5	<5
Beryllium	mg/kg		2	<2	<2	<2	<2	<2
Bismuth	mg/kg		5	<5	<5	<5	<5	<5
Boron	mg/kg		2	<2	<2	2	<2	<2
Cadmium	mg/kg		0.3	0.6	0.8	1.6	0.8	1.0
Chromium	mg/kg		2	<2	<2	<2	<2	<2
Cobalt	mg/kg		1	<1	<1	<1	<1	<1
Copper	mg/kg		2	16	20	36	18	12
Iron	mg/kg		50	<50	59	95	51	<50
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	0.9	<0.4
Manganese	mg/kg		2	4	14	17	6	5
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	<2	<2	<2	<2	<2
Selenium	mg/kg		1	2	1	1	1	1
Silver	mg/kg		0.5	0.5	0.6	1.0	0.6	<0.5
Strontium	mg/kg		5	38	95	29	43	38
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg		2	<2	<2	<2	<2	<2
Zinc	mg/kg		5	37	34	26	42	39

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
8387166-8387199 Results are based on the wet weight of the sample.

AGAT Laboratories
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Certificate of Analysis

AGAT WORK ORDER: 18X361280
PROJECT:

CLIENT NAME: NOVA SCOTIA LANDS INC — **ATTENTION TO: Tony Walker**
SAMPLING SITE: — **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 — **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	CNE1	RDL	CNE2	RDL	CNE3	RDL	CNE5
SAMPLE DESCRIPTION:				CNE1		CNE2		CNE3		CNE5
SAMPLE TYPE:				Tissue		Tissue		Tissue		Tissue
DATE SAMPLED:				2018-07-11		2018-07-11		2018-07-11		2018-07-11
				8387166		8387168		8387169		8387172
2,3,7,8-Tetra CDD	ng/kg		0.4	<0.4	0.2	<0.2	0.2	<0.2	0.6	<0.6
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4	0.4	<0.4	0.5	<0.5	0.6	<0.6
1,2,3,4,7,8-Hexa CDD	ng/kg		0.5	<0.5	0.3	<0.3	0.5	<0.5	0.9	<0.9
1,2,3,6,7,8-Hexa CDD	ng/kg		0.4	<0.4	0.2	<0.2	0.4	<0.4	0.8	<0.8
1,2,3,7,8,9-Hexa CDD	ng/kg		0.4	<0.4	0.3	<0.3	0.4	<0.4	0.8	<0.8
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.5	<0.5	0.6	<0.6	1	1	1	<1
Octa CDD	ng/kg		1	<1	0.7	0.7	0.9	1.2	1	2
2,3,7,8-Tetra CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.3	<0.3	0.5	0.6
1,2,3,7,8-Penta CDF	ng/kg		0.3	<0.3	0.4	<0.4	0.2	<0.2	0.7	<0.7
2,3,4,7,8-Penta CDF	ng/kg		0.2	<0.2	0.3	<0.3	0.2	<0.2	0.6	<0.6
1,2,3,4,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.6	<0.6	0.3	<0.3	0.5	0.6
1,2,3,6,7,8-Hexa CDF	ng/kg		0.4	<0.4	0.5	<0.5	0.3	<0.3	0.4	<0.4
2,3,4,6,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.5	<0.5	0.3	<0.3	0.4	<0.4
1,2,3,7,8,9-Hexa CDF	ng/kg		0.8	<0.8	0.9	<0.9	0.5	<0.5	0.7	<0.7
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.4	<0.4	0.4	<0.4	0.4	<0.4	0.9	<0.9
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.6	<0.6	0.6	<0.6	0.6	<0.6	1	<1
Octa CDF	ng/kg		1	<1	0.9	<0.9	2	<2	3	<3
Total Tetrachlorodibenzodioxins	ng/kg		0.4	0.6	0.2	<0.2	0.2	1.7	0.6	2.0
Total Pentachlorodibenzodioxins	ng/kg		0.4	0.5	0.4	0.8	0.5	1.8	0.6	1.6
Total Hexachlorodibenzodioxins	ng/kg		0.5	1.5	0.3	1.0	0.5	5.0	0.9	3.1
Total Heptachlorodibenzodioxins	ng/kg		0.5	1.0	0.6	1.0	1	3	1	6
Total PCDDs	ng/kg		1	4	0.7	3.4	1	13	2	14
Total Tetrachlorodibenzofurans	ng/kg		0.3	0.9	0.3	1.4	0.3	0.9	0.5	5.9
Total Pentachlorodibenzofurans	ng/kg		0.3	1.2	0.4	2.7	0.2	0.6	0.7	3.6
Total Hexachlorodibenzofurans	ng/kg		0.8	0.9	0.9	1.0	0.5	0.7	0.7	2.3
Total Heptachlorodibenzofurans	ng/kg		0.6	0.7	0.6	<0.6	0.6	0.8	1	5
Total PCDFs	ng/kg		1	3.7	0.9	5.3	2	3	3	17
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0

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CLIENT NAME: NOVA SCOTIA LANDS INC **ATTENTION TO: Tony Walker**
SAMPLING SITE: **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	CNE1		CNE2		CNE3		CNE5
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	8387166	RDL	8387168	RDL	8387169	RDL	8387172
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0		0.000207		0.0125		0.000539
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0		0		0.000358		0.0599
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0.0597
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0		0.000207		0.0129		0.120

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SAMPLING SITE: SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	CNE1		CNE2		CNE3		CNE5
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	8387166	RDL	8387168	RDL	8387169	RDL	8387172
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0		0.000207		0.0125		0.000539
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0		0		0.000358		0.0599
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0.0597
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0		0.000207		0.0129		0.120

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

		SAMPLE DESCRIPTION:	CNE1	CNE2	CNE3	CNE5
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	9397166	9397168	9397169	9397172
13C-2378-TCDF	%	30-140	51	108	55	55
13C-12378-PeCDF	%	30-140	48	71	50	51
13C-23478-PeCDF	%	30-140	64	64	59	60
13C-123478-HxCDF	%	30-140	56	54	65	63
13C-123678-HxCDF	%	30-140	82	76	98	61
13C-234678-HxCDF	%	30-140	69	74	81	70
13C-123789-HxCDF	%	30-140	61	60	64	59
13C-1234678-HpCDF	%	30-140	54	51	58	47
13C-1234789-HpCDF	%	30-140	45	40	49	43
13C-2378-TCDD	%	30-140	44	40	68	68
13C-12378-PeCDD	%	30-140	39	52	62	64
13C-123478-HxCDD	%	30-140	68	66	74	74
13C-123678-HxCDD	%	30-140	98	95	107	69
13C-1234678-HpCDD	%	30-140	53	46	59	52
13C-OCDD	%	30-140	36	34	35	35

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	CNE6		CNE7		CNE8		C N8
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9397173	RDL	9397174	RDL	9397180	RDL	9397188
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2	0.3	<0.3	0.4	<0.4	0.3	<0.3
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4	1	<1	0.5	<0.5	0.4	<0.4
1,2,3,4,7,8-Hexa CDD	ng/kg		0.7	<0.7	0.6	<0.6	0.4	0.4	0.3	<0.3
1,2,3,6,7,8-Hexa CDD	ng/kg		0.6	<0.6	0.5	<0.5	0.4	<0.4	0.3	<0.3
1,2,3,7,8,9-Hexa CDD	ng/kg		0.6	<0.6	0.6	<0.6	0.4	<0.4	0.3	<0.3
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.9	<0.9	1	<1	0.5	<0.5	0.6	0.6
Octa CDD	ng/kg		2	<2	1	<1	2	<2	1	<1
2,3,7,8-Tetra CDF	ng/kg		0.3	<0.3	0.4	0.7	0.4	<0.4	0.4	<0.4
1,2,3,7,8-Penta CDF	ng/kg		0.4	<0.4	0.6	<0.6	0.4	<0.4	0.7	<0.7
2,3,4,7,8-Penta CDF	ng/kg		0.3	<0.3	2	<2	0.3	<0.3	0.6	<0.6
1,2,3,4,7,8-Hexa CDF	ng/kg		0.4	<0.4	0.6	<0.6	0.3	<0.3	0.3	0.3
1,2,3,6,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.5	<0.5	0.2	<0.2	0.3	<0.3
2,3,4,6,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.6	<0.6	0.2	<0.2	0.3	<0.3
1,2,3,7,8,9-Hexa CDF	ng/kg		0.5	<0.5	0.8	<0.8	0.5	<0.5	0.4	<0.4
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.4	<0.4	1	<1	0.6	<0.6	0.4	<0.4
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.7	1.0	2	<2	1	<1	0.6	<0.6
Octa CDF	ng/kg		2	<2	2	<2	0.4	0.8	2	<2
Total Tetrachlorodibenzodioxins	ng/kg		0.2	<0.2	0.3	1.5	0.4	<0.4	0.3	3.6
Total Pentachlorodibenzodioxins	ng/kg		0.4	0.7	1	2	0.5	1.1	0.4	1.1
Total Hexachlorodibenzodioxins	ng/kg		0.7	<0.7	0.6	2.7	0.4	1.1	0.3	0.9
Total Heptachlorodibenzodioxins	ng/kg		0.9	1.5	1	4	0.5	0.6	0.6	0.6
Total PCDDs	ng/kg		2	2	1	10	2	3	1	6.2
Total Tetrachlorodibenzofurans	ng/kg		0.3	<0.3	0.4	3.0	0.4	<0.4	0.4	<0.4
Total Pentachlorodibenzofurans	ng/kg		0.4	0.7	2	3.3	0.4	0.4	0.7	1.2
Total Hexachlorodibenzofurans	ng/kg		0.5	0.5	0.8	2.6	0.5	<0.5	0.4	0.9
Total Heptachlorodibenzofurans	ng/kg		0.7	1.7	2	6	1	<1	0.6	1.0
Total PCDFs	ng/kg		2	3	2	15	1	1	2	3
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0.0430		0

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	CNE6		CNE7		CNE8		C N8
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	9397173	RDL	9397174	RDL	9397180	RDL	9397188
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0.00572
Octa CDD (TEF 0.0003)	TEQ			0		0		0		0
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0		0.0659		0		0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0.0302
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0.00950		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0.000246		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.00950		0.0659		0.0433		0.0360

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SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:	CNE6	CNE7	CNE8	C N8
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	9397173	9397174	9397180	9397188
13C-2378-TCDF	%	30-140	33	75	33	44
13C-12378-PeCDF	%	30-140	48	66	33	33
13C-23478-PeCDF	%	30-140	51	35	37	32
13C-123478-HxCDF	%	30-140	40	72	49	46
13C-123678-HxCDF	%	30-140	49	77	71	66
13C-234678-HxCDF	%	30-140	51	71	72	63
13C-123789-HxCDF	%	30-140	45	66	51	52
13C-1234678-HpCDF	%	30-140	35	45	46	41
13C-1234789-HpCDF	%	30-140	30	48	39	34
13C-2378-TCDD	%	30-140	30	91	99	34
13C-12378-PeCDD	%	30-140	30	66	38	41
13C-123478-HxCDD	%	30-140	50	73	63	52
13C-123678-HxCDD	%	30-140	63	80	95	80
13C-1234678-HpCDD	%	30-140	36	51	44	36
13C-OCDD	%	30-140	30	33	30	30

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Dartmouth, Nova Scotia
CANADA B3B 1M2
TEL (902)468-8718
FAX (902)468-8924
http://www.agatlabs.com

CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12

DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	C N7		C N8		C N4		C N3
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	8387182	RDL	8387183	RDL	8387184	RDL	8387188
2,3,7,8-Tetra CDD	ng/kg		0.3	<0.3	0.5	<0.5	0.2	<0.2	0.2	<0.2
1,2,3,7,8-Penta CDD	ng/kg		0.8	<0.8	0.4	<0.4	0.7	<0.7	0.4	<0.4
1,2,3,4,7,8-Hexa CDD	ng/kg		0.5	<0.5	0.7	<0.7	0.5	0.6	0.3	<0.3
1,2,3,6,7,8-Hexa CDD	ng/kg		0.5	<0.5	0.7	<0.7	0.5	<0.5	0.2	<0.2
1,2,3,7,8,9-Hexa CDD	ng/kg		0.5	<0.5	0.7	<0.7	0.5	<0.5	0.2	<0.2
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.7	<0.7	1	<1	0.6	<0.6	0.5	<0.5
Octa CDD	ng/kg		3	3	2	<2	2	<2	1	1
2,3,7,8-Tetra CDF	ng/kg		0.5	<0.5	0.1	0.2	0.2	<0.2	0.3	0.5
1,2,3,7,8-Penta CDF	ng/kg		0.5	<0.5	0.6	<0.6	0.5	<0.5	0.4	<0.4
2,3,4,7,8-Penta CDF	ng/kg		0.4	0.6	0.5	<0.5	0.4	<0.4	0.3	<0.3
1,2,3,4,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.6	<0.6	0.5	<0.5	0.4	<0.4
1,2,3,6,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.6	<0.6	0.5	<0.5	0.4	<0.4
2,3,4,6,7,8-Hexa CDF	ng/kg		0.5	<0.5	0.5	<0.5	0.5	<0.5	0.4	<0.4
1,2,3,7,8,9-Hexa CDF	ng/kg		0.7	<0.7	1	<1	0.7	<0.7	0.6	<0.6
1,2,3,4,6,7,8-Hepta CDF	ng/kg		1	<1	0.9	<0.9	0.6	0.6	0.4	<0.4
1,2,3,4,7,8,9-Hepta CDF	ng/kg		1	<1	1	<1	0.9	<0.9	0.6	<0.6
Octa CDF	ng/kg		2	<2	2	<2	2	<2	0.8	<0.8
Total Tetrachlorodibenzodioxins	ng/kg		0.3	1.6	0.5	0.6	0.2	0.4	0.2	0.2
Total Pentachlorodibenzodioxins	ng/kg		0.8	1.7	0.4	1.9	0.7	1.4	0.4	1.0
Total Hexachlorodibenzodioxins	ng/kg		0.5	1.1	0.7	2.8	0.5	1.9	0.3	1.2
Total Heptachlorodibenzodioxins	ng/kg		0.7	<0.7	1	3	0.6	1.5	0.5	0.7
Total PCDDs	ng/kg		3	8	2	8	2	5	1	4
Total Tetrachlorodibenzofurans	ng/kg		0.5	5.2	0.1	3.7	0.2	<0.2	0.3	2.5
Total Pentachlorodibenzofurans	ng/kg		0.5	3.7	0.6	0.9	0.5	0.8	0.4	1.1
Total Hexachlorodibenzofurans	ng/kg		0.7	1.8	1	1	0.7	0.8	0.6	0.9
Total Heptachlorodibenzofurans	ng/kg		1	2	1	3	0.9	1.8	0.6	0.6
Total PCDFs	ng/kg		2	12	2	9	2	3	0.8	5.1
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0.0581		0

Certificate of Analysis

AGAT Laboratories

AGAT WORK ORDER: 18X361280
PROJECT:

11 Morris Drive, Unit 122
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SAMPLING SITE:

ATTENTION TO: Tony Walker
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Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12

DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	C N7		C N8		C N4		C N3
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-11		2018-07-11		2018-07-11		2018-07-11
Parameter	Unit	G / S	RDL	8387182	RDL	8387183	RDL	8387184	RDL	8387188
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0
Octa CDD (TEF 0.0003)	TEQ			0.000934		0		0		0.000357
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0		0.0197		0		0.0500
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0.186		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0.00613		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.187		0.0197		0.0642		0.0503

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Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

		SAMPLE DESCRIPTION:	C N7	C N6	C N4	C N3
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-11	2018-07-11	2018-07-11	2018-07-11
Surrogate	Unit	Acceptable Limits	9387192	9387193	9387194	9387198
13C-2378-TCDF	%	30-140	34	66	64	61
13C-12378-PeCDF	%	30-140	30	55	48	60
13C-23478-PeCDF	%	30-140	34	74	57	66
13C-123478-HxCDF	%	30-140	49	67	58	59
13C-123678-HxCDF	%	30-140	52	79	59	64
13C-234678-HxCDF	%	30-140	52	112	60	62
13C-123789-HxCDF	%	30-140	49	86	55	65
13C-1234678-HpCDF	%	30-140	36	54	47	56
13C-1234789-HpCDF	%	30-140	41	53	46	47
13C-2378-TCDD	%	30-140	45	84	67	79
13C-12378-PeCDD	%	30-140	38	76	63	76
13C-123478-HxCDD	%	30-140	53	99	63	62
13C-123678-HxCDD	%	30-140	59	122	69	76
13C-1234678-HpCDD	%	30-140	45	59	52	55
13C-OCDD	%	30-140	31	35	38	32

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Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	C N2
			SAMPLE TYPE:	Tissue
			DATE SAMPLED:	2018-07-11
Parameter	Unit	G / S	RDL	9387199
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4
1,2,3,4,7,8-Hexa CDD	ng/kg		0.3	<0.3
1,2,3,6,7,8-Hexa CDD	ng/kg		0.2	<0.2
1,2,3,7,8,9-Hexa CDD	ng/kg		0.3	<0.3
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.9	<0.9
Octa CDD	ng/kg		3	<3
2,3,7,8-Tetra CDF	ng/kg		0.4	<0.4
1,2,3,7,8-Penta CDF	ng/kg		0.4	<0.4
2,3,4,7,8-Penta CDF	ng/kg		0.3	<0.3
1,2,3,4,7,8-Hexa CDF	ng/kg		0.4	<0.4
1,2,3,6,7,8-Hexa CDF	ng/kg		0.3	<0.3
2,3,4,6,7,8-Hexa CDF	ng/kg		0.3	<0.3
1,2,3,7,8,9-Hexa CDF	ng/kg		0.6	<0.6
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.4	<0.4
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.6	<0.6
Octa CDF	ng/kg		2	<2
Total Tetrachlorodibenzodioxins	ng/kg		0.2	<0.2
Total Pentachlorodibenzodioxins	ng/kg		0.4	0.8
Total Hexachlorodibenzodioxins	ng/kg		0.3	0.5
Total Heptachlorodibenzodioxins	ng/kg		0.9	0.9
Total PCDDs	ng/kg		3	<3
Total Tetrachlorodibenzofurans	ng/kg		0.4	<0.4
Total Pentachlorodibenzofurans	ng/kg		0.4	1.5
Total Hexachlorodibenzofurans	ng/kg		0.6	0.8
Total Heptachlorodibenzofurans	ng/kg		0.6	0.6
Total PCDFs	ng/kg		2	3
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0

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Certificate of Analysis

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	C N2
			SAMPLE TYPE:	Tissue
			DATE SAMPLED:	2018-07-11
Parameter	Unit	G / S	RDL	8397199
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0
Octa CDD (TEF 0.0003)	TEQ			0
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0
Octa CDF (TEF 0.0003)	TEQ			0
Total PCDDs and PCDFs (TEQ)	TEQ			0

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Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:	C N2
		SAMPLE TYPE:	Tissue
		DATE SAMPLED:	2018-07-11
Surrogate	Unit	Acceptable Limits	8397199
13C-2378-TCDF	%	30-140	36
13C-12378-PeCDF	%	30-140	32
13C-23478-PeCDF	%	30-140	50
13C-123478-HxCDF	%	30-140	44
13C-123678-HxCDF	%	30-140	60
13C-234678-HxCDF	%	30-140	55
13C-123789-HxCDF	%	30-140	40
13C-1234678-HpCDF	%	30-140	34
13C-1234789-HpCDF	%	30-140	34
13C-2378-TCDD	%	30-140	48
13C-12378-PeCDD	%	30-140	72
13C-123478-HxCDD	%	30-140	52
13C-123678-HxCDD	%	30-140	75
13C-1234678-HpCDD	%	30-140	32
13C-OCDD	%	30-140	30

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8397188-8397199 The results were corrected based on the surrogate percent recoveries.

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC
PROJECT:
SAMPLING SITE:

AGAT WORK ORDER: 18X361280
ATTENTION TO: Tony Walker
SAMPLED BY:

Soil Analysis

RPT Date: Aug 01, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Mercury Analysis in Tissue															
Mercury in Tissue	1	9397199	<0.05	<0.05	NA	< 0.05	74%	70%	130%	NA	70%	130%	90%	70%	130%
Metals in Tissue															
Aluminum	9397199	9397199	<10	<10	NA	< 10	100%	70%	130%	105%	70%	130%	NA	70%	130%
Antimony	9397199	9397199	<2	<2	NA	< 2	90%	70%	130%	105%	70%	130%	NA	70%	130%
Arsenic	9397199	9397199	4	5	NA	< 2	95%	70%	130%	96%	70%	130%	NA	70%	130%
Barium	9397199	9397199	<5	<5	NA	< 5	101%	70%	130%	102%	70%	130%	NA	70%	130%
Beryllium	9397199	9397199	<2	<2	NA	< 2	112%	70%	130%	111%	70%	130%	NA	70%	130%
Bismuth	9397199	9397199	<5	<5	NA	< 5	101%	70%	130%	NA	130%	130%	NA	70%	130%
Boron	9397199	9397199	<2	<2	NA	< 2	103%	70%	130%	107%	70%	130%	NA	70%	130%
Cadmium	9397199	9397199	1.0	1.0	NA	< 0.3	96%	70%	130%	96%	70%	130%	NA	70%	130%
Chromium	9397199	9397199	<2	<2	NA	< 2	98%	70%	130%	94%	70%	130%	NA	70%	130%
Cobalt	9397199	9397199	<1	<1	NA	< 1	97%	70%	130%	94%	70%	130%	NA	70%	130%
Copper	9397199	9397199	11	12	5.8%	< 2	96%	70%	130%	95%	70%	130%	NA	70%	130%
Iron	9397199	9397199	<50	<50	NA	< 50	90%	70%	130%	88%	70%	130%	NA	70%	130%
Lead	9397199	9397199	<0.4	<0.4	NA	< 0.4	104%	70%	130%	108%	70%	130%	NA	70%	130%
Manganese	9397199	9397199	5	5	NA	< 2	107%	70%	130%	109%	70%	130%	NA	70%	130%
Molybdenum	9397199	9397199	<2	<2	NA	< 2	94%	90%	110%	97%	90%	110%	NA	70%	130%
Nickel	9397199	9397199	<2	<2	NA	< 2	98%	70%	130%	96%	70%	130%	NA	70%	130%
Selenium	9397199	9397199	1	1	NA	< 1	90%	70%	130%	96%	70%	130%	NA	70%	130%
Silver	9397199	9397199	<0.5	<0.5	NA	< 0.5	100%	70%	130%	96%	70%	130%	NA	70%	130%
Strontium	9397199	9397199	38	38	2.1%	< 5	102%	70%	130%	104%	70%	130%	NA	70%	130%
Thallium	9397199	9397199	<0.1	<0.1	NA	< 0.1	96%	70%	130%	98%	70%	130%	NA	70%	130%
Tin	9397199	9397199	<2	<2	NA	< 2	96%	70%	130%	96%	70%	130%	NA	70%	130%
Uranium	9397199	9397199	<0.1	<0.1	NA	< 0.1	98%	70%	130%	101%	70%	130%	NA	70%	130%
Vanadium	9397199	9397199	<2	<2	NA	< 2	97%	70%	130%	93%	70%	130%	NA	70%	130%
Zinc	9397199	9397199	39	40	0.9%	< 5	97%	70%	130%	95%	70%	130%	NA	70%	130%

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC
PROJECT:
SAMPLING SITE:

AGAT WORK ORDER: 18X361280
ATTENTION TO: Tony Walker
SAMPLED BY:

Ultra Trace Analysis

RPT Date: Aug 01, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Dioxins and Furans (Tissue, WHO 2005)															
2,3,7,8-Tetra CDD	1	9397224	< 0.4	< 0.3	NA	< 0.1	93%	40%	130%	NA	40%	130%	83%	40%	130%
1,2,3,7,8-Penta CDD	1	9397224	< 0.5	< 0.7	NA	< 0.2	89%	40%	130%	NA	40%	130%	98%	40%	130%
1,2,3,4,7,8-Hexa CDD	1	9397224	< 0.7	< 0.8	NA	< 0.2	93%	40%	130%	NA	40%	130%	94%	40%	130%
1,2,3,6,7,8-Hexa CDD	1	9397224	< 0.6	< 0.8	NA	< 0.1	96%	40%	130%	NA	40%	130%	99%	40%	130%
1,2,3,7,8,9-Hexa CDD	1	9397224	< 0.7	< 0.7	NA	< 0.1	94%	40%	130%	NA	40%	130%	100%	40%	130%
1,2,3,4,6,7,8-Hepta CDD	1	9397224	< 1	< 1	NA	< 0.6	92%	40%	130%	NA	40%	130%	91%	40%	130%
Octa CDD	1	9397224	< 2	< 2	NA	< 0.4	92%	40%	130%	NA	40%	130%	90%	40%	130%
2,3,7,8-Tetra CDF	1	9397224	< 0.6	< 0.5	NA	< 0.1	99%	40%	130%	NA	40%	130%	99%	40%	130%
1,2,3,7,8-Penta CDF	1	9397224	< 0.9	< 1	NA	< 0.2	103%	40%	130%	NA	40%	130%	104%	40%	130%
2,3,4,7,8-Penta CDF	1	9397224	0.9	< 0.8	NA	< 0.1	109%	40%	130%	NA	40%	130%	108%	40%	130%
1,2,3,4,7,8-Hexa CDF	1	9397224	< 0.5	< 0.7	NA	< 0.2	103%	40%	130%	NA	40%	130%	108%	40%	130%
1,2,3,6,7,8-Hexa CDF	1	9397224	< 0.6	< 0.6	NA	< 0.2	98%	40%	130%	NA	40%	130%	104%	40%	130%
2,3,4,6,7,8-Hexa CDF	1	9397224	< 0.6	< 0.6	NA	< 0.2	106%	40%	130%	NA	40%	130%	105%	40%	130%
1,2,3,7,8,9-Hexa CDF	1	9397224	< 0.8	< 0.9	NA	< 0.2	94%	40%	130%	NA	40%	130%	103%	40%	130%
1,2,3,4,6,7,8-Hepta CDF	1	9397224	< 1	< 2	NA	< 0.2	102%	40%	130%	NA	40%	130%	106%	40%	130%
1,2,3,4,7,8,9-Hepta CDF	1	9397224	< 2	< 3	NA	< 0.2	95%	40%	130%	NA	40%	130%	104%	40%	130%
Octa CDF	1	9397224	< 2	< 3	NA	< 0.3	85%	40%	130%	NA	40%	130%	91%	40%	130%
Dioxins and Furans (Tissue, WHO 2005)															
2,3,7,8-Tetra CDD	1	9397198	< 0.2	< 0.2	NA	< 0.2	87%	40%	130%	NA	40%	130%	89%	40%	130%
1,2,3,7,8-Penta CDD	1	9397198	< 0.4	< 0.4	NA	< 0.4	100%	40%	130%	NA	40%	130%	98%	40%	130%
1,2,3,4,7,8-Hexa CDD	1	9397198	< 0.3	< 0.2	NA	< 0.2	96%	40%	130%	NA	40%	130%	103%	40%	130%
1,2,3,6,7,8-Hexa CDD	1	9397198	< 0.2	< 0.2	NA	< 0.2	107%	40%	130%	NA	40%	130%	100%	40%	130%
1,2,3,7,8,9-Hexa CDD	1	9397198	< 0.2	< 0.2	NA	< 0.2	109%	40%	130%	NA	40%	130%	112%	40%	130%
1,2,3,4,6,7,8-Hepta CDD	1	9397198	< 0.5	< 0.5	NA	< 0.5	104%	40%	130%	NA	40%	130%	99%	40%	130%
Octa CDD	1	9397198	1	1	0.0%	< 0.3	104%	40%	130%	NA	40%	130%	95%	40%	130%
2,3,7,8-Tetra CDF	1	9397198	0.5	0.5	0.0%	< 0.3	106%	40%	130%	NA	40%	130%	102%	40%	130%
1,2,3,7,8-Penta CDF	1	9397198	< 0.4	< 0.4	NA	< 0.2	110%	40%	130%	NA	40%	130%	105%	40%	130%
2,3,4,7,8-Penta CDF	1	9397198	< 0.3	< 0.4	NA	< 0.2	118%	40%	130%	NA	40%	130%	114%	40%	130%
1,2,3,4,7,8-Hexa CDF	1	9397198	< 0.4	< 0.4	NA	< 0.3	110%	40%	130%	NA	40%	130%	110%	40%	130%
1,2,3,6,7,8-Hexa CDF	1	9397198	< 0.4	< 0.4	NA	< 0.2	106%	40%	130%	NA	40%	130%	116%	40%	130%
2,3,4,6,7,8-Hexa CDF	1	9397198	< 0.4	< 0.4	NA	< 0.2	110%	40%	130%	NA	40%	130%	114%	40%	130%
1,2,3,7,8,9-Hexa CDF	1	9397198	< 0.6	< 0.6	NA	< 0.3	105%	40%	130%	NA	40%	130%	110%	40%	130%
1,2,3,4,6,7,8-Hepta CDF	1	9397198	< 0.4	< 0.4	NA	< 0.4	108%	40%	130%	NA	40%	130%	108%	40%	130%
1,2,3,4,7,8,9-Hepta CDF	1	9397198	< 0.6	< 0.6	NA	< 0.6	110%	40%	130%	NA	40%	130%	115%	40%	130%
Octa CDF	1	9397198	< 0.8	< 0.4	NA	< 0.4	105%	40%	130%	NA	40%	130%	101%	40%	130%

AGAT Laboratories

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC
PROJECT:
SAMPLING SITE:

AGAT WORK ORDER: 18X361280
ATTENTION TO: Tony Walker
SAMPLED BY:

Ultra Trace Analysis (Continued)

RPT Date: Aug 01, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper

Methyl Mercury Results

Flett Research Ltd.
440 DeSalaberry Ave. Winnipeg, MB R2L 0Y7
Fax/Phone (204) 667-2505
E-mail: flett@flettresearch.ca Webpage: http://www.flettresearch.ca

CLIENT: AGAT Labs - Dartmouth: 18x361280

Unit 122-11 Morris Drive
Dartmouth, NS B3B 1M2

Date Received: July 24, 2018
Sampling Date: July 11, 2018

Matrix: Tissue (wet)
Transaction ID: 718
PO/Contract No.:
Date Analysed: July 27, 2018
Analyst(s): Xiang W.

Analytical Method: M10220: Methyl Mercury in Tissue by Digestion, Aqueous Ethylation, Purge & Trap, and CVAFS with an Automated System (Version 3)

Comments: Samples are wet tissues which were homogenized at AGAT.

Detection Limit: 4 ng/g (ML) MDL = 1 ng/g The MDL was determined based on 7 replicates of analytical blanks (98% confidence level) and a 100 mg wet sample size.

For reporting purposes results will be flagged below the ML which is considered a practical quantitation limit.

Estimated Uncertainty: The estimated uncertainty of this method has been determined to be ± 13% at a concentration level of 4470 ng/g (95% confidence)

Results authorized by Dr. Robert J. Flett, Chief Scientist

QUALITY DATA

Blanks	pg of MeHg in whole ethylation EPA vial	Gross Peak Area	Mean Ethylation Blank (ng/L)
Ethylation blank (H_2O+Reagen	0.42	1422	0.01
Mean Eth. Blank (last 30 runs)	0.30		0.01

Blanks	Net pg MeHg in whole Ethylation EPA vial	Gross Peak Area	Equiv. CH Hg Conc. based on current batch mean weight (0.0971g) of wet sample, ng/g (Blots)
Method Blank 1	-0.30	387	-0.273
Method Blank 2	-0.29	437	-0.244
Method Blank 3	0.01	1448	0.007
Mean Method Blank	-0.20		-0.170

Standards	MeHg Standard Added to Ethylation EPA Vial (pg CH_3Hg)	Gross Peak Area	Net Corrected MeHg Std Calibration Factor (units / pg)
Mean Value			5788

Spike Recovery (Matrix Spike (MS) and Matrix Spike Duplicate (MSD))	Sample Identification	Sample Type	Gross Peak Area	% CH_3Hg Recovery Used for Calculations	Wet Sample Mass (g)	Net CH_3Hg as Hg (ng/g-Wet-Wt)	CH_3Hg Recovery (%)
	Mean of Recoveries of July 27, 2018						91.1
QC Samples	Dorm-4 ID1501 (355± 28 ng/g)		321862	100%	0.025		95.3
	Dorm-4 ID1501 (355± 28 ng/g)	Repeat Aliquot	313604	100%	0.025		92.9
	Mean of Dorm-4						94.1
Alternate Source Standard (A.S.S.)	A.S.S. - Alfa ID1302 (1000 ng/L)		186408	100%		< Net CH_3Hg as Hg (ng/L)	108.7

LAB ID	Sampling Details	Sample ID	Date Sampled	Sample Type	Gross Peak Area	% CH_3Hg Recovery Used for Calculations	Weighed Wet Sample Mass (g)	Net CH3Hg as Hg (ng/g) Wet Wt. [recovery corrected]
89003	9397168C	CNE1	July 11, 2018		117577	91.1	0.0564	57.5
89004	9397168C	CNE2	July 11, 2018		53171	91.1	0.0613	24.0
89005	9397180C	CNE8	July 11, 2018		273254	91.1	0.2338	32.6
89006	9397188C	C N8	July 11, 2018		72788	91.1	0.0745	27.0
89007	9397198C	C N3	July 11, 2018		124832	91.1	0.0874	39.5
89008	9397199C	C N2	July 11, 2018		63666	91.1	0.0590	25.7

* : See 'Comments' section above for discussion.

Q:\Clients A-L\AGAT Labs - Dartmouth\2018\718\Methyl Mercury\MT80707 27 B00W1.xls

This test report shall not be reproduced, except in full, without written approval of the laboratory.
Note: Results relate only to the items tested.

CALA
Testing Accreditation No. A 3356

ISO/IEC 17025:2005 Accredited with the Canadian Association for Laboratory Accreditation

M10000-1 Version 09/2017

AGAT Laboratories

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CLIENT NAME: NOVA SCOTIA LANDS INC
PO BOX 430, STATION A
SYDNEY , NS B1P6H2
(902) 564-7933

ATTENTION TO: Tony Walker

PROJECT: Mussel

AGAT WORK ORDER: 18X361338

MISCELLANEOUS ANALYSIS REVIEWED BY: Kelly Hogue, B.Sc, P.Chem, Operations Manager

SOIL ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

ULTRA TRACE REVIEWED BY: Philippe Morneau, chimiste

DATE REPORTED: Aug 01, 2018

PAGES (INCLUDING COVER): 17

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 18X361338
PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC
SAMPLING SITE:

ATTENTION TO: Tony Walker
SAMPLED BY:

Subcontracted Data Received

DATE RECEIVED: 2018-07-12 **DATE REPORTED:** 2018-08-01

			SAMPLE DESCRIPTION:	M3	M4	M8
			SAMPLE TYPE:	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-10	2018-07-10	2018-07-10
Parameter	Unit	G / S	RDL	8387661	8387667	8387681
Subcontracted Data				Y	Y	Y

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 18X361338
PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC **ATTENTION TO: Tony Walker**
SAMPLING SITE: **SAMPLED BY:**

Mercury Analysis in Tissue

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	M1	M2	M3	M4	M5	M6	M7	M8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10
Parameter	Unit	G / S	RDL	9397650	9397660	9397661	9397667	9397674	9397679	9397680	9397681
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9397650-9397681 Results are based on the wet weight of the sample.

AGAT Laboratories

Certificate of Analysis

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CLIENT NAME: NOVA SCOTIA LANDS INC ATTENTION TO: Tony Walker
SAMPLING SITE: SAMPLED BY:

Metals in Tissue

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	M1	M2	M3	M4	M5	M6	M7	M8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10
Parameter	Unit	G / S	RDL	9397650	9397660	9397661	9397667	9397674	9397679	9397680	9397681
Aluminum	mg/kg		10	24	31	36	26	23	<10	20	30
Antimony	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Barium	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg		2	3	3	4	3	4	4	4	3
Cadmium	mg/kg		0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3	<0.3	<0.3
Chromium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	2
Iron	mg/kg		50	67	96	85	89	60	<50	67	77
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Manganese	mg/kg		2	16	19	13	11	17	4	9	12
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	8	11	21	8	13	7	19	6
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Zinc	mg/kg		5	17	9	13	11	13	7	15	20

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
9397650-9397681 Results are based on the wet weight of the sample.

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 18X361338
PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC ATTENTION TO: Tony Walker
SAMPLING SITE: SAMPLED BY:

Tissue Prep

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

			SAMPLE DESCRIPTION:	M1	M2	M3	M4	M5	M6	M7	M8
			SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
			DATE SAMPLED:	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10	2018-07-10
Parameter	Unit	G / S	RDL	9397650	9397660	9397661	9397667	9397674	9397679	9397680	9397681
Prep Complete				Y	Y	Y	Y	Y	Y	Y	Y

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC **ATTENTION TO: Tony Walker**
SAMPLING SITE: **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 **DATE REPORTED: 2018-08-01**

Parameter	Unit	G / S	RDL	M1 Tissue 2018-07-10 9397650	RDL	M2 Tissue 2018-07-10 9397660	RDL	M3 Tissue 2018-07-10 9397661	RDL	M4 Tissue 2018-07-10 9397667
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4	0.4	<0.4	0.4	<0.4	0.4	<0.4
1,2,3,4,7,8-Hexa CDD	ng/kg		0.4	<0.4	0.6	<0.6	0.3	<0.3	0.2	<0.2
1,2,3,6,7,8-Hexa CDD	ng/kg		0.3	<0.3	0.5	<0.5	0.3	<0.3	0.2	<0.2
1,2,3,7,8,9-Hexa CDD	ng/kg		0.3	<0.3	0.6	<0.6	0.3	<0.3	0.2	<0.2
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.5	0.5	0.7	0.8	0.5	<0.5	0.5	0.9
Octa CDD	ng/kg		2	5	2	6	1	1	0.7	<0.7
2,3,7,8-Tetra CDF	ng/kg		0.3	0.3	0.3	0.3	0.3	<0.3	0.3	<0.3
1,2,3,7,8-Penta CDF	ng/kg		0.3	<0.3	0.4	<0.4	0.2	<0.2	0.2	<0.2
2,3,4,7,8-Penta CDF	ng/kg		0.2	<0.2	0.3	<0.3	0.2	<0.2	0.2	<0.2
1,2,3,4,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.3	<0.3	0.3	<0.3
1,2,3,6,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.2	<0.2	0.2	<0.2
2,3,4,6,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.3	<0.3	0.2	<0.2
1,2,3,7,8,9-Hexa CDF	ng/kg		0.4	<0.4	0.4	<0.4	0.4	<0.4	0.3	<0.3
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.4	<0.4	0.4	<0.4	0.4	<0.4	0.4	<0.4
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.6	<0.6	0.6	<0.6	0.6	<0.6	0.6	<0.6
Octa CDF	ng/kg		0.8	<0.8	0.5	<0.5	0.9	<0.9	2	<2
Total Tetrachlorodibenzodioxins	ng/kg		0.2	0.5	0.2	0.7	0.2	0.3	0.2	0.6
Total Pentachlorodibenzodioxins	ng/kg		0.4	<0.4	0.4	0.9	0.4	0.4	0.4	0.5
Total Hexachlorodibenzodioxins	ng/kg		0.4	<0.4	0.6	1.0	0.3	1.0	0.2	0.5
Total Heptachlorodibenzodioxins	ng/kg		0.5	4.1	0.7	3.3	0.5	1.4	0.5	0.8
Total PCDDs	ng/kg		2	10	2	12	1	4	0.7	2.7
Total Tetrachlorodibenzofurans	ng/kg		0.3	2.1	0.3	1.1	0.3	0.7	0.3	0.7
Total Pentachlorodibenzofurans	ng/kg		0.3	1.0	0.4	1.4	0.2	0.9	0.2	0.2
Total Hexachlorodibenzofurans	ng/kg		0.4	0.7	0.4	0.5	0.4	0.5	0.3	0.3
Total Heptachlorodibenzofurans	ng/kg		0.6	0.7	0.6	1.3	0.6	0.7	0.6	<0.6
Total PCDFs	ng/kg		0.8	4.5	0.6	4.4	0.9	2.9	2	<2
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0

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Certificate of Analysis

AGAT WORK ORDER: 18X361338
PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC ATTENTION TO: Tony Walker
SAMPLING SITE: SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 DATE REPORTED: 2018-08-01

Parameter	Unit	G / S	RDL	M1 Tissue 2018-07-10 9397650	RDL	M2 Tissue 2018-07-10 9397660	RDL	M3 Tissue 2018-07-10 9397661	RDL	M4 Tissue 2018-07-10 9397667
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0.00546		0.00842		0		0.00885
Octa CDD (TEF 0.0003)	TEQ			0.00138		0.00183		0.000365		0
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0.0281		0.0274		0		0
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.0349		0.0377		0.000365		0.00885

Certificate of Analysis

AGAT Laboratories

AGAT WORK ORDER: 18X361338
PROJECT: Mussel

11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
CANADA B3B 1M2
TEL (902)468-8718
FAX (902)468-8924
http://www.agatlabs.com

CLIENT NAME: NOVA SCOTIA LANDS INC | ATTENTION TO: Tony Walker
SAMPLING SITE: | SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

		SAMPLE DESCRIPTION:	M1	M2	M3	M4
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-10	2018-07-10	2018-07-10	2018-07-10
Surrogate	Unit	Acceptable Limits	8387650	8387660	8387661	8387667
13C-2378-TCDF	%	30-140	61	65	64	59
13C-12378-PeCDF	%	30-140	55	62	59	54
13C-23478-PeCDF	%	30-140	63	72	69	62
13C-123478-HxCDF	%	30-140	63	60	58	59
13C-123678-HxCDF	%	30-140	70	63	65	64
13C-234678-HxCDF	%	30-140	72	61	64	65
13C-123789-HxCDF	%	30-140	68	64	60	61
13C-1234678-HpCDF	%	30-140	60	57	54	53
13C-1234789-HpCDF	%	30-140	57	55	49	51
13C-2378-TCDD	%	30-140	77	80	77	76
13C-12378-PeCDD	%	30-140	70	78	76	68
13C-123478-HxCDD	%	30-140	75	66	67	66
13C-123678-HxCDD	%	30-140	83	76	76	77
13C-1234678-HpCDD	%	30-140	64	60	54	56
13C-OCDD	%	30-140	34	33	32	34

Certificate of Analysis

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PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC | ATTENTION TO: Tony Walker
SAMPLING SITE: | SAMPLED BY:

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | DATE REPORTED: 2018-08-01

			SAMPLE DESCRIPTION:	M5		M6		M7		M8
			SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue
			DATE SAMPLED:	2018-07-10		2018-07-10		2018-07-10		2018-07-10
Parameter	Unit	G / S	RDL	8397674	RDL	8397679	RDL	8397680	RDL	8397681
2,3,7,8-Tetra CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2
1,2,3,7,8-Penta CDD	ng/kg		0.4	<0.4	0.4	<0.4	0.4	<0.4	0.4	<0.4
1,2,3,4,7,8-Hexa CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.4	<0.4	0.6	<0.6
1,2,3,6,7,8-Hexa CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.3	<0.3	0.5	<0.5
1,2,3,7,8,9-Hexa CDD	ng/kg		0.2	<0.2	0.2	<0.2	0.4	<0.4	0.6	<0.6
1,2,3,4,6,7,8-Hepta CDD	ng/kg		0.5	<0.5	0.6	<0.6	0.7	<0.7	1	2
Octa CDD	ng/kg		1	2.7	1	<1	0.9	<0.9	4	7
2,3,7,8-Tetra CDF	ng/kg		0.3	0.3	0.3	<0.3	0.3	0.4	0.4	0.4
1,2,3,7,8-Penta CDF	ng/kg		0.2	<0.2	0.2	<0.2	0.2	<0.2	0.4	<0.4
2,3,4,7,8-Penta CDF	ng/kg		0.2	<0.2	0.2	<0.2	0.2	<0.2	0.4	<0.4
1,2,3,4,7,8-Hexa CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.3	<0.3	0.3	<0.3
1,2,3,6,7,8-Hexa CDF	ng/kg		0.2	<0.2	0.2	<0.2	0.2	<0.2	0.3	<0.3
2,3,4,6,7,8-Hexa CDF	ng/kg		0.2	<0.2	0.2	<0.2	0.2	<0.2	0.5	<0.5
1,2,3,7,8,9-Hexa CDF	ng/kg		0.3	<0.3	0.3	<0.3	0.3	<0.3	0.7	<0.7
1,2,3,4,6,7,8-Hepta CDF	ng/kg		0.4	<0.4	0.4	<0.4	0.5	<0.5	0.6	<0.6
1,2,3,4,7,8,9-Hepta CDF	ng/kg		0.6	<0.6	0.6	<0.6	0.8	<0.8	1	<1
Octa CDF	ng/kg		0.7	<0.7	1	<1	1	<1	1	<1
Total Tetrachlorodibenzodioxins	ng/kg		0.2	0.3	0.2	<0.2	0.2	1.7	0.2	1.5
Total Pentachlorodibenzodioxins	ng/kg		0.4	0.6	0.4	0.5	0.4	1.4	0.4	3.8
Total Hexachlorodibenzodioxins	ng/kg		0.2	0.8	0.2	0.3	0.4	2.6	0.6	1.4
Total Heptachlorodibenzodioxins	ng/kg		0.5	1.2	0.6	<0.6	0.7	1.5	1	6
Total PCDDs	ng/kg		1	6	1	<1	0.9	7.1	4	19
Total Tetrachlorodibenzofurans	ng/kg		0.3	0.6	0.3	0.5	0.3	1.3	0.4	2.9
Total Pentachlorodibenzofurans	ng/kg		0.2	0.7	0.2	<0.2	0.2	0.8	0.4	4.7
Total Hexachlorodibenzofurans	ng/kg		0.3	0.3	0.3	<0.3	0.3	0.5	0.7	1.1
Total Heptachlorodibenzofurans	ng/kg		0.6	<0.6	0.6	<0.6	0.8	<0.8	1	<1
Total PCDFs	ng/kg		0.7	1.8	1	1	1	3	1	9
2,3,7,8-Tetra CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,7,8-Penta CDD (TEF 1.0)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 18X361338
PROJECT: Mussel

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

		SAMPLE DESCRIPTION:		M5		M6		M7		M8
		SAMPLE TYPE:		Tissue		Tissue		Tissue		Tissue
		DATE SAMPLED:		2018-07-10		2018-07-10		2018-07-10		2018-07-10
Parameter	Unit	G / S	RDL	8397874	RDL	8397879	RDL	8397880	RDL	8397881
1,2,3,6,7,8-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDD (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDD (TEF 0.01)	TEQ			0		0		0		0.0138
Octa CDD (TEF 0.0003)	TEQ			0.000798		0		0		0.00210
2,3,7,8-Tetra CDF (TEF 0.1)	TEQ			0.0292		0		0.0358		0.0365
1,2,3,7,8-Penta CDF (TEF 0.03)	TEQ			0		0		0		0
2,3,4,7,8-Penta CDF (TEF 0.3)	TEQ			0		0		0		0
1,2,3,4,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
2,3,4,6,7,8-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,7,8,9-Hexa CDF (TEF 0.1)	TEQ			0		0		0		0
1,2,3,4,6,7,8-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
1,2,3,4,7,8,9-Hepta CDF (TEF 0.01)	TEQ			0		0		0		0
Octa CDF (TEF 0.0003)	TEQ			0		0		0		0
Total PCDDs and PCDFs (TEQ)	TEQ			0.0300		0		0.0358		0.0555

AGAT Laboratories

Certificate of Analysis

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CLIENT NAME: NOVA SCOTIA LANDS INC | **ATTENTION TO: Tony Walker**
SAMPLING SITE: | **SAMPLED BY:**

Dioxins and Furans (Tissue, WHO 2005)

DATE RECEIVED: 2018-07-12 | **DATE REPORTED: 2018-08-01**

		SAMPLE DESCRIPTION:	M5	M6	M7	M8
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-07-10	2018-07-10	2018-07-10	2018-07-10
Surrogate	Unit	Acceptable Limits	8397874	8397879	8397880	8397881
13C-2378-TCDF	%	30-140	56	36	50	38
13C-12378-PeCDF	%	30-140	53	44	41	116
13C-23478-PeCDF	%	30-140	57	47	46	66
13C-123478-HxCDF	%	30-140	62	62	72	62
13C-123678-HxCDF	%	30-140	74	88	104	80
13C-234678-HxCDF	%	30-140	73	89	95	70
13C-123789-HxCDF	%	30-140	69	64	71	59
13C-1234678-HpCDF	%	30-140	52	58	63	62
13C-1234789-HpCDF	%	30-140	50	44	59	52
13C-2378-TCDD	%	30-140	75	82	62	94
13C-12378-PeCDD	%	30-140	64	73	48	112
13C-123478-HxCDD	%	30-140	70	72	82	59
13C-123678-HxCDD	%	30-140	82	113	123	92
13C-1234678-HpCDD	%	30-140	54	61	64	59
13C-OCDD	%	30-140	31	34	32	32

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
8397860-8397881 The results were corrected based on the surrogate percent recoveries.

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC — **AGAT WORK ORDER: 18X361338**

PROJECT: Mussel — **ATTENTION TO: Tony Walker**

SAMPLING SITE: — **SAMPLED BY:**

Soil Analysis

RPT Date: Aug 01, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Metals in Tissue															
Aluminum	9397881	9397881	30	37	NA	< 10	98%	70%	130%	102%	70%	130%	NA	70%	130%
Antimony	9397881	9397881	<2	<2	NA	< 2	91%	70%	130%	101%	70%	130%	NA	70%	130%
Arsenic	9397881	9397881	<2	<2	NA	< 2	98%	70%	130%	101%	70%	130%	NA	70%	130%
Barium	9397881	9397881	<5	<5	NA	< 5	95%	70%	130%	96%	70%	130%	NA	70%	130%
Beryllium	9397881	9397881	<2	<2	NA	< 2	104%	70%	130%	107%	70%	130%	NA	70%	130%
Bismuth	9397881	9397881	<5	<5	NA	< 5	104%	70%	130%	NA	130%	130%	NA	70%	130%
Boron	9397881	9397881	3	4	NA	< 2	105%	70%	130%	106%	70%	130%	NA	70%	130%
Cadmium	9397881	9397881	<0.3	<0.3	NA	< 0.3	97%	70%	130%	99%	70%	130%	NA	70%	130%
Chromium	9397881	9397881	<2	<2	NA	< 2	107%	70%	130%	107%	70%	130%	NA	70%	130%
Cobalt	9397881	9397881	<1	<1	NA	< 1	106%	70%	130%	107%	70%	130%	NA	70%	130%
Copper	9397881	9397881	2	2	NA	< 2	106%	70%	130%	110%	70%	130%	NA	70%	130%
Iron	9397881	9397881	77	103	NA	< 50	103%	70%	130%	114%	70%	130%	NA	70%	130%
Lead	9397881	9397881	<0.4	0.4	NA	< 0.4	104%	70%	130%	106%	70%	130%	NA	70%	130%
Manganese	9397881	9397881	12	13	9.1%	< 2	113%	70%	130%	114%	70%	130%	NA	70%	130%
Molybdenum	9397881	9397881	<2	<2	NA	< 2	98%	90%	110%	102%	90%	110%	NA	70%	130%
Nickel	9397881	9397881	<2	<2	NA	< 2	105%	70%	130%	106%	70%	130%	NA	70%	130%
Selenium	9397881	9397881	<1	<1	NA	< 1	97%	70%	130%	96%	70%	130%	NA	70%	130%
Silver	9397881	9397881	<0.5	<0.5	NA	< 0.5	106%	70%	130%	110%	70%	130%	NA	70%	130%
Strontium	9397881	9397881	6	7	NA	< 5	102%	70%	130%	106%	70%	130%	NA	70%	130%
Thallium	9397881	9397881	<0.1	<0.1	NA	< 0.1	103%	70%	130%	105%	70%	130%	NA	70%	130%
Tin	9397881	9397881	<2	<2	NA	< 2	96%	70%	130%	97%	70%	130%	NA	70%	130%
Uranium	9397881	9397881	<0.1	<0.1	NA	< 0.1	101%	70%	130%	102%	70%	130%	NA	70%	130%
Vanadium	9397881	9397881	<2	<2	NA	< 2	105%	70%	130%	106%	70%	130%	NA	70%	130%
Zinc	9397881	9397881	20	19	NA	< 5	102%	70%	130%	104%	70%	130%	NA	70%	130%
Mercury Analysis in Tissue															
Mercury in Tissue	1	9403978	0.05	0.05	NA	< 0.05	NA	70%	130%	NA	70%	130%	89%	70%	130%

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Quality Assurance

CLIENT NAME: NOVA SCOTIA LANDS INC | AGAT WORK ORDER: 18X361338
PROJECT: Mussel | ATTENTION TO: Tony Walker
SAMPLING SITE: | SAMPLED BY:

Ultra Trace Analysis

RPT Date: Aug 01, 2018			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Dioxins and Furans (Tissue, WHO 2005)															
2,3,7,8-Tetra CDD	1	9397198	< 0.2	< 0.2	NA	< 0.2	87%	40%	130%	NA	40%	130%	89%	40%	130%
1,2,3,7,8-Penta CDD	1	9397198	< 0.4	< 0.4	NA	< 0.4	100%	40%	130%	NA	40%	130%	98%	40%	130%
1,2,3,4,7,8-Hexa CDD	1	9397198	< 0.3	< 0.2	NA	< 0.2	96%	40%	130%	NA	40%	130%	103%	40%	130%
1,2,3,6,7,8-Hexa CDD	1	9397198	< 0.2	< 0.2	NA	< 0.2	107%	40%	130%	NA	40%	130%	100%	40%	130%
1,2,3,7,8,9-Hexa CDD	1	9397198	< 0.2	< 0.2	NA	< 0.2	109%	40%	130%	NA	40%	130%	112%	40%	130%
1,2,3,4,6,7,8-Hepta CDD	1	9397198	< 0.5	< 0.5	NA	< 0.5	104%	40%	130%	NA	40%	130%	99%	40%	130%
Octa CDD	1	9397198	1	1	0.0%	< 0.3	104%	40%	130%	NA	40%	130%	95%	40%	130%
2,3,7,8-Tetra CDF	1	9397198	0.5	0.5	0.0%	< 0.3	106%	40%	130%	NA	40%	130%	102%	40%	130%
1,2,3,7,8-Penta CDF	1	9397198	< 0.4	< 0.4	NA	< 0.2	110%	40%	130%	NA	40%	130%	105%	40%	130%
2,3,4,7,8-Penta CDF	1	9397198	< 0.3	< 0.4	NA	< 0.2	118%	40%	130%	NA	40%	130%	114%	40%	130%
1,2,3,4,7,8-Hexa CDF	1	9397198	< 0.4	< 0.4	NA	< 0.3	110%	40%	130%	NA	40%	130%	110%	40%	130%
1,2,3,6,7,8-Hexa CDF	1	9397198	< 0.4	< 0.4	NA	< 0.2	106%	40%	130%	NA	40%	130%	116%	40%	130%
2,3,4,6,7,8-Hexa CDF	1	9397198	< 0.4	< 0.4	NA	< 0.2	110%	40%	130%	NA	40%	130%	114%	40%	130%
1,2,3,7,8,9-Hexa CDF	1	9397198	< 0.6	< 0.6	NA	< 0.3	105%	40%	130%	NA	40%	130%	110%	40%	130%
1,2,3,4,6,7,8-Hepta CDF	1	9397198	< 0.4	< 0.4	NA	< 0.4	106%	40%	130%	NA	40%	130%	106%	40%	130%
1,2,3,4,7,8,9-Hepta CDF	1	9397198	< 0.6	< 0.6	NA	< 0.6	110%	40%	130%	NA	40%	130%	115%	40%	130%
Octa CDF	1	9397198	< 0.8	< 0.4	NA	< 0.4	105%	40%	130%	NA	40%	130%	101%	40%	130%

Methyl Mercury Results

Flett Research Ltd.

[illegible] Ave. Winnipeg, MB [illegible]
[illegible]
E-mail: [illegible] Webpage: [illegible]

CLIENT: AGAT Labs - Dartmouth: 18x361338

Unit 122-11 Morris Drive
Dartmouth, NS B3B 1M2

Date Received: July 19, 2018
Sampling Date: July 10, 2018

Matrix: Tissue (wet)
Transaction ID: 718
PO/Contract No.:
Date Analysed: July 26, 2018
Analyst(s): Xiang W.

Analytical Method: [illegible] Methyl Mercury in Tissue by Digestion, Aqueous Ethylation, Purge & Trap, and CVAFS with an Automated System (Version 2)

Comments: Samples are wet tissues which were homogenized at AGAT.

Detection Limit: 4 ng/g (ML) MDL = 1 ng/g The MDL was determined based on 7 replicates of analytical blanks (99% confidence level) and a 100 mg wet sample size.
For reporting purposes results will be flagged below the ML which is considered a practical quantitation limit.

Estimated Uncertainty: The estimated uncertainty of this method has been determined to be ± 13% at a concentration level of 4470 ng/g (95% confidence)

Results authorized by Dr. Robert J. Flett, Chief Scientist

QUALITY DATA

Blanks		pg of MeHg in whole ethylation EPA vial	Gross Peak Area	Mean Ethylation Blank (ng/L)
	Ethylation blank (H₂O+Reagent)	0.24	778	0.01
	Mean Eth. Blank (last 30 runs)	0.30		0.01

		Net pg MeHg in whole Ethylation EPA vial	Gross Peak Area	Equiv. CH₃Hg Conc. based on current batch mean weight (0.1075g) of wet sample, ng/g (Note)
	Method Blank 1	-0.02	700	-0.019
	Method Blank 2	-0.10	454	-0.074
	Method Blank 3	-0.03	665	-0.027
	Mean Method Blank	-0.05		-0.040

Standards		MeHg Standard Added to Ethylation EPA Vial (pg CH_3Hg)	Gross Peak Area	Net Corrected MeHg Std Calibration Factor (units / pg)
	Mean Value			5603

Spike Recovery [illegible]	Sample Identification	Sample Type	Gross Peak Area	% CH_3Hg Recovery Used for Calculations	Wet Sample Mass (g)	Net CH_3Hg as Hg (ng/g Wet Wt)	CH_3Hg Recovery (%)
	[illegible] (M4)	MSD	160679	100%	0.089	84	92.1
	[illegible] (M4)	MSDD	180020	100%	0.085	79	99.3
	Mean of Recoveries						95.7
QC Samples	Dorm-4 ID:[illegible] (355± 28 ng/g)		326692	100%	0.028		100.1
	Dorm-4 ID:[illegible] (355± 28 ng/g)	Repeat Aliquot	308031	100%	0.028		94.6
	Mean of Dorm-4						97.3
[illegible]	A.S.S. - Alfa ID:[illegible] (1000 ng/L)		170381	100%		[illegible]	102.9

LAB ID	Sampling Details	Sample ID	Date Sampled	Sample Type	Gross Peak Area	% CH_3Hg Recovery Used for Calculations	Weighed Wet Sample Mass (g)	Net CH_3Hg as Hg (ng/g) Wet Wt. [recovery corrected]
[illegible]	[illegible]	M3	July 10, 2018		16601	95.7	0.1760	< 3.52
[illegible]	[illegible]	M4	July 10, 2018		9426	95.7	0.1160	< 1.81
[illegible]	[illegible]	M7	July 10, 2018	Dup#1	13048	95.7	0.0575	5.40
[illegible]	[illegible]	M7	July 10, 2018	Dup#2	15676	95.7	0.0761	5.35

* : See 'Comments' section above for discussion.

< : Result below the official detection limit for this analyte in this matrix.

Dup : Duplicate - two subsamples of the same sample carried through the analytical procedure in an identical manner.

[illegible]

This test report shall not be reproduced, except in full, without written approval of the laboratory.
Note: Results relate only to the items tested.

CALA

[illegible]

Your C.O.C. #: 08471354

Attention: Tony Walker
DALHOUSIE UNIVERSITY
WATER RESOURCE STUDIES
PO 15000 (D401)
1360 BARRINGTON ST
HALIFAX, NS
CANADA B3H 4R2

Report Date: 2019/07/31
Report #: R2761156
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B948830
Received: 2019/06/20, 09:00

Sample Matrix: Water
Samples Received: 20

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Mercury (Total) by CV	10	2019/07/05	2019/07/10	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Mercury (Total) by CV	10	2019/07/05	2019/07/29	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Elements by ICPMS Digested LL (total)	10	2019/07/05	2019/07/11	BBY7SOP-00003 / BBY7SOP-00002	EPA 6020b R2 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

BV Labs Job #: B948830
Report Date: 2019/07/31

DALHOUSIE UNIVERSITY

MERCURY BY COLD VAPOR (WATER)

BV Labs ID		VY0286	VY0287	VY0288	VY0289	VY0290	VY0291	VY0292		
Sampling Date		2019/06/18 09:35	2019/06/18 09:42	2019/06/18 09:50	2019/06/18 09:52	2019/06/18 09:59	2019/06/18 10:07	2019/06/18 10:15		
COC Number		08471354	08471354	08471354	08471354	08471354	08471354	08471354		
	UNITS	BHM-1	BHM-2	BHM-3	BHM-4	BHM-5	BHM-6	BHM-7	RDL	QC Batch
Elements										
Total Mercury (Hg)	ug/L	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	0.020	9518064

RDL = Reportable Detection Limit
(1) Detection limit raised based on sample volume used for analysis.

BV Labs ID		VY0293	VY0294	VY0295		VY0296	VY0297	VY0298		
Sampling Date		2019/06/18 10:21	2019/06/18 10:22	2019/06/18 10:36		2019/06/18 09:35	2019/06/18 09:42	2019/06/18 09:50		
COC Number		08471354	08471354	08471354		08471354	08471354	08471354		
	UNITS	BHM-8	BHM-9	BHM-10	QC Batch	BHHG-1	BHHG-2	BHHG-3	RDL	QC Batch
Elements										
Total Mercury (Hg)	ug/L	<0.020 (1)	<0.020 (1)	<0.020 (1)	9518064	<0.020	<0.020	<0.020	0.020	9494808

RDL = Reportable Detection Limit
(1) Detection limit raised based on sample volume used for analysis.

BV Labs ID		VY0299	VY0300	VY0301	VY0302	VY0303	VY0304	VY0305		
Sampling Date		2019/06/18 09:52	2019/06/18 09:59	2019/06/18 10:07	2019/06/18 10:15	2019/06/18 10:21	2019/06/18 10:22	2019/06/18 10:36		
COC Number		08471354	08471354	08471354	08471354	08471354	08471354	08471354		
	UNITS	BHHG-4	BHHG-5	BHHG-6	BHHG-7	BHHG-8	BHHG-9	BHHG-10	RDL	QC Batch
Elements										
Total Mercury (Hg)	ug/L	0.030	<0.020	<0.020	<0.020	0.030	0.025	<0.020	0.020	9494808

RDL = Reportable Detection Limit

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

BV Labs ID		VY0286	VY0287	VY0288	VY0289	VY0290	VY0291	VY0292		
Sampling Date		2019/06/18 09:35	2019/06/18 09:42	2019/06/18 09:50	2019/06/18 09:52	2019/06/18 09:59	2019/06/18 10:07	2019/06/18 10:15		
COC Number		08471354	08471354	08471354	08471354	08471354	08471354	08471354		
	UNITS	BHM-1	BHM-2	BHM-3	BHM-4	BHM-5	BHM-6	BHM-7	RDL	QC Batch
Total Metals by ICPMS										
Total Aluminum (Al)	ug/L	351	576	528	263	610	568	661	30	9494801
Total Antimony (Sb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	9494801
Total Arsenic (As)	ug/L	1.07	1.60	1.31	1.39	1.35	1.16	1.56	0.20	9494801
Total Barium (Ba)	ug/L	658	1180	711	732	788	602	874	0.50	9494801
Total Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	9494801
Total Bismuth (Bi)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	9494801
Total Boron (B)	ug/L	<100	<100	<100	<100	<100	<100	<100	100	9494801
Total Cadmium (Cd)	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	9494801
Total Chromium (Cr)	ug/L	1.4	1.4	1.3	2.0	1.4	1.3	1.2	1.0	9494801
Total Cobalt (Co)	ug/L	0.18	0.27	0.18	0.46	0.31	0.18	0.20	0.10	9494801
Total Copper (Cu)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	9494801
Total Iron (Fe)	ug/L	60	<50	194	96	505	480	458	50	9494801
Total Lead (Pb)	ug/L	0.81	1.05	0.94	1.22	1.11	1.15	1.49	0.20	9494801
Total Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	9494801
Total Manganese (Mn)	ug/L	10100	10300	8540	12700	9610	6320	9770	1.0	9494801
Total Molybdenum (Mo)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.77	1.00	0.50	9494801
Total Nickel (Ni)	ug/L	2.7	2.5	<1.0	2.3	1.0	1.0	1.4	1.0	9494801
Total Phosphorus (P)	ug/L	1820	2190	1360	2250	821	668	761	50	9494801
Total Selenium (Se)	ug/L	0.57	<0.40	<0.40	0.99	<0.40	<0.40	<0.40	0.40	9494801
Total Silicon (Si)	ug/L	<500	909	<500	670	<500	<500	<500	500	9494801
Total Silver (Ag)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	9494801
Total Strontium (Sr)	ug/L	49.5	131	45.4	55.7	44.2	29.0	45.7	0.50	9494801
Total Thallium (Tl)	ug/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.027	0.020	9494801
Total Tin (Sn)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	9494801
Total Titanium (Ti)	ug/L	386	524	433	590	307	286	417	20	9494801
Total Uranium (U)	ug/L	0.102	0.214	0.290	0.087	0.751	0.621	0.766	0.050	9494801
Total Vanadium (V)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	9494801
Total Zinc (Zn)	ug/L	<10	<10	<10	<10	20	19	25	10	9494801
Total Zirconium (Zr)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	9494801
Total Sulphur (S)	ug/L	<6000	<6000	<6000	<6000	<6000	<6000	<6000	6000	9494801
RDL = Reportable Detection Limit										

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

BV Labs ID		VY0293	VY0294	VY0295		
Sampling Date		2019/06/18 10:21	2019/06/18 10:22	2019/06/18 10:36		
COC Number		08471354	08471354	08471354		
	UNITS	BHM-8	BHM-9	BHM-10	RDL	QC Batch
Total Metals by ICPMS						
Total Aluminum (Al)	ug/L	523	402	389	30	9494801
Total Antimony (Sb)	ug/L	<0.20	<0.20	<0.20	0.20	9494801
Total Arsenic (As)	ug/L	1.41	1.33	1.48	0.20	9494801
Total Barium (Ba)	ug/L	846	894	378	0.50	9494801
Total Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	0.10	9494801
Total Bismuth (Bi)	ug/L	<0.10	<0.10	<0.10	0.10	9494801
Total Boron (B)	ug/L	<100	<100	<100	100	9494801
Total Cadmium (Cd)	ug/L	<0.050	<0.050	<0.050	0.050	9494801
Total Chromium (Cr)	ug/L	1.7	1.4	1.3	1.0	9494801
Total Cobalt (Co)	ug/L	0.39	0.20	0.32	0.10	9494801
Total Copper (Cu)	ug/L	1.3	<1.0	<1.0	1.0	9494801
Total Iron (Fe)	ug/L	<50	<50	<50	50	9494801
Total Lead (Pb)	ug/L	0.93	1.07	1.65	0.20	9494801
Total Lithium (Li)	ug/L	<5.0	<5.0	<5.0	5.0	9494801
Total Manganese (Mn)	ug/L	10500	9080	2450	1.0	9494801
Total Molybdenum (Mo)	ug/L	<0.50	0.54	1.63	0.50	9494801
Total Nickel (Ni)	ug/L	2.1	1.4	1.7	1.0	9494801
Total Phosphorus (P)	ug/L	1780	1600	875	50	9494801
Total Selenium (Se)	ug/L	<0.40	0.57	<0.40	0.40	9494801
Total Silicon (Si)	ug/L	797	610	1440	500	9494801
Total Silver (Ag)	ug/L	<0.10	<0.10	<0.10	0.10	9494801
Total Strontium (Sr)	ug/L	85.6	122	169	0.50	9494801
Total Thallium (Tl)	ug/L	<0.020	<0.020	<0.020	0.020	9494801
Total Tin (Sn)	ug/L	<2.0	<2.0	<2.0	2.0	9494801
Total Titanium (Ti)	ug/L	459	461	548	20	9494801
Total Uranium (U)	ug/L	0.196	0.325	0.174	0.050	9494801
Total Vanadium (V)	ug/L	<2.0	<2.0	<2.0	2.0	9494801
Total Zinc (Zn)	ug/L	<10	<10	20	10	9494801
Total Zirconium (Zr)	ug/L	<1.0	<1.0	<1.0	1.0	9494801
Total Sulphur (S)	ug/L	<6000	<6000	<6000	6000	9494801
RDL = Reportable Detection Limit						

BV Labs Job #: B948830
Report Date: 2019/07/31

DALHOUSIE UNIVERSITY

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9494801	VCN	Spiked Blank	Total Aluminum (Al)	2019/07/11		102	%	80 - 120
			Total Antimony (Sb)	2019/07/11		95	%	80 - 120
			Total Arsenic (As)	2019/07/11		100	%	80 - 120
			Total Barium (Ba)	2019/07/11		98	%	80 - 120
			Total Beryllium (Be)	2019/07/11		89	%	80 - 120
			Total Bismuth (Bi)	2019/07/11		80	%	80 - 120
			Total Boron (B)	2019/07/11		102	%	80 - 120
			Total Cadmium (Cd)	2019/07/11		93	%	80 - 120
			Total Chromium (Cr)	2019/07/11		91	%	80 - 120
			Total Cobalt (Co)	2019/07/11		87	%	80 - 120
			Total Copper (Cu)	2019/07/11		84	%	80 - 120
			Total Iron (Fe)	2019/07/11		103	%	80 - 120
			Total Lead (Pb)	2019/07/11		92	%	80 - 120
			Total Lithium (Li)	2019/07/11		88	%	80 - 120
			Total Manganese (Mn)	2019/07/11		91	%	80 - 120
			Total Molybdenum (Mo)	2019/07/11		102	%	80 - 120
			Total Nickel (Ni)	2019/07/11		90	%	80 - 120
			Total Selenium (Se)	2019/07/11		100	%	80 - 120
			Total Silver (Ag)	2019/07/11		89	%	80 - 120
			Total Strontium (Sr)	2019/07/11		103	%	80 - 120
			Total Thallium (Tl)	2019/07/11		90	%	80 - 120
			Total Tin (Sn)	2019/07/11		94	%	80 - 120
			Total Titanium (Ti)	2019/07/11		98	%	80 - 120
			Total Uranium (U)	2019/07/11		94	%	80 - 120
			Total Vanadium (V)	2019/07/11		89	%	80 - 120
			Total Zinc (Zn)	2019/07/11		91	%	80 - 120
			Total Zirconium (Zr)	2019/07/11		70 (1)	%	80 - 120
9494801	VCN	RPD	Total Aluminum (Al)	2019/07/11	7.8		%	20
			Total Antimony (Sb)	2019/07/11	96 (1)		%	20
			Total Arsenic (As)	2019/07/11	28 (1)		%	20
			Total Barium (Ba)	2019/07/11	0.62		%	20
			Total Beryllium (Be)	2019/07/11	2.7		%	20
			Total Bismuth (Bi)	2019/07/11	51 (1)		%	20
			Total Boron (B)	2019/07/11	6.0		%	20
			Total Cadmium (Cd)	2019/07/11	1.1		%	20
			Total Chromium (Cr)	2019/07/11	13		%	20
			Total Cobalt (Co)	2019/07/11	6.5		%	20
			Total Copper (Cu)	2019/07/11	11		%	20
			Total Iron (Fe)	2019/07/11	26 (1)		%	20
			Total Lead (Pb)	2019/07/11	4.4		%	20
			Total Lithium (Li)	2019/07/11	4.5		%	20
			Total Manganese (Mn)	2019/07/11	8.6		%	20
			Total Molybdenum (Mo)	2019/07/11	19		%	20
			Total Nickel (Ni)	2019/07/11	5.1		%	20
			Total Selenium (Se)	2019/07/11	27 (1)		%	20
			Total Silver (Ag)	2019/07/11	7.1		%	20
			Total Strontium (Sr)	2019/07/11	10		%	20
			Total Thallium (Tl)	2019/07/11	16		%	20
			Total Tin (Sn)	2019/07/11	25 (1)		%	20
			Total Titanium (Ti)	2019/07/11	21 (1)		%	20
			Total Uranium (U)	2019/07/11	29 (1)		%	20
			Total Vanadium (V)	2019/07/11	12		%	20
			Total Zinc (Zn)	2019/07/11	3.9		%	20
			Total Zirconium (Zr)	2019/07/11	28 (1)		%	20
			Total Aluminum (Al)	2019/07/11	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Antimony (Sb)	2019/07/11	NC		%	20
			Total Arsenic (As)	2019/07/11	144 (1)		%	20
			Total Barium (Ba)	2019/07/11	74 (1)		%	20
			Total Beryllium (Be)	2019/07/11	NC		%	20
			Total Bismuth (Bi)	2019/07/11	NC		%	20
			Total Boron (B)	2019/07/11	NC		%	20
			Total Cadmium (Cd)	2019/07/11	NC		%	20
			Total Chromium (Cr)	2019/07/11	NC		%	20
			Total Cobalt (Co)	2019/07/11	NC		%	20
			Total Copper (Cu)	2019/07/11	NC		%	20
			Total Iron (Fe)	2019/07/11	NC		%	20
			Total Lead (Pb)	2019/07/11	147 (1)		%	20
			Total Lithium (Li)	2019/07/11	NC		%	20
			Total Manganese (Mn)	2019/07/11	NC		%	20
			Total Molybdenum (Mo)	2019/07/11	NC		%	20
			Total Nickel (Ni)	2019/07/11	NC		%	20
			Total Phosphorus (P)	2019/07/11	NC		%	20
			Total Selenium (Se)	2019/07/11	NC		%	20
			Total Silicon (Si)	2019/07/11	NC		%	20
			Total Silver (Ag)	2019/07/11	NC		%	20
			Total Strontium (Sr)	2019/07/11	157 (1)		%	20
			Total Thallium (Tl)	2019/07/11	NC		%	20
			Total Tin (Sn)	2019/07/11	NC		%	20
			Total Titanium (Ti)	2019/07/11	180 (1)		%	20
			Total Uranium (U)	2019/07/11	NC		%	20
			Total Vanadium (V)	2019/07/11	NC		%	20
			Total Zinc (Zn)	2019/07/11	NC		%	20
			Total Zirconium (Zr)	2019/07/11	NC		%	20
			Total Sulphur (S)	2019/07/11	NC		%	20
9494801	VCN	Method Blank	Total Aluminum (Al)	2019/07/16	<30		ug/L	
			Total Antimony (Sb)	2019/07/16	<0.20		ug/L	
			Total Arsenic (As)	2019/07/16	<0.20		ug/L	
			Total Barium (Ba)	2019/07/16	0.95, RDL=0.50 (2)		ug/L	
			Total Beryllium (Be)	2019/07/16	<0.10		ug/L	
			Total Bismuth (Bi)	2019/07/16	<0.10		ug/L	
			Total Boron (B)	2019/07/16	<100		ug/L	
			Total Cadmium (Cd)	2019/07/16	<0.050		ug/L	
			Total Chromium (Cr)	2019/07/16	<1.0		ug/L	
			Total Cobalt (Co)	2019/07/16	<0.10		ug/L	
			Total Copper (Cu)	2019/07/16	<1.0		ug/L	
			Total Iron (Fe)	2019/07/16	<50		ug/L	
			Total Lead (Pb)	2019/07/16	<0.20		ug/L	
			Total Lithium (Li)	2019/07/16	<5.0		ug/L	
			Total Manganese (Mn)	2019/07/16	<1.0		ug/L	
			Total Molybdenum (Mo)	2019/07/16	<0.50		ug/L	
			Total Nickel (Ni)	2019/07/16	<1.0		ug/L	
			Total Phosphorus (P)	2019/07/16	<50		ug/L	
			Total Selenium (Se)	2019/07/16	<0.40		ug/L	
			Total Silicon (Si)	2019/07/16	<500		ug/L	
			Total Silver (Ag)	2019/07/16	<0.10		ug/L	
			Total Strontium (Sr)	2019/07/16	0.54, RDL=0.50 (3)		ug/L	
			Total Thallium (Tl)	2019/07/16	<0.020		ug/L	
			Total Tin (Sn)	2019/07/16	<2.0		ug/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Titanium (Ti)	2019/07/16	<20		ug/L	
			Total Uranium (U)	2019/07/16	<0.050		ug/L	
			Total Vanadium (V)	2019/07/16	<2.0		ug/L	
			Total Zinc (Zn)	2019/07/16	<10		ug/L	
			Total Zirconium (Zr)	2019/07/16	<1.0		ug/L	
			Total Sulphur (S)	2019/07/16	<6000		ug/L	
9494808	EL2	Spiked Blank	Total Mercury (Hg)	2019/07/10		83	%	80 - 120
9494808	EL2	RPD	Total Mercury (Hg)	2019/07/10	20		%	20
			Total Mercury (Hg)	2019/07/10	NC		%	20
9494808	EL2	Method Blank	Total Mercury (Hg)	2019/07/10	<0.020		ug/L	
9518064	CJY	Spiked Blank	Total Mercury (Hg)	2019/07/29		92	%	80 - 120
9518064	CJY	RPD	Total Mercury (Hg)	2019/07/29	0.77		%	20
			Total Mercury (Hg)	2019/07/29	NC (4)		%	20
9518064	CJY	Method Blank	Total Mercury (Hg)	2019/07/29	<0.020 (4)		ug/L	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(2) Reagent Blank exceeds acceptance limits for (Barium) - 2X RDL acceptable for low level metals determination.

(3) Reagent Blank exceeds acceptance limits for (Strontium) - 2X RDL acceptable for low level metals determination.

(4) Detection limit raised based on sample volume used for analysis.

Your C.O.C. #: 08470876

Attention: Tony Walker

DALHOUSIE UNIVERSITY
WATER RESOURCE STUDIES
PO 15000 (D401)
1360 BARRINGTON ST
HALIFAX, NS
CANADA B3H 4R2

Report Date: 2019/07/26
Report #: R2758351
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B941369
Received: 2019/05/30, 09:45

Sample Matrix: Water
Samples Received: 18

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Mercury (Total) by CV	18	2019/06/07	2019/06/13	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Elements by ICPMS Digested LL (total)	9	2019/06/05	2019/06/07	BBY7SOP-00003 / BBY7SOP-00002	EPA 6020b R2 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

BV Labs Job #: B941369
Report Date: 2019/07/26

DALHOUSIE UNIVERSITY

MERCURY BY COLD VAPOR (WATER)

BV Labs ID		VT8226	VT8227	VT8228	VT8229	VT8230	VT8231	VT8232		
Sampling Date		2019/05/28 09:20	2019/05/28 09:25	2019/05/28 09:35	2019/05/28 09:42	2019/05/28 09:48	2019/05/28 09:57	2019/05/28 10:05		
COC Number		08470876	08470876	08470876	08470876	08470876	08470876	08470876		
	UNITS	ESM-1	ESM-2	ESM-3	ESM-4	ESM-5	ESM-6	ESM-7	RDL	QC Batch
Elements										
Total Mercury (Hg)	ug/L	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	0.020	9454183

RDL = Reportable Detection Limit
(1) Detection limit raised due to interferent.

BV Labs ID		VT8233	VT8234		VT8236		VT8237	VT8238	VT8239		
Sampling Date		2019/05/28 10:09	2019/05/28 10:15		2019/05/28 09:20		2019/05/28 09:25	2019/05/28 09:35	2019/05/28 09:42		
COC Number		08470876	08470876		08470876		08470876	08470876	08470876		
	UNITS	ESM-8	ESM-9	RDL	ES HG-1	RDL	ES HG-2	ES HG-3	ES HG-4	RDL	QC Batch
Elements											
Total Mercury (Hg)	ug/L	<0.020 (1)	<0.020 (1)	0.020	0.0078 (1)	0.0020	<0.020 (1)	<0.020 (1)	<0.020 (1)	0.020	9454183

RDL = Reportable Detection Limit
(1) Detection limit raised due to interferent.

BV Labs ID		VT8240	VT8241	VT8242	VT8244	VT8245		
Sampling Date		2019/05/28 09:48	2019/05/28 09:57	2019/05/28 10:05	2019/05/28 10:15	2019/05/28 10:18		
COC Number		08470876	08470876	08470876	08470876	08470876		
	UNITS	ES HG-5	ES HG-6	ES HG-7	ES HG-9	ES HG-10	RDL	QC Batch
Elements								
Total Mercury (Hg)	ug/L	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	<0.020 (1)	0.020	9454183

RDL = Reportable Detection Limit
(1) Detection limit raised due to interferent.

BV Labs Job #: B941369
Report Date: 2019/07/26

DALHOUSIE UNIVERSITY

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

BV Labs ID		VT8226	VT8227	VT8228	VT8229	VT8230	VT8231	VT8232		
Sampling Date		2019/05/28 09:20	2019/05/28 09:25	2019/05/28 09:35	2019/05/28 09:42	2019/05/28 09:48	2019/05/28 09:57	2019/05/28 10:05		
COC Number		08470876	08470876	08470876	08470876	08470876	08470876	08470876		
	UNITS	ESM-1	ESM-2	ESM-3	ESM-4	ESM-5	ESM-6	ESM-7	RDL	QC Batch
Total Metals by ICPMS										
Total Aluminum (Al)	ug/L	161	176	105	160	139	98	96	30	9449329
Total Antimony (Sb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	9449329
Total Arsenic (As)	ug/L	3.93	4.33	2.90	4.11	4.15	3.23	3.87	0.20	9449329
Total Barium (Ba)	ug/L	110	151	153	100	91.8	50.8	55.6	0.50	9449329
Total Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	9449329
Total Bismuth (Bi)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	9449329
Total Boron (B)	ug/L	<100	<100	<100	<100	<100	<100	<100	100	9449329
Total Cadmium (Cd)	ug/L	0.069	0.081	0.093	0.118	0.110	0.100	0.106	0.050	9449329
Total Chromium (Cr)	ug/L	2.1	1.8	2.0	2.0	1.7	1.7	1.8	1.0	9449329
Total Cobalt (Co)	ug/L	0.33	0.23	0.18	0.21	0.31	0.15	0.19	0.10	9449329
Total Copper (Cu)	ug/L	2.1	<1.0	<1.0	1.0	1.5	<1.0	<1.0	1.0	9449329
Total Iron (Fe)	ug/L	<50	61	<50	62	57	<50	<50	50	9449329
Total Lead (Pb)	ug/L	1.37	1.85	2.15	1.84	1.77	1.28	1.62	0.20	9449329
Total Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	9449329
Total Manganese (Mn)	ug/L	1980	1950	1340	1230	1370	636	585	1.0	9449329
Total Molybdenum (Mo)	ug/L	8.34	12.8	10.0	14.0	14.1	12.7	16.0	0.50	9449329
Total Nickel (Ni)	ug/L	3.0	1.3	1.2	1.5	1.7	1.3	<1.0	1.0	9449329
Total Phosphorus (P)	ug/L	205	245	180	212	230	156	186	50	9449329
Total Selenium (Se)	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	9449329
Total Silicon (Si)	ug/L	<500	508	<500	<500	<500	<500	<500	500	9449329
Total Silver (Ag)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	9449329
Total Strontium (Sr)	ug/L	106	125	95.7	130	127	92.1	115	0.50	9449329
Total Thallium (Tl)	ug/L	0.097	0.063	0.049	0.052	0.032	0.031	0.027	0.020	9449329
Total Tin (Sn)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	9449329
Total Titanium (Ti)	ug/L	336	410	337	418	414	295	381	20	9449329
Total Uranium (U)	ug/L	0.748	1.22	1.40	1.29	1.42	1.19	1.23	0.050	9449329
Total Vanadium (V)	ug/L	3.8	4.4	2.6	4.1	4.1	3.2	3.2	2.0	9449329
Total Zinc (Zn)	ug/L	14	14	14	13	16	10	11	10	9449329
Total Zirconium (Zr)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	9449329
Total Sulphur (S)	ug/L	<6000	<6000	<6000	<6000	<6000	<6000	<6000	6000	9449329

RDL = Reportable Detection Limit

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

BV Labs ID		VT8233	VT8234		
Sampling Date		2019/05/28 10:09	2019/05/28 10:15		
COC Number		08470876	08470876		
	UNITS	ESM-8	ESM-9	RDL	QC Batch
Total Metals by ICPMS					
Total Aluminum (Al)	ug/L	56	58	30	9449329
Total Antimony (Sb)	ug/L	<0.20	<0.20	0.20	9449329
Total Arsenic (As)	ug/L	3.41	2.96	0.20	9449329
Total Barium (Ba)	ug/L	32.5	41.1	0.50	9449329
Total Beryllium (Be)	ug/L	<0.10	<0.10	0.10	9449329
Total Bismuth (Bi)	ug/L	<0.10	<0.10	0.10	9449329
Total Boron (B)	ug/L	<100	<100	100	9449329
Total Cadmium (Cd)	ug/L	0.116	0.080	0.050	9449329
Total Chromium (Cr)	ug/L	2.0	1.8	1.0	9449329
Total Cobalt (Co)	ug/L	0.18	0.36	0.10	9449329
Total Copper (Cu)	ug/L	1.0	<1.0	1.0	9449329
Total Iron (Fe)	ug/L	<50	<50	50	9449329
Total Lead (Pb)	ug/L	1.41	1.20	0.20	9449329
Total Lithium (Li)	ug/L	<5.0	<5.0	5.0	9449329
Total Manganese (Mn)	ug/L	202	2280	1.0	9449329
Total Molybdenum (Mo)	ug/L	15.4	16.2	0.50	9449329
Total Nickel (Ni)	ug/L	1.1	1.3	1.0	9449329
Total Phosphorus (P)	ug/L	142	152	50	9449329
Total Selenium (Se)	ug/L	<0.40	<0.40	0.40	9449329
Total Silicon (Si)	ug/L	<500	<500	500	9449329
Total Silver (Ag)	ug/L	<0.10	<0.10	0.10	9449329
Total Strontium (Sr)	ug/L	95.6	86.2	0.50	9449329
Total Thallium (Tl)	ug/L	<0.020	<0.020	0.020	9449329
Total Tin (Sn)	ug/L	<2.0	<2.0	2.0	9449329
Total Titanium (Ti)	ug/L	346	361	20	9449329
Total Uranium (U)	ug/L	1.26	1.38	0.050	9449329
Total Vanadium (V)	ug/L	3.2	2.7	2.0	9449329
Total Zinc (Zn)	ug/L	<10	11	10	9449329
Total Zirconium (Zr)	ug/L	<1.0	<1.0	1.0	9449329
Total Sulphur (S)	ug/L	<6000	<6000	6000	9449329
RDL = Reportable Detection Limit					

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9449329	VBA	Spiked Blank	Total Aluminum (Al)	2019/06/21		98	%	80 - 120
			Total Antimony (Sb)	2019/06/21		91	%	80 - 120
			Total Arsenic (As)	2019/06/21		91	%	80 - 120
			Total Barium (Ba)	2019/06/21		91	%	80 - 120
			Total Beryllium (Be)	2019/06/21		88	%	80 - 120
			Total Bismuth (Bi)	2019/06/21		87	%	80 - 120
			Total Boron (B)	2019/06/21		83	%	80 - 120
			Total Cadmium (Cd)	2019/06/21		88	%	80 - 120
			Total Chromium (Cr)	2019/06/21		89	%	80 - 120
			Total Cobalt (Co)	2019/06/21		86	%	80 - 120
			Total Copper (Cu)	2019/06/21		82	%	80 - 120
			Total Iron (Fe)	2019/06/21		9.5 (1)	%	80 - 120
			Total Lead (Pb)	2019/06/21		87	%	80 - 120
			Total Lithium (Li)	2019/06/21		88	%	80 - 120
			Total Manganese (Mn)	2019/06/21		87	%	80 - 120
			Total Molybdenum (Mo)	2019/06/21		98	%	80 - 120
			Total Nickel (Ni)	2019/06/21		86	%	80 - 120
			Total Phosphorus (P)	2019/06/21		11 (1)	%	80 - 120
			Total Selenium (Se)	2019/06/21		89	%	80 - 120
			Total Silicon (Si)	2019/06/21		11 (1)	%	80 - 120
			Total Silver (Ag)	2019/06/21		86	%	80 - 120
			Total Strontium (Sr)	2019/06/21		93	%	80 - 120
			Total Thallium (Tl)	2019/06/21		87	%	80 - 120
			Total Tin (Sn)	2019/06/21		90	%	80 - 120
			Total Titanium (Ti)	2019/06/21		88	%	80 - 120
			Total Uranium (U)	2019/06/21		90	%	80 - 120
			Total Vanadium (V)	2019/06/21		86	%	80 - 120
			Total Zinc (Zn)	2019/06/21		86	%	80 - 120
			Total Zirconium (Zr)	2019/06/21		83	%	80 - 120
			Total Sulphur (S)	2019/06/21		84	%	80 - 120
9449329	VBA	RPD	Total Aluminum (Al)	2019/06/21	1.3		%	20
			Total Antimony (Sb)	2019/06/21	104 (1)		%	20
			Total Arsenic (As)	2019/06/21	23 (1)		%	20
			Total Barium (Ba)	2019/06/21	0.68		%	20
			Total Beryllium (Be)	2019/06/21	2.8		%	20
			Total Bismuth (Bi)	2019/06/21	63 (1)		%	20
			Total Boron (B)	2019/06/21	2.7		%	20
			Total Cadmium (Cd)	2019/06/21	5.3		%	20
			Total Chromium (Cr)	2019/06/21	11		%	20
			Total Cobalt (Co)	2019/06/21	9.3		%	20
			Total Copper (Cu)	2019/06/21	7.9		%	20
			Total Iron (Fe)	2019/06/21	156 (1)		%	20
			Total Lead (Pb)	2019/06/21	2.6		%	20
			Total Lithium (Li)	2019/06/21	13		%	20
			Total Manganese (Mn)	2019/06/21	14		%	20
			Total Molybdenum (Mo)	2019/06/21	158 (1)		%	20
			Total Nickel (Ni)	2019/06/21	5.4		%	20
			Total Phosphorus (P)	2019/06/21	94 (1)		%	20
			Total Selenium (Se)	2019/06/21	20		%	20
			Total Silicon (Si)	2019/06/21	0		%	20
			Total Silver (Ag)	2019/06/21	11		%	20
			Total Strontium (Sr)	2019/06/21	5.1		%	20
			Total Thallium (Tl)	2019/06/21	18		%	20
			Total Tin (Sn)	2019/06/21	155 (1)		%	20
			Total Titanium (Ti)	2019/06/21	168 (1)		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Uranium (U)	2019/06/21	24 (1)		%	20
			Total Vanadium (V)	2019/06/21	12		%	20
			Total Zinc (Zn)	2019/06/21	2.8		%	20
			Total Zirconium (Zr)	2019/06/21	148 (1)		%	20
			Total Sulphur (S)	2019/06/21	0		%	20
			Total Aluminum (Al)	2019/06/21	NC		%	20
			Total Antimony (Sb)	2019/06/21	NC		%	20
			Total Arsenic (As)	2019/06/21	143 (1)		%	20
			Total Barium (Ba)	2019/06/21	93 (1)		%	20
			Total Beryllium (Be)	2019/06/21	NC		%	20
			Total Bismuth (Bi)	2019/06/21	NC		%	20
			Total Boron (B)	2019/06/21	NC		%	20
			Total Cadmium (Cd)	2019/06/21	NC		%	20
			Total Chromium (Cr)	2019/06/21	18		%	20
			Total Cobalt (Co)	2019/06/21	NC		%	20
			Total Copper (Cu)	2019/06/21	NC		%	20
			Total Iron (Fe)	2019/06/21	NC		%	20
			Total Lead (Pb)	2019/06/21	146 (1)		%	20
			Total Lithium (Li)	2019/06/21	NC		%	20
			Total Manganese (Mn)	2019/06/21	NC		%	20
			Total Molybdenum (Mo)	2019/06/21	NC		%	20
			Total Nickel (Ni)	2019/06/21	NC		%	20
			Total Phosphorus (P)	2019/06/21	NC		%	20
			Total Selenium (Se)	2019/06/21	NC		%	20
			Total Silicon (Si)	2019/06/21	NC		%	20
			Total Silver (Ag)	2019/06/21	NC		%	20
			Total Strontium (Sr)	2019/06/21	162 (1)		%	20
			Total Thallium (Tl)	2019/06/21	NC		%	20
			Total Tin (Sn)	2019/06/21	NC		%	20
			Total Titanium (Ti)	2019/06/21	181 (1)		%	20
			Total Uranium (U)	2019/06/21	NC		%	20
			Total Vanadium (V)	2019/06/21	NC		%	20
			Total Zinc (Zn)	2019/06/21	NC		%	20
			Total Zirconium (Zr)	2019/06/21	NC		%	20
			Total Sulphur (S)	2019/06/21	NC		%	20
9449329	VBA	Method Blank	Total Aluminum (Al)	2019/06/21	<30		ug/L	
			Total Antimony (Sb)	2019/06/21	<0.20		ug/L	
			Total Arsenic (As)	2019/06/21	<0.20		ug/L	
			Total Barium (Ba)	2019/06/21	0.81, RDL=0.50		ug/L	
			Total Beryllium (Be)	2019/06/21	<0.10		ug/L	
			Total Bismuth (Bi)	2019/06/21	<0.10		ug/L	
			Total Boron (B)	2019/06/21	<100		ug/L	
			Total Cadmium (Cd)	2019/06/21	<0.050		ug/L	
			Total Chromium (Cr)	2019/06/21	1.4, RDL=1.0		ug/L	
			Total Cobalt (Co)	2019/06/21	<0.10		ug/L	
			Total Copper (Cu)	2019/06/21	<1.0		ug/L	
			Total Iron (Fe)	2019/06/21	<50		ug/L	
			Total Lead (Pb)	2019/06/21	<0.20		ug/L	
			Total Lithium (Li)	2019/06/21	<5.0		ug/L	
			Total Manganese (Mn)	2019/06/21	<1.0		ug/L	
			Total Molybdenum (Mo)	2019/06/21	<0.50		ug/L	
			Total Nickel (Ni)	2019/06/21	<1.0		ug/L	
			Total Phosphorus (P)	2019/06/21	<50		ug/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Selenium (Se)	2019/06/21	<0.40		ug/L	
			Total Silicon (Si)	2019/06/21	<500		ug/L	
			Total Silver (Ag)	2019/06/21	<0.10		ug/L	
			Total Strontium (Sr)	2019/06/21	<0.50		ug/L	
			Total Thallium (Tl)	2019/06/21	<0.020		ug/L	
			Total Tin (Sn)	2019/06/21	<2.0		ug/L	
			Total Titanium (Ti)	2019/06/21	<20		ug/L	
			Total Uranium (U)	2019/06/21	<0.050		ug/L	
			Total Vanadium (V)	2019/06/21	<2.0		ug/L	
			Total Zinc (Zn)	2019/06/21	<10		ug/L	
			Total Zirconium (Zr)	2019/06/21	<1.0		ug/L	
			Total Sulphur (S)	2019/06/21	<6000		ug/L	
9454183	EL2	Spiked Blank	Total Mercury (Hg)	2019/06/13		72 (1)	%	80 - 120
9454183	EL2	RPD	Total Mercury (Hg)	2019/06/13	2.4		%	20
			Total Mercury (Hg)	2019/06/13	NC (2)		%	20
9454183	EL2	Method Blank	Total Mercury (Hg)	2019/06/13	<0.020 (2)		ug/L	

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(2) Detection limit raised due to interferent.

A paleolimnological assessment of sediment in Sitmu'k Lagoon, Pictou Landing, Nova Scotia, to determine the influence of geogenic and anthropogenic activity on water quality change through time

By

Dylan G. Wyles

Thesis submitted in partial fulfillment of

the requirements for a

Degree of Bachelor of

Science with Honours in Geology

Acadia University

April 2019

This thesis by Dylan G. Wyles

is accepted in its present form by the

Department of Earth and Environmental Science

as satisfying the thesis requirements for the degree of

Bachelor of Science with Honours

Approved by the Thesis Supervisor

____________________________ ____________________________

Dr. Ian Spooner Date

Approved by Acting Head of the Department

____________________________ ____________________________

Dr. Rob Raeside Date

Approved by the Honours Committee

____________________________ ____________________________

Dr. Joseph Hayes Date

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Dylan G. Wyles

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Date

Acknowledgements

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Abstract

This project focused on a lagoon and barrier beach complex known as Sitmu'k in Pictou Landing, Nova Scotia. This dynamic system has historically been of importance to the community of Pictou Landing First Nation for recreational and cultural purposes. Over the past few decades there has been significant landscape change and human activity in the area that has inhibited use and enjoyment of this valued landscape feature. Issues identified include water quality degradation, and the legacy of historical industrial impacts. The purpose of this thesis was to determine influences of environmental change through time in Sitmu'k by conducting a paleolimnological assessment of the geochemical changes recorded in the sediment archive. To determine anthropogenic and geogenic influences on Sitmu'k, the data was compared to nearby reference sites. Geochemical analysis was conducted using x-ray fluorescence (XRF), total carbon (C), total nitrogen (N) and stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$). Total C/N and isotope analysis indicated that carbon input at Sitmu'k is predominantly from marine sources. XRF analysis indicated that metal concentrations were below sediment quality guidelines and reference site averages. Water quality tests were conducted throughout the summer 2018 season to determine current environmental conditions in the lagoon. Water quality data indicated gradual but persistent increases in temperature, total coliforms, nitrate and total phosphorus from May to August. Through air photo and satellite imaging, it is apparent that the barrier, Lighthouse Beach, is migrating towards mainland. Sediment redistribution from the beach into Sitmu'k has resulted in shallowing and restricting which is causing higher water temperatures, poor circulation and elevated nutrient and coliform levels. Collectively the data suggest that much of the water quality degradation

noted in the past 50 years is likely due to natural landward migration of the barrier-beach complex, resulting in reduced water depth and circulation coupled with increased local anthropogenic land use; the data did not indicate significant industrial impact at the site.

Chapter 1: Introduction

1.1 Background

Pictou Landing is a small community in northeastern Nova Scotia, which is also the location of Pictou Landing First Nation (PLFN). Within Pictou Landing there is Sitmu'k, also known as Moodie's Cove, which is a shallow salt water lagoon system with tidal influence enclosed by a barrier beach, known as Lighthouse Beach (LHB; Figure 1). Currently, Sitmu'k is an inactive part of the community and is not a suitable recreational site for activities such as swimming. In the past, Sitmu'k was a popular recreational site for the Pictou Landing community. Sitmu'k was very popular for swimming because the barrier beach system blocks the high energy water of the Northumberland Strait, keeping the water calm and warm. Furthermore, LHB offers a 2 km long double-sided beach with cool ocean waters on one side, and the calm, warm lagoon waters on the other side. LHB once housed facilities such as a canteen, bathroom stalls, salt-rinse showers, and picnic tables (Holmes et al., 2017). This area was well utilized by the community and comparable to popular nearby barrier beaches along the Northumberland Strait such as Melmerby Beach, which now is a Provincial Park. This research is focused on an investigation of the precieved environmental degredation and providing insight on change through time at the site.

Figure 1. A labelled map of the area showing the town of Pictou Landing, Boat Harbour, Sitmu'k, and 3 reference sites. These three reference sites were studied by Davidson (2018). The reference sites include: Boat Harbour Estuary, Fergusons Pond, and Chance Harbour Estuary.

There are several sources for contaminants in the area that have the potential to impact Sitmu'k. Contamination from water sources would include the effluent from a nearby chloro-alkali plant that has since shut down, and over 50 years of organic effluent wastewater treatment from the pulp mill in Pictou that was discharged from Boat Harbour (Walker et al., 2016). There is potential for impact from the outfall of the Pictou Landing First Nation (PLFN)'s sewage treatment plant which is located immediately east of Lighthouse Beach (Jacques Whitford, 2005). Furthermore, there are local anthropogenic sources that discharge directly into the air potentially resulting in contamination from aerial deposition. Some of these sources include a local coal-fired thermal generating plant, a tire manufacturing plant, and the smokestacks of the local pulp mill (Hoffman et al., 2017).

To understand how anthropogenic, geogenic, or atmospheric sources have been influencing Sitmu'k; various attributes needed to be examined. The sediment archives in Sitmu'k were analysed using applied paleolimnological assessments and compared to three nearby references sites that were studied in 2017 (Davidson, 2018). Sediment cores were extracted from site and tested for metal concentrations using X-Ray Fluorescence (XRF). Furthermore, sediment samples were tested for total carbon (C), total nitrogen (N), and stable isotopes ($\delta^{13}C$, $\delta^{15}N$). These data were compared to data from similar tests done in nearby sites including: Boat Harbour Estuary, one kilometer east, and Fergusons Pond, three kilometers east, and Chance Harbour Estuary, six kilometers east (Figure 1). A Comparison to these reference sites is useful to determine if the geochemistry in the sediment archive is related to natural or anthropogenic sources or a combination of both. Water chemistry analysis was also completed to determine the present environmental conditions in Sitmu'k and if any local anthropogenic sources are currently impacting the site. During the field season water chemistry was monitored and included the following analyses: total phosphorous, nitrate, pH, conductivity, temperature, dissolved oxygen, and coliforms (total coliform counts and E. *coli* counts).

1.2 Site Description

Lighthouse Beach extends westwards from the shore roughly 1.4 km and is generally comprised of fine grained, quartz-dominated sand. Sitmu'k is roughly 1.4 km long, it varies between 250 m and 500 m wide, and it ranges between 1 m and 3 m deep. The sediment in Sitmu'k is fine to very fine grained, angular, poorly sorted, quartz-rich sand with silt and clay interbedded. Sunlight penetrates through the water column to the lagoon floor, as the majority of Sitmu'k is less than 3 m deep at low tide. In this environment a diverse marine floral thrives, the dominant species is eel grasses (*Zostera Marina*). Lighthouse Beach provides habitat for vegetation including, but not limited to: the American marram grass (*Ammophila breviligulata*), seaside pea (*Lathyrus japonicus*), seaside goldenrod (*Solidago sempervirens*), American searocket (*Cakile edentula*), hoary mugwort (*Artemisia stelleriana*), staghorn sumac (*Rhus typhina*), northern bayberry (*Morella pensylvanica*), and clammy locust (*Robinia viscosa*). Many of these species were planted to help anchor the sand as part of the beach restoration project that was completed in 2005 by Nova Scotia Transportation and Public Works (Jacques Whitford, 2005). The restoration project was undertaken to stabilize a breach in Lighthouse Beach that occurred in 2003 which was leading to erosion and possible circulation changes such that treated pulp mill effluent and sewage waste was entering Sitmu'k (Jacques Whitford, 2005).

Figure 2. Drone aerial photo of Sitmu'k and Lighthouse Beach. Photo taken on August 1st, 2018.

1.3 A Changing Landscape

Sitmu'k and Lighthouse beach (LHB) comprise a transgressive barrier complex. With sea level rise, the beach requires a constant supply of sediment from longshore drift to remain stable. Through air photo and satellite imaging it has become apparent that LHB is slowly migrating toward the mainland. Figure 3 was derived from Google Earth© imagery and shows the movement of LHB from 2003 to 2017. Over time the beach has been breached by storms (blow out) leading to sediment deposition into Sitmu'k. Blow out deposits are visible along the inner shoreline of LHB (Figure 4). The landward movement has resulted in sediment redistribution from the beach into Sitmu'k, which has led to shallowing and reduced circulation. These changes can impact the water quality because the lagoon can become prone to rapid temperature and reduced circulation due to shallowing and outlet restriction causing nutrients and bacteria to concentrate in the lagoon. As transgression associated with sea level rise is expected to continue the beach will remain moving in a landward direction.

1.4 Thesis Statement

The purpose of this study is to determine the legacy of environmental change that has been preserved in Sitmu'k sediments by conducting an applied paleolimnological assessment of the sediment archive from the lagoon. A comparison of metal concentrations to previous studies done in the area will establish whether the changes are unique and if they can be related to local industrial activity. An assessment of the present environmental conditions in the lagoon was achieved through applied water chemistry analysis.

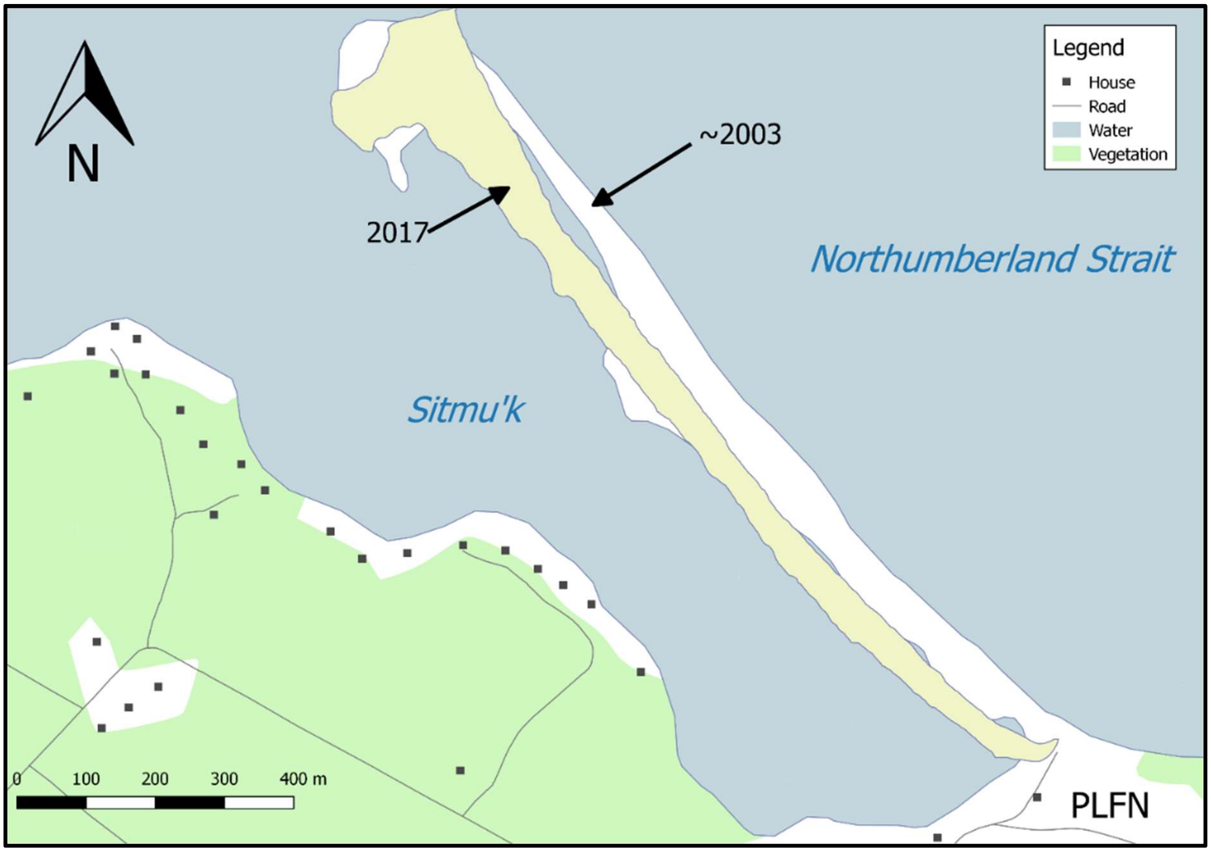

Figure 3. A map of Lighthouse Beach transgression from 2003 to 2017.

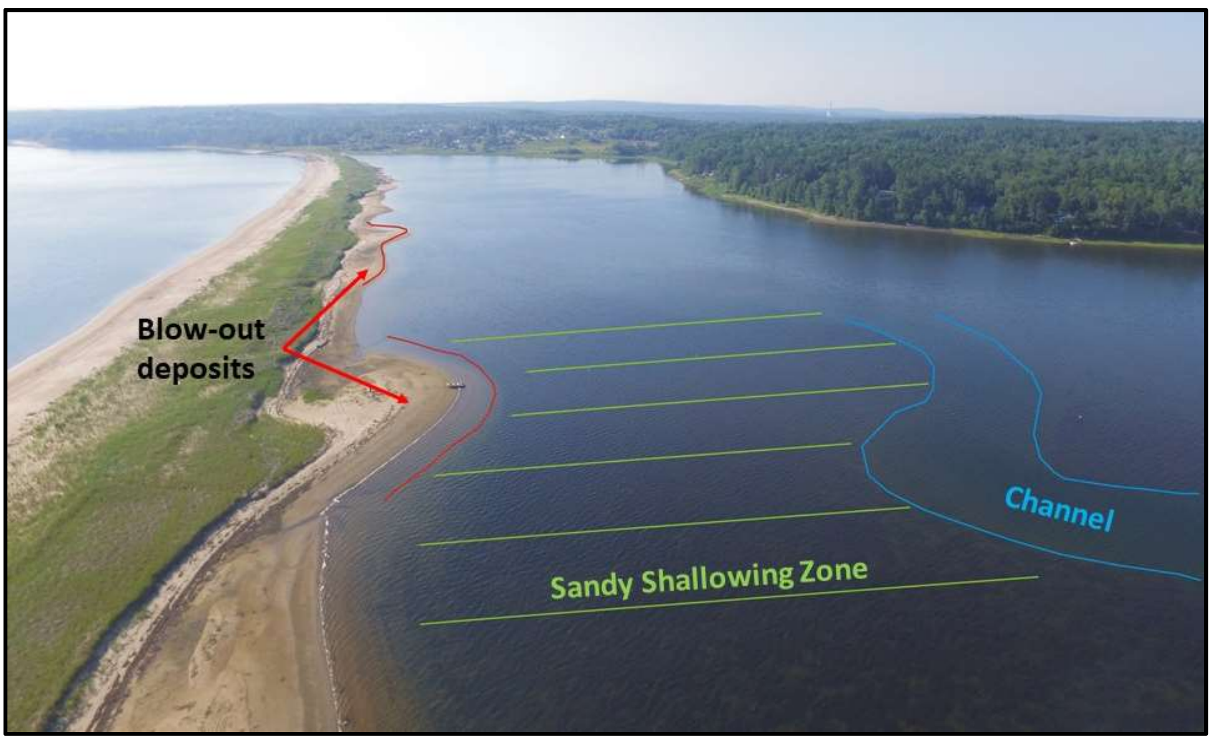

Figure 4. An annotated photo of Sitmu'k illustrating blow out deposits along Lighthouse Beach, a shallowing zone where sediment is being deposit, and the main water channel.

Chapter 2: Literature Review

2.1 Paleolimnology assessment of sediment cores

Paleolimnological assessments study changes in water quality parameters through time by evaluating geochemical and biological compositions in the sediment archives at the bottom of a waterbody (Smol, 1995). Sediment archives are created through time with deposition. As sediment collects in the basins, it is continuously covered by superseding sediment until it is separated from the water column above (von Gunten et al., 1997). When sediment cores are taken from a basin, samples from the core can be accessed to determine past environmental conditions through indicators such as, metals, dissolved gases, and biotic components. These studies can be effective for decoupling anthropogenic and natural contribution to a waterbody. To establish realistic goals for the future quality of an environment, an understanding of it's past and current trends is necessary (Smol, 1992).

2.2 Anthropogenic Contribution

Natural processes can often result in the presence of metals in sediment, however industrial processes can also produce effluent that has high metal concentrations and complex organic composition (Cohen, 2003). Anthropogenic contribution from a variety of sources is evident in the sediments at Boat Harbour (Walker et al., 2016). These sources have potential to influence sediment bulk geochemistry at Sitmu'k as well.

A study by Davidson (2018) in Boat Harbour determined that overlying effluent had minimal influence on the sediment that it have been deposited over. It was determined that no overprinting occurred into the estuarine sediment, however, 8 of the 9 metals found in the effluent (As, Cr, Cu, Mo, Ni, Pb, Ti, Zn) were also present in the estuarine sediment and on average they all exceeded Interim Sediment Quality Guidelines (ISQG) set by the government (Davidson, 2018). A study of nearby reference estuarine sites that were unaffected by the pulp mill effluent indicated that these same metals were present and above ISQG's in lagoon bottom sediment. These studies indicate that in the Pictou Landing area there is a natural geogenic source for many of these metals of concern as well as a possible atmospheric source for some (Davidson, 2018). Therefore, ISQG's cannot be used to determine the presence of contamination as the natural system can accumulate metals that exceed guidelines.

2.3 Local Geology

The local geology and physiography of Pictou County is summarised by JWEL & Beak (1992). Along the Northumberland Strait and covering almost the entire width of Pictou County, the bedrock geology consists of non-marine sedimentary rocks that are Pennsylvanian in age. These strata consist of red and grey sandstones, siltstones, shales, and conglomerates which have all experienced structural deformation producing the east-west trending valley and ridge structures in which they reside. The Tony River Till which overlies the bedrock, makes up much of the surficial sediment in the area and consists of grey, reddish-brown, stony sand sediment. There are numerous boulders near the surface in addition to angular grey and red carboniferous sandstone inclusions throughout. Overlying the till is a soil which is derived from the carboniferous sandstone bedrock but varies compositionally. The west, north, and northeast shores of Boat Harbour consist of 60 to 80 cm of well-drained gravelly sandy loam over more compact dark brown gravelly sandy loam. The soil south of Boat

Harbour consists of 40-60 cm of moderately well drained sandy loam to loam. The soil southeast of Boat Harbour consists of 40-60 cm of imperfectly drained sandy loam to gravelly loam (JWEL & Beak, 1992).

2.4 Local Sediment Characteristics

Several studies of the sediment archive in Boat Harbour have been completed in recent years (Holmes, 2018; Spooner and Dunnington, 2016a, 2016b; JWEL, 2005). Boat Harbour has gone through significant changes in the past 50 years, since the construction of the effluent waste treatment facility (Walker et al., 2016). Boat Harbour was originally a marine estuary until it was dammed by a causeway and became a freshwater lake with very high inputs of organic matter. These changes were well-resolved in the sediment record (Figure 5). Prior to being dammed, the sediment in Boat Harbour was a dense grey-brown, shelly, marine clay and now it is overlain by a less dense, unconsolidated, silty, organic-rich black sediment (Spooner and Dunnington, 2016a). Metals in the sediment at Boat Harbour that exceed Canadian ISQGs for fresh water life protection were found to be Cd, As, Zn, Pb, Cr, and Cu, with Zn being the most indicative of effluent influence (Holmes, 2018; Hoffman et al., 2017; JWEL, 2005).

A paleolimnological survey has also been completed in nearby estuarine systems (Davidson, 2018). This study provided evidence that some metals preserved in polluted sediments may be derived from local geogenic sources. However, some metals in Boat Harbour (Zn in particular) were found to be elevated compared to concentrations at reference sites, indicating effluent influence (Holmes, 2018).

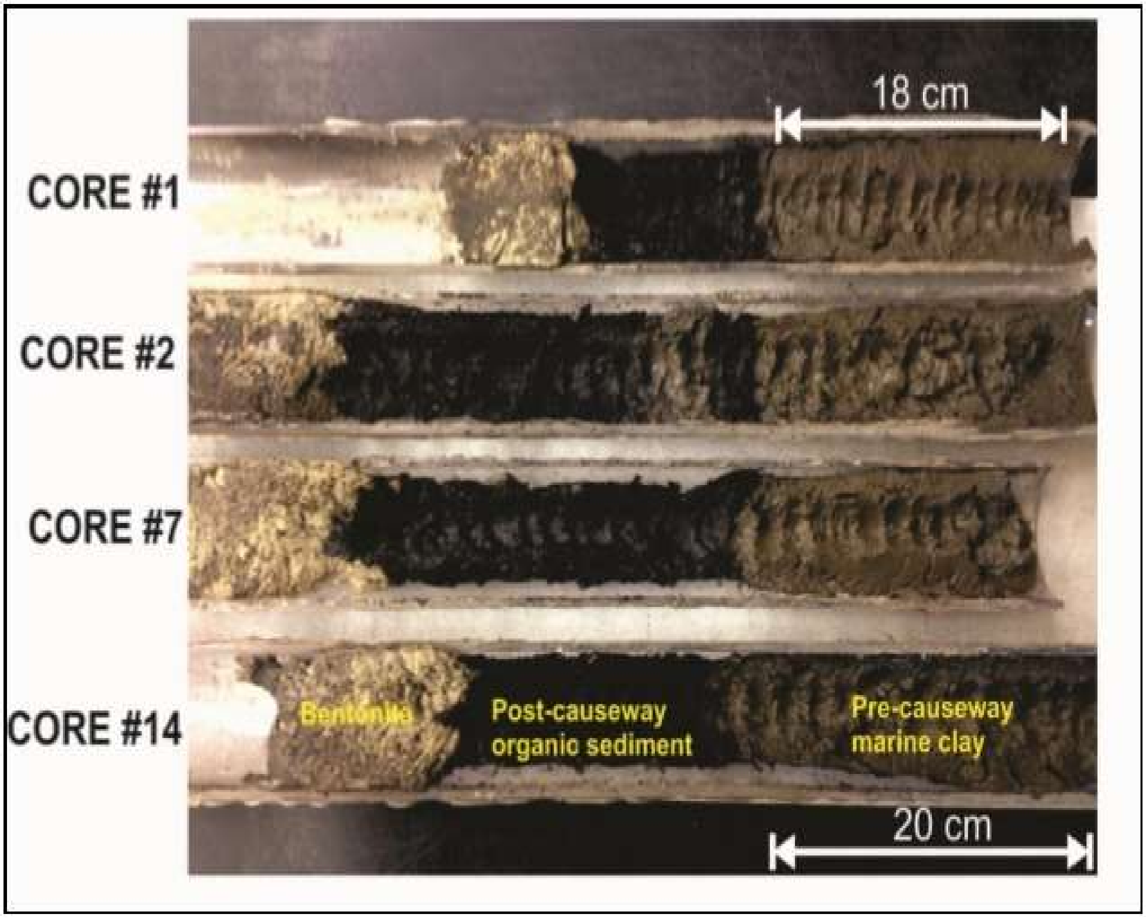

Figure 5. Sediment cores taken from Boat Harbour. The pre-causeway sediment was deposited in an estuarine setting before the site was subject to pulp mill effluent introduction. The post-causeway sediment is effluent influenced sediment that was deposited into Boat Harbour after it had been modified. (From Spooner and Dunnington (2016a).

Chapter 3: Methods

3.1 Sediment Sampling

Prior to sampling, all equipment was cleaned, calibrated, and set up to be ready for use in the field. Eight cores were collected within Sitmu'k lagoon on July 4^{th}, 2018. (Figure 6). To collect the sediment cores, a Glew gravity corer was used with 30 cm core tubes (Glew, 1989). The location of each core was determined using GPS to accurately map core locations. Cores were sealed with bentonite clay on-site to prevent further disturbance and were frozen within 8 hours of collection. After being frozen for at least 24 hours, the cores were centrally split using a diamond inclusion bladed table saw and left to thaw. Once thawed, one core was sampled at 1 cm intervals from the centre to avoid potential cross contamination caused by edge smearing during the coring process (Dunnington and Spooner, 2017). All other cores were centrally split, and two samples were taken, one from the top and one from the bottom. The samples were dried for 72 hours at 40-60^{o}C. Samples were then ground using a mortar and pestle and stored in sealed containers for XRF analysis. Thin sections were also made of the core sediment from core SM18-2, SM18-5, and SM18-7 to characterize sediment and composition.

3.2 Water Quality Testing

Water quality testing in Sitmu'k consisted of monitoring temperature, total coliform, conductivity, pH, dissolved oxygen, phosphorus, and nitrate. Water samples for these tests were collected at sites A, B and C (Figure 6). AGAT Laboratories (Halifax, NS) conducted standard water analysis, total metal analysis, total coliform, and E. *coli* counts on water samples taken from these locations (Appendix B). Water samples were also sent to

Dalhousie University Center for Water Resources Studies where additional total coliform and E. *coli* count tests were conducted (Appendix B).

Water temperature was monitored using Hobo MX Pendant temperature loggers. These were placed at three sites in Sitmu'k (Figure 6). At each site a buoy was tied to a concrete block, which was used as an anchor. For the first two locations a temperature logger was secured just above the concrete block at the bottom of the lagoon, placing it approximately 1 m above the lagoon floor. The third location was in a deeper channel within the lagoon, so a temperature logger was secured just above the concrete block near the base and another secured below the buoy near the surface. Each logger recorded temperature every 30 minutes and collected data from June 27th until September 17th, 2018.

For on-site total coliform testing, the Lamotte coliform indicator test kits were used and the Lamotte procedure was followed. Water samples were collected and placed into test vials which contained coliform indicating tablets and were then stored at room temperature for 48 hours to allow incubation. After 48 hours the vials were examined to determine if coliform bacteria were present.

A YSI Professional Plus water quality sonde was used to measure water quality on-site. This unit has a 3-probe system in which one probe measured pH, another probe measured dissolved oxygen, and the third probe measured both temperature and conductivity. The YSI was used to do tests immediately onsite at locations A, B, and C (Figure 6) and results were recorded.

Phosphorus and Nitrate tests were conducted on water samples collected from locations A, B, and C (Figure 6). Tests were completed using HACH equipment and followed HACH's procedure. Phosphorus tests were conducted with a HACH DREL 2400 Spectrophotometer and followed HACH's USEPA PhosVer 3 with acid persulfate digestion method, method 8190, including the Test 'N Tube Vials (HACH, 2007). Nitrate tests were conducted with a HACH DR 820 colourimeter and followed HACH's cadmium reduction method using powder pillows, method 8039 (HACH, 2004).

3.3 Data Analysis

Sediment samples were analyzed using x-ray fluorescence (XRF). The results of these tests were compared to results from the same tests done in nearby reference estuaries (Holmes, 2018; Davidson, 2018). XRF analysis measured concentrations of Calcium (Ca), Copper (Cu), Iron (Fe), Potassium (K), Manganese (Mn), Lead (Pb), Rubidium (Rb), Strontium (Sr), Titanium (Ti), and Zinc (Zn). Shells are comprised of calcium carbonate; making Ca and Sr representative of shell content within sediment. This is useful, as sudden increases or decreases could correlate to that of the number of living organisms and thus the quality of the environment. Ti, K, and Rb are associated with the clastic content of the sediment (Dunnington et al, 2018), whereas Cu, Pb, and Zn are metals that can indicate anthropogenic influence. Every third sample was run on the XRF three times to ensure data accuracy. Quality assurance and quality control measures were used during XRF analysis (Appendix A).

Isotope analysis was completed by the Stable Isotopes in Nature Laboratory (SINLAB) at the University of New Brunswick to measure total carbon, total nitrogen, and stable isotopes

($\delta^{13}C$, $\delta^{15}N$). $\delta^{13}C$ represents the relative carbon isotope difference between the sample and the international standard (Pee Dee Belemnite) using the formula:

$$\delta^{13}C = [(Rsample/Rstandard)-1]*1000$$

where R is the isotopic ratio of the heavy to light ($^{13}C/^{12}C$) (Logan et al., 2008). Similarly, $\delta^{15}N$ represents the relative nitrogen isotope ratio difference between the sample and the international standard using the formula:

$$\delta^{15}N = [(Rsample/Rstandard)-1]*1000$$

where R is the isotopic ratio of the heavy to light ($^{15}N/^{14}N$) (Logan et al., 2008). A C/N vs. $\delta^{13}C$ biplot was used to determine provenance of the organic material within the sediment.

3.4 Photography

DGI – Phantom 3 and Phantom 4 drones were used to obtain aerial photos of Sitmu'k to provide an aerial perspective on the landscape. These photos were compared to older satellite imagery and aerial photos taken of the area to detect changes in the morphology of Lighthouse Beach (erosion, deposition, or longshore drift) and to detect any other natural or anthropogenic changes in the landscape.

Chapter 4: Results

Data collection sites at Sitmu'k and Lighthouse Beach are mapped in Figure 6. The yellow stars labelled A, B, and C are the locations of water quality sampling sites. Each red triangle depicts a location of one of the eight gravity core samples. The three orange circles labelled X, Y, and Z were the locations of the temperature data loggers and lastly, the black line A to A' was the transect in which conductivity tests were done while also mapping the base of the lagoon.

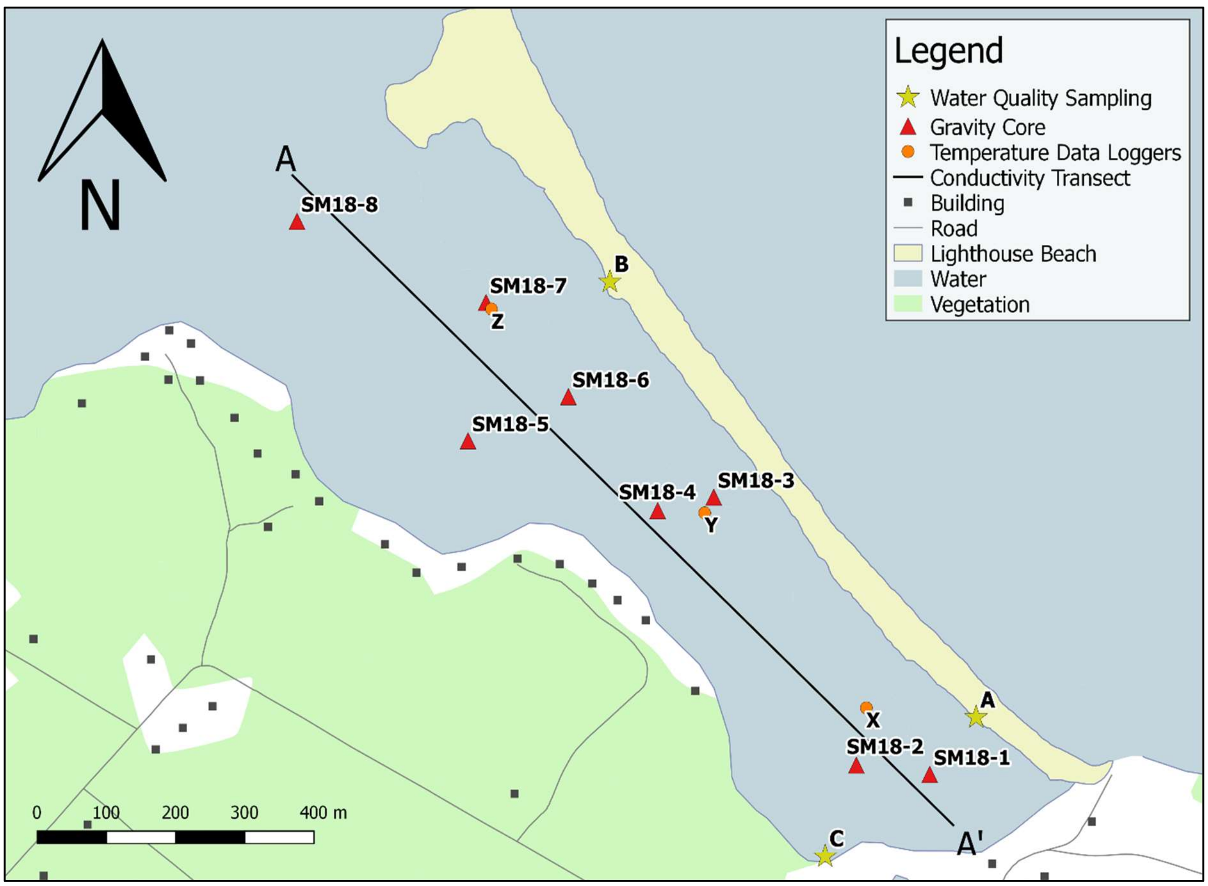

Figure 6. Map of data collection sites in Sitmu'k completed throughout the summer of 2018.

4.1 *Water Chemistry and Quality*

Conductivity of Sitmu'k was tested along a transect from A – A' (Figure 6; Figure 7), along the centre of the water body from the open end of the lagoon to the inner beach. The conductivity appeared highest near the surface on the eastern and inner most part of the lagoon. The conductivity also shows a general decrease to the west and with depth. The base of Sitmu'k was also mapped during this transect, showing an increase in depth to the west as the transect moves toward the mouth of Sitmu'k. The third stop shows a depth of 2 m and this is believed to be the main water channel that enters the lagoon.

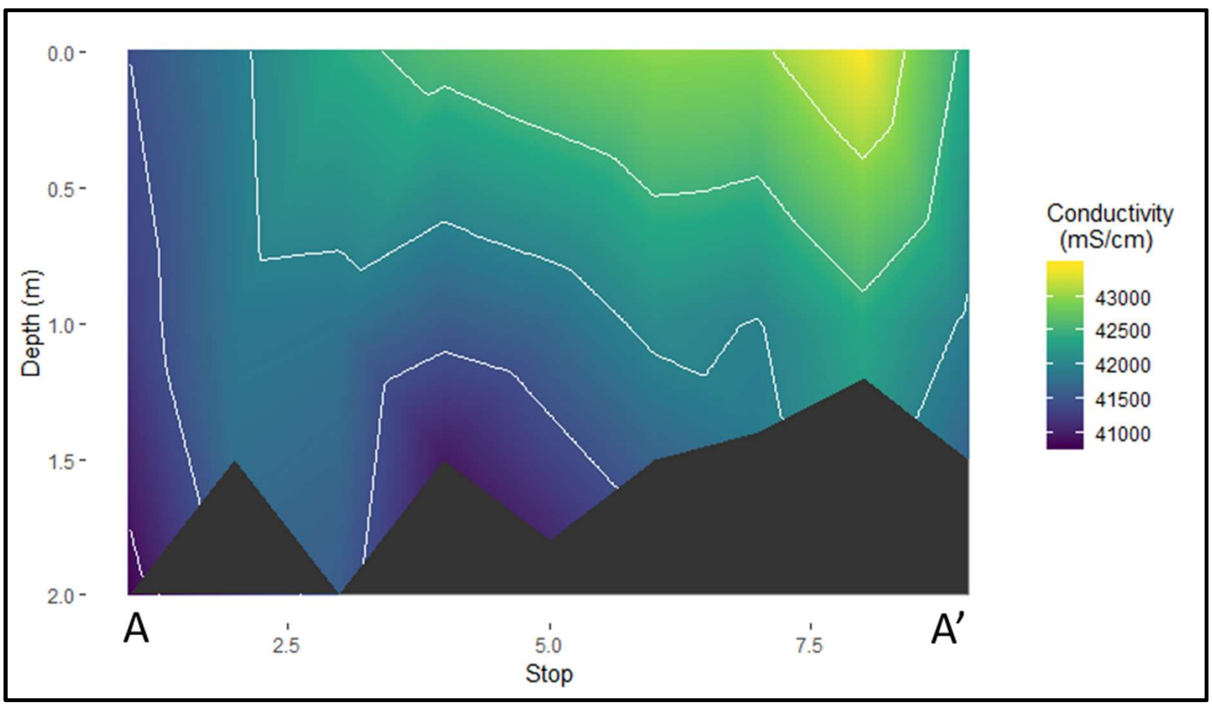

Figure 7. Conductivity test and map of basement in Sitmu'k along transect A-A'. The standard sea water conductivity is 50,000mS/cm. Typical freshwater is .05 to 200mS/cm.

Four temperature data loggers recorded data every 30 minutes from June 27th until September 17th, 2018. Location Z (Figure 6) had two data loggers, one near the surface and another near the base. Location X and Y (Figure 6) each had one logger near the base. Figure 8 shows the temperature fluctuations and overall trend from June to September. The red line indicating the overall trend shows a gradual increase in temperature throughout June and the beginning of July until the temperature peaks during the end of July and beginning of August. The rest of August and September shows a gradual decline in temperature. For most of the months of July and August the water temperature rises above 25°C and sometimes rises over 30°C. Throughout the summer the water temperature at the bottom versus the surface varies by about 5°C. Furthermore, from day to day the water temperature in Sitmu'k varied by about 10°C from the hottest to the coldest and did not drop below 15°C. For the month of August, the water temperature only rarely dropped below 20°C. In comparison, the Northumberland Strait, which Sitmu'k is connected to, had an average water temperature in July of 16°C, and a maximum temperature in July of 22°C (Petrie and Francis, 1993). In July Sitmu'k had an average of 22°C, and a maximum temperature of 32°C.

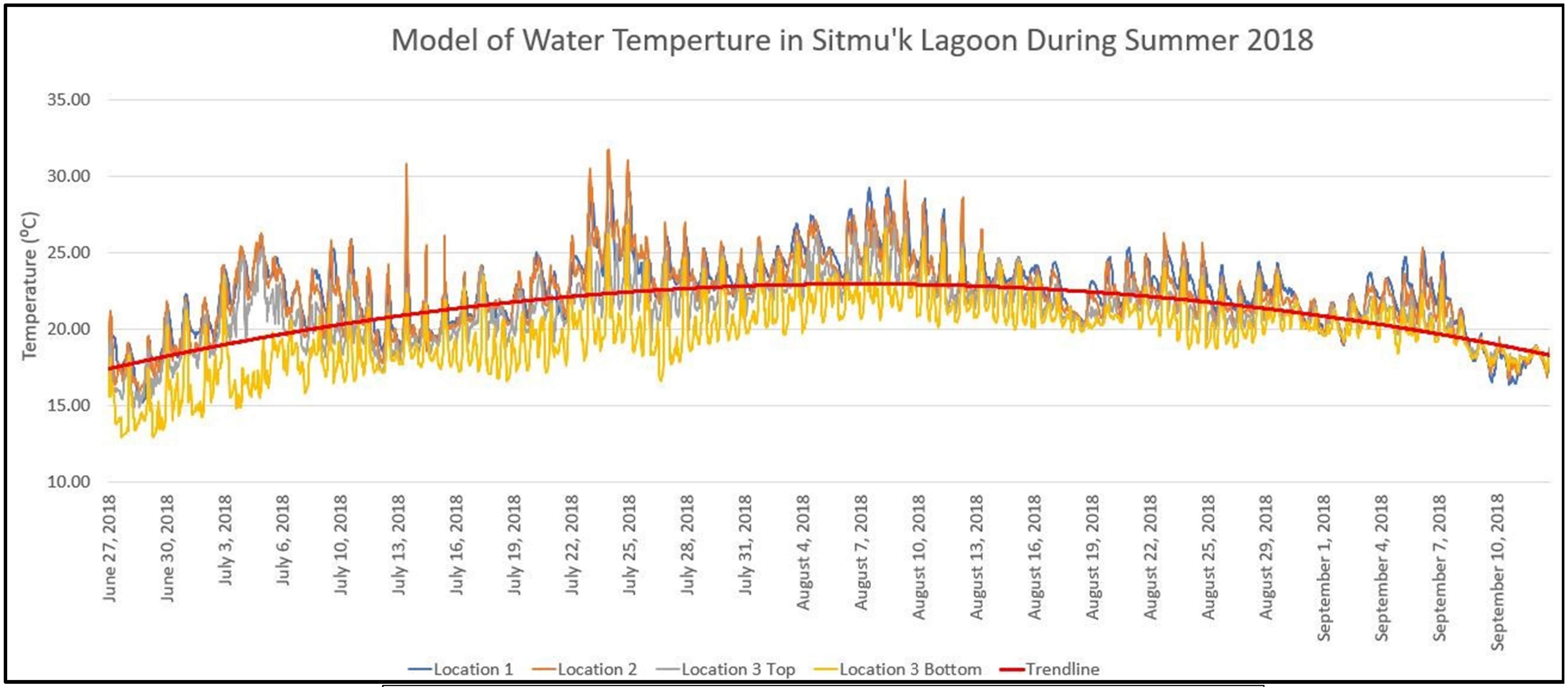

Figure 8. Temperature graph showing the results from four data loggers in Sitmu'k from June to September, and an overall trendline in red.

4.2 Total Coliforms and E. coli

La Motte coliform indicator test kits were used in Sitmu'k to determine the level of coliform contamination. These indicator test kits were used on June 19th, July 16th, and August 10th and in each case the test yielded the highest positive result, indicating a high level of coliform contamination (Figure 9). Water samples were then sent to a lab for analysis to obtain an exact coliform count which can be compared to the Canadian Recreational Water Quality Guidelines (Health Canada, 2012).

Figure 9. Results from a coliform indicator test kit used on June 19th, 2018 showing a strong positive result.

Table 1 below summarizes the results of two coliform counts, first completed on June 27th and the second completed August 1st. The acceptable limit of E. *coli* in water for recreational use is 200 MPN/100mL (most probable number) (Health Canada, 2012). Early in the summer the first round of tests were completed on surface samples retrieved from sites A, B, and C (figure 6), and the results indicated that the E. *coli* count was below unacceptable limits, with an average of 36 MPN/100mL. Later in the summer, the second round of tests for all three locations indicated an E. *coli* count above the 200 MPN/100mL limit, with an average of 383 MPN/100mL. The total coliform count from June to August also increased from 1048 MPN/100mL to 1799 MPN/100mL.

Table 1. Results from total coliform and E. *coli* counts for sites A, B, and C in Sitmu'k. All values are in MPN/100mL.

	June 27th, 2018		August 1st, 2018	
	Total Coliforms	E. *coli*	Total Coliforms	E. *coli*
Site A	1300	25	2419	210
Site B	980	47	1860	365
Site C	866	37	1120	573
Average	1048	36	1799	383

Nitrate and total phosphorus tests were conducted throughout the summer on water samples collected from sites A, B, and C (figure 6). Overall there is a general increasing trend noticeable in both total phosphorous and nitrate as the season progressed (Figure 10). Total phosphorus levels peaked in late August and began to decrease in September. Nitrate levels followed a similar trend, increasing from June to August and then remaining consistent into September. A data gap is present in nitrate for late August due to sample loss.

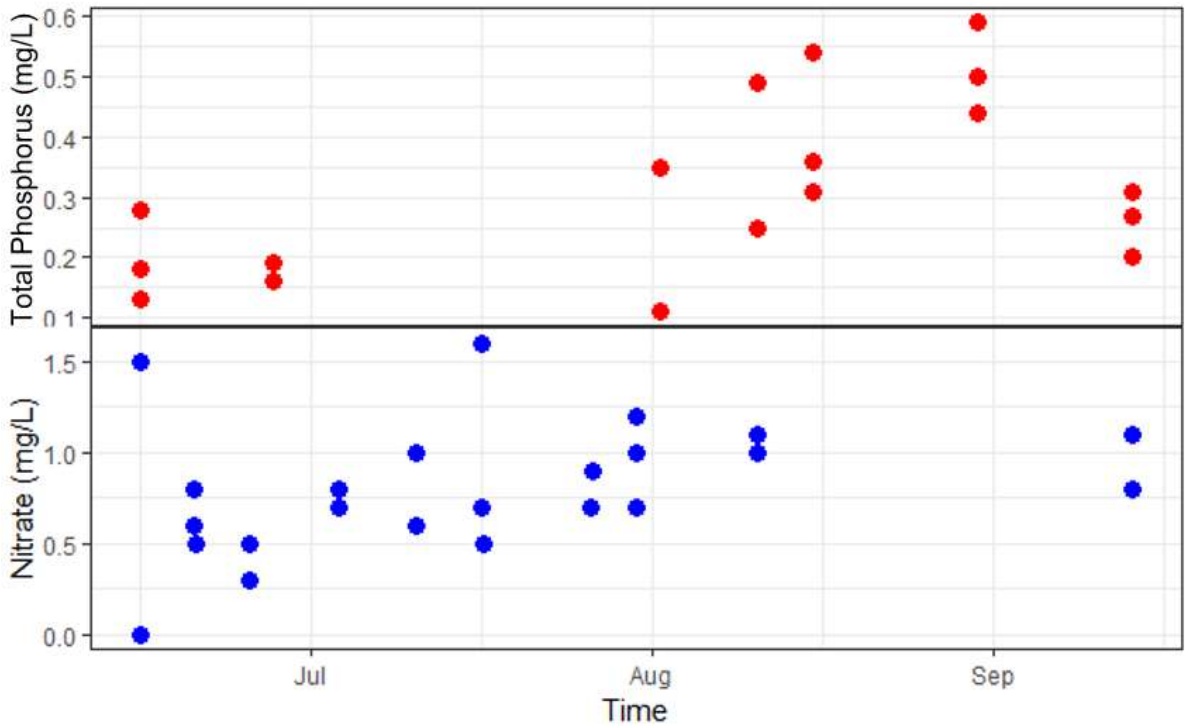

Figure 10. Phosphate (red) and Nitrate (blue) data collected from June to September. Both show a general increase from left to right.

4.3 Sedimentology

The lagoon sediment consists 70% of silty clay matrix with mixed organics (woody material). Large interconnected pores are present throughout. The mineralogy is mostly (95%) fine-grained quartz with minor amounts of potassium feldspar, plagioclase, muscovite, biotite, titanite. The sample overall is texturally immature and mineralogically mature, fine-grained to very fine-grained, angular, and poorly sorted. Iron oxidation is noticeable throughout the sample.

Lighthouse Beach consists mainly of quartz dominated fine-grained sand. The mineralogy is mostly (90%) quartz with some potassium feldspar (7%) and lithics (3%). The sample is overall texturally sub-mature and mineralogically mature, fine to medium grained, well rounded, and well sorted.

4.4 XRF metal concentration box-range plots

XRF analysis of samples taken from the top and bottom of each sediment core from Sitmu'k are summarized as box-range plots in Figure 11. This analysis includes concentrations of Ca, Cu, Fe, K, Mn, Pb, Rb, Sr, Ti, and Zn, each of which have been identified as indicators for various important attributes.

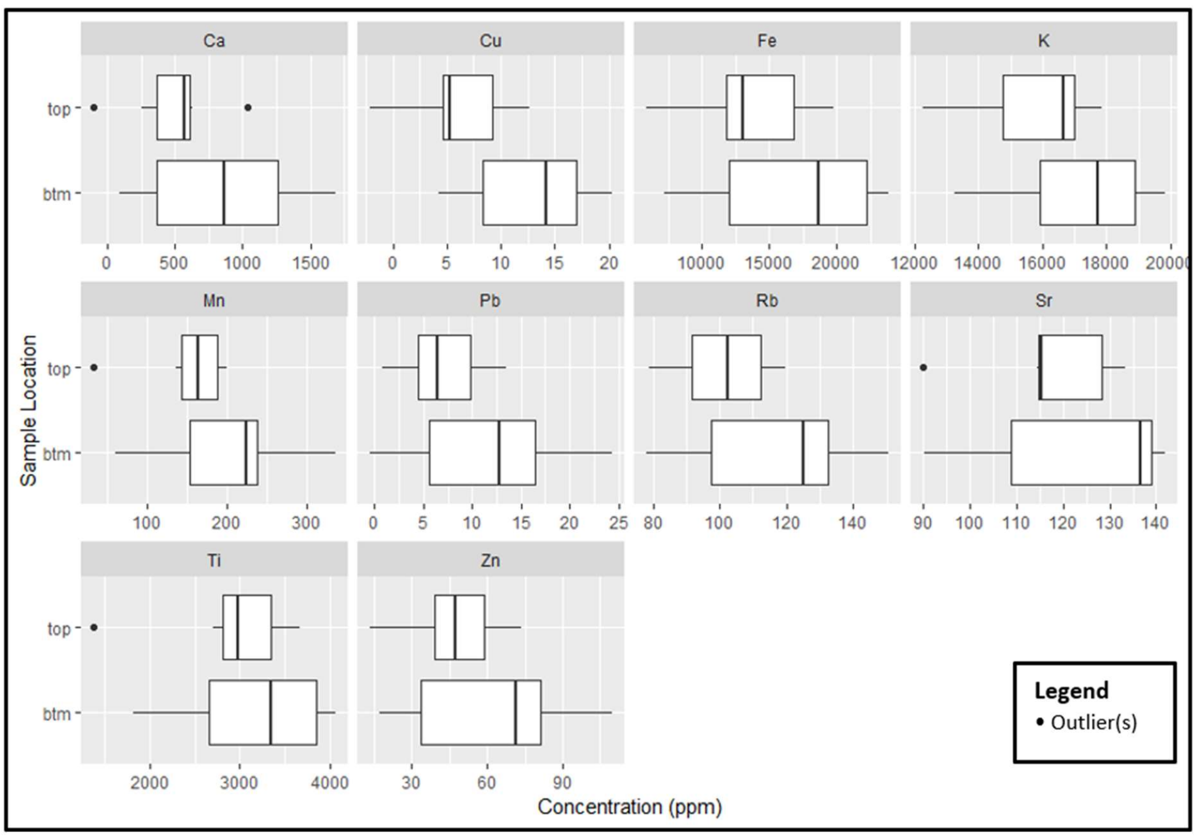

Figure 11. Top and bottom analysis of sediment cores from Sitmu'k. Average element concentrations were plotted for all the top and bottom samples from the eight sediment cores with outliers labelled appropriately (Appendix C).

4.4.1 Calcium (Ca)

There was no significant difference between the average Ca concentrations of the top and bottom samples, however, it was observed that the average Ca concentration for the bottom was higher than that of the top. The average Ca concentration for the top was 558 ± 15 ppm. The average Ca concentration for the bottom was 858 ± 13 ppm. However, the analyses for the bottom of core 5 (SM18-5) gave concentrations that were abnormally high (13618 ppm). This high abnormality was left out of the calculated average and box plots emphasize low-concentration variability.

4.4.2 Copper (Cu)

Cu concentrations of the top and bottom samples for Sitmu'k averaged below the ISQG limit. The Cu ISQG for marine sediment is 19 ppm (CCME, 2016). There was no significant difference between the average Cu concentrations of the top and bottom samples. The average Cu concentration for the top was 8 ± 1 ppm. No top samples were above the Cu ISQG limit. The average Cu concentrations for the bottom was 14 ± 3 ppm. 23.1% of bottom samples were found to be above the Cu ISQG limit.

4.4.3 Iron (Fe)

There was no significant difference between the average Fe concentrations of the top and bottom samples, however, it was observed that the average Fe concentrations for the bottom was higher than that of the top samples. The average Fe concentration for the top was 14784 ± 167 ppm. The average Fe concentration for the bottom was 17529 ± 57 ppm.

4.4.4 Potassium (K)

There was no significant difference between the average K concentrations of the top and bottom samples. The average K concentration for the top was 16149 ± 38 ppm. The average K concentration for the bottom was 17417 ± 264 ppm.

4.4.5 Manganese (Mn)

There was no significant difference between the average Mn concentrations of the top and bottom samples, however, it was observed that the average Mn concentration for the bottom samples was higher than that of the top samples. The average Mn concentration for the top was 158 ± 5 ppm. The average Mn concentration for the bottom was 202 ± 4 ppm.

4.4.6 Lead (Pb)

Pb concentrations of the top and bottom samples for Sitmu'k averaged below the ISQG limit. The Pb ISQG for marine sediment is 30.2ppm (CCME, 2016). There was no significant difference between the average Pb concentrations of the top and bottom samples. The average Pb concentration for the top was 9 ± 2 ppm. No top samples were above the Pb ISQG limit. The average Pb concentrations for the bottom was 13 ± 1 ppm. 15.4% of bottom samples were found to be above the Pb ISQG limit.

4.4.7 Rubidium (Rb)

There was no significant difference between the average Rb concentrations of the top and bottom samples. The average Rb concentration for the top was 106 ± 2 ppm. The average Rb concentration for the bottom was 119 ± 1 ppm.

4.4.8 Strontium (Sr)

There was no significant difference between the average Sr concentrations of the top and bottom samples. The average Sr concentration for the top was 121 ± 2 ppm. The average Sr concentration for the bottom was 128 ± 2 ppm.

4.4.9 Titanium (Ti)

There was no significant difference between the average Ti concentrations of the top and bottom samples. The average Ti concentration for the top was 3016 ± 35 ppm. The average Ti concentration for the bottom was 3175 ± 42 ppm.

4.4.10 Zinc (Zn)

Zn concentrations of the top and bottom samples for Sitmu'k averaged below the ISQG limit. The Zn ISQG for marine sediment is 124 ppm (CCME, 2016). There was no significant difference between the average Zn concentrations of the top and bottom samples. The average Zn concentration for the top was 54 ± 3 ppm. No top samples were above the Zn ISQG limit. The average Zn concentrations for the bottom was 65 ± 2 ppm. No bottom samples were above the Zn ISQG limit.

4.5 Summary Table of Top and Bottom Analysis

Table 2 shows a summary of the average metal concentrations for the top and bottom samples taken from the Sitmu'k sediment cores. For all metals, the average concentration in the bottom appeared higher than that of the top. For the metals with an ISQG limit, the percentage of exceedances is also shown in Table 2. There were no samples taken from the top of the sediment cores which showed ISQG exceedances for Cu, Pb, or Zn. In the bottom samples Zn did not exceed the ISQG limit but Cu and Pb exceeded the ISQG limit on occasion.

Table 2. Summarized results of top and bottom analyses for metal concentrations in Sitmu'k.

	Average top (ppm)	Average bottom (ppm)	% top over ISQG	% bottom over ISQG
Calcium	558.46	858.05	N/A	N/A
Copper	8.08	13.93	0%	23.10%
Iron	14784.33	17529.04	N/A	N/A
Potassium	16148.77	17417.24	N/A	N/A
Manganese	157.66	202.06	N/A	N/A
Lead	8.64	13.31	0%	15.40%
Rubidium	106.42	118.65	N/A	N/A
Strontium	120.72	128.25	N/A	N/A
Titanium	3015.76	3174.59	N/A	N/A
Zinc	53.95	65.03	0%	0%

4.6 Metal Concentrations Through Time

Sediment core SM18-5 was selected for high resolution in which a sample was collected every centimeter down core. SM18-5 was selected because it was the deepest core, therefore representing the longest and least disturbed record from the lagoon. Each sample was analysed for concentrations of Ca, Cu, Fe, K, Mn, Pb, Rb, Sr, Ti, and Zn. Each metal concentration was plotted against depth within the core to show change through time (Figure 12), where the top is the youngest material, and the bottom is the oldest material. Several trends within the element concentrations were identified. Ca and Sr, representative of shell content within sediment, both show a similar and consistent trend until approximately 12 cm depth where there is a sudden significant increase in concentration. Ti is representative of clastic input into the system and shows a sudden significant decrease around 12 cm depth, similar, but opposite, to Ca and Sr. The remaining concentrations, Cu, Fe, K, Mn, Pb, Rb, and Zn show similar overall trends of decreasing metal concentrations at 4 cm and 12 cm depth. Between these two events metal concentrations remained relatively constant. In the top two centimeters of the core metal concentrations increased.

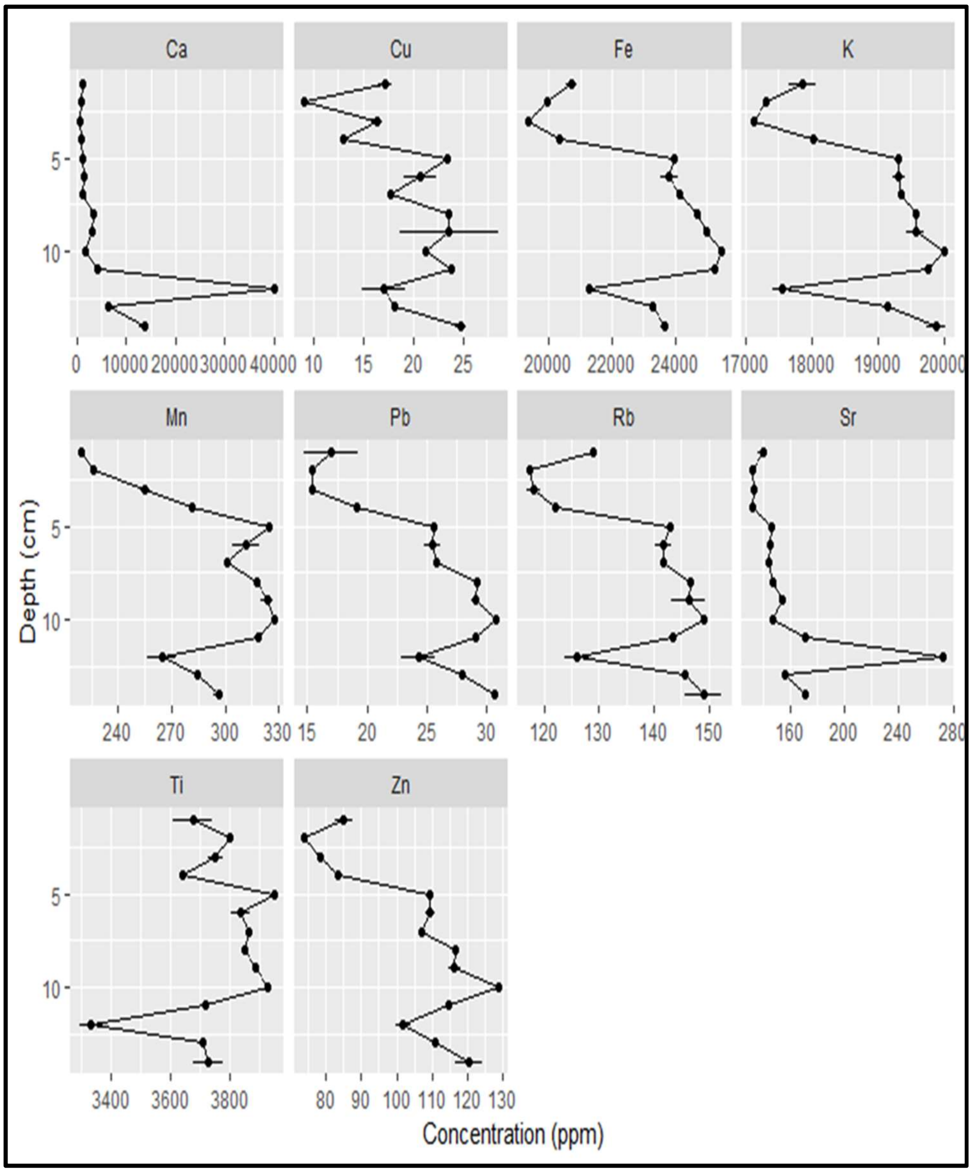

Figure 12. XRF analysis of Metal Concentrations from core SM18-5 measured and recorded from top to bottom in 1 cm intervals (Appendix C).

4.7 Total C/N & Stable Isotope Analysis

Total C and total N data (Appendix D) was plotted down-core in centimeter intervals to determine change through time in the organic portion of the sediment (Figure 13; Figure 14). Total C and N both show similar overall trends. Between 5 cm and 3 cm depth there is significant decrease in both C and N. The C and N concentrations at the top of the core increase. Overall there is a gradual decreasing trend in total C and N moving up-core.

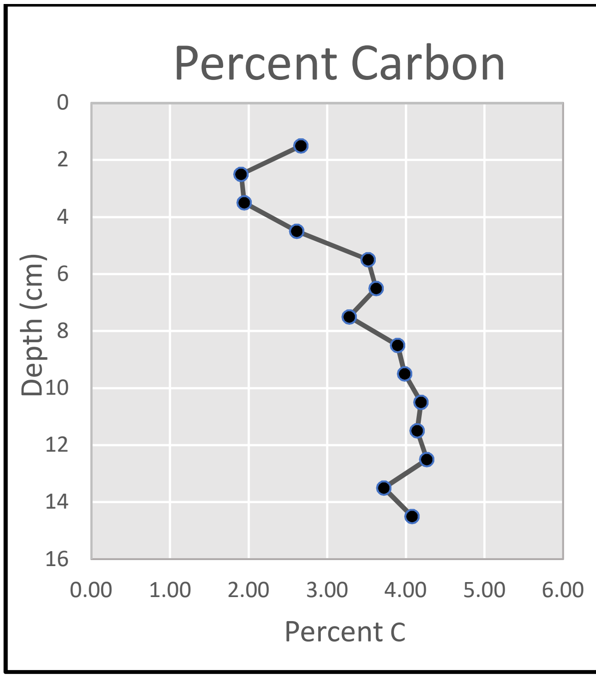

Figure 13. Total Carbon % plotted from top to bottom of core SM18-5.

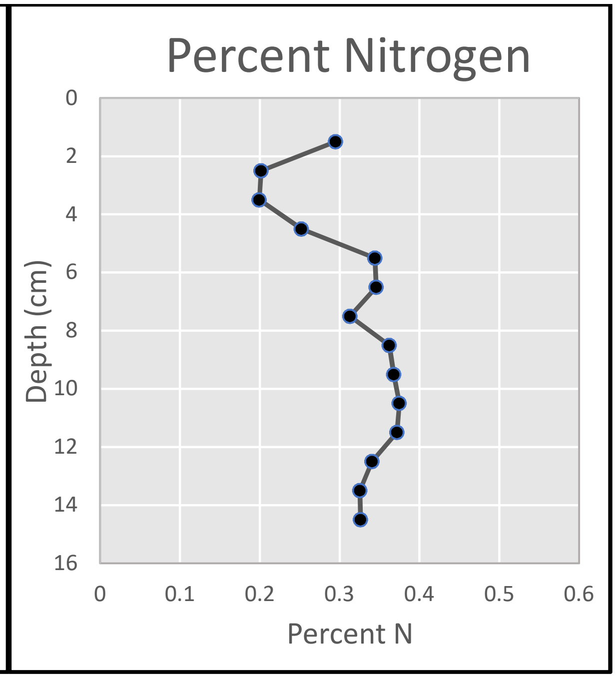

Figure 14. Total Nitrogen % plotted from top to bottom of core SM18-5.

$\delta^{13}C$ and $\delta^{15}N$ were each plotted down-core in centimeter intervals to determine change through time, using samples from SM18-5 (Figure 15; Figure 16; Appendix D). $\delta^{15}N$ and $\delta^{13}C$ both remained relatively consistent with depth. $\delta^{15}N$ ranged mostly between 4% and 4.5%, and $\delta^{13}C$ ranged mostly between -18% and -20%, with higher values between 12 cm and 15 cm depth. $\delta^{13}C$ appears to have a gradual decreasing trend moving up-core. $\delta^{13}C$ values between -10% and -22% indicate organic matter is from a marine source (Mackie, 2005). Terrestrial and freshwater sourced carbon material is typically represented by $\delta^{13}C$ values around 27% (Mackie, 2005). The $\delta^{13}C$ values in SM18-5 range from -16% to -20%, indicating the source of organic material in Sitmu'k sediment to be marine. $\delta^{15}N$ values indicate that the main source of nitrogen is likely oceanic phytoplankton, represented by values typically around 6%, and terrestrial organic matter, represented by values between -10% and +10% (Alonso-Hernández et al., 2017).

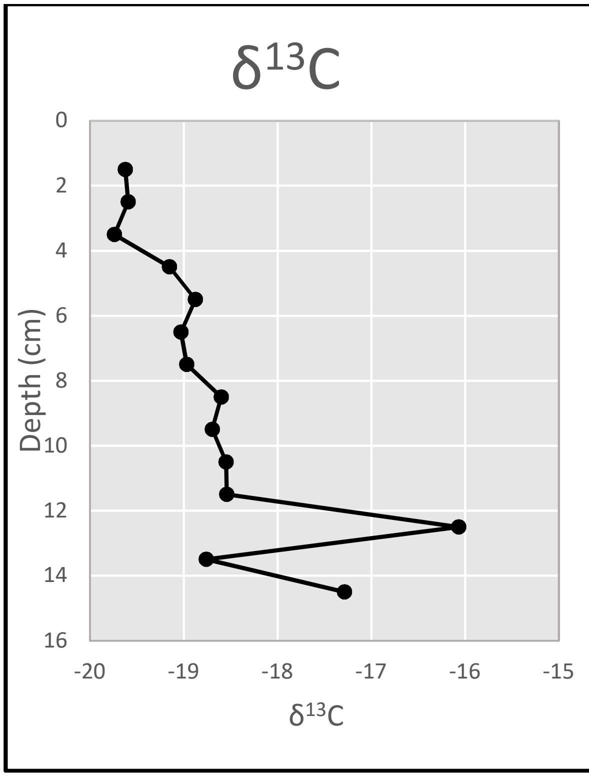

Figure 15. $\delta^{13}C$ plotted down-core using samples from core SM18-5.

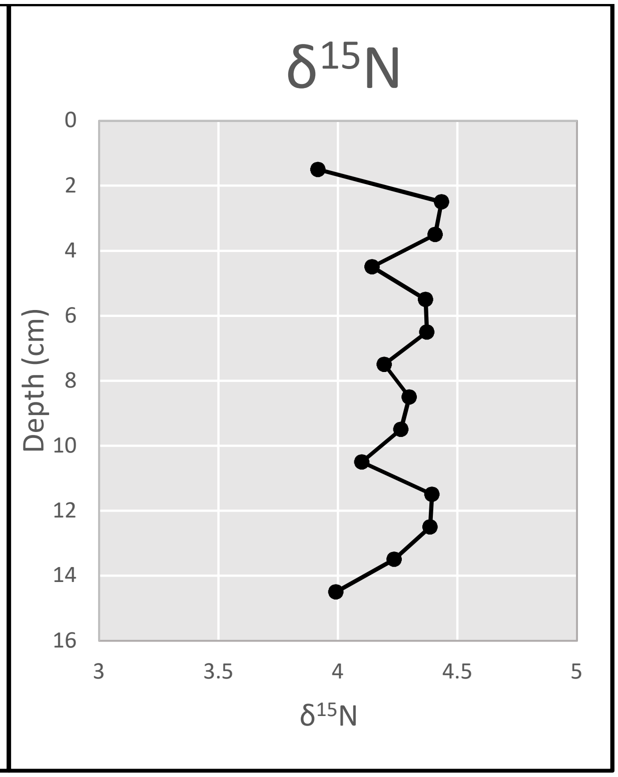

Figure 16. $\delta^{15}N$ plotted down-core using samples from core SM18-5.

Furthermore, the carbon/nitrogen ratio was graphed against $\delta^{13}C$ to determine the source of carbon input using predefined data fields (Figure 17). The data fields are defined as follows: C/N ratio of 11-17 and $\delta^{13}C$ values between -24.9% and 32.5% characterize freshwater aquatics. C/N ratio between 4 and 42 and $\delta^{13}C$ values greater than -23% characterize marine material. C/N ratio of 5-11 and 17-58 and $\delta^{13}C$ values of -24.9%-32.5% characterize terrestrial material (White, 2012; Meyers & Lallier-Vergés, 1999). Organic material from Sitmu'k plotted within the marine material boundaries, like reference site Chance Harbour. Organic material from Boat Harbour Estuary has a more terrestrial carbon input, likely influenced by Boat Harbour (and the pulp effluent) which empties into it.

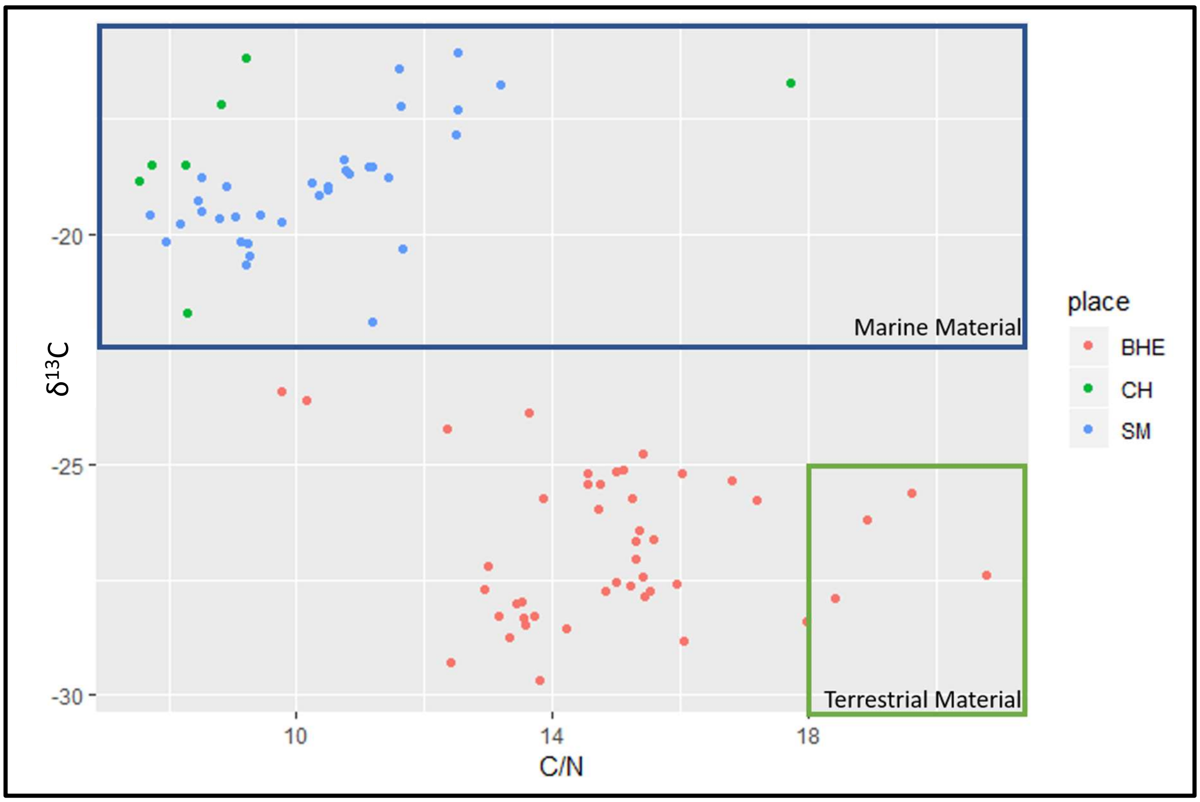

Figure 17. $\delta^{13}C$ versus C/N ratio to determine the source of carbon input in Sitmu'k (SM) in comparison to reference sites Chance Harbour (CH) and Boat Harbour Estuary (BHE).

Chapter 5: Interpretation and Discussion

5.1 Water Chemistry Analysis

Sitmu'k and Lighthouse Beach are changing through time and both sites are influenced by a combination of anthropogenic activity and natural geogenic processes. A back-barrier lagoon complex will decrease in size over time with sea level transgression as the barrier beach moves landward and fills the lagoon with sediment. Benallack et al. (2016) studied a non-migrating back-barrier lagoon complex in Africa. Benallack et al. (2016) found that the sedimentation rates are stable, and the lagoon stays relatively deep (due to tidal flushing), unlike the Atlantic margin of North America in which barriers are typically migrating landward and beach sediment is deposited over lagoon sediments. This process is occurring rapidly in Sitmu'k. Blow out deposition along LHB, and the landward movement of LHB as seen through past air photos are causing Sitmu'k to become shallower and more restricted from Pictou Harbour and the Northumberland Strait. These processes are strongly influencing water quality in Sitmu'k.

Water quality analysis from June to September showed an overall increasing trend as the summer progressed. Temperature of the waterbody rose steadily through June, July, and August, reaching temperatures above 30°C. Increasingly warm water temperatures are expected with Sitmu'k becoming shallower and the outlet becoming more restricted resulting is less mixing with the colder water of the Northumberland Strait.

Total coliform indicator tests were consistently high, indicating a high coliform count in Sitmu'k from June to September. Coliforms are a diverse group of bacterial taxa, most of which are not a threat to human health (Stevens et al., 2003). E. *coli* is one of the coliforms that is a threat to human health and is only found in the intestines of humans and mammals, making it a good indicator for sewage and wastewater contamination. E. *coli* tests were completed twice, once in late June, and another on the first of August. In June, E. *coli* counts were at acceptable levels for recreational purposes, but by August E. *coli* levels had risen well above recreational guidelines, limiting recreational use. It is probable that septic or sewage water contamination is entering the lagoon. Further research is required to determine the source of E. *coli* contamination. However, the restriction and shallowing of Sitmu'k is an important influence on-site because the lagoon remains warmer for longer periods of time and does not circulate water quickly, allowing bacteria such as E. *coli* to proliferate.

Following the same increasing trend over the summer, total phosphorus and nitrate levels showed a gradual incline, peaking in August. Nitrogen input can be an indicator for fertilizer transport from agricultural sources, sewage and fecal contamination, and/or aerial deposition (Smith et al., 1999). Phosphate input is also an indicator for erosion, fertilizer, animal manure, and wastewater traveling overland through water systems (Smith et al., 1999). Guidelines set by the Canadian Council of Ministers for the Environment (CCME) for nitrogen concentrations in marine systems are set at 16 mg/L (CCME, 2007). Nitrogen concentrations in water samples from Sitmu'k were below these guidelines, peaking at roughly 1.5 mg/L. Phosphorus can be used as an indicator for eutrophication in water systems. Sitmu'k is a complex estuarine system therefore many factors need to be considered when defining its trophic status such as flush rate and the rate at which the system can use these nutrients. Although these factors were not fully explored in this study, CCME recommends that a system should not exceed 0.05 mg/L of phosphorus in peak productivity (CCME, 2004). Sitmu'k total phosphorus concentrations were consistently above 0.05 mg/L through June to September and peaked at 0.6 mg/L. Phosphorous concentrations are likely being influenced by sewage wastewater and/or fertilizer runoff.

5.2 Sitmu'k Metal Analysis

All ten elements selected for XRF analysis (Ca, Cu, Fe, K, Mn, Pb, Rb, Sr, Ti, Zn) showed little stratigraphic variation in the sediment core records. The box plots comparing top and bottom element concentrations in Sitmu'k all showed that concentrations near the bottom of the core are slightly elevated compared to concentrations near the surface, however, no overall significant change has occurred. Slightly elevated metal concentrations in the past are likely related to the sediments ability to capture these metals which appears to decrease as the lagoon becomes shallower, sedimentation rates increase and organic content decreases. Figure 18 shows Cu, Pb, Ti, and Zn concentrations in Sitmu'k compared to concentrations at reference sites (Fergusons Pond, Chance Harbour, Boat Harbour Estuary; Figure 1), with black dots representing outliers. Ti, Cu and Pb concentrations in Sitmu'k are similar or less than concentrations in reference sites. Zn concentrations are significantly less than the average concentrations of the reference sites. Elevated concentrations of Zn in the Boat Harbour and Boat Harbour estuary sediment have been associated with influence from pulp effluent (Davidson, 2018; Holmes, 2018; Spooner and Dunnington, 2016a, 2016b). Sitmu'k has low Zn concentrations, all of which are below ISQGs for marine sediments, showing no apparent legacy of influence from pulp effluent.

This data does not prove that pulp effluent has not entered Sitmu'k in the past, but it does indicate that there is likely no preservation of contamination, if it did indeed occur, on site.

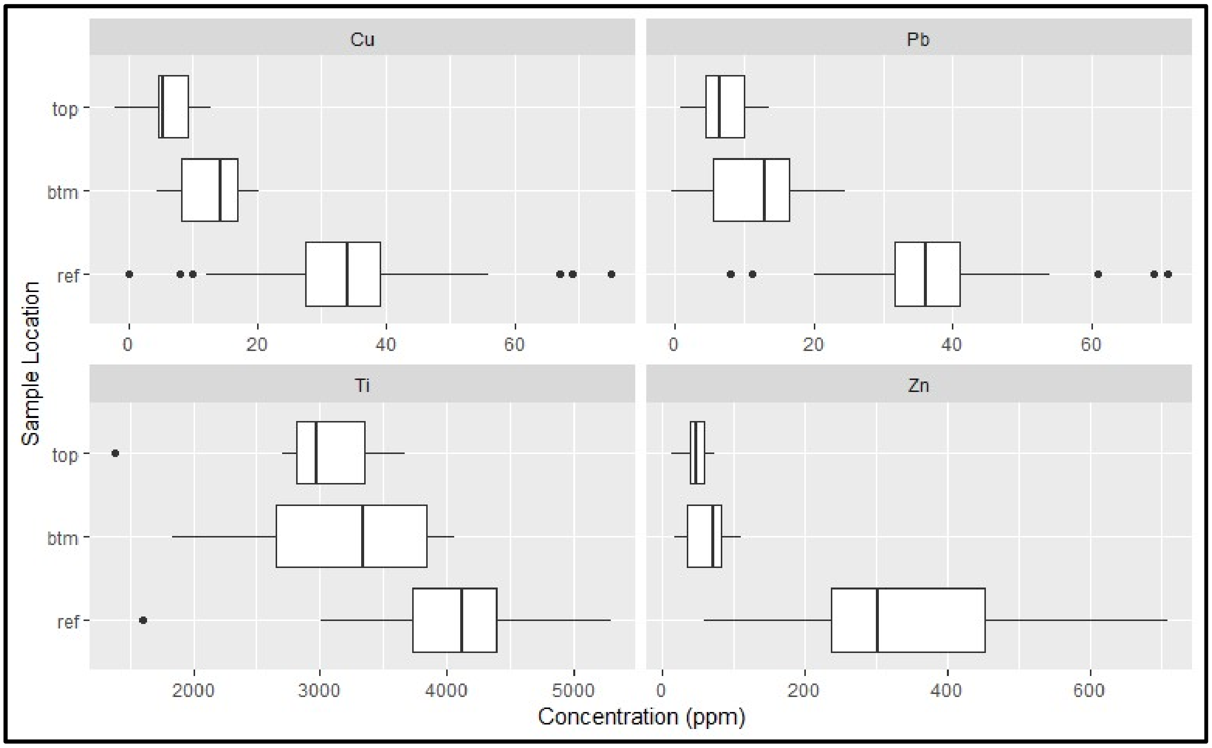

Figure 18. Box plots of Cu, Pb, Ti, and Zn concentrations at the top and bottom (btm) of the Sitmu'k cores in comparison to the reference sites (ref) Fergusons Pond, Chance Harbour and Boat Harbour Estuary.

XRF data from detailed analysis of SM18-5 (Figure 12), shows all elements to be relatively consistent from the top to the bottom of the core. As mentioned previously, two events are observed to have occurred at 4 cm and 12 cm depth, causing a decrease in metal concentrations. A likely cause of these trends are sudden increases in sedimentation in Sitmu'k, such as through a blow out and transfer of sand from the barrier beach into the lagoon. Blow out deposits form during storms when the barrier is breached. The deposits are visible along the barrier beach, and a significant breach occurred in 2003 which required a restoration project (Jacques Whitford, 2005). These events would cause a rapid but short-lived increase in minerogenic sedimentation into the lagoon and therefore the sediment had less time for metals to collect with deposition. This event would be resolved in the sediment record as a sudden decrease in metal concentrations. It is possible that the breaching event in 2003 is recorded in the sediment record as the event at 4 cm depth as this was the most recent major sedimentation event known to have happened. Metal concentrations began to increase in the uppermost centimeters of the core, perhaps associated with increased organic sediment accumulation as Sitmu'k became more restricted. At 12 cm depth there is also a sudden increase of Ca and Sr concentrations. The likely explanation for this is the "nugget effect" in which a piece of a component within the sediment sample, such as a shell, that has high concentrations of one or more elements causes an offset in the data (Geboy and Engle, 2011).

Metal concentrations are similar or lower in comparison to reference site averages. Blue lines on Figure 19 indicate average concentrations for reference sites (Chance Harbour, Fergusons Pond, and Boat Harbour Estuary). Zn concentrations appear to be much lower than the reference sites, indicating no record of Boat Harbour effluent influence. Cu, Pb, Ti and Zn concentrations were all observed to be below ISQG's set by the Canadian Government (CCME, 2016). These concentrations indicate that the site is not polluted by excess concentrations of these metals. A study by Davidson (2018) on sediment in Boat Harbour, Boat Harbour Estuary, Fergusons Pond, and Chance Harbour Estuary found that this region has high concentrations of these metals, likely from a local geogenic source. The metals found in Sitmu'k sediments are likely derived from the same geogenic source. The lower concentrations found in Sitmu'k compared to the reference sites is likely due to the high minerogenic and low organic sedimentation rates caused by the erosion and landward migration of Lighthouse Beach.

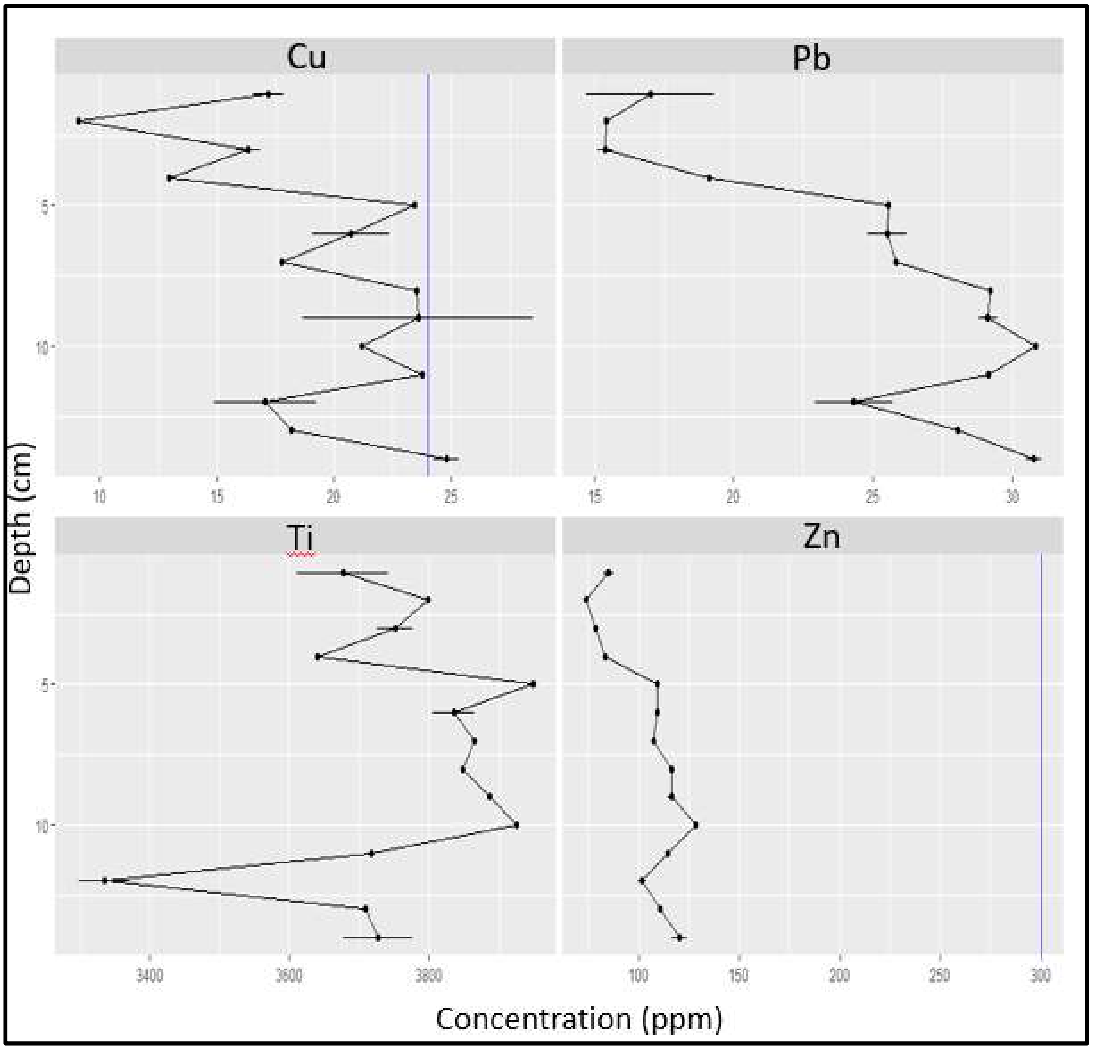

Figure 19. Metal concentrations with depth using samples from SM18-5 compared to average concentrations of the reference sites (blue lines).

5.3 Total Carbon, Total Nitrogen, and Stable Isotope Analysis

Total C and total N percentage were observed to be fairly consistent, with one event around 4 cm depth. It is likely that this decrease occurred in 2003 when Lighthouse Beach was breached, and minerogenic sedimentation rates increased. The sudden sedimentation increase in the lagoon would decrease the ability for organic matter to accumulate with the sediment. $\delta^{13}C$, $\delta^{15}N$ and the relationship between $\delta^{13}C$ and C/N was used to determine the source of organic material in the lagoon. All three methods indicated that the source of organic material in Sitmu'k is dominantly marine. $\delta^{15}N$ values suggested that nitrogen-bearing material is likely coming from oceanic phytoplankton or terrestrial sources on Lighthouse Beach. These analyses determined a marine origin for the organic material in Sitmu'k, suggesting that sources such as the pulp effluent (derived from terrestrial organic matter) in Boat Harbour are not a likely influence on-site. Boat Harbour organic material is of strong terrestrial origin due to the organic components of the effluent being sources from tree pulp (Holmes, 2018).

Chapter 6: Conclusion

There is strong evidence for natural environmental change at Sitmu'k. Lighthouse Beach is moving landward due to sea level rise and wave activity, causing the lagoon to become shallower, the sediment to become more minerogenic and reducing circulation. This allows nutrients and bacteria to collect and concentrate during the summer months. XRF analysis of the lagoon sediment archives does not provide evidence for sequestered contaminants or extensive change. There are two events in the sediment archive that change metal concentrations, both are likely due to sudden rapid sedimentation rates caused by breaches in the barrier beach. Evidence for anthropogenic impact on-site is found in the water quality data. E. *coli* bacteria is likely coming from a source of fecal contamination. High phosphorus concentrations may be related to septic influence. Total carbon, total nitrogen, and stable isotope analysis indicated that organic material is of marine origin, reducing the likelihood that pulp effluent impacted the site. The main driver of environmental degradation at Sitmu'k is the landward movement of Lighthouse Beach. The landward movement of Lighthouse Beach has created an environment that is lacking circulation and is becoming shallower. This is allowing water temperatures to rise, nutrients to collect, and bacteria to rapidly reproduce and concentrate within the lagoon.

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Appendix

A: XRF Quality Assurance/Control

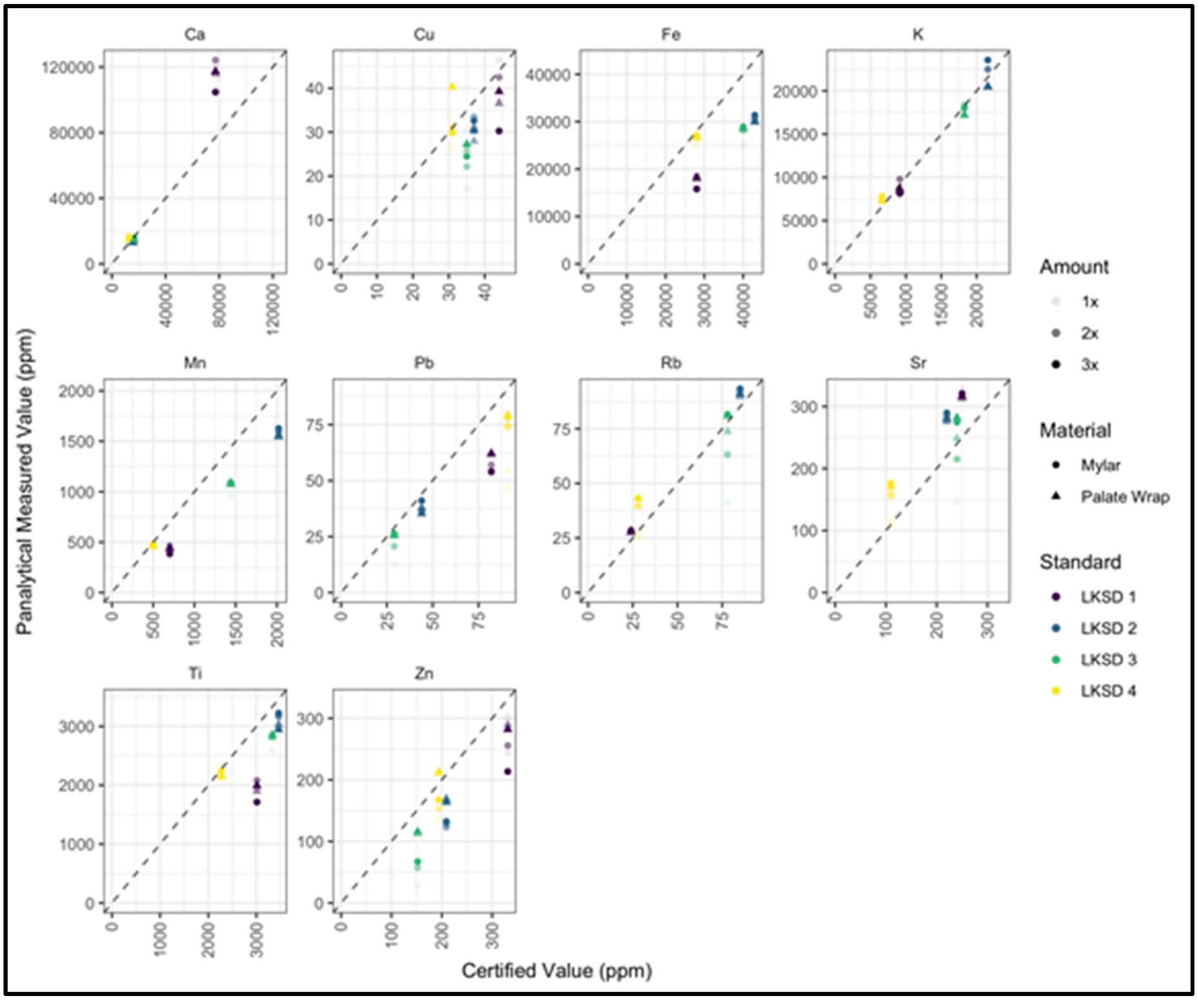

Figure 1A: A calibrated curve of certified reference materials ran on the XRF. Various sediment masses and container sealing materials were used throughout.

B: Water Quality Data

Table 1B: Standard water analysis and total metal analysis test results from AGAT Labs in Dartmouth, Nova Scotia. Water samples taken on June 15, 2018, results were produced on June 26, 2018.

Parameter	**Unit**	**S18-A1**	**S18-B1**	**S18-C1**
pH		7.91	8.05	7.86
Reactive Silica as SiO2	mg/L	<0.5	<0.5	0.9
Chloride	mg/L	14500	14700	9460
Fluoride	mg/L	<24	<24	<24
Sulphate	mg/L	1920	1960	1240
Alkalinity	mg/L	96	97	72
True Color	TCU	11	21	15
Turbidity	NTU	3.6	0.9	5.6
Electrical Conductivity	umho/cm	40100	40800	27200
Nitrate + Nitrite as N	mg/L	<0.05	<0.05	<0.05
Nitrate as N	mg/L	<10	<10	<10
Nitrite as N	mg/L	<10	<10	<10
Ammonia as N	mg/L	<0.03	<0.03	<0.03
Total Organic Carbon	mg/L	3.2	3.4	3.9
Ortho-Phosphate as P	mg/L	0.04	<0.01	<0.01
Total Sodium	mg/L	8500	9110	5520
Total Potassium	mg/L	309	348	203
Total Calcium	mg/L	329	370	213
Total Magnesium	mg/L	1010	1090	656
Bicarb. Alkalinity (as CaCO3)	mg/L	96	97	72
Carb. Alkalinity (as CaCO3)	mg/L	<10	<10	<10
Hydroxide	mg/L	<5	<5	<5
Calculated TDS	mg/L	26600	27600	17300
Hardness	mg/L	4980	5410	3230
Langelier Index (@20C)	NA	0.58	0.77	0.23
Langelier Index (@ 4C)	NA	0.26	0.45	-0.09
Saturation pH (@ 20C)	NA	7.33	7.28	7.63
Saturation pH (@ 4C)	NA	7.65	7.60	7.95
Anion Sum	me/L	451	457	294
Cation sum	me/L	477	513	310
% Difference/ Ion Balance (NS)	%	2.8	5.7	2.6
Total Aluminum	ug/L	167	60	167
Total Antimony	ug/L	<2	<2	<2
Total Arsenic	ug/L	8	7	7
Total Barium	ug/L	17	15	96
Total Beryllium	ug/L	<2	<2	<2
Total Bismuth	ug/L	<2	<2	<2
Total Boron	ug/L	3010	3090	2200
Total Cadmium	ug/L	<0.09	<0.09	<0.09
Total Chromium	ug/L	14	13	11
Total Cobalt	ug/L	2	2	1

Total Copper	ug/L	19	19	13
Total Iron	ug/L	470	283	733
Total Lead	ug/L	<0.5	<0.5	0.7
Total Manganese	ug/L	60	46	275
Total Molybdenum	ug/L	9	10	7
Total Nickel	ug/L	37	41	34
Total Phosphorous	mg/L	<0.02	0.07	0.03
Total Selenium	ug/L	3	3	2
Total Silver	ug/L	<0.1	<0.1	<0.1
Total Strontium	ug/L	5810	6260	3710
Total Thallium	ug/L	<0.1	<0.1	<0.1
Total Tin	ug/L	<2	<2	<2
Total Titanium	ug/L	20	19	16
Total Uranium	ug/L	2.3	2.4	1.5
Total Vanadium	ug/L	152	154	108
Total Zinc	ug/L	24	22	22

Table 2B: Standard water analysis and total metal analysis test results from AGAT Labs in Dartmouth, Nova Scotia. Water samples taken on June 27, 2018, results were produced on July 6, 2018.

Parameter	**Unit**	**S18-A2**	**S18-B2**	**S18-C2**
pH		7.90	7.91	7.94
Reactive Silica as SiO2	mg/L	0.5	0.5	0.5
Chloride	mg/L	9660	9490	9620
Fluoride	mg/L	<24	<24	<24
Sulphate	mg/L	1320	1310	1320
Alkalinity	mg/L	78	76	78
True Color	TCU	19	14	19
Turbidity	NTU	2.8	2.5	2.5
Electrical Conductivity	umho/cm	31300	30700	31800
Nitrate + Nitrite as N	mg/L	<0.05	<0.05	<0.05
Nitrate as N	mg/L	<10	<10	<10
Nitrite as N	mg/L	<10	<10	<10
Ammonia as N	mg/L	<0.03	<0.03	<0.03
Total Organic Carbon	mg/L	2.1	2.0	1.8
Ortho-Phosphate as P	mg/L	<0.01	<0.01	<0.01
Total Sodium	mg/L	6240	5800	5470
Total Potassium	mg/L	273	242	284
Total Calcium	mg/L	280	254	290
Total Magnesium	mg/L	754	733	681
Bicarb. Alkalinity (as CaCO3)	mg/L	78	76	78
Carb. Alkalinity (as CaCO3)	mg/L	<10	<10	<10
Hydroxide	mg/L	<5	<5	<5
Calculated TDS	mg/L	18600	17900	17700
Hardness	mg/L	3800	3650	3530
Langelier Index (@20C)	NA	0.43	0.38	0.48

Langelier Index (@ 4C)	NA	0.11	0.06	0.16
Saturation pH (@ 20C)	NA	7.47	7.53	7.46
Saturation pH (@ 4C)	NA	7.79	7.85	7.78
Anion Sum	me/L	302	296	300
Cation sum	me/L	354	331	315
% Difference/ Ion Balance (NS)	%	8.0	5.5	2.4
Total Aluminum	ug/L	141	192	128
Total Antimony	ug/L	<2	<2	<2
Total Arsenic	ug/L	<2	<2	<2
Total Barium	ug/L	22	22	25
Total Beryllium	ug/L	<2	<2	<2
Total Bismuth	ug/L	<2	<2	<2
Total Boron	ug/L	2940	2500	2860
Total Cadmium	ug/L	<0.09	<0.09	<0.09
Total Chromium	ug/L	2	3	3
Total Cobalt	ug/L	1	2	2
Total Copper	ug/L	7	11	11
Total Iron	ug/L	164	240	348
Total Lead	ug/L	0.8	<0.5	<0.5
Total Manganese	ug/L	57	57	60
Total Molybdenum	ug/L	9	8	8
Total Nickel	ug/L	11	11	11
Total Phosphorous	mg/L	0.04	0.04	0.04
Total Selenium	ug/L	<1	<1	<1
Total Silver	ug/L	<0.1	<0.1	<0.1
Total Strontium	ug/L	5030	4610	5170
Total Thallium	ug/L	<0.1	<0.1	<0.1
Total Tin	ug/L	<2	<2	<2
Total Titanium	ug/L	10	14	15
Total Uranium	ug/L	1.6	1.5	1.6
Total Vanadium	ug/L	42	48	109
Total Zinc	ug/L	12	13	14
Total Coliforms (MPN)	MPN/100 mL	1300	980	866
E. Coli (MPN)	MPN/100 mL	25	47	37

Table 3B: Total Coliform count and E. *coli* count test results from the Center for Water Resources Studies at Dalhousie University in Halifax, Nova Scotia. Water samples taken on August 1, 2018, results were produced on August 27, 2018.

Parameter	**Unit**	**S18-A3**	**S18-B3**	**S18-C3**
Total Coliforms (MPN)	MPN/100 mL	>2419	1860	1120
E. *coli* (MPN)	MPN/100 mL	210	365	573

C: X-Ray Fluorescence Analysis

Table 1C: Raw XRF data of metal concentrations (ppm) retrieved from an Epsilon1 XRF.

core	depth	K	Ca	Ti	Mn	Fe	Cu	Zn	Rb	Sr	Pb
SM18-1	1	17837.5	1033.471	3431.896	195.378	19733.67	12.664	67.294	118.061	131.308	12.511
SM18-1	6	17703.9	558.137	2745.171	143.752	12412.64	9.256	32.372	98.647	100.215	5.294
SM18-2	1	17025.31	603.791	3610.854	193.81	18489.67	11.065	77.32	118.617	130.285	11.048
SM18-2	12	18758.43	1119.229	3706.969	335.696	23623.66	17.216	109.813	150.691	142.035	24.371
SM18-3	1	13098.08	-308.521	1560.156	31.334	5921.018	-2.246	10.323	81.205	87.333	0.988
SM18-3	1	11439.36	103.052	1204.664	35.502	5934.429	-2.003	16.291	76.322	92.912	0.698
SM18-3	3	12761.75	145.642	1958.674	70.731	7383.4	4.276	19.011	76.155	93.713	-1.545
SM18-4	1	16663.77	597.654	3259.343	148.513	14937.86	5.155	50.224	106.103	125.509	6.432
SM18-4	6	14844.74	183.01	2572.679	164.91	11746.35	7.45	34.715	96.559	117.592	5.726
SM18-6	1	16071.95	570.726	2665.448	127.918	12951.95	5.302	48.388	99.337	112.029	5.893
SM18-6	8	17016.38	1389.962	3334.689	224.708	18670.32	14.249	74.683	127.855	136.989	12.823
SM18-7	1	15346.65	481.347	2970.143	163.525	13077.41	5.291	43.728	97.495	115.164	7.233
SM18-7	9	20245.89	1666.158	3907.372	249.23	23956.53	18.294	69.757	137.243	143.421	17.212
SM18-8	1	14138.68	251.24	2705.759	181.588	10545.47	4.133	34.65	86.117	115.29	3.755
SM18-8	7	19042.28	859.371	4054.959	225.047	20759.63	20.336	87.898	125.215	136.487	16.79
SM18-5	1	17705.61	1081.301	3722.887	218.698	20595.78	16.703	83.353	128.773	137.289	15.375
SM18-5	14	19777.56	14294.2	3691.058	298.213	23574.99	25.183	117.681	146.704	170.048	30.954
SM18-5	1	18000.71	990.441	3629.559	219.068	20851.42	17.632	86.802	128.838	141.899	18.631
SM18-5	2	17305.84	771.334	3797.833	226.258	19956.53	9.067	73.809	117.369	131.646	15.426
SM18-5	3	17149.31	696.978	3779.36	253.753	19341.85	16.624	78.217	118.025	131.823	15.106
SM18-5	3	17093.56	680.88	3741.44	253.553	19330.26	15.703	77.955	119.245	134.674	15.467
SM18-5	3	17101.2	699.223	3731.392	258.015	19382.34	16.655	79.481	117.009	131.901	15.618
SM18-5	4	18021.82	814.021	3640.174	281.617	20311.24	12.948	83.29	121.994	132.147	19.144
SM18-5	5	19305.63	1196.23	3949.098	324.328	23981.07	23.44	109.318	142.949	146.158	25.56
SM18-5	6	19395.13	1388.519	3840.172	319.522	23978.28	22.593	110.603	142.347	145.949	25.231

SM18-5	6	19326.88	1349.878	3862.235	310.172	23966.09	19.548	108.133	142.911	147.062	26.312
SM18-5	6	19215.09	1365.675	3802.757	304.403	23479.61	20.009	109.507	140.149	143.037	24.989
SM18-5	7	19348.49	1227.048	3864.164	301.082	24131.66	17.772	107.166	141.662	144.264	25.823
SM18-5	8	19573.47	3471.76	3847.526	317.619	24698.41	23.503	116.572	146.739	146.535	29.21
SM18-5	9	19431.69	3121.363	3887.6	319.838	25027.56	18.344	114.729	148.292	155.633	28.787
SM18-5	9	19592.33	3182.158	3889.297	325	25009.55	28.104	118.015	142.721	152.838	29.464
SM18-5	9	19684.28	3172.269	3883.096	325.579	24994.63	24.326	116.022	147.832	154.189	29.122
SM18-5	10	19996.11	1672.233	3924.896	327.714	25478.74	21.194	128.646	149.169	147.377	30.825
SM18-5	11	19756.37	4303.018	3717.017	318.518	25234.99	23.776	114.581	143.512	171.304	29.159
SM18-5	12	17605.62	39954.08	3329.94	259.316	21289.27	16.005	104.064	128.293	274.372	24.111
SM18-5	12	17652.44	40025.92	3299.555	260.098	21247.71	19.582	101.091	125.946	272.657	25.816
SM18-5	12	17396.86	39883.77	3373.817	273.792	21240.19	15.628	99.983	123.898	270.65	23.047
SM18-5	13	19137.12	6339.958	3708.27	284.279	23283.34	18.187	110.922	145.629	156.117	28.028
SM18-5	14	19981.5	12943.25	3761.444	294.491	23746.46	24.421	122.954	151.399	170.882	30.577
SM18-2	1	17043.86	628.28	3658.77	208.164	18831.47	13.466	72.945	123.138	136.45	14.225
SM18-2	1	16948.65	647.457	3714.023	199.431	18899.54	13.617	69.902	117.881	133.24	14.961
SM18-3	3	13548.63	42.017	1611.226	42.916	6408.914	3.98	14.114	78.184	83.314	0.219
SM18-3	3	13438.02	83.525	1920.632	72.078	7939.382	4.612	18.317	80.079	93.767	-0.169
SM18-6	1	17382.3	543.172	3037.325	145.237	13118.7	7.894	48.198	103.545	114.649	3.955
SM18-6	1	17380.34	595.018	3049.801	139.015	13092.18	4.471	45.92	104.436	116.79	5.294
SM18-7	9	19688.39	1686.977	3987.913	248.258	23790.88	18.108	70.059	138.637	139.572	15.36
SM18-7	9	19616.63	1704.503	4016.945	256.773	23864.35	13.751	74.013	135.021	139.175	15.464
SM18-8	1	14138.68	251.240	2705.759	181.588	10545.47	4.133	34.650	86.117	115.290	3.755
SM18-8	7	19042.28	859.371	4054.759	225.047	20759.63	20.336	87.898	125.215	136.487	16.790

D: Total Carbon, Total Nitrogen, and Stable Isotope data

Table 1D: Raw data from Stable Isotope in Nature (SIN) Lab at the University of New Brunswick. This table includes total C, total N, C/N, and stable isotope data for sediment cores taken from Sitmu'k in 2018 and Boat Harbour Estuary, Chance Harbour Estuary, and Fergusons Pond in 2017.

Core	Depth	CO2_Ampl	N2_Ampl	d13C	d15N	C	N	C_N
SM18-5	1	1.78	1.505	-19.67	4.50	2.78	0.32	8.79
SM18-5	1	0.45	0.33	-19.63	3.92	2.66	0.30	9.03
SM18-5	2	1.347	1.038	-19.59	4.43	1.91	0.20	9.44
SM18-5	3	1.378	1.022	-19.74	4.41	1.95	0.20	9.76
SM18-5	4	1.788	1.278	-19.15	4.14	2.61	0.25	10.36
SM18-5	5	2.235	1.663	-18.87	4.37	3.52	0.34	10.23
SM18-5	6	2.256	1.641	-19.03	4.37	3.62	0.35	10.48
SM18-5	7	2.166	1.559	-18.97	4.19	3.28	0.31	10.49
SM18-5	8	2.438	1.733	-18.60	4.30	3.90	0.36	10.76
SM18-5	9	2.507	1.776	-18.70	4.26	3.98	0.37	10.83
SM18-5	10	2.569	1.767	-18.55	4.10	4.19	0.37	11.19
SM18-5	11	2.552	1.771	-18.54	4.39	4.14	0.37	11.14
SM18-5	12	2.666	1.629	-16.07	4.39	4.27	0.34	12.53
SM18-5	13	2.292	1.53	-18.76	4.23	3.72	0.33	11.43
SM18-5	14	2.552	1.565	-17.28	3.99	4.08	0.33	12.51
SM18-5	14	0.736	0.394	-17.83	4.18	3.92	0.31	12.49
SM18-1	1	1.317	1.169	-19.75	4.38	2.02	0.25	8.17
SM18-1	1	0.335	0.263	-19.27	4.26	1.86	0.22	8.47
SM18-1	6	0.569	0.45	-18.97	4.18	0.81	0.09	8.90
SM18-1	6	0.473	0.388	-18.78	3.93	0.68	0.08	8.51
SM18-2	1	1.162	0.973	-19.50	4.21	1.78	0.21	8.52
SM18-2	12	2.459	1.755	-18.36	3.56	3.47	0.32	10.74
SM18-3	1	0.249	0.226	-19.58	4.76	0.31	0.04	7.71
SM18-3	3	0.227	0.2	-20.16	5.05	0.33	0.04	7.95
SM18-4	1	0.732	0.561	-20.66	4.24	1.05	0.11	9.20
SM18-4	6	0.216	0.136	-21.89	4.53	0.34	0.03	11.19
SM18-6	1	0.702	0.535	-20.46	4.05	1.05	0.11	9.26
SM18-6	8	1.69	1.07	-20.30	4.37	2.51	0.22	11.67
SM18-7	1	0.586	0.446	-20.21	4.40	0.83	0.09	9.23
SM18-7	9	2.087	1.345	-16.41	3.51	3.17	0.27	11.61
SM18-8	1	0.407	0.311	-20.17	4.29	0.64	0.07	9.13
SM18-8	7	1.471	0.921	-17.20	4.41	2.18	0.19	11.62
SM18-8	7	0.5	0.251	-16.74	3.98	4.70	0.36	13.18
BHE17-1	1	4.61	2.683	-23.40	3.49	16.74	1.71	9.77
BHE17-1	1	4.612	2.758	-23.61	3.34	17.07	1.68	10.14

BHE17-1	17	2.745	1.258	-24.21	3.01	9.94	0.80	12.35
BHE17-1	33	2.06	0.847	-23.87	3.17	7.05	0.52	13.63
BHE17-3	1	3.415	1.436	-29.70	-0.51	12.41	0.90	13.81
BHE17-3	24	2.082	0.749	-26.62	1.13	7.35	0.47	15.59
BHE17-3	48	3.765	1.731	-25.10	3.18	6.05	0.40	15.10
BHE17-2	1	3.103	1.446	-29.31	0.44	10.98	0.88	12.41
BHE17-2	2	3.148	1.335	-27.96	1.10	11.13	0.82	13.53
BHE17-2	3	3.437	1.463	-28.33	0.62	12.30	0.91	13.55
BHE17-2	4	3.537	1.587	-27.70	1.41	12.80	0.99	12.94
BHE17-2	5	3.589	1.615	-27.21	1.62	10.92	0.84	13.00
BHE17-2	6	4.322	1.949	-28.74	0.58	13.48	1.01	13.34
BHE17-2	7	4.19	1.848	-28.29	0.42	13.03	0.95	13.73
BHE17-2	8	3.88	1.68	-28.48	0.31	12.21	0.90	13.57
BHE17-2	9	3.052	1.305	-28.02	0.89	9.13	0.68	13.44
BHE17-2	9	3.09	1.342	-28.31	0.78	9.10	0.69	13.16
BHE17-2	10	4.095	1.875	-27.62	0.66	6.98	0.46	15.22
BHE17-2	12	1.336	0.479	-26.65	2.14	3.86	0.25	15.31
BHE17-2	14	2.874	1.078	-27.44	1.03	8.64	0.56	15.41
BHE17-2	14	2.304	0.847	-27.06	1.30	6.66	0.44	15.29
BHE17-2	16	3.858	1.479	-27.77	0.08	11.77	0.76	15.53
BHE17-2	18	4.44	1.74	-27.85	-0.03	14.09	0.91	15.44
BHE17-2	20	3.664	1.436	-27.56	-0.23	11.26	0.75	15.01
BHE17-2	22	2.223	0.818	-25.73	1.86	6.37	0.42	15.26
BHE17-2	24	3.325	1.267	-26.45	1.09	9.85	0.64	15.35
BHE17-2	26	2.322	0.907	-25.43	2.21	6.95	0.48	14.56
BHE17-2	28	1.891	0.757	-25.75	3.17	5.44	0.39	13.86
BHE17-2	30	2.693	0.746	-27.40	0.18	7.94	0.38	20.78
BHE17-2	32	5.462	2.242	-28.84	-0.43	13.73	0.85	16.07
BHE17-2	34	5.71	2.655	-28.56	0.41	14.47	1.02	14.21
BHE17-2	36	4.018	1.608	-27.76	0.49	9.28	0.63	14.83
BHE17-2	38	4.92	2.254	-27.59	0.04	11.52	0.72	15.93
BHE17-2	40	3.071	1.218	-25.98	2.06	6.69	0.45	14.72
BHE17-2	42	5.594	2.039	-28.42	-0.31	13.94	0.78	17.98
BHE17-2	44	6.638	2.537	-27.89	0.25	17.54	0.95	18.42
BHE17-2	46	4.232	1.355	-26.19	1.81	9.86	0.52	18.93
BHE17-2	48	5.083	1.934	-25.33	1.96	12.46	0.74	16.81
BHE17-2	48	4.838	1.747	-25.77	1.59	11.77	0.68	17.19
BHE17-2	50	3.083	1.15	-24.76	2.34	6.88	0.45	15.42
BHE17-2	52	2.106	0.806	-25.43	3.17	4.57	0.31	14.74
BHE17-2	54	1.668	0.637	-25.20	3.56	3.65	0.25	14.56
BHE17-2	56	1.916	0.713	-25.15	3.90	4.12	0.27	15.00
BHE17-2	58	2.021	0.71	-25.21	3.75	4.31	0.27	16.02
BHE17-2	60	2.894	0.85	-25.61	3.97	6.35	0.32	19.60

FP17-1	2	1.505	0.714	-29.98	2.38	3.23	0.28	11.62
FP17-1	17	3.181	1.259	-27.77	1.93	2.19	0.13	17.30
FP17-2	2	2.489	1.149	-30.18	1.86	8.88	0.72	12.26
FP17-2	32	1.847	0.76	-28.40	1.31	6.53	0.48	13.54
FP17-3	2	2.559	1.455	-31.52	1.32	9.22	0.93	9.93
FP17-3	34	3.646	1.523	-28.61	0.47	12.74	0.98	12.97
FP17-3	34	3.481	1.554	-28.61	0.39	12.56	0.97	12.98
CH17-1	1	1.269	0.831	-18.83	4.34	4.30	0.57	7.53
CH17-1	1	4.617	4.156	-18.47	4.01	4.33	0.56	7.74
CH17-1	18	3.186	2.43	-17.19	4.12	2.78	0.32	8.81
CH17-2	1	3.407	2.745	-18.49	4.35	2.93	0.35	8.25
CH17-2	18	3.486	2.586	-16.15	3.85	3.05	0.33	9.21
CH17-3	1	0.107	0.089	-21.71	0.83	0.05	0.01	8.28
CH17-3	21	1.429	0.52	-16.71	3.61	0.66	0.04	17.73

E: Photos

Figure 1E. Photo taken from sample site A.

Figure 2E. Photo taken from sample site B.

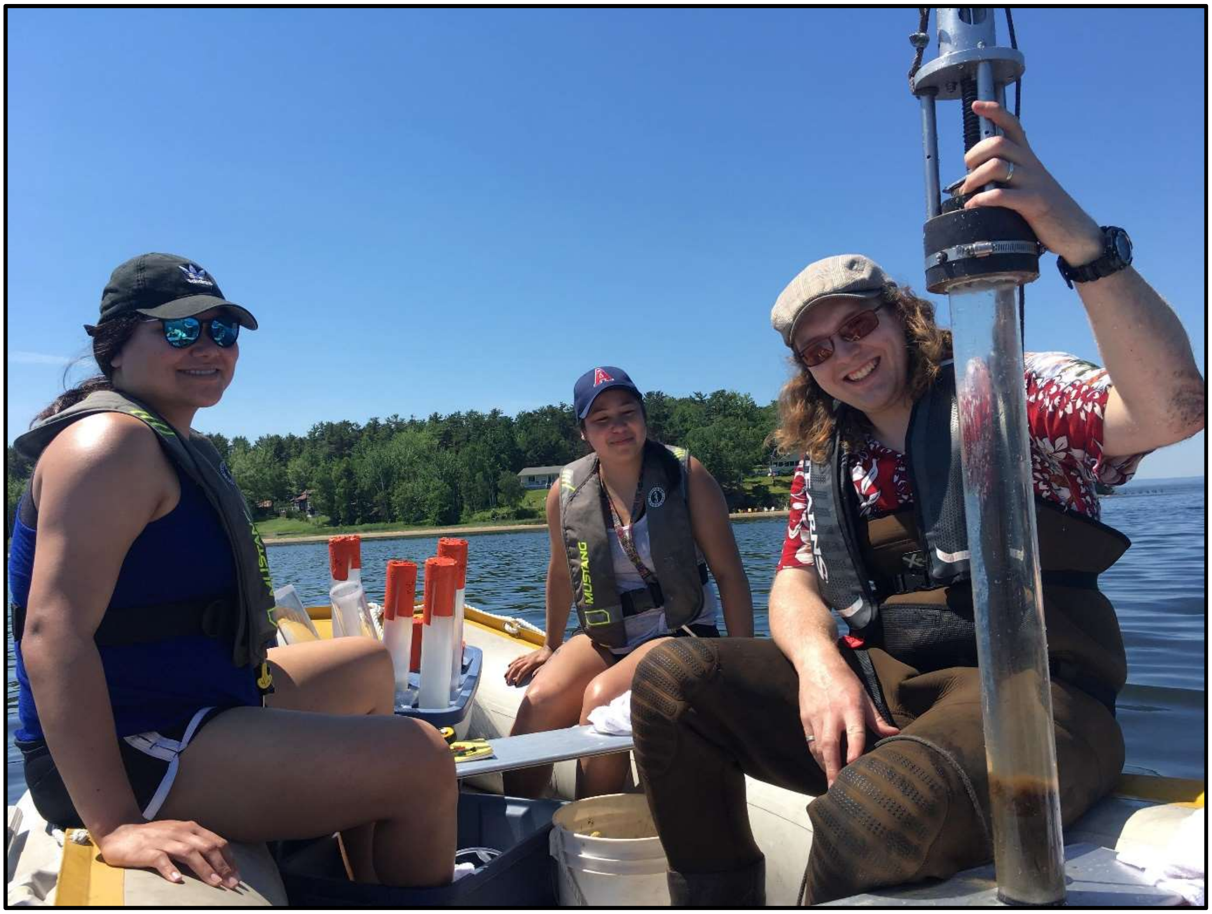

Figure 3E. Sediment gravity coring with the help of Kirklyn Davidson, Baillie Holmes, Selena Denny and Savanna Francis. (Featured from left to right: Savanna Francis, Selena Denny, Kirklyn Davidson).

Figure 4E. Drone aerial photo taken on August 1st, 2018 portraying the inundation of Lighthouse Beach at its landward end.

Figure 5E. Core SM18-5 after being thawed and split.

A paleolimnological assessment of sediment in Sitmu'k Lagoon, Pictou Landing, Nova Scotia, to determine the influence of geogenic and anthropogenic activity on water quality change through time

By

Dylan G. Wyles

Thesis submitted in partial fulfillment of

the requirements for a

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This thesis by Dylan G. Wyles

is accepted in its present form by the

Department of Earth and Environmental Science

as satisfying the thesis requirements for the degree of

Bachelor of Science with Honours

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Abstract

This project focused on a lagoon and barrier beach complex known as Sitmu'k in Pictou Landing, Nova Scotia. This dynamic system has historically been of importance to the community of Pictou Landing First Nation for recreational and cultural purposes. Over the past few decades there has been significant landscape change and human activity in the area that has inhibited use and enjoyment of this valued landscape feature. Issues identified include water quality degradation, and the legacy of historical industrial impacts. The purpose of this thesis was to determine influences of environmental change through time in Sitmu'k by conducting a paleolimnological assessment of the geochemical changes recorded in the sediment archive. To determine anthropogenic and geogenic influences on Sitmu'k, the data was compared to nearby reference sites. Geochemical analysis was conducted using x-ray fluorescence (XRF), total carbon (C), total nitrogen (N) and stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$). Total C/N and isotope analysis indicated that carbon input at Sitmu'k is predominantly from marine sources. XRF analysis indicated that metal concentrations were below sediment quality guidelines and reference site averages. Water quality tests were conducted throughout the summer 2018 season to determine current environmental conditions in the lagoon. Water quality data indicated gradual but persistent increases in temperature, total coliforms, nitrate and total phosphorus from May to August. Through air photo and satellite imaging, it is apparent that the barrier, Lighthouse Beach, is migrating towards mainland. Sediment redistribution from the beach into Sitmu'k has resulted in shallowing and restricting which is causing higher water temperatures, poor circulation and elevated nutrient and coliform levels. Collectively the data suggest that much of the water quality degradation

noted in the past 50 years is likely due to natural landward migration of the barrier-beach complex, resulting in reduced water depth and circulation coupled with increased local anthropogenic land use; the data did not indicate significant industrial impact at the site.

Chapter 1: Introduction

1.1 Background

Pictou Landing is a small community in northeastern Nova Scotia, which is also the location of Pictou Landing First Nation (PLFN). Within Pictou Landing there is Sitmu'k, also known as Moodie's Cove, which is a shallow salt water lagoon system with tidal influence enclosed by a barrier beach, known as Lighthouse Beach (LHB; Figure 1). Currently, Sitmu'k is an inactive part of the community and is not a suitable recreational site for activities such as swimming. In the past, Sitmu'k was a popular recreational site for the Pictou Landing community. Sitmu'k was very popular for swimming because the barrier beach system blocks the high energy water of the Northumberland Strait, keeping the water calm and warm. Furthermore, LHB offers a 2 km long double-sided beach with cool ocean waters on one side, and the calm, warm lagoon waters on the other side. LHB once housed facilities such as a canteen, bathroom stalls, salt-rinse showers, and picnic tables (Holmes et al., 2017). This area was well utilized by the community and comparable to popular nearby barrier beaches along the Northumberland Strait such as Melmerby Beach, which now is a Provincial Park. This research is focused on an investigation of the precieved environmental degredation and providing insight on change through time at the site.

Figure 1. A labelled map of the area showing the town of Pictou Landing, Boat Harbour, Sitmu'k, and 3 reference sites. These three reference sites were studied by Davidson (2018). The reference sites include: Boat Harbour Estuary, Fergusons Pond, and Chance Harbour Estuary.

There are several sources for contaminants in the area that have the potential to impact Sitmu'k. Contamination from water sources would include the effluent from a nearby chloro-alkali plant that has since shut down, and over 50 years of organic effluent wastewater treatment from the pulp mill in Pictou that was discharged from Boat Harbour (Walker et al., 2016). There is potential for impact from the outfall of the Pictou Landing First Nation (PLFN)'s sewage treatment plant which is located immediately east of Lighthouse Beach (Jacques Whitford, 2005). Furthermore, there are local anthropogenic sources that discharge directly into the air potentially resulting in contamination from aerial deposition. Some of these sources include a local coal-fired thermal generating plant, a tire manufacturing plant, and the smokestacks of the local pulp mill (Hoffman et al., 2017).

To understand how anthropogenic, geogenic, or atmospheric sources have been influencing Sitmu'k; various attributes needed to be examined. The sediment archives in Sitmu'k were analysed using applied paleolimnological assessments and compared to three nearby references sites that were studied in 2017 (Davidson, 2018). Sediment cores were extracted from site and tested for metal concentrations using X-Ray Fluorescence (XRF). Furthermore, sediment samples were tested for total carbon (C), total nitrogen (N), and stable isotopes ($\delta^{13}C$, $\delta^{15}N$). These data were compared to data from similar tests done in nearby sites including: Boat Harbour Estuary, one kilometer east, and Fergusons Pond, three kilometers east, and Chance Harbour Estuary, six kilometers east (Figure 1). A Comparison to these reference sites is useful to determine if the geochemistry in the sediment archive is related to natural or anthropogenic sources or a combination of both. Water chemistry analysis was also completed to determine the present environmental conditions in Sitmu'k and if any local anthropogenic sources are currently impacting the site. During the field season water chemistry was monitored and included the following analyses: total phosphorous, nitrate, pH, conductivity, temperature, dissolved oxygen, and coliforms (total coliform counts and E. *coli* counts).

1.2 Site Description

Lighthouse Beach extends westwards from the shore roughly 1.4 km and is generally comprised of fine grained, quartz-dominated sand. Sitmu'k is roughly 1.4 km long, it varies between 250 m and 500 m wide, and it ranges between 1 m and 3 m deep. The sediment in Sitmu'k is fine to very fine grained, angular, poorly sorted, quartz-rich sand with silt and clay interbedded. Sunlight penetrates through the water column to the lagoon floor, as the majority of Sitmu’k is less than 3 m deep at low tide. In this environment a diverse marine floral thrives, the dominant species is eel grasses (*Zostera Marina*). Lighthouse Beach provides habitat for vegetation including, but not limited to: the American marram grass (*Ammophila breviligulata*), seaside pea (*Lathyrus japonicus*), seaside goldenrod (*Solidago sempervirens*), American searocket (*Cakile edentula*), hoary mugwort (*Artemisia stelleriana*), staghorn sumac (*Rhus typhina*), northern bayberry (*Morella pensylvanica*), and clammy locust (*Robinia viscosa*). Many of these species were planted to help anchor the sand as part of the beach restoration project that was completed in 2005 by Nova Scotia Transportation and Public Works (Jacques Whitford, 2005). The restoration project was undertaken to stabilize a breach in Lighthouse Beach that occurred in 2003 which was leading to erosion and possible circulation changes such that treated pulp mill effluent and sewage waste was entering Sitmu’k (Jacques Whitford, 2005).

Figure 2. Drone aerial photo of Sitmu'k and Lighthouse Beach. Photo taken on August 1st, 2018.

1.3 A Changing Landscape

Sitmu'k and Lighthouse beach (LHB) comprise a transgressive barrier complex. With sea level rise, the beach requires a constant supply of sediment from longshore drift to remain stable. Through air photo and satellite imaging it has become apparent that LHB is slowly migrating toward the mainland. Figure 3 was derived from Google Earth© imagery and shows the movement of LHB from 2003 to 2017. Over time the beach has been breached by storms (blow out) leading to sediment deposition into Sitmu'k. Blow out deposits are visible along the inner shoreline of LHB (Figure 4). The landward movement has resulted in sediment redistribution from the beach into Sitmu'k, which has led to shallowing and reduced circulation. These changes can impact the water quality because the lagoon can become prone to rapid temperature and reduced circulation due to shallowing and outlet restriction causing nutrients and bacteria to concentrate in the lagoon. As transgression associated with sea level rise is expected to continue the beach will remain moving in a landward direction.

1.4 Thesis Statement

The purpose of this study is to determine the legacy of environmental change that has been preserved in Sitmu'k sediments by conducting an applied paleolimnological assessment of the sediment archive from the lagoon. A comparison of metal concentrations to previous studies done in the area will establish whether the changes are unique and if they can be related to local industrial activity. An assessment of the present environmental conditions in the lagoon was achieved through applied water chemistry analysis.

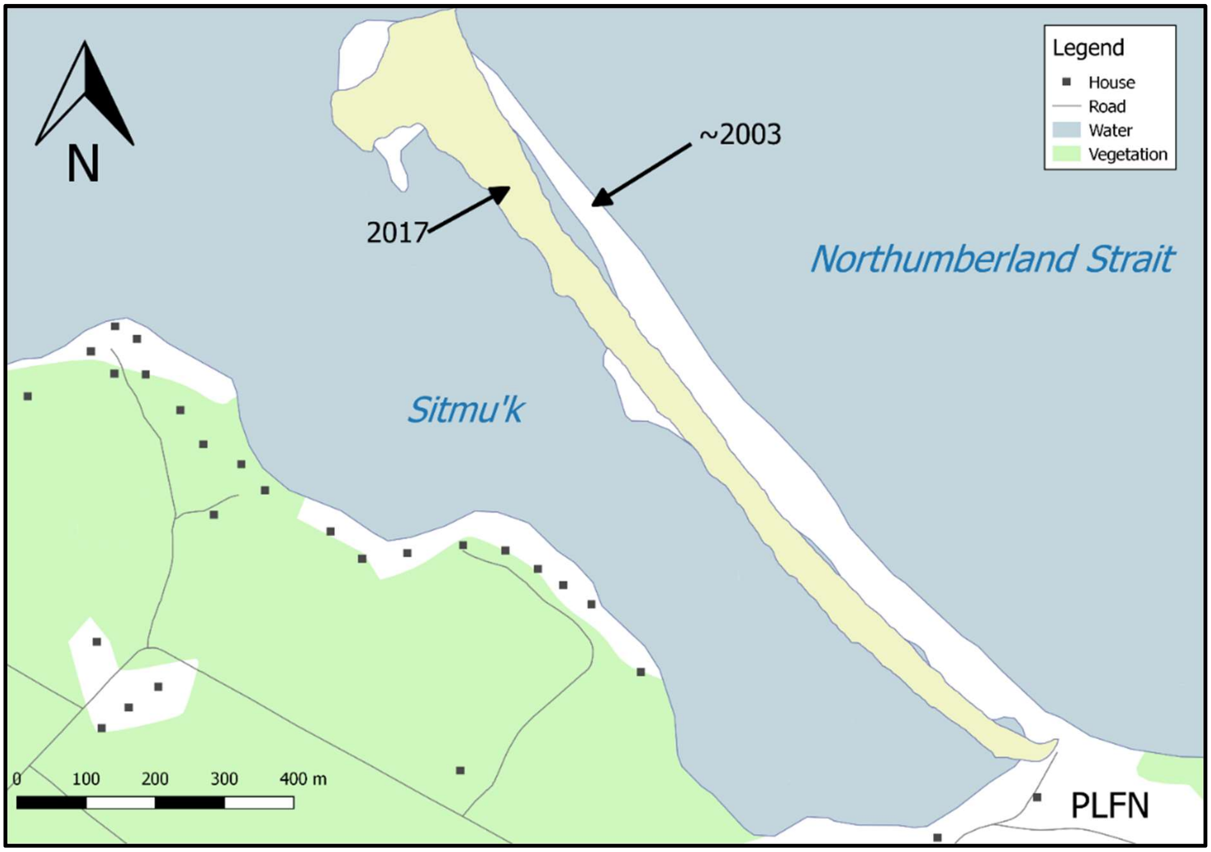


Figure 3. A map of Lighthouse Beach transgression from 2003 to 2017.

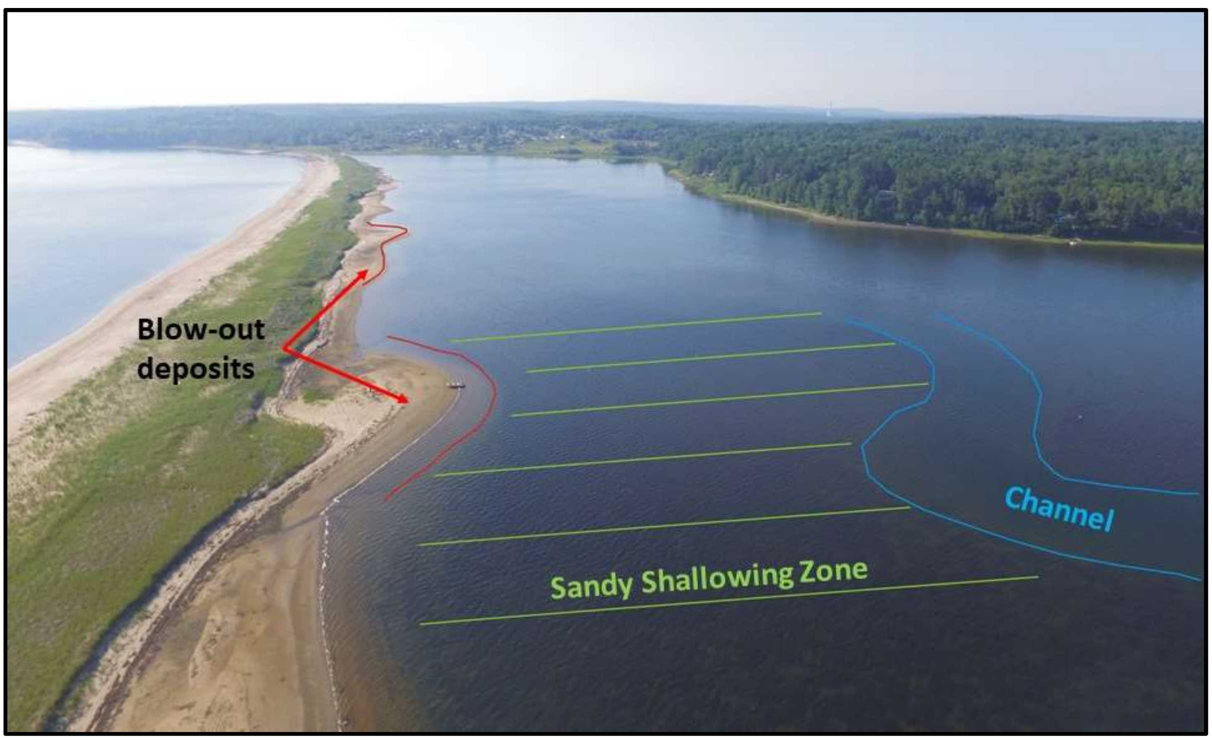


Figure 4. An annotated photo of Sitmu'k illustrating blow out deposits along Lighthouse Beach, a shallowing zone where sediment is being deposit, and the main water channel.

Chapter 2: Literature Review

2.1 Paleolimnology assessment of sediment cores

Paleolimnological assessments study changes in water quality parameters through time by evaluating geochemical and biological compositions in the sediment archives at the bottom of a waterbody (Smol, 1995). Sediment archives are created through time with deposition. As sediment collects in the basins, it is continuously covered by superseding sediment until it is separated from the water column above (von Gunten et al., 1997). When sediment cores are taken from a basin, samples from the core can be accessed to determine past environmental conditions through indicators such as, metals, dissolved gases, and biotic components. These studies can be effective for decoupling anthropogenic and natural contribution to a waterbody. To establish realistic goals for the future quality of an environment, an understanding of it's past and current trends is necessary (Smol, 1992).

2.2 Anthropogenic Contribution

Natural processes can often result in the presence of metals in sediment, however industrial processes can also produce effluent that has high metal concentrations and complex organic composition (Cohen, 2003). Anthropogenic contribution from a variety of sources is evident in the sediments at Boat Harbour (Walker et al., 2016). These sources have potential to influence sediment bulk geochemistry at Sitmu'k as well.

A study by Davidson (2018) in Boat Harbour determined that overlying effluent had minimal influence on the sediment that it have been deposited over. It was determined that no overprinting occurred into the estuarine sediment, however, 8 of the 9 metals found in the effluent (As, Cr, Cu, Mo, Ni, Pb, Ti, Zn) were also present in the estuarine sediment and on average they all exceeded Interim Sediment Quality Guidelines (ISQG) set by the government (Davidson, 2018). A study of nearby reference estuarine sites that were unaffected by the pulp mill effluent indicated that these same metals were present and above ISQG's in lagoon bottom sediment. These studies indicate that in the Pictou Landing area there is a natural geogenic source for many of these metals of concern as well as a possible atmospheric source for some (Davidson, 2018). Therefore, ISQG's cannot be used to determine the presence of contamination as the natural system can accumulate metals that exceed guidelines.

2.3 Local Geology

The local geology and physiography of Pictou County is summarised by JWEL & Beak (1992). Along the Northumberland Strait and covering almost the entire width of Pictou County, the bedrock geology consists of non-marine sedimentary rocks that are Pennsylvanian in age. These strata consist of red and grey sandstones, siltstones, shales, and conglomerates which have all experienced structural deformation producing the east-west trending valley and ridge structures in which they reside. The Tony River Till which overlies the bedrock, makes up much of the surficial sediment in the area and consists of grey, reddish-brown, stony sand sediment. There are numerous boulders near the surface in addition to angular grey and red carboniferous sandstone inclusions throughout. Overlying the till is a soil which is derived from the carboniferous sandstone bedrock but varies compositionally. The west, north, and northeast shores of Boat Harbour consist of 60 to 80 cm of well-drained gravelly sandy loam over more compact dark brown gravelly sandy loam. The soil south of Boat

Harbour consists of 40-60 cm of moderately well drained sandy loam to loam. The soil southeast of Boat Harbour consists of 40-60 cm of imperfectly drained sandy loam to gravelly loam (JWEL & Beak, 1992).

2.4 Local Sediment Characteristics

Several studies of the sediment archive in Boat Harbour have been completed in recent years (Holmes, 2018; Spooner and Dunnington, 2016a, 2016b; JWEL, 2005). Boat Harbour has gone through significant changes in the past 50 years, since the construction of the effluent waste treatment facility (Walker et al., 2016). Boat Harbour was originally a marine estuary until it was dammed by a causeway and became a freshwater lake with very high inputs of organic matter. These changes were well-resolved in the sediment record (Figure 5). Prior to being dammed, the sediment in Boat Harbour was a dense grey-brown, shelly, marine clay and now it is overlain by a less dense, unconsolidated, silty, organic-rich black sediment (Spooner and Dunnington, 2016a). Metals in the sediment at Boat Harbour that exceed Canadian ISQGs for fresh water life protection were found to be Cd, As, Zn, Pb, Cr, and Cu, with Zn being the most indicative of effluent influence (Holmes, 2018; Hoffman et al., 2017; JWEL, 2005).

A paleolimnological survey has also been completed in nearby estuarine systems (Davidson, 2018). This study provided evidence that some metals preserved in polluted sediments may be derived from local geogenic sources. However, some metals in Boat Harbour (Zn in particular) were found to be elevated compared to concentrations at reference sites, indicating effluent influence (Holmes, 2018).

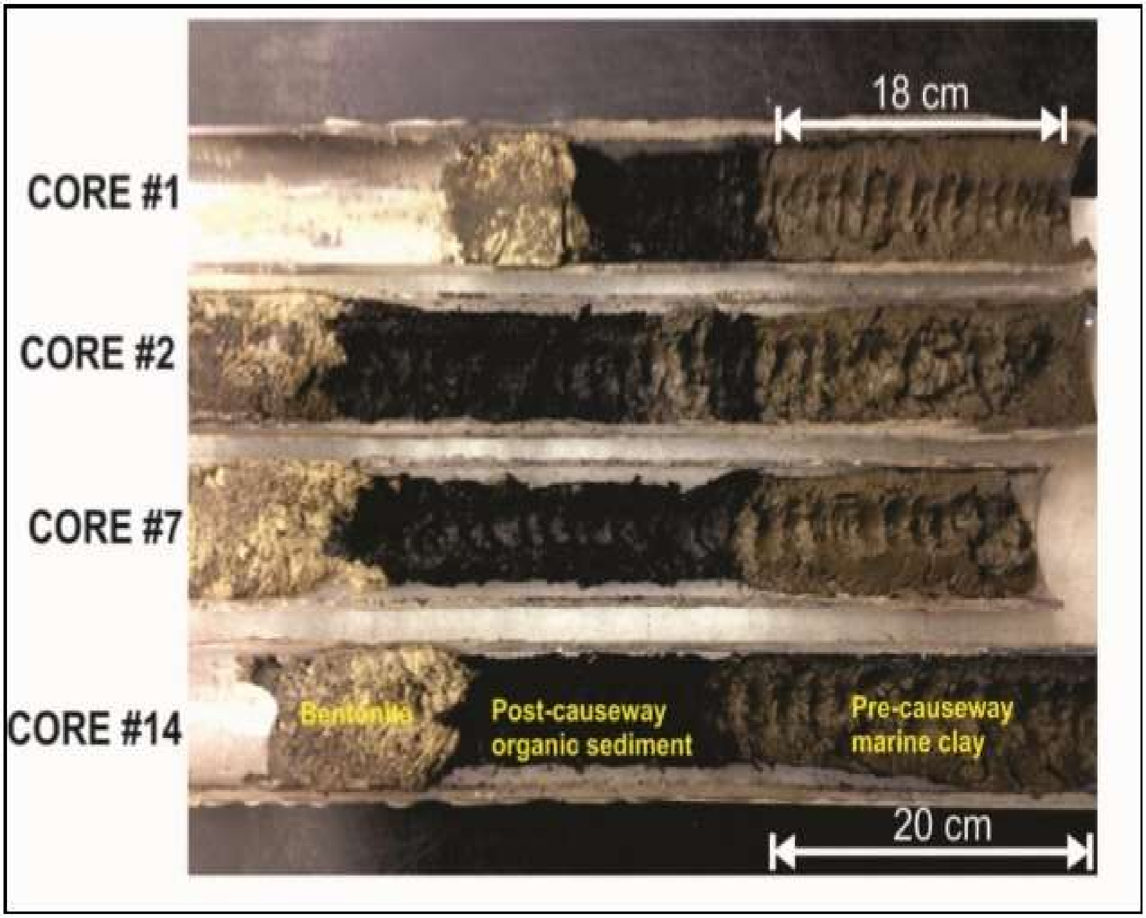


Figure 5. Sediment cores taken from Boat Harbour. The pre-causeway sediment was deposited in an estuarine setting before the site was subject to pulp mill effluent introduction. The post-causeway sediment is effluent influenced sediment that was deposited into Boat Harbour after it had been modified. (From Spooner and Dunnington (2016a).

Chapter 3: Methods

3.1 Sediment Sampling

Prior to sampling, all equipment was cleaned, calibrated, and set up to be ready for use in the field. Eight cores were collected within Sitmu'k lagoon on July 4th, 2018. (Figure 6). To collect the sediment cores, a Glew gravity corer was used with 30 cm core tubes (Glew, 1989). The location of each core was determined using GPS to accurately map core locations. Cores were sealed with bentonite clay on-site to prevent further disturbance and were frozen within 8 hours of collection. After being frozen for at least 24 hours, the cores were centrally split using a diamond inclusion bladed table saw and left to thaw. Once thawed, one core was sampled at 1 cm intervals from the centre to avoid potential cross contamination caused by edge smearing during the coring process (Dunnington and Spooner, 2017). All other cores were centrally split, and two samples were taken, one from the top and one from the bottom. The samples were dried for 72 hours at 40-60^{o}C. Samples were then ground using a mortar and pestle and stored in sealed containers for XRF analysis. Thin sections were also made of the core sediment from core SM18-2, SM18-5, and SM18-7 to characterize sediment and composition.

3.2 Water Quality Testing

Water quality testing in Sitmu'k consisted of monitoring temperature, total coliform, conductivity, pH, dissolved oxygen, phosphorus, and nitrate. Water samples for these tests were collected at sites A, B and C (Figure 6). AGAT Laboratories (Halifax, NS) conducted standard water analysis, total metal analysis, total coliform, and E. *coli* counts on water samples taken from these locations (Appendix B). Water samples were also sent to

Dalhousie University Center for Water Resources Studies where additional total coliform and E. *coli* count tests were conducted (Appendix B).

Water temperature was monitored using Hobo MX Pendant temperature loggers. These were placed at three sites in Sitmu'k (Figure 6). At each site a buoy was tied to a concrete block, which was used as an anchor. For the first two locations a temperature logger was secured just above the concrete block at the bottom of the lagoon, placing it approximately 1 m above the lagoon floor. The third location was in a deeper channel within the lagoon, so a temperature logger was secured just above the concrete block near the base and another secured below the buoy near the surface. Each logger recorded temperature every 30 minutes and collected data from June 27th until September 17th, 2018.

For on-site total coliform testing, the Lamotte coliform indicator test kits were used and the Lamotte procedure was followed. Water samples were collected and placed into test vials which contained coliform indicating tablets and were then stored at room temperature for 48 hours to allow incubation. After 48 hours the vials were examined to determine if coliform bacteria were present.

A YSI Professional Plus water quality sonde was used to measure water quality on-site. This unit has a 3-probe system in which one probe measured pH, another probe measured dissolved oxygen, and the third probe measured both temperature and conductivity. The YSI was used to do tests immediately onsite at locations A, B, and C (Figure 6) and results were recorded.

Phosphorus and Nitrate tests were conducted on water samples collected from locations A, B, and C (Figure 6). Tests were completed using HACH equipment and followed HACH's procedure. Phosphorus tests were conducted with a HACH DREL 2400 Spectrophotometer and followed HACH's USEPA PhosVer 3 with acid persulfate digestion method, method 8190, including the Test 'N Tube Vials (HACH, 2007). Nitrate tests were conducted with a HACH DR 820 colourimeter and followed HACH's cadmium reduction method using powder pillows, method 8039 (HACH, 2004).

3.3 Data Analysis

Sediment samples were analyzed using x-ray fluorescence (XRF). The results of these tests were compared to results from the same tests done in nearby reference estuaries (Holmes, 2018; Davidson, 2018). XRF analysis measured concentrations of Calcium (Ca), Copper (Cu), Iron (Fe), Potassium (K), Manganese (Mn), Lead (Pb), Rubidium (Rb), Strontium (Sr), Titanium (Ti), and Zinc (Zn). Shells are comprised of calcium carbonate; making Ca and Sr representative of shell content within sediment. This is useful, as sudden increases or decreases could correlate to that of the number of living organisms and thus the quality of the environment. Ti, K, and Rb are associated with the clastic content of the sediment (Dunnington et al, 2018), whereas Cu, Pb, and Zn are metals that can indicate anthropogenic influence. Every third sample was run on the XRF three times to ensure data accuracy. Quality assurance and quality control measures were used during XRF analysis (Appendix A).

Isotope analysis was completed by the Stable Isotopes in Nature Laboratory (SINLAB) at the University of New Brunswick to measure total carbon, total nitrogen, and stable isotopes

($\delta^{13}C$, $\delta^{15}N$). $\delta^{13}C$ represents the relative carbon isotope difference between the sample and the international standard (Pee Dee Belemnite) using the formula:

$$\delta^{13}C = [(Rsample/Rstandard)-1]*1000$$

where R is the isotopic ratio of the heavy to light ($^{13}C/^{12}C$) (Logan et al., 2008). Similarly, $\delta^{15}N$ represents the relative nitrogen isotope ratio difference between the sample and the international standard using the formula:

$$\delta^{15}N = [(Rsample/Rstandard)-1]*1000$$

where R is the isotopic ratio of the heavy to light ($^{15}N/^{14}N$) (Logan et al., 2008). A C/N vs. $\delta^{13}C$ biplot was used to determine provenance of the organic material within the sediment.

3.4 Photography

DGI – Phantom 3 and Phantom 4 drones were used to obtain aerial photos of Sitmu’k to provide an aerial perspective on the landscape. These photos were compared to older satellite imagery and aerial photos taken of the area to detect changes in the morphology of Lighthouse Beach (erosion, deposition, or longshore drift) and to detect any other natural or anthropogenic changes in the landscape.

Chapter 4: Results

Data collection sites at Sitmu'k and Lighthouse Beach are mapped in Figure 6. The yellow stars labelled A, B, and C are the locations of water quality sampling sites. Each red triangle depicts a location of one of the eight gravity core samples. The three orange circles labelled X, Y, and Z were the locations of the temperature data loggers and lastly, the black line A to A' was the transect in which conductivity tests were done while also mapping the base of the lagoon.

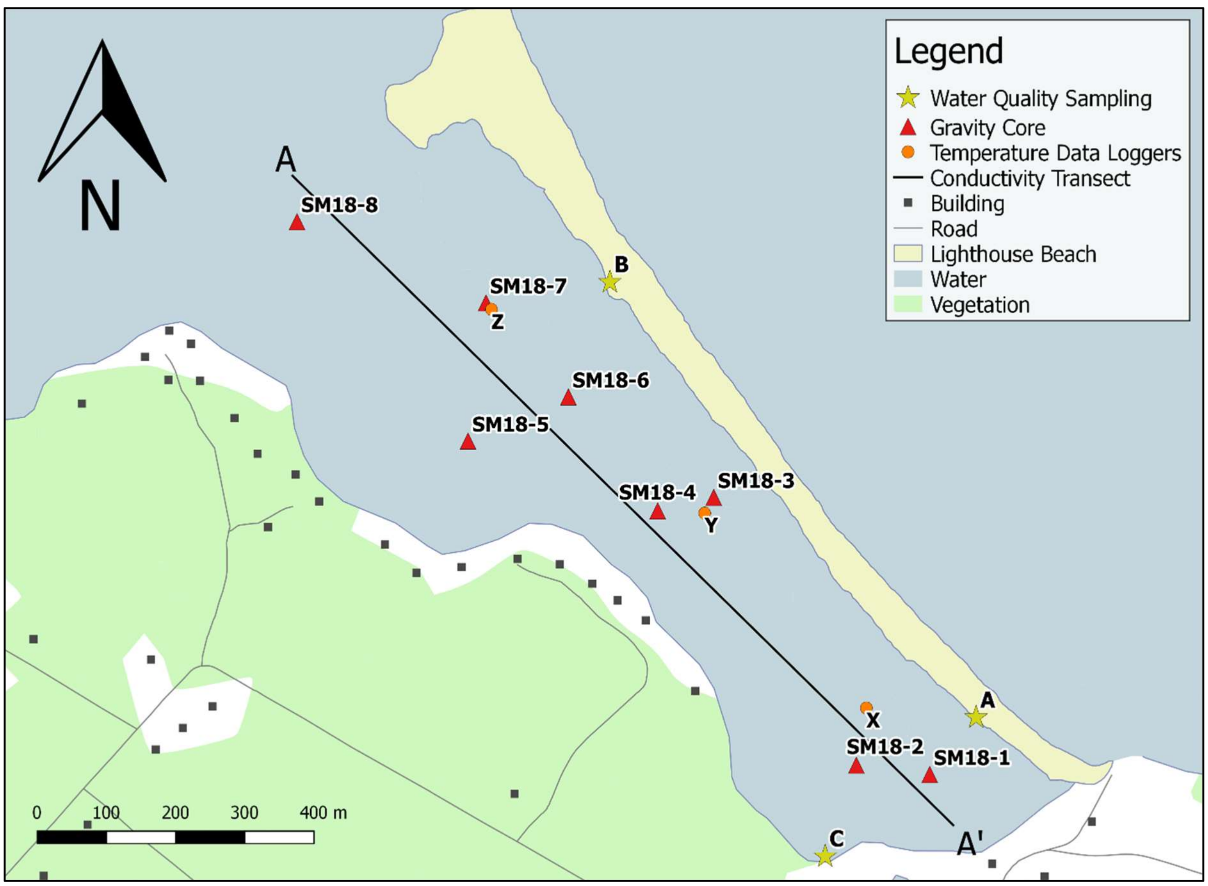


Figure 6. Map of data collection sites in Sitmu'k completed throughout the summer of 2018.

4.1 *Water Chemistry and Quality*

Conductivity of Sitmu'k was tested along a transect from A – A' (Figure 6; Figure 7), along the centre of the water body from the open end of the lagoon to the inner beach. The conductivity appeared highest near the surface on the eastern and inner most part of the lagoon. The conductivity also shows a general decrease to the west and with depth. The base of Sitmu'k was also mapped during this transect, showing an increase in depth to the west as the transect moves toward the mouth of Sitmu'k. The third stop shows a depth of 2 m and this is believed to be the main water channel that enters the lagoon.

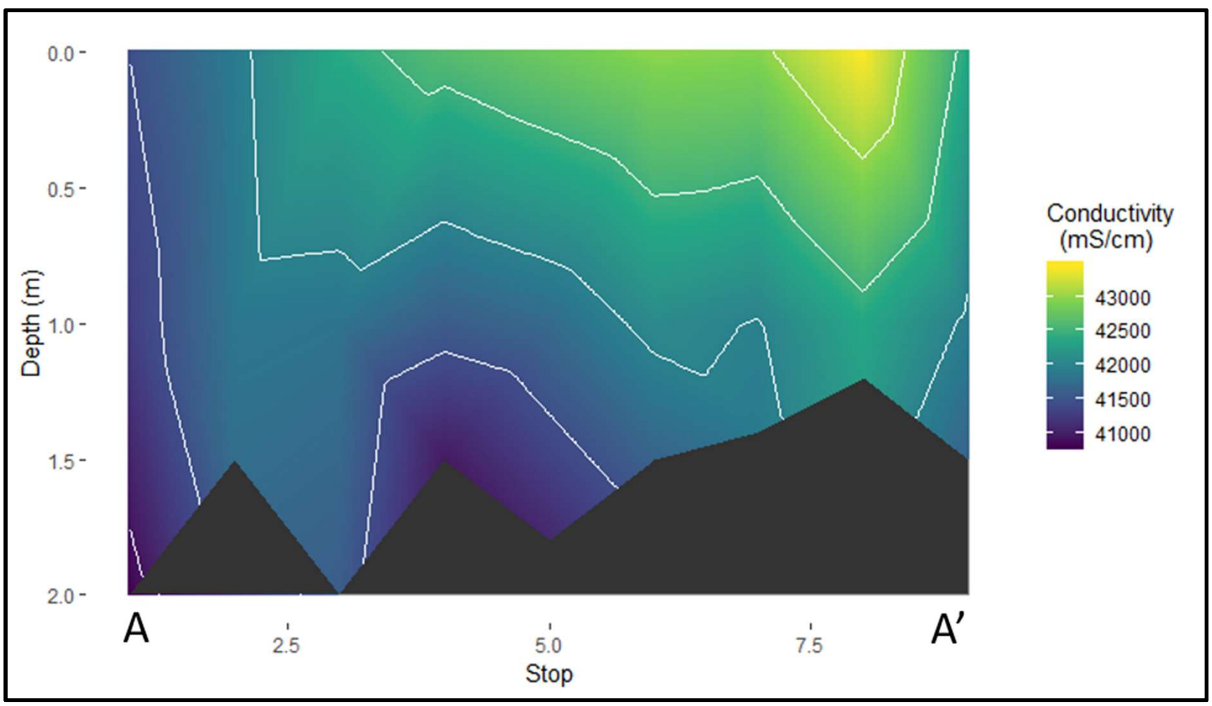


Figure 7. Conductivity test and map of basement in Sitmu'k along transect A-A'. The standard sea water conductivity is 50,000mS/cm. Typical freshwater is .05 to 200mS/cm.

Four temperature data loggers recorded data every 30 minutes from June 27th until September 17th, 2018. Location Z (Figure 6) had two data loggers, one near the surface and another near the base. Location X and Y (Figure 6) each had one logger near the base. Figure 8 shows the temperature fluctuations and overall trend from June to September. The red line indicating the overall trend shows a gradual increase in temperature throughout June and the beginning of July until the temperature peaks during the end of July and beginning of August. The rest of August and September shows a gradual decline in temperature. For most of the months of July and August the water temperature rises above 25°C and sometimes rises over 30°C. Throughout the summer the water temperature at the bottom versus the surface varies by about 5°C. Furthermore, from day to day the water temperature in Sitmu'k varied by about 10°C from the hottest to the coldest and did not drop below 15°C. For the month of August, the water temperature only rarely dropped below 20°C. In comparison, the Northumberland Strait, which Sitmu'k is connected to, had an average water temperature in July of 16°C, and a maximum temperature in July of 22°C (Petrie and Francis, 1993). In July Sitmu'k had an average of 22°C, and a maximum temperature of 32°C.

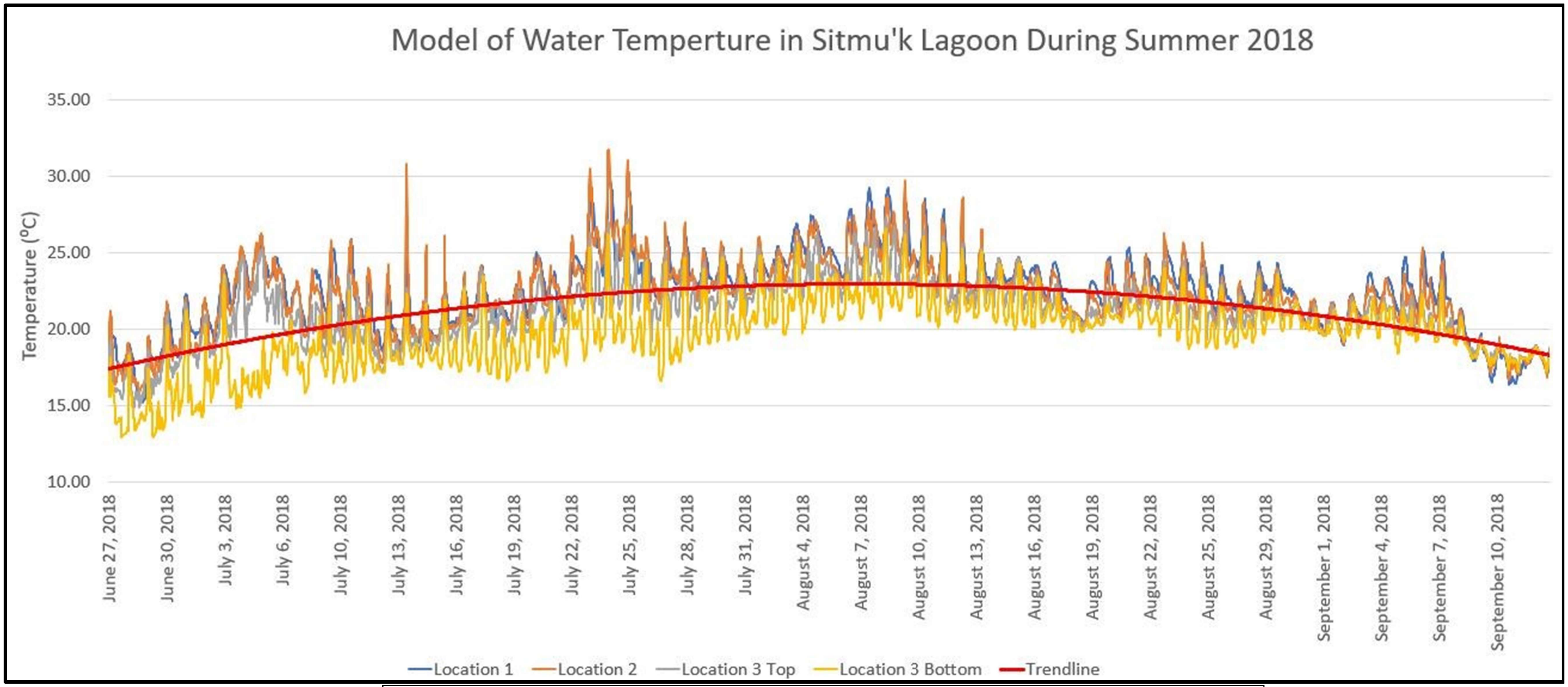


Figure 8. Temperature graph showing the results from four data loggers in Sitmu'k from June to September, and an overall trendline in red.

4.2 *Total Coliforms and E. coli*

La Motte coliform indicator test kits were used in Sitmu'k to determine the level of coliform contamination. These indicator test kits were used on June 19th, July 16th, and August 10th and in each case the test yielded the highest positive result, indicating a high level of coliform contamination (Figure 9). Water samples were then sent to a lab for analysis to obtain an exact coliform count which can be compared to the Canadian Recreational Water Quality Guidelines (Health Canada, 2012).

Figure 9. Results from a coliform indicator test kit used on June 19th, 2018 showing a strong positive result.

Table 1 below summarizes the results of two coliform counts, first completed on June 27th and the second completed August 1st. The acceptable limit of E. *coli* in water for recreational use is 200 MPN/100mL (most probable number) (Health Canada, 2012). Early in the summer the first round of tests were completed on surface samples retrieved from sites A, B, and C (figure 6), and the results indicated that the E. *coli* count was below unacceptable limits, with an average of 36 MPN/100mL. Later in the summer, the second round of tests for all three locations indicated an E. *coli* count above the 200 MPN/100mL limit, with an average of 383 MPN/100mL. The total coliform count from June to August also increased from 1048 MPN/100mL to 1799 MPN/100mL.

<u>Table 1</u>. Results from total coliform and E. *coli* counts for sites A, B, and C in Sitmu'k. All values are in MPN/100mL.

	June 27th, 2018		August 1st, 2018	
	Total Coliforms	E. *coli*	Total Coliforms	E. *coli*
Site A	1300	25	2419	210
Site B	980	47	1860	365
Site C	866	37	1120	573
Average	1048	36	1799	383

Nitrate and total phosphorus tests were conducted throughout the summer on water samples collected from sites A, B, and C (figure 6). Overall there is a general increasing trend noticeable in both total phosphorous and nitrate as the season progressed (Figure 10). Total phosphorus levels peaked in late August and began to decrease in September. Nitrate levels followed a similar trend, increasing from June to August and then remaining consistent into September. A data gap is present in nitrate for late August due to sample loss.

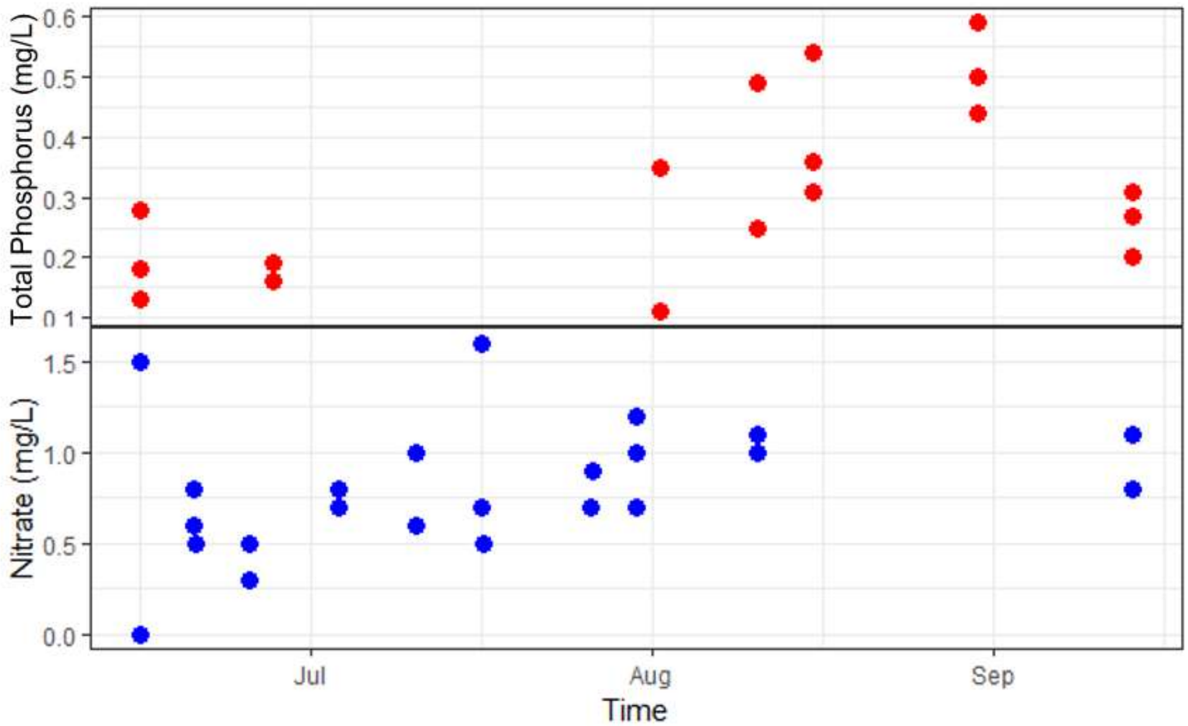


Figure 10. Phosphate (red) and Nitrate (blue) data collected from June to September. Both show a general increase from left to right.

4.3 Sedimentology

The lagoon sediment consists 70% of silty clay matrix with mixed organics (woody material). Large interconnected pores are present throughout. The mineralogy is mostly (95%) fine-grained quartz with minor amounts of potassium feldspar, plagioclase, muscovite, biotite, titanite. The sample overall is texturally immature and mineralogically mature, fine-grained to very fine-grained, angular, and poorly sorted. Iron oxidation is noticeable throughout the sample.

Lighthouse Beach consists mainly of quartz dominated fine-grained sand. The mineralogy is mostly (90%) quartz with some potassium feldspar (7%) and lithics (3%). The sample is overall texturally sub-mature and mineralogically mature, fine to medium grained, well rounded, and well sorted.

4.4 XRF metal concentration box-range plots

XRF analysis of samples taken from the top and bottom of each sediment core from Sitmu'k are summarized as box-range plots in Figure 11. This analysis includes concentrations of Ca, Cu, Fe, K, Mn, Pb, Rb, Sr, Ti, and Zn, each of which have been identified as indicators for various important attributes.

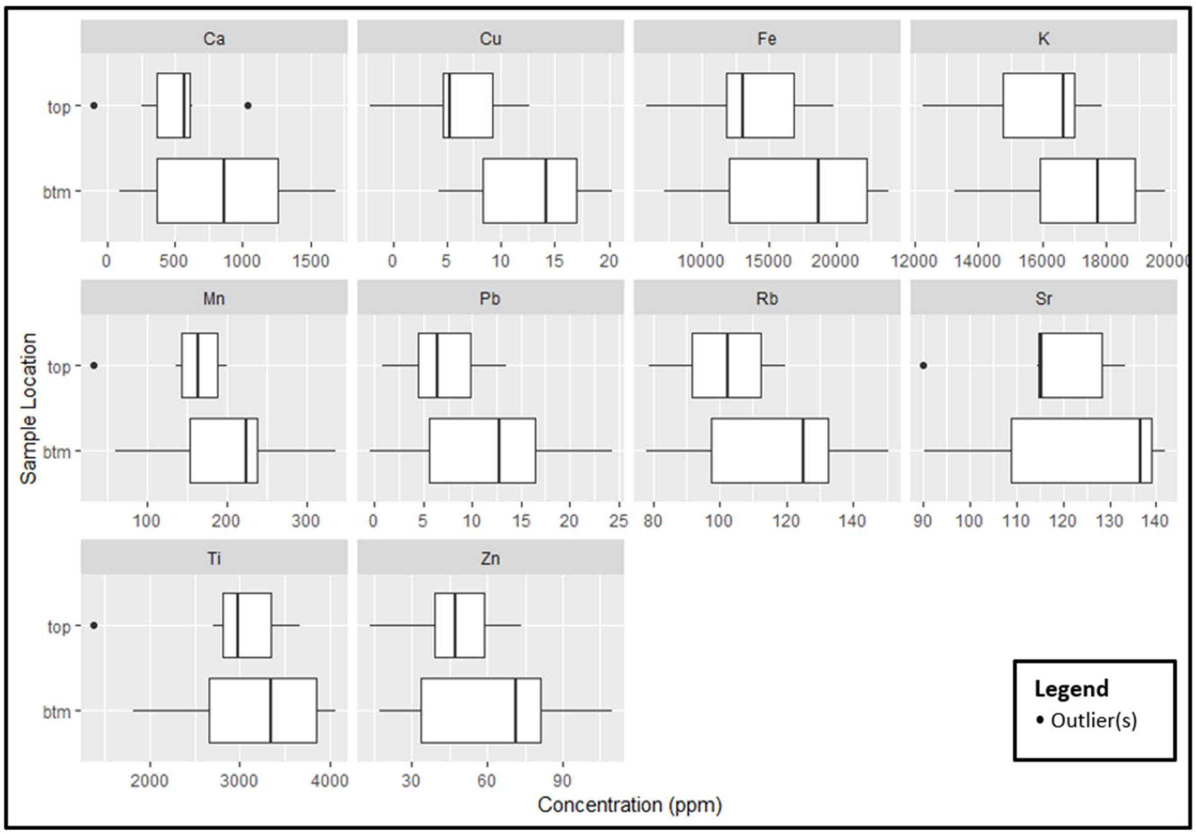


Figure 11. Top and bottom analysis of sediment cores from Sitmu'k. Average element concentrations were plotted for all the top and bottom samples from the eight sediment cores with outliers labelled appropriately (Appendix C).

4.4.1 Calcium (Ca)

There was no significant difference between the average Ca concentrations of the top and bottom samples, however, it was observed that the average Ca concentration for the bottom was higher than that of the top. The average Ca concentration for the top was 558 ± 15 ppm. The average Ca concentration for the bottom was 858 ± 13 ppm. However, the analyses for the bottom of core 5 (SM18-5) gave concentrations that were abnormally high (13618 ppm). This high abnormality was left out of the calculated average and box plots emphasize low-concentration variability.

4.4.2 Copper (Cu)

Cu concentrations of the top and bottom samples for Sitmu'k averaged below the ISQG limit. The Cu ISQG for marine sediment is 19 ppm (CCME, 2016). There was no significant difference between the average Cu concentrations of the top and bottom samples. The average Cu concentration for the top was 8 ± 1 ppm. No top samples were above the Cu ISQG limit. The average Cu concentrations for the bottom was 14 ± 3 ppm. 23.1% of bottom samples were found to be above the Cu ISQG limit.

4.4.3 Iron (Fe)

There was no significant difference between the average Fe concentrations of the top and bottom samples, however, it was observed that the average Fe concentrations for the bottom was higher than that of the top samples. The average Fe concentration for the top was 14784 ± 167 ppm. The average Fe concentration for the bottom was 17529 ± 57 ppm.

4.4.4 Potassium (K)

There was no significant difference between the average K concentrations of the top and bottom samples. The average K concentration for the top was 16149 ± 38 ppm. The average K concentration for the bottom was 17417 ± 264 ppm.

4.4.5 Manganese (Mn)

There was no significant difference between the average Mn concentrations of the top and bottom samples, however, it was observed that the average Mn concentration for the bottom samples was higher than that of the top samples. The average Mn concentration for the top was 158 ± 5 ppm. The average Mn concentration for the bottom was 202 ± 4 ppm.

4.4.6 Lead (Pb)

Pb concentrations of the top and bottom samples for Sitmu'k averaged below the ISQG limit. The Pb ISQG for marine sediment is 30.2ppm (CCME, 2016). There was no significant difference between the average Pb concentrations of the top and bottom samples. The average Pb concentration for the top was 9 ± 2 ppm. No top samples were above the Pb ISQG limit. The average Pb concentrations for the bottom was 13 ± 1 ppm. 15.4% of bottom samples were found to be above the Pb ISQG limit.

4.4.7 Rubidium (Rb)

There was no significant difference between the average Rb concentrations of the top and bottom samples. The average Rb concentration for the top was 106 ± 2 ppm. The average Rb concentration for the bottom was 119 ± 1 ppm.

4.4.8 Strontium (Sr)

There was no significant difference between the average Sr concentrations of the top and bottom samples. The average Sr concentration for the top was 121 ± 2 ppm. The average Sr concentration for the bottom was 128 ± 2 ppm.

4.4.9 Titanium (Ti)

There was no significant difference between the average Ti concentrations of the top and bottom samples. The average Ti concentration for the top was 3016 ± 35 ppm. The average Ti concentration for the bottom was 3175 ± 42 ppm.

4.4.10 Zinc (Zn)

Zn concentrations of the top and bottom samples for Sitmu'k averaged below the ISQG limit. The Zn ISQG for marine sediment is 124 ppm (CCME, 2016). There was no significant difference between the average Zn concentrations of the top and bottom samples. The average Zn concentration for the top was 54 ± 3 ppm. No top samples were above the Zn ISQG limit. The average Zn concentrations for the bottom was 65 ± 2 ppm. No bottom samples were above the Zn ISQG limit.

4.5 Summary Table of Top and Bottom Analysis

Table 2 shows a summary of the average metal concentrations for the top and bottom samples taken from the Sitmu'k sediment cores. For all metals, the average concentration in the bottom appeared higher than that of the top. For the metals with an ISQG limit, the percentage of exceedances is also shown in Table 2. There were no samples taken from the top of the sediment cores which showed ISQG exceedances for Cu, Pb, or Zn. In the bottom samples Zn did not exceed the ISQG limit but Cu and Pb exceeded the ISQG limit on occasion.

Table 2. Summarized results of top and bottom analyses for metal concentrations in Sitmu'k.

	Average top (ppm)	Average bottom (ppm)	% top over ISQG	% bottom over ISQG
Calcium	558.46	858.05	N/A	N/A
Copper	8.08	13.93	0%	23.10%
Iron	14784.33	17529.04	N/A	N/A
Potassium	16148.77	17417.24	N/A	N/A
Manganese	157.66	202.06	N/A	N/A
Lead	8.64	13.31	0%	15.40%
Rubidium	106.42	118.65	N/A	N/A
Strontium	120.72	128.25	N/A	N/A
Titanium	3015.76	3174.59	N/A	N/A
Zinc	53.95	65.03	0%	0%

4.6 Metal Concentrations Through Time

Sediment core SM18-5 was selected for high resolution in which a sample was collected every centimeter down core. SM18-5 was selected because it was the deepest core, therefore representing the longest and least disturbed record from the lagoon. Each sample was analysed for concentrations of Ca, Cu, Fe, K, Mn, Pb, Rb, Sr, Ti, and Zn. Each metal concentration was plotted against depth within the core to show change through time (Figure 12), where the top is the youngest material, and the bottom is the oldest material. Several trends within the element concentrations were identified. Ca and Sr, representative of shell content within sediment, both show a similar and consistent trend until approximately 12 cm depth where there is a sudden significant increase in concentration. Ti is representative of clastic input into the system and shows a sudden significant decrease around 12 cm depth, similar, but opposite, to Ca and Sr. The remaining concentrations, Cu, Fe, K, Mn, Pb, Rb, and Zn show similar overall trends of decreasing metal concentrations at 4 cm and 12 cm depth. Between these two events metal concentrations remained relatively constant. In the top two centimeters of the core metal concentrations increased.

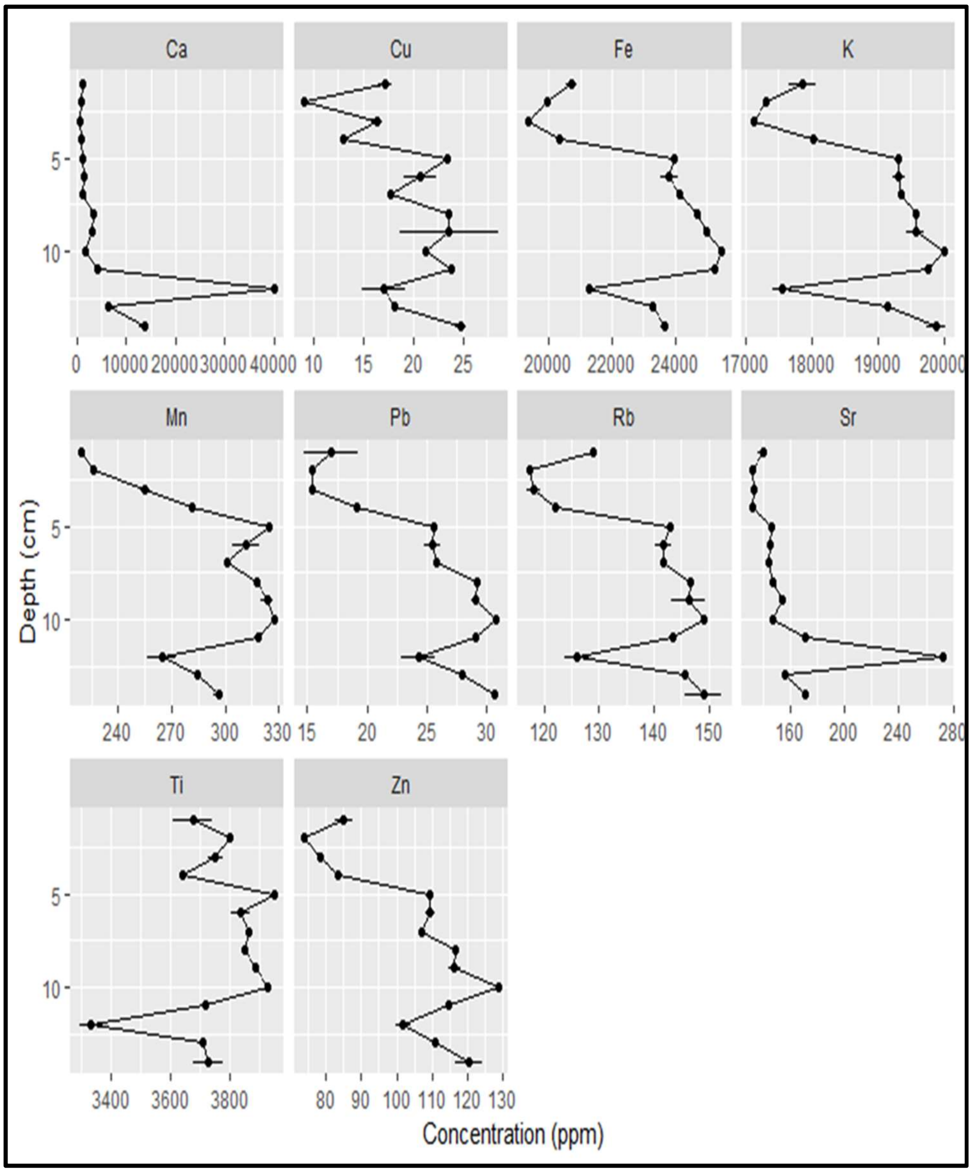
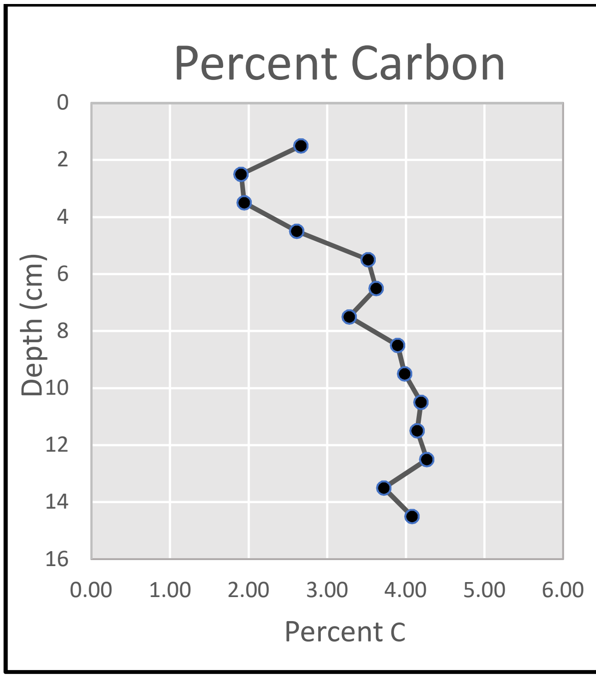


Figure 12. XRF analysis of Metal Concentrations from core SM18-5 measured and recorded from top to bottom in 1 cm intervals (Appendix C).

4.7 Total C/N & Stable Isotope Analysis

Total C and total N data (Appendix D) was plotted down-core in centimeter intervals to determine change through time in the organic portion of the sediment (Figure 13; Figure 14). Total C and N both show similar overall trends. Between 5 cm and 3 cm depth there is significant decrease in both C and N. The C and N concentrations at the top of the core increase. Overall there is a gradual decreasing trend in total C and N moving up-core.



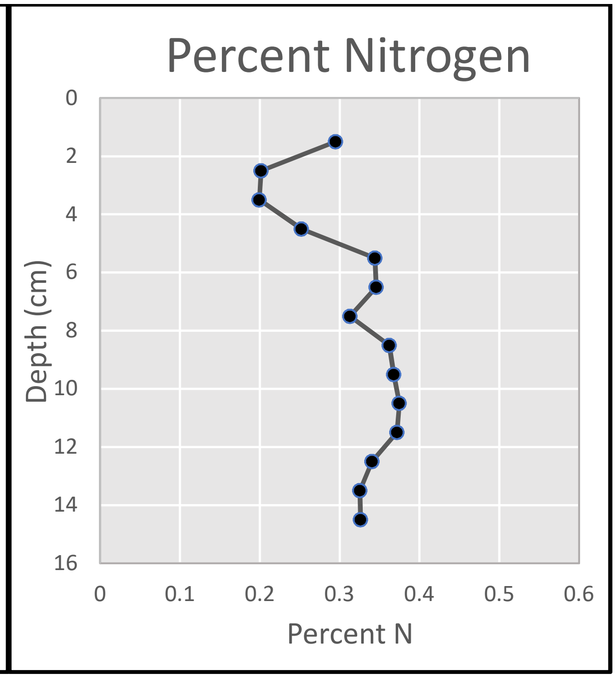


Figure 13. Total Carbon % plotted from top to bottom of core SM18-5.

Figure 14. Total Nitrogen % plotted from top to bottom of core SM18-5.

$\delta^{13}C$ and $\delta^{15}N$ were each plotted down-core in centimeter intervals to determine change through time, using samples from SM18-5 (Figure 15; Figure 16; Appendix D). $\delta^{15}N$ and $\delta^{13}C$ both remained relatively consistent with depth. $\delta^{15}N$ ranged mostly between 4% and 4.5%, and $\delta^{13}C$ ranged mostly between -18% and -20%, with higher values between 12 cm and 15 cm depth. $\delta^{13}C$ appears to have a gradual decreasing trend moving up-core. $\delta^{13}C$ values between -10% and -22% indicate organic matter is from a marine source (Mackie, 2005). Terrestrial and freshwater sourced carbon material is typically represented by $\delta^{13}C$ values around 27% (Mackie, 2005). The $\delta^{13}C$ values in SM18-5 range from -16% to -20%, indicating the source of organic material in Sitmu'k sediment to be marine. $\delta^{15}N$ values indicate that the main source of nitrogen is likely oceanic phytoplankton, represented by values typically around 6%, and terrestrial organic matter, represented by values between -10% and +10% (Alonso-Hernández et al., 2017).

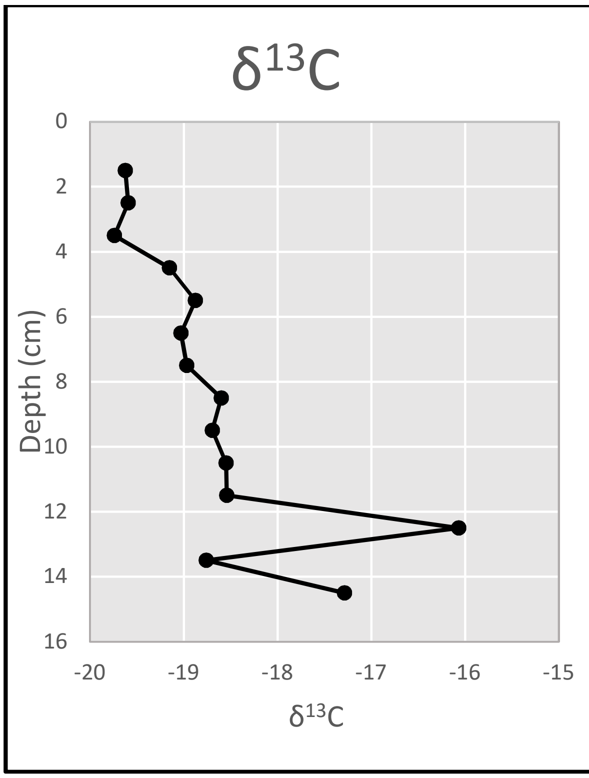


Figure 15. $\delta^{13}C$ plotted down-core using samples from core SM18-5.

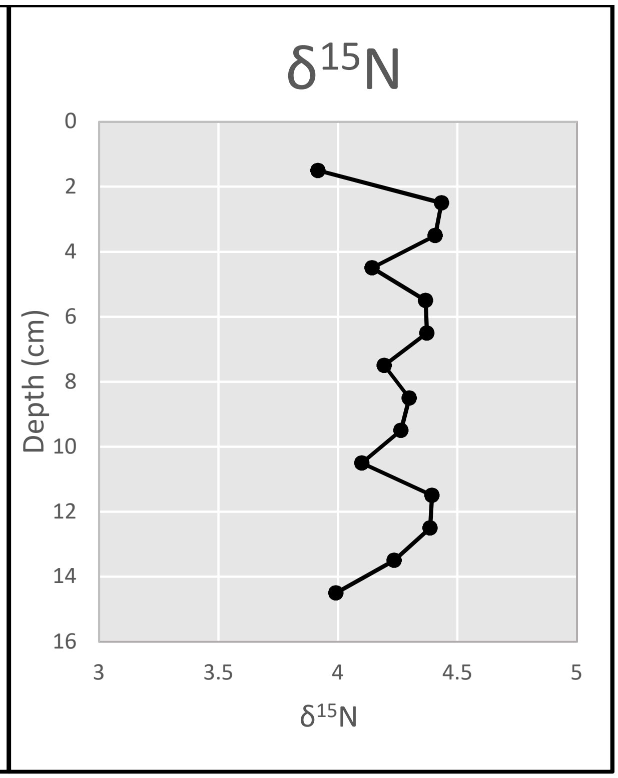


Figure 16. $\delta^{15}N$ plotted down-core using samples from core SM18-5.

Furthermore, the carbon/nitrogen ratio was graphed against $\delta^{13}C$ to determine the source of carbon input using predefined data fields (Figure 17). The data fields are defined as follows: C/N ratio of 11-17 and $\delta^{13}C$ values between -24.9% and 32.5% characterize freshwater aquatics. C/N ratio between 4 and 42 and $\delta^{13}C$ values greater than -23% characterize marine material. C/N ratio of 5-11 and 17-58 and $\delta^{13}C$ values of -24.9%-32.5% characterize terrestrial material (White, 2012; Meyers & Lallier-Vergés, 1999). Organic material from Sitmu'k plotted within the marine material boundaries, like reference site Chance Harbour. Organic material from Boat Harbour Estuary has a more terrestrial carbon input, likely influenced by Boat Harbour (and the pulp effluent) which empties into it.

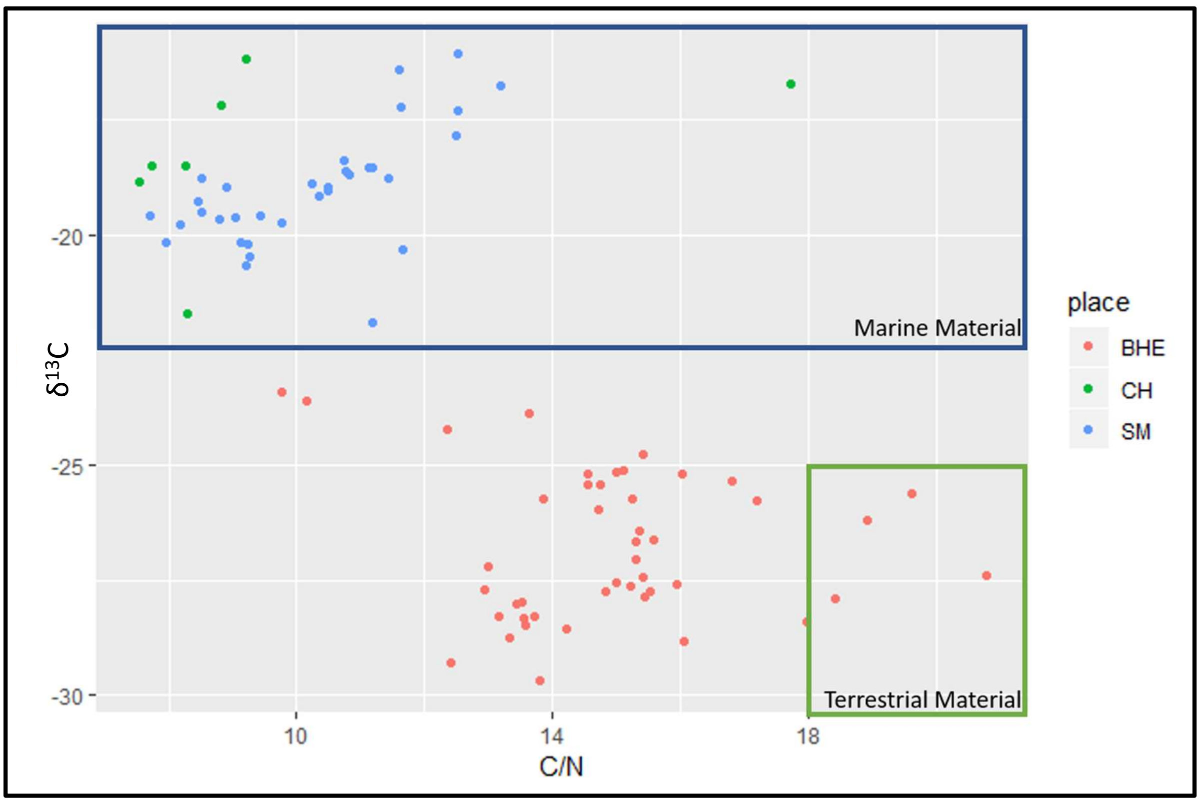


Figure 17. $\delta^{13}C$ versus C/N ratio to determine the source of carbon input in Sitmu'k (SM) in comparison to reference sites Chance Harbour (CH) and Boat Harbour Estuary (BHE).

Chapter 5: Interpretation and Discussion

5.1 Water Chemistry Analysis

Sitmu'k and Lighthouse Beach are changing through time and both sites are influenced by a combination of anthropogenic activity and natural geogenic processes. A back-barrier lagoon complex will decrease in size over time with sea level transgression as the barrier beach moves landward and fills the lagoon with sediment. Benallack et al. (2016) studied a non-migrating back-barrier lagoon complex in Africa. Benallack et al. (2016) found that the sedimentation rates are stable, and the lagoon stays relatively deep (due to tidal flushing), unlike the Atlantic margin of North America in which barriers are typically migrating landward and beach sediment is deposited over lagoon sediments. This process is occurring rapidly in Sitmu'k. Blow out deposition along LHB, and the landward movement of LHB as seen through past air photos are causing Sitmu'k to become shallower and more restricted from Pictou Harbour and the Northumberland Strait. These processes are strongly influencing water quality in Sitmu'k.

Water quality analysis from June to September showed an overall increasing trend as the summer progressed. Temperature of the waterbody rose steadily through June, July, and August, reaching temperatures above 30°C. Increasingly warm water temperatures are expected with Sitmu'k becoming shallower and the outlet becoming more restricted resulting is less mixing with the colder water of the Northumberland Strait.

Total coliform indicator tests were consistently high, indicating a high coliform count in Sitmu'k from June to September. Coliforms are a diverse group of bacterial taxa, most of which are not a threat to human health (Stevens et al., 2003). E. *coli* is one of the coliforms that is a threat to human health and is only found in the intestines of humans and mammals, making it a good indicator for sewage and wastewater contamination. E. *coli* tests were completed twice, once in late June, and another on the first of August. In June, E. *coli* counts were at acceptable levels for recreational purposes, but by August E. *coli* levels had risen well above recreational guidelines, limiting recreational use. It is probable that septic or sewage water contamination is entering the lagoon. Further research is required to determine the source of E. *coli* contamination. However, the restriction and shallowing of Sitmu'k is an important influence on-site because the lagoon remains warmer for longer periods of time and does not circulate water quickly, allowing bacteria such as E. *coli* to proliferate.

Following the same increasing trend over the summer, total phosphorus and nitrate levels showed a gradual incline, peaking in August. Nitrogen input can be an indicator for fertilizer transport from agricultural sources, sewage and fecal contamination, and/or aerial deposition (Smith et al., 1999). Phosphate input is also an indicator for erosion, fertilizer, animal manure, and wastewater traveling overland through water systems (Smith et al., 1999). Guidelines set by the Canadian Council of Ministers for the Environment (CCME) for nitrogen concentrations in marine systems are set at 16 mg/L (CCME, 2007). Nitrogen concentrations in water samples from Sitmu'k were below these guidelines, peaking at roughly 1.5 mg/L. Phosphorus can be used as an indicator for eutrophication in water systems. Sitmu'k is a complex estuarine system therefore many factors need to be considered when defining its trophic status such as flush rate and the rate at which the system can use these nutrients. Although these factors were not fully explored in this study, CCME recommends that a system should not exceed 0.05 mg/L of phosphorus in peak productivity (CCME, 2004). Sitmu'k total phosphorus concentrations were consistently above 0.05 mg/L through June to September and peaked at 0.6 mg/L. Phosphorous concentrations are likely being influenced by sewage wastewater and/or fertilizer runoff.

5.2 Sitmu'k Metal Analysis

All ten elements selected for XRF analysis (Ca, Cu, Fe, K, Mn, Pb, Rb, Sr, Ti, Zn) showed little stratigraphic variation in the sediment core records. The box plots comparing top and bottom element concentrations in Sitmu'k all showed that concentrations near the bottom of the core are slightly elevated compared to concentrations near the surface, however, no overall significant change has occurred. Slightly elevated metal concentrations in the past are likely related to the sediments ability to capture these metals which appears to decrease as the lagoon becomes shallower, sedimentation rates increase and organic content decreases. Figure 18 shows Cu, Pb, Ti, and Zn concentrations in Sitmu'k compared to concentrations at reference sites (Fergusons Pond, Chance Harbour, Boat Harbour Estuary; Figure 1), with black dots representing outliers. Ti, Cu and Pb concentrations in Sitmu'k are similar or less than concentrations in reference sites. Zn concentrations are significantly less than the average concentrations of the reference sites. Elevated concentrations of Zn in the Boat Harbour and Boat Harbour estuary sediment have been associated with influence from pulp effluent (Davidson, 2018; Holmes, 2018; Spooner and Dunnington, 2016a, 2016b). Sitmu'k has low Zn concentrations, all of which are below ISQGs for marine sediments, showing no apparent legacy of influence from pulp effluent.

This data does not prove that pulp effluent has not entered Sitmu'k in the past, but it does indicate that there is likely no preservation of contamination, if it did indeed occur, on site.

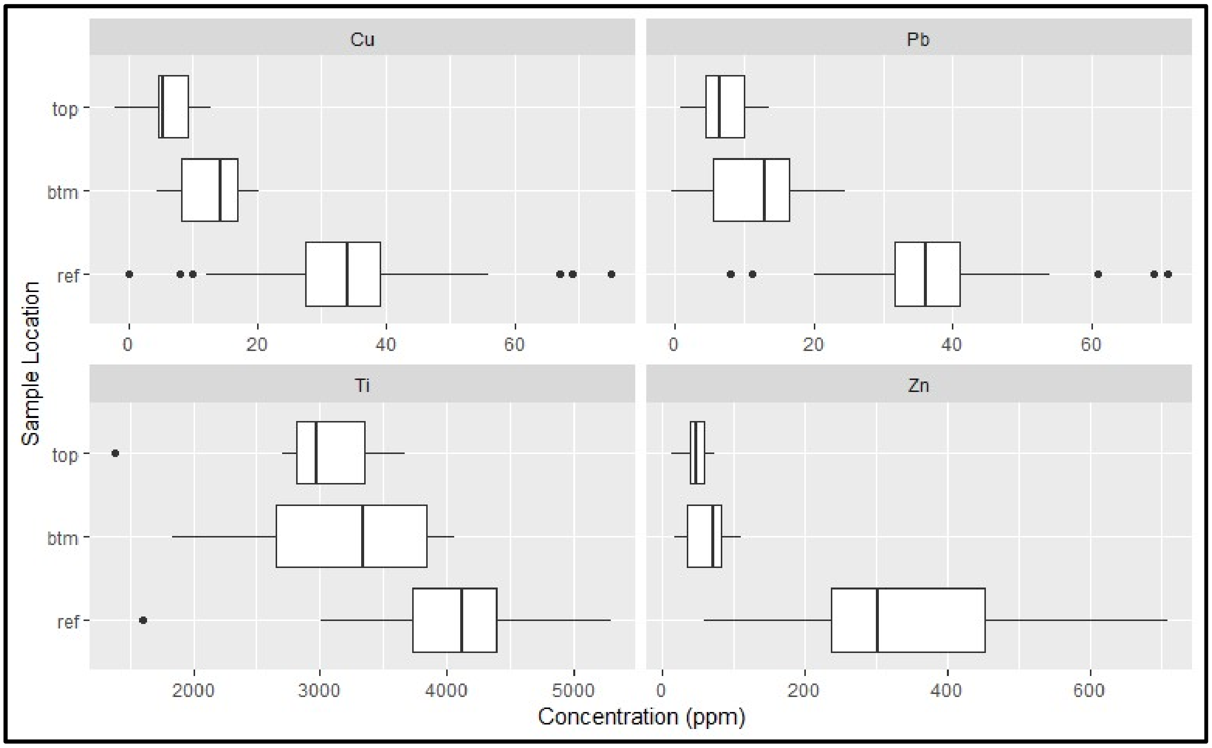


Figure 18. Box plots of Cu, Pb, Ti, and Zn concentrations at the top and bottom (btm) of the Sitmu'k cores in comparison to the reference sites (ref) Fergusons Pond, Chance Harbour and Boat Harbour Estuary.

XRF data from detailed analysis of SM18-5 (Figure 12), shows all elements to be relatively consistent from the top to the bottom of the core. As mentioned previously, two events are observed to have occurred at 4 cm and 12 cm depth, causing a decrease in metal concentrations. A likely cause of these trends are sudden increases in sedimentation in Sitmu'k, such as through a blow out and transfer of sand from the barrier beach into the lagoon. Blow out deposits form during storms when the barrier is breached. The deposits are visible along the barrier beach, and a significant breach occurred in 2003 which required a restoration project (Jacques Whitford, 2005). These events would cause a rapid but short-lived increase in minerogenic sedimentation into the lagoon and therefore the sediment had less time for metals to collect with deposition. This event would be resolved in the sediment record as a sudden decrease in metal concentrations. It is possible that the breaching event in 2003 is recorded in the sediment record as the event at 4 cm depth as this was the most recent major sedimentation event known to have happened. Metal concentrations began to increase in the uppermost centimeters of the core, perhaps associated with increased organic sediment accumulation as Sitmu'k became more restricted. At 12 cm depth there is also a sudden increase of Ca and Sr concentrations. The likely explanation for this is the “nugget effect” in which a piece of a component within the sediment sample, such as a shell, that has high concentrations of one or more elements causes an offset in the data (Geboy and Engle, 2011).

Metal concentrations are similar or lower in comparison to reference site averages. Blue lines on Figure 19 indicate average concentrations for reference sites (Chance Harbour, Fergusons Pond, and Boat Harbour Estuary). Zn concentrations appear to be much lower than the reference sites, indicating no record of Boat Harbour effluent influence. Cu, Pb, Ti and Zn concentrations were all observed to be below ISQG's set by the Canadian Government (CCME, 2016). These concentrations indicate that the site is not polluted by excess concentrations of these metals. A study by Davidson (2018) on sediment in Boat Harbour, Boat Harbour Estuary, Fergusons Pond, and Chance Harbour Estuary found that this region has high concentrations of these metals, likely from a local geogenic source. The metals found in Sitmu'k sediments are likely derived from the same geogenic source. The lower concentrations found in Sitmu'k compared to the reference sites is likely due to the high minerogenic and low organic sedimentation rates caused by the erosion and landward migration of Lighthouse Beach.

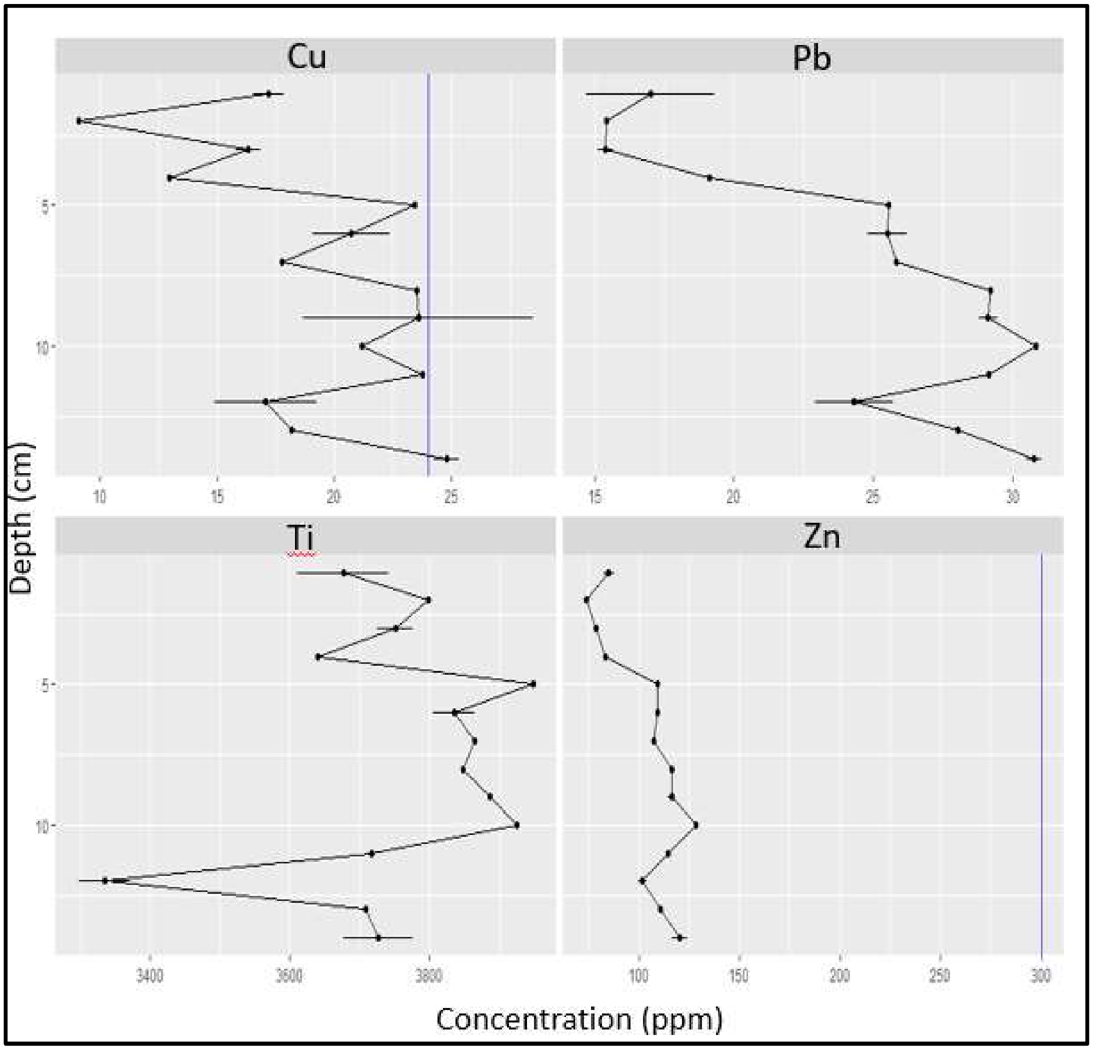


Figure 19. Metal concentrations with depth using samples from SM18-5 compared to average concentrations of the reference sites (blue lines).

5.3 Total Carbon, Total Nitrogen, and Stable Isotope Analysis

Total C and total N percentage were observed to be fairly consistent, with one event around 4 cm depth. It is likely that this decrease occurred in 2003 when Lighthouse Beach was breached, and minerogenic sedimentation rates increased. The sudden sedimentation increase in the lagoon would decrease the ability for organic matter to accumulate with the sediment. $\delta^{13}C$, $\delta^{15}N$ and the relationship between $\delta^{13}C$ and C/N was used to determine the source of organic material in the lagoon. All three methods indicated that the source of organic material in Sitmu'k is dominantly marine. $\delta^{15}N$ values suggested that nitrogen-bearing material is likely coming from oceanic phytoplankton or terrestrial sources on Lighthouse Beach. These analyses determined a marine origin for the organic material in Sitmu'k, suggesting that sources such as the pulp effluent (derived from terrestrial organic matter) in Boat Harbour are not a likely influence on-site. Boat Harbour organic material is of strong terrestrial origin due to the organic components of the effluent being sources from tree pulp (Holmes, 2018).

Chapter 6: Conclusion

There is strong evidence for natural environmental change at Sitmu'k. Lighthouse Beach is moving landward due to sea level rise and wave activity, causing the lagoon to become shallower, the sediment to become more minerogenic and reducing circulation. This allows nutrients and bacteria to collect and concentrate during the summer months. XRF analysis of the lagoon sediment archives does not provide evidence for sequestered contaminants or extensive change. There are two events in the sediment archive that change metal concentrations, both are likely due to sudden rapid sedimentation rates caused by breaches in the barrier beach. Evidence for anthropogenic impact on-site is found in the water quality data. E. *coli* bacteria is likely coming from a source of fecal contamination. High phosphorus concentrations may be related to septic influence. Total carbon, total nitrogen, and stable isotope analysis indicated that organic material is of marine origin, reducing the likelihood that pulp effluent impacted the site. The main driver of environmental degradation at Sitmu'k is the landward movement of Lighthouse Beach. The landward movement of Lighthouse Beach has created an environment that is lacking circulation and is becoming shallower. This is allowing water temperatures to rise, nutrients to collect, and bacteria to rapidly reproduce and concentrate within the lagoon.

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Figure 5E. Core SM18-5 after being thawed and split.

Langelier Index (@ 4C)	NA	0.11	0.06	0.16
Saturation pH (@ 20C)	NA	7.47	7.53	7.46
Saturation pH (@ 4C)	NA	7.79	7.85	7.78
Anion Sum	me/L	302	296	300
Cation sum	me/L	354	331	315
% Difference/ Ion Balance (NS)	%	8.0	5.5	2.4
Total Aluminum	ug/L	141	192	128
Total Antimony	ug/L	<2	<2	<2
Total Arsenic	ug/L	<2	<2	<2
Total Barium	ug/L	22	22	25
Total Beryllium	ug/L	<2	<2	<2
Total Bismuth	ug/L	<2	<2	<2
Total Boron	ug/L	2940	2500	2860
Total Cadmium	ug/L	<0.09	<0.09	<0.09
Total Chromium	ug/L	2	3	3
Total Cobalt	ug/L	1	2	2
Total Copper	ug/L	7	11	11
Total Iron	ug/L	164	240	348
Total Lead	ug/L	0.8	<0.5	<0.5
Total Manganese	ug/L	57	57	60
Total Molybdenum	ug/L	9	8	8
Total Nickel	ug/L	11	11	11
Total Phosphorous	mg/L	0.04	0.04	0.04
Total Selenium	ug/L	<1	<1	<1
Total Silver	ug/L	<0.1	<0.1	<0.1
Total Strontium	ug/L	5030	4610	5170
Total Thallium	ug/L	<0.1	<0.1	<0.1
Total Tin	ug/L	<2	<2	<2
Total Titanium	ug/L	10	14	15
Total Uranium	ug/L	1.6	1.5	1.6
Total Vanadium	ug/L	42	48	109
Total Zinc	ug/L	12	13	14
Total Coliforms (MPN)	MPN/100 mL	1300	980	866
E. Coli (MPN)	MPN/100 mL	25	47	37

Table 3B: Total Coliform count and E. *coli* count test results from the Center for Water Resources Studies at Dalhousie University in Halifax, Nova Scotia. Water samples taken on August 1, 2018, results were produced on August 27, 2018.

Parameter	**Unit**	**S18-A3**	**S18-B3**	**S18-C3**
Total Coliforms (MPN)	MPN/100 mL	>2419	1860	1120
E. *coli* (MPN)	MPN/100 mL	210	365	573

C: X-Ray Fluorescence Analysis

Table 1C: Raw XRF data of metal concentrations (ppm) retrieved from an Epsilon1 XRF.

core	depth	K	Ca	Ti	Mn	Fe	Cu	Zn	Rb	Sr	Pb
SM18-1	1	17837.5	1033.471	3431.896	195.378	19733.67	12.664	67.294	118.061	131.308	12.511
SM18-1	6	17703.9	558.137	2745.171	143.752	12412.64	9.256	32.372	98.647	100.215	5.294
SM18-2	1	17025.31	603.791	3610.854	193.81	18489.67	11.065	77.32	118.617	130.285	11.048
SM18-2	12	18758.43	1119.229	3706.969	335.696	23623.66	17.216	109.813	150.691	142.035	24.371
SM18-3	1	13098.08	-308.521	1560.156	31.334	5921.018	-2.246	10.323	81.205	87.333	0.988
SM18-3	1	11439.36	103.052	1204.664	35.502	5934.429	-2.003	16.291	76.322	92.912	0.698
SM18-3	3	12761.75	145.642	1958.674	70.731	7383.4	4.276	19.011	76.155	93.713	-1.545
SM18-4	1	16663.77	597.654	3259.343	148.513	14937.86	5.155	50.224	106.103	125.509	6.432
SM18-4	6	14844.74	183.01	2572.679	164.91	11746.35	7.45	34.715	96.559	117.592	5.726
SM18-6	1	16071.95	570.726	2665.448	127.918	12951.95	5.302	48.388	99.337	112.029	5.893
SM18-6	8	17016.38	1389.962	3334.689	224.708	18670.32	14.249	74.683	127.855	136.989	12.823
SM18-7	1	15346.65	481.347	2970.143	163.525	13077.41	5.291	43.728	97.495	115.164	7.233
SM18-7	9	20245.89	1666.158	3907.372	249.23	23956.53	18.294	69.757	137.243	143.421	17.212
SM18-8	1	14138.68	251.24	2705.759	181.588	10545.47	4.133	34.65	86.117	115.29	3.755
SM18-8	7	19042.28	859.371	4054.959	225.047	20759.63	20.336	87.898	125.215	136.487	16.79
SM18-5	1	17705.61	1081.301	3722.887	218.698	20595.78	16.703	83.353	128.773	137.289	15.375
SM18-5	14	19777.56	14294.2	3691.058	298.213	23574.99	25.183	117.681	146.704	170.048	30.954
SM18-5	1	18000.71	990.441	3629.559	219.068	20851.42	17.632	86.802	128.838	141.899	18.631
SM18-5	2	17305.84	771.334	3797.833	226.258	19956.53	9.067	73.809	117.369	131.646	15.426
SM18-5	3	17149.31	696.978	3779.36	253.753	19341.85	16.624	78.217	118.025	131.823	15.106
SM18-5	3	17093.56	680.88	3741.44	253.553	19330.26	15.703	77.955	119.245	134.674	15.467
SM18-5	3	17101.2	699.223	3731.392	258.015	19382.34	16.655	79.481	117.009	131.901	15.618
SM18-5	4	18021.82	814.021	3640.174	281.617	20311.24	12.948	83.29	121.994	132.147	19.144
SM18-5	5	19305.63	1196.23	3949.098	324.328	23981.07	23.44	109.318	142.949	146.158	25.56
SM18-5	6	19395.13	1388.519	3840.172	319.522	23978.28	22.593	110.603	142.347	145.949	25.231

SM18-5	6	19326.88	1349.878	3862.235	310.172	23966.09	19.548	108.133	142.911	147.062	26.312
SM18-5	6	19215.09	1365.675	3802.757	304.403	23479.61	20.009	109.507	140.149	143.037	24.989
SM18-5	7	19348.49	1227.048	3864.164	301.082	24131.66	17.772	107.166	141.662	144.264	25.823
SM18-5	8	19573.47	3471.76	3847.526	317.619	24698.41	23.503	116.572	146.739	146.535	29.21
SM18-5	9	19431.69	3121.363	3887.6	319.838	25027.56	18.344	114.729	148.292	155.633	28.787
SM18-5	9	19592.33	3182.158	3889.297	325	25009.55	28.104	118.015	142.721	152.838	29.464
SM18-5	9	19684.28	3172.269	3883.096	325.579	24994.63	24.326	116.022	147.832	154.189	29.122
SM18-5	10	19996.11	1672.233	3924.896	327.714	25478.74	21.194	128.646	149.169	147.377	30.825
SM18-5	11	19756.37	4303.018	3717.017	318.518	25234.99	23.776	114.581	143.512	171.304	29.159
SM18-5	12	17605.62	39954.08	3329.94	259.316	21289.27	16.005	104.064	128.293	274.372	24.111
SM18-5	12	17652.44	40025.92	3299.555	260.098	21247.71	19.582	101.091	125.946	272.657	25.816
SM18-5	12	17396.86	39883.77	3373.817	273.792	21240.19	15.628	99.983	123.898	270.65	23.047
SM18-5	13	19137.12	6339.958	3708.27	284.279	23283.34	18.187	110.922	145.629	156.117	28.028
SM18-5	14	19981.5	12943.25	3761.444	294.491	23746.46	24.421	122.954	151.399	170.882	30.577
SM18-2	1	17043.86	628.28	3658.77	208.164	18831.47	13.466	72.945	123.138	136.45	14.225
SM18-2	1	16948.65	647.457	3714.023	199.431	18899.54	13.617	69.902	117.881	133.24	14.961
SM18-3	3	13548.63	42.017	1611.226	42.916	6408.914	3.98	14.114	78.184	83.314	0.219
SM18-3	3	13438.02	83.525	1920.632	72.078	7939.382	4.612	18.317	80.079	93.767	-0.169
SM18-6	1	17382.3	543.172	3037.325	145.237	13118.7	7.894	48.198	103.545	114.649	3.955
SM18-6	1	17380.34	595.018	3049.801	139.015	13092.18	4.471	45.92	104.436	116.79	5.294
SM18-7	9	19688.39	1686.977	3987.913	248.258	23790.88	18.108	70.059	138.637	139.572	15.36
SM18-7	9	19616.63	1704.503	4016.945	256.773	23864.35	13.751	74.013	135.021	139.175	15.464
SM18-8	1	14138.68	251.240	2705.759	181.588	10545.47	4.133	34.650	86.117	115.290	3.755
SM18-8	7	19042.28	859.371	4054.759	225.047	20759.63	20.336	87.898	125.215	136.487	16.790

D: Total Carbon, Total Nitrogen, and Stable Isotope data

Table 1D: Raw data from Stable Isotope in Nature (SIN) Lab at the University of New Brunswick. This table includes total C, total N, C/N, and stable isotope data for sediment cores taken from Sitmu'k in 2018 and Boat Harbour Estuary, Chance Harbour Estuary, and Fergusons Pond in 2017.

Core	Depth	CO2_Ampl	N2_Ampl	d13C	d15N	C	N	C_N
SM18-5	1	1.78	1.505	-19.67	4.50	2.78	0.32	8.79
SM18-5	1	0.45	0.33	-19.63	3.92	2.66	0.30	9.03
SM18-5	2	1.347	1.038	-19.59	4.43	1.91	0.20	9.44
SM18-5	3	1.378	1.022	-19.74	4.41	1.95	0.20	9.76
SM18-5	4	1.788	1.278	-19.15	4.14	2.61	0.25	10.36
SM18-5	5	2.235	1.663	-18.87	4.37	3.52	0.34	10.23
SM18-5	6	2.256	1.641	-19.03	4.37	3.62	0.35	10.48
SM18-5	7	2.166	1.559	-18.97	4.19	3.28	0.31	10.49
SM18-5	8	2.438	1.733	-18.60	4.30	3.90	0.36	10.76
SM18-5	9	2.507	1.776	-18.70	4.26	3.98	0.37	10.83
SM18-5	10	2.569	1.767	-18.55	4.10	4.19	0.37	11.19
SM18-5	11	2.552	1.771	-18.54	4.39	4.14	0.37	11.14
SM18-5	12	2.666	1.629	-16.07	4.39	4.27	0.34	12.53
SM18-5	13	2.292	1.53	-18.76	4.23	3.72	0.33	11.43
SM18-5	14	2.552	1.565	-17.28	3.99	4.08	0.33	12.51
SM18-5	14	0.736	0.394	-17.83	4.18	3.92	0.31	12.49
SM18-1	1	1.317	1.169	-19.75	4.38	2.02	0.25	8.17
SM18-1	1	0.335	0.263	-19.27	4.26	1.86	0.22	8.47
SM18-1	6	0.569	0.45	-18.97	4.18	0.81	0.09	8.90
SM18-1	6	0.473	0.388	-18.78	3.93	0.68	0.08	8.51
SM18-2	1	1.162	0.973	-19.50	4.21	1.78	0.21	8.52
SM18-2	12	2.459	1.755	-18.36	3.56	3.47	0.32	10.74
SM18-3	1	0.249	0.226	-19.58	4.76	0.31	0.04	7.71
SM18-3	3	0.227	0.2	-20.16	5.05	0.33	0.04	7.95
SM18-4	1	0.732	0.561	-20.66	4.24	1.05	0.11	9.20
SM18-4	6	0.216	0.136	-21.89	4.53	0.34	0.03	11.19
SM18-6	1	0.702	0.535	-20.46	4.05	1.05	0.11	9.26
SM18-6	8	1.69	1.07	-20.30	4.37	2.51	0.22	11.67
SM18-7	1	0.586	0.446	-20.21	4.40	0.83	0.09	9.23
SM18-7	9	2.087	1.345	-16.41	3.51	3.17	0.27	11.61
SM18-8	1	0.407	0.311	-20.17	4.29	0.64	0.07	9.13
SM18-8	7	1.471	0.921	-17.20	4.41	2.18	0.19	11.62
SM18-8	7	0.5	0.251	-16.74	3.98	4.70	0.36	13.18
BHE17-1	1	4.61	2.683	-23.40	3.49	16.74	1.71	9.77
BHE17-1	1	4.612	2.758	-23.61	3.34	17.07	1.68	10.14

BHE17-1	17	2.745	1.258	-24.21	3.01	9.94	0.80	12.35
BHE17-1	33	2.06	0.847	-23.87	3.17	7.05	0.52	13.63
BHE17-3	1	3.415	1.436	-29.70	-0.51	12.41	0.90	13.81
BHE17-3	24	2.082	0.749	-26.62	1.13	7.35	0.47	15.59
BHE17-3	48	3.765	1.731	-25.10	3.18	6.05	0.40	15.10
BHE17-2	1	3.103	1.446	-29.31	0.44	10.98	0.88	12.41
BHE17-2	2	3.148	1.335	-27.96	1.10	11.13	0.82	13.53
BHE17-2	3	3.437	1.463	-28.33	0.62	12.30	0.91	13.55
BHE17-2	4	3.537	1.587	-27.70	1.41	12.80	0.99	12.94
BHE17-2	5	3.589	1.615	-27.21	1.62	10.92	0.84	13.00
BHE17-2	6	4.322	1.949	-28.74	0.58	13.48	1.01	13.34
BHE17-2	7	4.19	1.848	-28.29	0.42	13.03	0.95	13.73
BHE17-2	8	3.88	1.68	-28.48	0.31	12.21	0.90	13.57
BHE17-2	9	3.052	1.305	-28.02	0.89	9.13	0.68	13.44
BHE17-2	9	3.09	1.342	-28.31	0.78	9.10	0.69	13.16
BHE17-2	10	4.095	1.875	-27.62	0.66	6.98	0.46	15.22
BHE17-2	12	1.336	0.479	-26.65	2.14	3.86	0.25	15.31
BHE17-2	14	2.874	1.078	-27.44	1.03	8.64	0.56	15.41
BHE17-2	14	2.304	0.847	-27.06	1.30	6.66	0.44	15.29
BHE17-2	16	3.858	1.479	-27.77	0.08	11.77	0.76	15.53
BHE17-2	18	4.44	1.74	-27.85	-0.03	14.09	0.91	15.44
BHE17-2	20	3.664	1.436	-27.56	-0.23	11.26	0.75	15.01
BHE17-2	22	2.223	0.818	-25.73	1.86	6.37	0.42	15.26
BHE17-2	24	3.325	1.267	-26.45	1.09	9.85	0.64	15.35
BHE17-2	26	2.322	0.907	-25.43	2.21	6.95	0.48	14.56
BHE17-2	28	1.891	0.757	-25.75	3.17	5.44	0.39	13.86
BHE17-2	30	2.693	0.746	-27.40	0.18	7.94	0.38	20.78
BHE17-2	32	5.462	2.242	-28.84	-0.43	13.73	0.85	16.07
BHE17-2	34	5.71	2.655	-28.56	0.41	14.47	1.02	14.21
BHE17-2	36	4.018	1.608	-27.76	0.49	9.28	0.63	14.83
BHE17-2	38	4.92	2.254	-27.59	0.04	11.52	0.72	15.93
BHE17-2	40	3.071	1.218	-25.98	2.06	6.69	0.45	14.72
BHE17-2	42	5.594	2.039	-28.42	-0.31	13.94	0.78	17.98
BHE17-2	44	6.638	2.537	-27.89	0.25	17.54	0.95	18.42
BHE17-2	46	4.232	1.355	-26.19	1.81	9.86	0.52	18.93
BHE17-2	48	5.083	1.934	-25.33	1.96	12.46	0.74	16.81
BHE17-2	48	4.838	1.747	-25.77	1.59	11.77	0.68	17.19
BHE17-2	50	3.083	1.15	-24.76	2.34	6.88	0.45	15.42
BHE17-2	52	2.106	0.806	-25.43	3.17	4.57	0.31	14.74
BHE17-2	54	1.668	0.637	-25.20	3.56	3.65	0.25	14.56
BHE17-2	56	1.916	0.713	-25.15	3.90	4.12	0.27	15.00
BHE17-2	58	2.021	0.71	-25.21	3.75	4.31	0.27	16.02
BHE17-2	60	2.894	0.85	-25.61	3.97	6.35	0.32	19.60

FP17-1	2	1.505	0.714	-29.98	2.38	3.23	0.28	11.62
FP17-1	17	3.181	1.259	-27.77	1.93	2.19	0.13	17.30
FP17-2	2	2.489	1.149	-30.18	1.86	8.88	0.72	12.26
FP17-2	32	1.847	0.76	-28.40	1.31	6.53	0.48	13.54
FP17-3	2	2.559	1.455	-31.52	1.32	9.22	0.93	9.93
FP17-3	34	3.646	1.523	-28.61	0.47	12.74	0.98	12.97
FP17-3	34	3.481	1.554	-28.61	0.39	12.56	0.97	12.98
CH17-1	1	1.269	0.831	-18.83	4.34	4.30	0.57	7.53
CH17-1	1	4.617	4.156	-18.47	4.01	4.33	0.56	7.74
CH17-1	18	3.186	2.43	-17.19	4.12	2.78	0.32	8.81
CH17-2	1	3.407	2.745	-18.49	4.35	2.93	0.35	8.25
CH17-2	18	3.486	2.586	-16.15	3.85	3.05	0.33	9.21
CH17-3	1	0.107	0.089	-21.71	0.83	0.05	0.01	8.28
CH17-3	21	1.429	0.52	-16.71	3.61	0.66	0.04	17.73

E: Photos

Figure 1E. Photo taken from sample site A.

Figure 2E. Photo taken from sample site B.

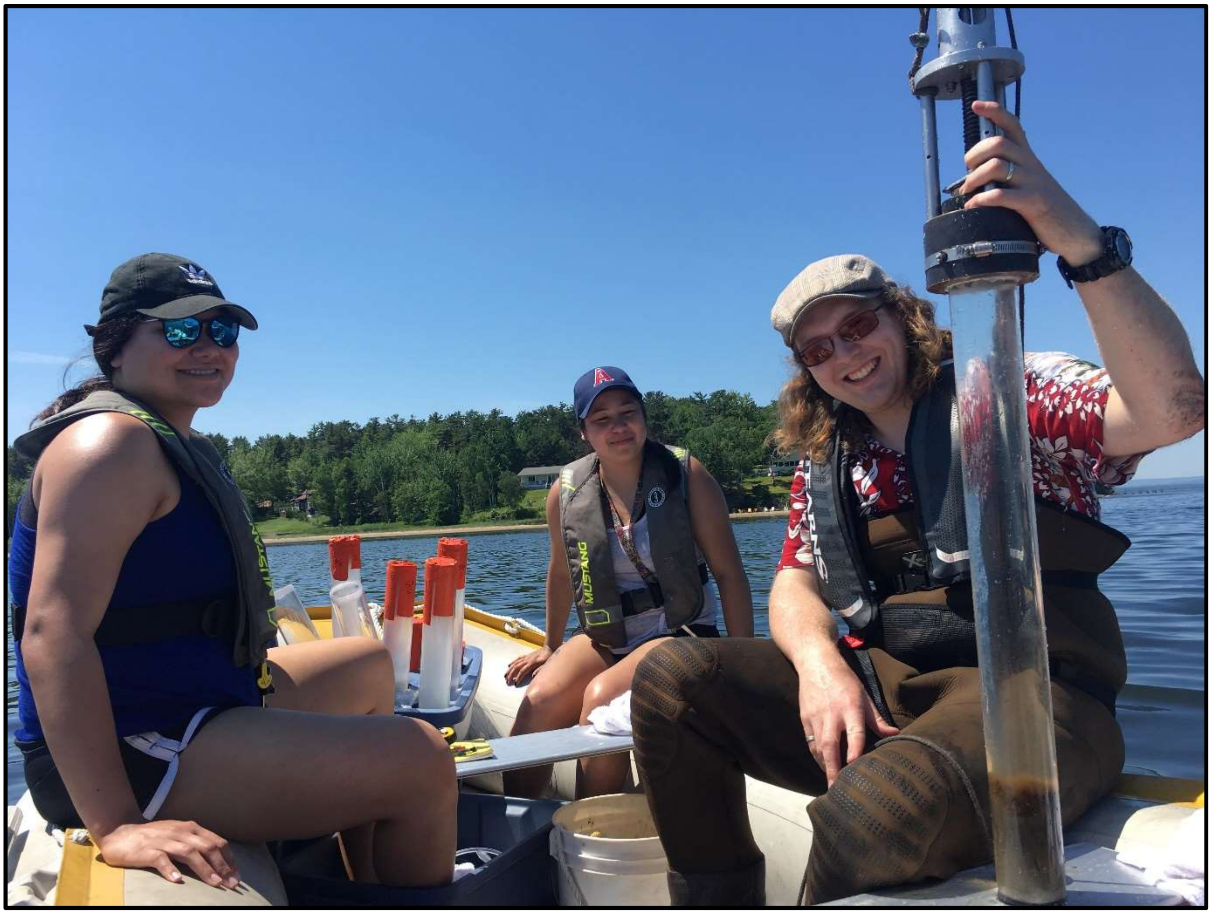

Figure 3E. Sediment gravity coring with the help of Kirklyn Davidson, Baillie Holmes, Selena Denny and Savanna Francis. (Featured from left to right: Savanna Francis, Selena Denny, Kirklyn Davidson).

Figure 4E. Drone aerial photo taken on August 1st, 2018 portraying the inundation of Lighthouse Beach at its landward end.

Figure 5E. Core SM18-5 after being thawed and split.

American lobster (*Homarus americanus*) tissue sampling for trace metal(loid)s and organic contaminants: baseline report for Boat Harbour remediation project

Prepared for NS Lands

Prepared by MSc candidate

Supervisors:

Final report submitted November 11th, 2019

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Executive summary

This report is intended to establish a baseline of the contaminant levels in lobster tissues prior to remediation of Boat Harbour. Three additional objectives were to 1) determine if contaminants in lobsters exceed any guideline values 2) record the differences in contamination between sites and 3) test for any bioaccumulation effect in lobsters.

In the summer of 2018, three age classes of lobsters (adults, subadults, and juveniles) were collected from three different sites; Ballantynes Cove (~45 km from Boat Harbour outfall), Merigomish (~15 km from Boat Harbour outfall), and Pictou Road (>1 km from Boat Harbour outfall). The lobsters were submitted to Maxxam Analytics to be analyzed for various contaminants, including heavy metals and metalloids, methylmercury (MeHg), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs). Depending on the contaminant and lobster age class, animals were either analyzed individually or as a pooled single sample from each site, and either as the hepatopancreas or the whole-body (without the hepatopancreas). Further details concerning collection sites, sample sizes, and methods can be found below in the detailed report and the appendix.

Whole-body lobster tissues were analyzed for metals. For each contaminant in individual tissue samples, a one-way ANOVA and a two-way ANOVA were applied to the adult lobster data followed by Tukey's HSD test to test for significant differences in concentrations of each contaminant between age groups and sites.

Comparing age classes, it was expected that adults would contain the highest levels of contaminants, as they have had more time to accumulate. However, this was not always the case

and often the contaminant concentrations in subadults and juveniles exceeded those in adults. Notably, juveniles contained higher levels of aluminum, iron, manganese, and strontium at all sites, some of which exceeded guideline levels and reference study levels. This finding was unexpected, however there is a lack of data regarding contaminant loads in juvenile lobsters, thus it is unknown whether this is typical in lobsters at this life stage. A bioaccumulation effect was observed with several metals (arsenic at Ballantynes, cadmium, copper, mercury, silver, and zinc), MeHg, and all organic contaminants (PCDD/Fs and possibly PAHs). Several metals were not detected at all in any sample including antimony, barium, beryllium, cobalt, lead, lithium, molybdenum, nickel, thallium, tin, uranium, and vanadium.

Comparing sites, it was expected that Pictou Road would have overall elevated contaminant levels due to the industrial activities in the area, but the results indicated that any (or none) of the three sites could have significantly higher metal concentrations, depending on the contaminant.

Generally, metal concentrations did not exceed regulatory guidelines with a few exceptions. The average arsenic levels in all lobster samples exceeded Canadian Food Inspection Agency (CFIA) guideline levels at all sites. Despite these exceedances, these results were similar to arsenic levels in other studies that analyzed for trace metals in American lobster (*Homarus americanus*) tissues from the U.S coastal waters (Hall et al., 1978), rock crab (*Cancer irroratus*) tissues from Sydney Harbour, NS (Walker et al., 2013a), and *Homarus americanus* hepatopancreas tissues from coastal regions along Nova Scotia (Stewart et al., 2019). Regulatory guidelines for boron, cadmium, chromium, iron, selenium, strontium, and zinc were not identified and do not exist to our knowledge.

MeHg, measured in whole-body samples, was detected in all lobsters, but the average concentrations in all age classes were well below the CFIA guideline level (0.5 ppm) at all sites. Adults from Pictou Road appeared to have slightly higher concentrations than the other two sites, but this is likely driven by a single outlier (0.221 ppm). A bioaccumulation effect was observed: adults contained the highest level of MeHg contamination, subadults contained a lower degree of contamination, and the juveniles had the lowest degree of contamination. This is to be expected, as MeHg is an organic contaminant that is known to bioaccumulate in biota tissues.

Lobster hepatopancreas tissue was dissected (prior to whole-body analysis) and analyzed for PAHs. PAHs were not previously considered a concern in Boat Harbour sediment but were included in this baseline as a precaution. The most potent and hazardous PAH congener, benzo[a]pyrene, was not detected in any sample. No PAHs whatsoever were detected in any sub-adult or juvenile lobster tissues and were not detected in any age class of lobsters from the Merigomish or Ballantynes Cove sites. The only two congeners of PAHs (fluoranthene and pyrene) that were detected were from adult lobster tissues from Pictou Road. Hepatopancreas tissue samples were pooled for analyses, thus we were unable to test for significant differences between sites. To our knowledge, there are no suitable guidelines for PAH, fluoranthene, or pyrene concentrations in marine biota tissue and water. However, PAHs in our lobster samples are not of concern and similar to what was detected in reference studies.

Pooled hepatopancreas tissues were also analyzed for PCDD/Fs. The average PCDD/F TEQ_{total} concentrations in juveniles and subadults were well below the guideline values at all sites. All lobster samples had concentrations well below the CFIA guideline value (20 ppt). This guideline value indicates the maximum concentration permitted in fish products for human consumption in Canada, above which the fish product is rejected. Thus, we suggest that although the lobster samples have detectable PCDD/F contamination, they are unlikely to be of concern. In comparisons among the sites, there was evidence that suggested PCDD/F concentrations at Pictou Road were significantly higher than at Ballantynes or Merigomish.

Overall, none of the contaminants we tested for had concentrations that appear to be of great concern. There was evidence of significant differences in contamination between sites, but these differences varied among contaminants such that no site had consistently higher levels of all or most contaminants. Adults and subadults mostly had higher contaminant concentrations than juveniles, with a few exceptions. Adult and sub-adult concentrations tended to be similar with metal contaminants but there was a clear bioaccumulation effect with organic contaminants, as adults had higher concentrations. This survey will prove to be valuable for general knowledge of contaminant loads in lobster tissues from Northumberland Strait and will be used as a comparative study for assessing the effects of Boat Harbour remediation.

<u>Detailed report</u>

Introduction

The following is the detailed report of the baseline survey monitoring the impact of Boat Harbour remediation on lobsters in the Northumberland Strait fishing area 26A (Figure 22). It is possible that the planned remediation efforts could result in contaminated sediment from Boat Harbour being dispersed into the lobster fishing district once tidal communication with the strait is restored, and the contaminated sediment could impair lobster survival, growth, reproduction, and marketability. It is expected that the environmental planning, regulatory approval, and oversight processes will safeguard the dispersion of deleterious substances into the lobster fishing region as regulated under the Fisheries Act. Thus, this survey was conducted prior to remediation to establish the contamination levels in lobsters before any chance of effects from the Boat Harbour remediation. We were interested in testing for heavy metals and PCDD/Fs based on their detection in past studies of Boat Harbour sediment (Hoffman et al. In press; (Hoffman et al., 2017)). Boat Harbour biota, water, or sediment has not been tested for MeHg to our knowledge. Therefore, it has been included in this baseline report to fill this gap of knowledge. In addition, there was at least one chlor-alkali pipeline leak in the 1980’s that released mercury into the surrounding environment so it is possible MeHg is currently present in the biota, water, or sediment of Boat Harbour (Taylor, 2015). In the environment, inorganic mercury is regularly methylated into its organic form (MeHg) which can readily bioaccumulate in organisms and is also known to biomagnify through the food chain (Hammerschmidt, and Fitzgerald, 2006). Therefore, monitoring MeHg levels in lobster tissues throughout the remediation process is important. Although not currently a concern in the Boat Harbour sediment, PAHs were also included in the analysis to establish a broad range of contaminants in lobsters.

This study analyzed both the lobster whole-body tissues (including edible meats) and the hepatopancreas tissues. This was done to determine whether contaminants in edible lobster meat are exceeding guidelines that regulate whether the product is suitable for human consumption. The hepatopancreas is a fatty tissue that acts similarly to the liver and often accumulates higher levels of organic contaminants. Therefore, we selected the hepatopancreas tissue to be analyzed for PAHs and PCDD/Fs. This will also likely show the maximum contaminant levels present in the lobster tissues. Future surveys will be conducted during and after remediation and compared to the baseline study to monitor the possibility of remediation affecting contamination levels in lobsters.

Methods

In the summer of 2018, male lobsters were collected from the Northumberland Strait and submitted to an accredited laboratory (Maxxam analytics; Bedford branch) to be analyzed for contaminants. A scientific collection permit from the Department of Fisheries and Oceans Canada (DFO) was obtained prior to lobster collections (refer to the appendix). To acquire a broad dataset, we collected three different age classes, categorized as juveniles[1] (Carapace Length (CL) 15-35mm), subadults (CL 55-70mm), and adults (CL < 70mm). We collected adults (n=20), subadults (n=10), and juveniles (n=30) from each site: Ballantynes Cove, Merigomish Big Island, and Pictou Road (Figure 21). These sites were selected based on their relative proximity to Boat Harbour and the risk of exposure should any contaminated sediment be

[1] Note: juvenile sex could not be determined due to the early life stage

released: Ballantynes (unlikely), Merigomish (possible), and Pictou Road (likely). Lobsters were either collected in traps retrieved by boats (adults and sub-adults) in late June or by SCUBA (juveniles) in late August/early September. Upon collection, lobsters were placed in a cooler and immediately transported to Maxxam analytics and submitted for analysis. Maxxam analytics was selected based on their quick response to a quote request and their willingness to collaborate [2].

Analysis

Maxxam analytics

The contaminants analyzed included heavy metals, MeHg, PAHs, and PCDD/Fs. Lobsters were dissected and the hepatopancreas was removed from the body. The whole-body tissues (excluding the carapace and hepatopancreas) of lobsters were analyzed for metals and MeHg. Due to small sample sizes, juvenile whole-body tissue samples had to be pooled to meet the minimum requirements for analysis (metals 2.5g; methylmercury 5g). The lobster hepatopancreas tissues were analyzed for PCDD/Fs, in either individual samples (adults) or pooled samples (subadults and juveniles) to meet the minimum analysis requirements (10 g). The leftover hepatopancreas samples were then submitted for PAH analyses, and all samples had to be pooled by site to reach the minimum analysis requirement (5 g). There were no remaining tissues leftover to submit for PAH analysis for subadults from Ballantynes and adults from Merigomish. Although PAHs were not identified as a concern in Boat Harbour sediments, they were included in the analyses to establish a broad baseline of contaminant concentrations. Please

[2] Note: by the time AGAT had responded to the quote request, lobster collection had already commenced. Upon discovering that AGAT Laboratories Ltd. had an existing partnership with NS Lands and offered a considerably lower price for analyses, it was determined that future studies should utilize AGAT's services.

refer to the detailed flow chart in the appendix that displays the various sample sizes and types of analyses completed (Figure 20).

Statistical analysis

A one-way ANOVA, two-way ANOVA, and Tukey's HSD test were performed to determine if a significant difference existed in contaminant concentrations between age groups (adults and subadults) and among sites. No statistical tests were performed for pooled tissue samples (Figure 20). Samples that reported no detection (ND) were replaced with half the detection limit (DL) of that contaminant (Table 4). This provides a conservative estimate of contaminant levels in lobster tissues.

Results and Discussion

Guidelines

To put our findings into context, we compared the lobster contaminant results to guideline values provided by the Canadian Food Inspection Agency (CFIA), the U.S Agency for Toxic Substances and Disease Registry (ATSDR), the U.S Food and Drug Administration (FDA), and the U.S Environmental Protection Agency (EPA) to help establish whether any contaminants exceeded safety levels. Clear conclusions in this regard are hampered by the heterogeneity in guideline levels available for different contaminants. In addition, few guidelines are directly applicable to contaminants in lobster tissues. In particular, we could not find guideline values for many metals detected in our lobster samples, including boron, cadmium, chromium, iron, selenium, strontium, and zinc. As such, we compared our results to similar studies of contaminant loads in lobsters, including Hall et al. (1978), U.S ATSDR (2003), U.S FDA (2017), Walker et al. (2013a), Stewart et al. (2019). Although there are several elements of these surveys that differ from our survey (location, study animal, and tissues analyzed), these were the best options available for providing context for our own measurements.

Metal(loid)s

<u>Metals not detected</u>

Several metals were not detected in any lobster sample at any site, including antimony, barium, beryllium, cobalt, lead, lithium, molybdenum, nickel, thallium, tin, uranium, and vanadium.

<u>Aluminum</u>

Our results show a reverse bioaccumulation pattern in the lobster age groups, with the average aluminum concentration decreasing as lobsters mature (Figure 1). Subadults had slightly higher aluminum concentrations than adults at all sites. There was no evidence of a significant difference (.338) in aluminum levels between age class (Table 8). The low aluminum average in adults from Merigomish was likely a result of there being a single aluminum detection out of the 19 samples (Table 1). Concentrations in juvenile pooled tissue samples were considerably higher than adult and sub-adult samples at all sites. It is unknown why this would be the case, as juveniles are more likely to contain the lowest concentration of metals because they have not had as long to accumulate contaminants. By pooling tissues, we lost information regarding the variability between individuals, therefore a single outlier could be driving the elevated levels. It is also possible that immature lobsters have considerably higher levels of aluminum because of the high frequency of molting (Campbell, 1983; Comeau and Savoie, 2001). It has been shown that some metals (cadmium, copper, zinc, and lead) can accumulate in the carapace of lobsters, and although aluminum was not tested for, it is possible it is also deposited in the carapace (Canli and Furness, 1993). The shed exoskeleton is regularly consumed by juveniles and has been shown to be a beneficial nutrient source that increases survival (Castell et al., 1975). The increased frequency of exoskeleton consumption may be driving the increased levels of aluminum in juvenile tissues (Canli and Furness, 1993). Accordingly, mature lobsters would have lower concentrations of certain metals. Overall, there is very little data on aluminum levels in marine biota tissues or in the environment in Atlantic Canada, which makes it difficult to speculate why levels detected in juveniles are so high.

There was evidence (.031) that lobsters from Ballantynes had significantly higher levels than those from Merigomish and Pictou Road, however there was no evidence (.095) of a significant difference of aluminum levels in adults between sites (Table 8). Although no statistical tests were performed for juvenile samples, it is clear that aluminum levels in juveniles from Ballantynes were considerably higher than those at Merigomish and Pictou Road. It is unknown why aluminum levels in juveniles from Ballantynes would be high. It is possible aluminum-rich sediments are suspended from the deep boundary off of Nova Scotia are deposited at higher rates at Ballantynes than at Merigomish and Pictou Road (Moran and Moore, 1991). As lobsters are benthic invertebrates, it is possible they are exposed to aluminum-rich sediments. In addition, if there is a region with particularly high levels of aluminum in the sediment, juveniles would have increased exposure due to their shelter-restricted behaviour.

The average aluminum level for all samples exceeded the U.S Agency for Toxic Substances and Disease Registry (U.S ATSDR) intermediate-duration oral exposure (1 ppm/day) (U.S ATSDR, 2008). Adults and subadults only minimally exceeded this guideline level. This guideline is the estimated daily exposure to humans that is not likely to cause adverse effects. To further assess the degree of contamination in our lobster samples, our results were compared to those from the National Marine Fisheries Service study conducted in Puerto Rico (U.S ATSDR, 2003). It should be noted that this survey is not an ideal comparison, as the levels reported in this survey are not a government-issued guideline levels and the location and the shellfish species sampled were different. However, there is little data on aluminum concentrations in lobster tissues from Atlantic Canada. Thus, any reference guideline is useful in understanding the degree of contamination in our lobster samples. This survey assessed metal concentrations in shellfish including spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*), which were reported to be safe for public consumption. All aluminum levels in our lobster samples were below the highest reported level (43.9 ppm) in the ATSDR survey and most were below the average aluminum level (15.5 ppm), with the exception of juveniles from Ballantynes. All juveniles exceeded the lowest reported level (3.2 ppm), as well as adults and subadults from Ballantynes, although only minimally.

Overall, aluminum levels in our adult and subadult lobster samples seem to be typical as they only minimally exceed the U.S ATSDR oral MRL guideline level and are similar to what was reported in the ATSDR survey. The elevated aluminum levels in juveniles are not necessarily a concern, as they are not commercial-grade lobsters. Further, it is possible early life-stage lobsters naturally have higher levels which decrease as they mature. Research is needed to investigate this pattern.

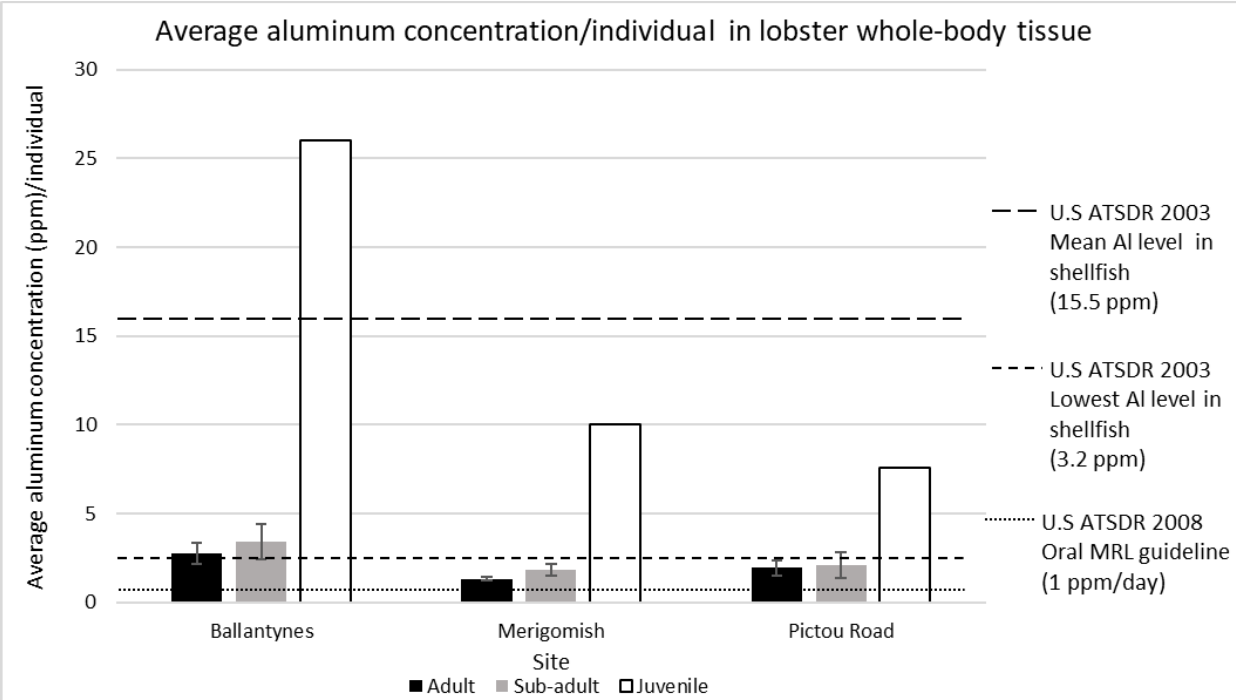

Figure 1. The average aluminum concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The U.S ATSDR (2008) guideline (1 ppm/day) is the minimal risk level (MRL) at which, if exposed to aluminum orally, will likely not have adverse effects over an intermediate-duration (15-364 days). The U.S ATSDR (2003) survey reported a range of 3.2-43.9 ppm (highest level not displayed on graph) with an average 15.5 ppm aluminum level in shellfish: spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*) collected from Puerto Rico coastal waters. Error bars represent standard error.

Arsenic

Only at Ballantynes was a typical bioaccumulation pattern observed, where adults contained the highest arsenic load and juveniles contained the lowest (Figure 2). This was not as clear at Merigomish and Pictou Road, where subadults had higher levels than adults and juveniles. Juveniles had the lowest concentrations among all sites. There was no evidence (.187) of a significant difference in arsenic levels between adults and subadults (Table 8). There was evidence (.000) that arsenic levels in adults from Ballantynes was significantly higher than adults from Merigomish and Pictou Road (Table 8). This was unexpected as there is minimal industrial activity in that area and contaminants should theoretically be at low levels.

The arsenic levels in all lobster samples from all sites exceeded the CFIA action level (3.5 ppm) which is the guideline value above which fish products will be rejected for Canadian commercial use (CFIA, 2012). Please note that this action level is based on contaminant levels in muscle tissue, excluding organ meats (CFIA, 2012). The metal analysis for our lobster samples included the whole-body of the lobster (except the hepatopancreas and the carapace), thus our results are likely an overestimate of what lobster tissues would be consumed by the public. In addition, the arsenic action level is the maximum level permitted in fish protein, which may differ from lobster tissue in terms of accumulation rates and transfer rates into consumers. The CFIA has confirmed that lobster is included under this category (Peter Barrett, personal communication, 2019-02-20), however more specific guidelines for lobster tissues should be explored. Note there were no recommended CCME guideline values for arsenic levels in biota tissue due to a lack of data (CCME, 1998).

The high levels of arsenic are not surprising, as an arsenic range of 2-42 ppm has been reported in Nova Scotia coastal sediments, some of which have exceeded the sediment background guideline level of 20 ppm (Loring et al. 1996 as cited in (Stewart et al., 2019). Nova Scotia bedrock formations are a natural sources which likely contribute to elevated levels of arsenic (Stewart et al., 2019). The elevated arsenic levels could also be explained by the release of arsenic-containing tailings into the environment from gold mine operations in the early 1900’s (Walker et al., 2009). Although these gold mines were predominantly located along the southern shore of Nova Scotia (DNR, 2013), it is possible for arsenic-containing sediment to be suspended and deposited in other coastal regions.

Our results were also similar to the range of arsenic detected in lobster from other studies. A National Marine Fisheries Service study that analyzed trace metals in American lobster (*Homarus americanus*) claw and tail tissues from U.S coastal waters reported a range of 20-30 ppm (Hall et al., 1978). All of our samples contained levels below this range, which is particularly promising as our analysis included a larger variety of tissues and organs, thus a higher concentration might be expected. Another study looking at contaminant loads in rock crabs, *Cancer irroratus* (*C.irroratus*), from Sydney Harbour, NS, determined a range of 3.6-15.3 ppm in the hepatopancreas tissues (Walker et al., 2013). None of our samples exceeded the highest reported value (15.3 ppm) in the Walker study, but all samples were found to exceed the lowest reported value (3.6 ppm). The range of arsenic levels in Walker's study was determined to be relatively low compared to other crab and lobster hepatopancreas tissues in eastern Canada (Ernest et al. 1999; Sirota et al. 1984, as cited in Walker et al. (2013a)), thus, our results can also be considered to be relatively low. However, we are comparing arsenic levels in lobster tissue (not including the hepatopancreas) to those in crab hepatopancreas tissue. The hepatopancreas typically has higher levels of contaminants than in other tissues in both crabs and lobsters (Chou et al., 2000; Walker et al., 2013a). In addition, different species are likely to have different accumulation rates of trace metals. These are important to take into account when making this comparison and it would be more informative to compare to other levels detected in lobster tissue from Atlantic Canada. Stewart et al. (2019) reported an arsenic range of 8.71-16.20 ppm (wet weight) detected in *Homarus americanus* hepatopancreas tissues from coastal areas along Nova Scotia. We report similar ranges in the adult and sub-adult lobsters from all sites.

Despite the exceedances of the CFIA action level, the arsenic levels detected in our lobster samples appear to be typical of what would be found from coastal Nova Scotia.

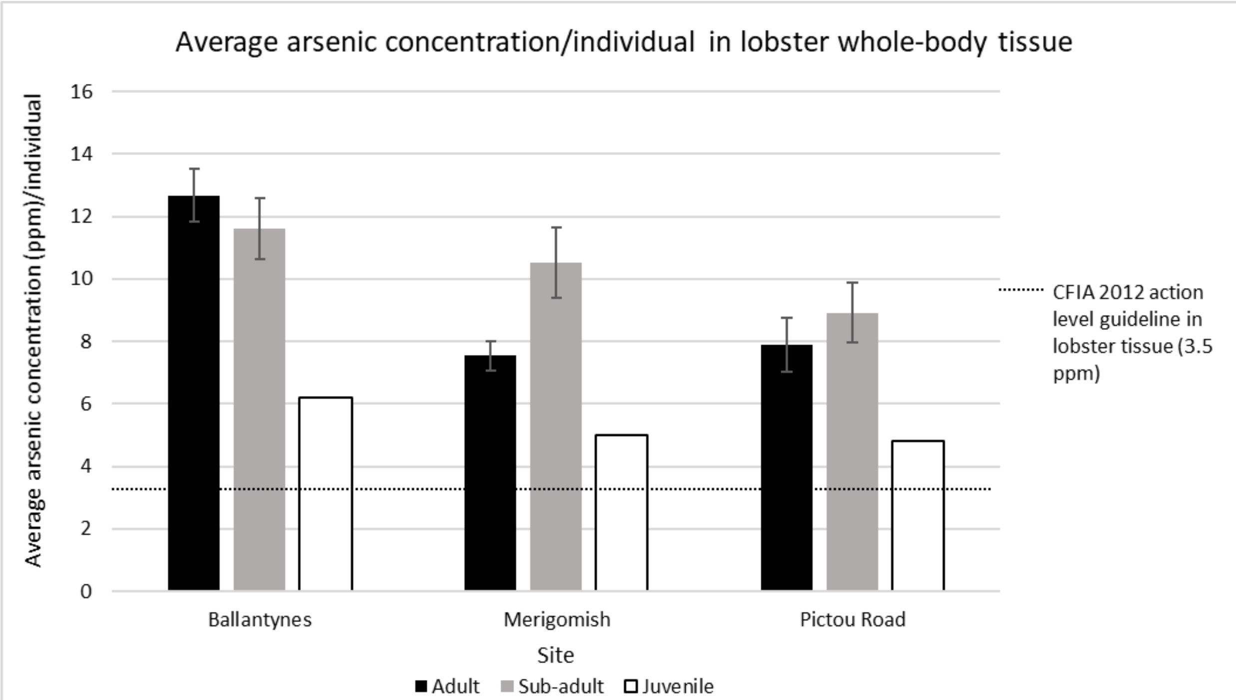

Figure 2. The average arsenic concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Fish products that exceed the Canadian Food Inspection Agency (CFIA) action level guideline (3.5 ppm) will be rejected from Canadian commercial use. Error bars represent standard error.

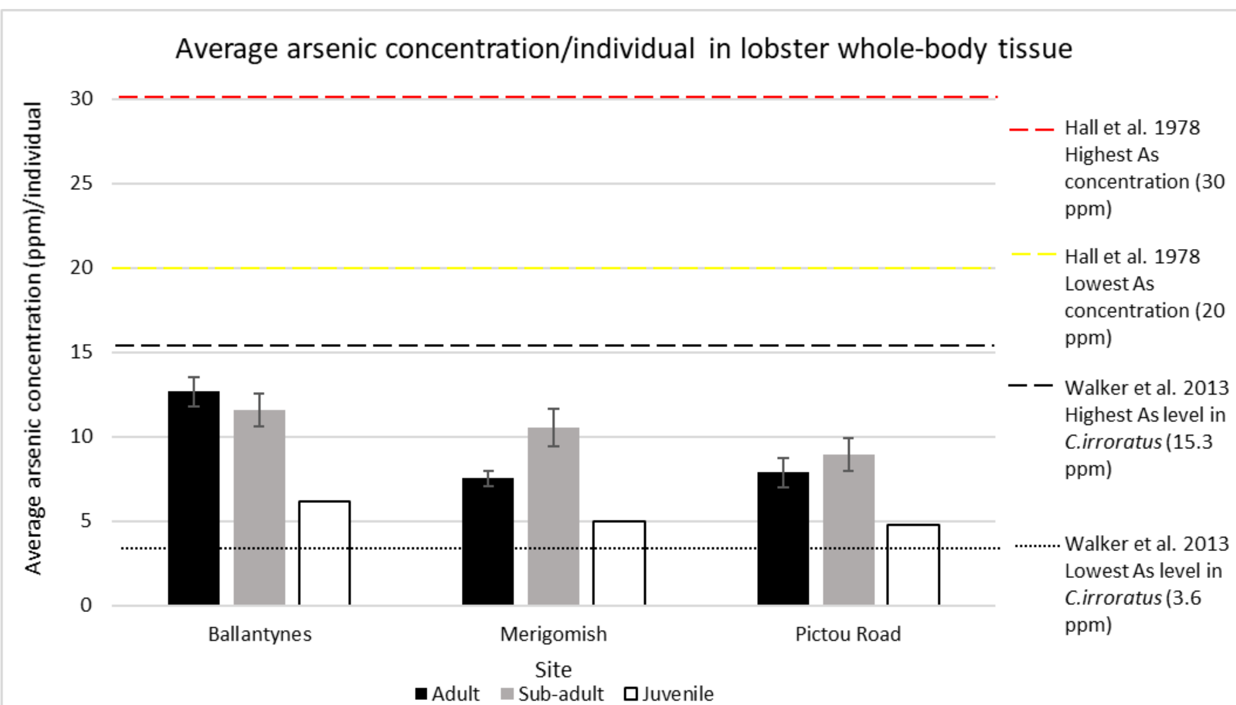

Figure 3. The average arsenic concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Hall et al. (1978) survey

reported a range of 20-30 ppm in *H.americanus* claw and tail tissues from U.S coastal regions. Walker et al. (2013a) reported a range of 3.6-15.3 ppm in crab hepatopancreas tissue collected from Sydney Harbour, NS. Error bars represent standard error.

Boron

Boron concentrations were only detected in adult and sub-adult samples from Ballantynes and Merigomish and in adults from Pictou Road (Figure 4). There was evidence (.000) that boron levels in subadults were significantly higher than those in adults (Table 8). It was unexpected that subadults would have higher levels than adults, as adults have had more time to accumulate. There was evidence (.000) that adults and subadults from Merigomish had significantly higher levels and that adults from Merigomish were significantly (.009) higher than at Ballantynes or Pictou Road (Table 8). There were no guideline levels identified for boron, thus the degree of contamination in our samples cannot be established. There is a general lack of data available regarding boron concentrations in biota tissues, however it is not a typically regarded as a contaminant of concern.

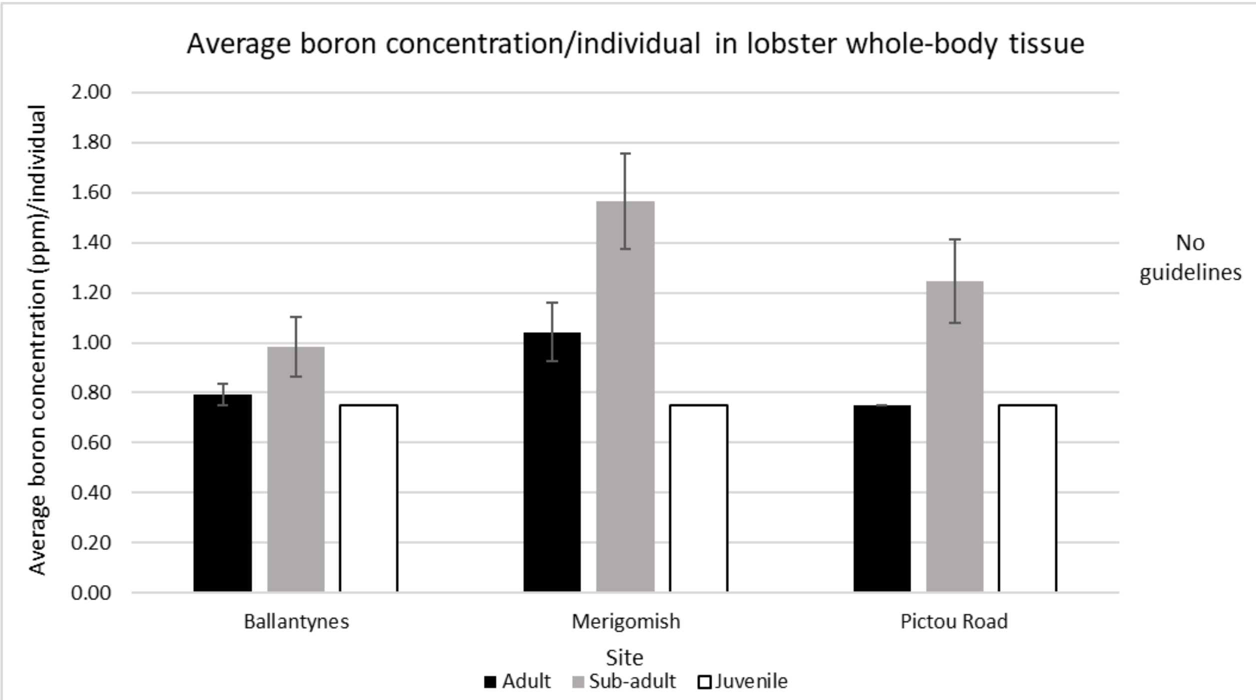

Figure 4. The average boron concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Error bars represent standard error.

Cadmium

A bioaccumulation pattern was apparent among all sites, with the lowest cadmium levels in juveniles and the highest detected in adults. There was no evidence that a significant difference in cadmium levels existed between ages (.299) or among sites (.105) (Table 8). There was no detection of cadmium in any juvenile lobster sample.

There were surprisingly few resources regarding guideline levels for cadmium in biota tissues. The Canadian Council of Ministers of the Environment (CCME) had no Tissue Residue Quality Guidelines levels for cadmium in biota tissues (CCME, 1997). Further, there was no CFIA action level for cadmium. To determine how typical our results were, studies were instead used as a reference guideline. Walker et al. (2013) reported a cadmium range of 0.5-6.9 ppm detected *C.irroratus* hepatopancreas tissues from Sydney Harbour, NS. All cadmium concentrations in our lobster samples were found to be below this range. The average cadmium level in all lobster samples were found to be below the range (0.2-0.3 ppm) reported by Hall et al. (1978), that was detected in *H.americanus* claw and tail tissues from U.S coastal waters. The National Marine Fisheries Service study conducted in Puerto Rico reported a similar range of 0.2-0.69 ppm in shellfish tissues (refer to aluminum results section) that was elevated compared to our findings (U.S ATSDR, 2003). Stewart et al. (2019) reviewed numerous studies reporting cadmium concentrations from various inlets in Nova Scotia that ranged from 0.04-1.31 ppm. The cadmium concentrations in our results are consistently lower than those reported in reference studies and are therefore not a concern.

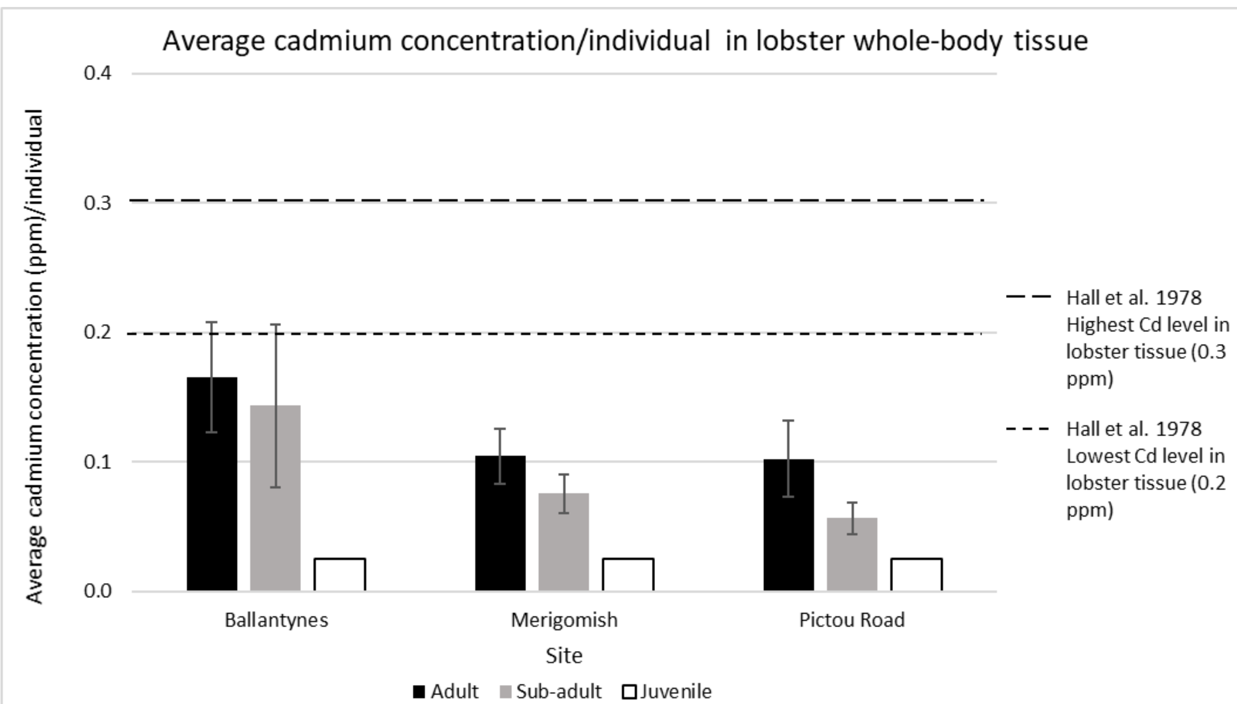

Figure 5. The average cadmium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.2-0.3 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. Error bars represent standard error.

<u>Chromium</u>

There was a single detection of chromium in an adult lobster sample from Ballantynes (Table 1). There was no evidence of a significant difference in age (.489) or among sites (.618) (Table 8). There were no regulatory guideline values for chromium concentration in aquatic biota tissues. The chromium level in our study is similar to the chromium range (0.1-0.2 ppm) reported by Hall et al. (1978) in *H.americanus* claw and tail tissues from U.S coastal waters. Our results are also similar to the range reported by the National Marine Fisheries Service study that found 0.076-1.29 ppm in shellfish tissues from Puerto Rico (refer to the aluminum results section) (U.S ATSDR, 2003). The low frequency of detection of chromium in our lobster samples and the similar levels to the reference studies indicates that chromium is not of concern.

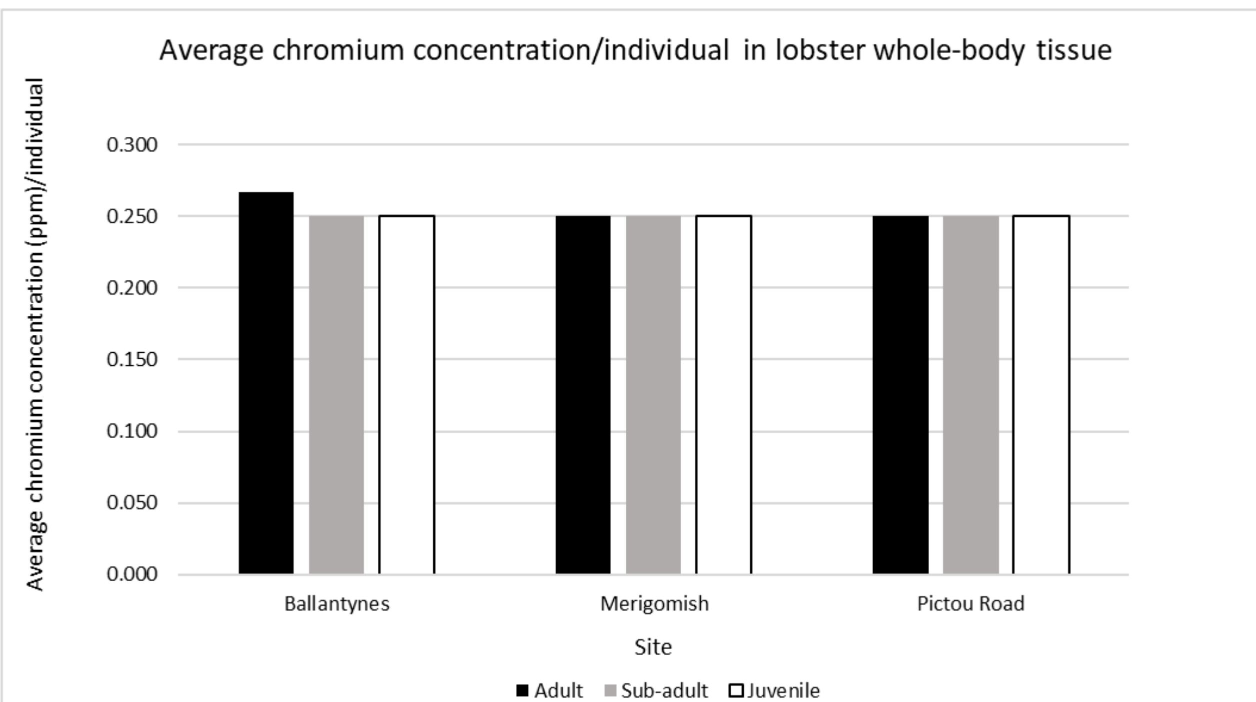

Figure 6. The average chromium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.1-0.2 ppm (not displayed) in *H.americanus* claw and tail tissues from U.S coastal waters. The range (0.076-1.29 ppm) detected in shellfish (spiny lobster (*Panulirus argus*)

and the blue land crab (*Cardisoma guanhumi*)) claw and tail tissues collected from Puerto Rico coastal waters is not displayed on the graph. Error bars represent standard error.

<u>Copper</u>

The bioaccumulation pattern was apparent in lobster ages at all sites (Figure 7). There was no evidence (.073) that a significant difference in copper levels existed between adults and subadults (Table 8). Lobsters from Ballantynes were found to have significantly lower levels of copper than lobsters from Merigomish or Pictou Road. There was evidence (.017) that copper levels in adults from Ballantynes were significantly lower than those from Merigomish and Pictou Road.

There were no regulatory guideline levels identified for copper in aquatic biota tissues. The average copper concentrations in all of our lobster samples, except for juveniles at Ballantynes, were found to be within the range (10-20 ppm) reported by Hall et al. (1978), who analyzed claw and tail tissues from *H.americanus* collected from U.S coastal waters. The copper concentration in juveniles from Ballantynes was slightly below this range. Most of the average copper concentrations in our lobster samples were within the range (1.35-17.6 ppm) detected in shellfish from Puerto Rico (refer to the aluminum results section) in the National Marine Fisheries Service study (U.S ATSDR, 2003). Walker et al. (2013a) analyzed *C.irroratus* hepatopancreas tissues from Sydney Harbour, NS, and found a copper concentration range of 9.8-28 ppm. Our results are similar to the ranges detected in the reference studies and indicate that the copper levels in our lobsters are not of concern.

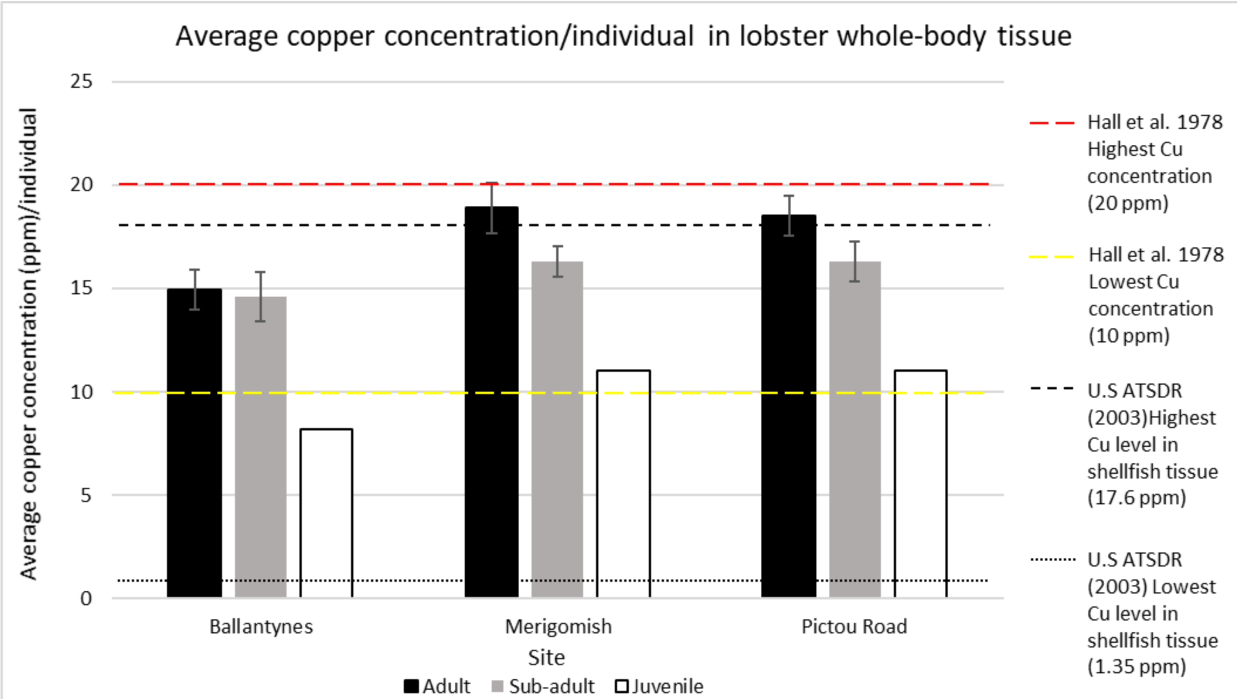

Figure 7. The average copper concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 10-20 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 1.35-17.6 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Error bars represent standard error.

Iron

A reverse bioaccumulation effect was observed with iron concentrations in lobsters at all sites (Figure 8). Iron was detected in juveniles at all sites and only in adults and subadults from Ballantynes, where juveniles had considerably higher levels. This was an unexpected finding, as mature lobsters are more likely to have accumulated higher concentrations of metals, while juveniles have not had as long to accumulate. It is possible that a few outliers are driving the elevated levels, however, because juvenile tissues were pooled for analysis it is impossible to know individual variation. It would be interesting to investigate the iron uptake and accumulation rates during the different life stages of lobsters in the future. Another unexpected finding was that juveniles from Ballantynes contained the highest levels of iron, while juveniles from Pictou Road contained the lowest. Pictou Road is known to have high anthropogenic and industrial activity in the area, while Ballantynes is less impacted by these activities. There was no evidence of a significant difference (.407) of iron levels between adults and subadults (Table 8). There was evidence (.011) that lobsters from Ballantynes were significantly higher than those from Merigomish and Pictou Road. Further, there was evidence (.005) adults from Ballantynes were significantly higher those from Merigomish and Pictou Road

It was challenging to determine if iron levels in our lobster samples were of concern, due to the lack of regulatory guideline levels and reference studies that looked at iron levels in aquatic biota tissues. The one study that analyzed for iron was the National Marine Fisheries Service study, that reported a range of 1.62-162 ppm detected in shellfish from Puerto Rico (refer to the aluminum results section) (U.S ATSDR, 2003). This is a very broad range of iron concentrations, that our results fall within, and suggest that there is high variability of iron concentrations in shellfish. Regardless, the reverse bioaccumulation pattern observed in our results show a decrease of iron concentration in adult tissues that would be consumed by the public; therefore, it is not likely to be of concern.

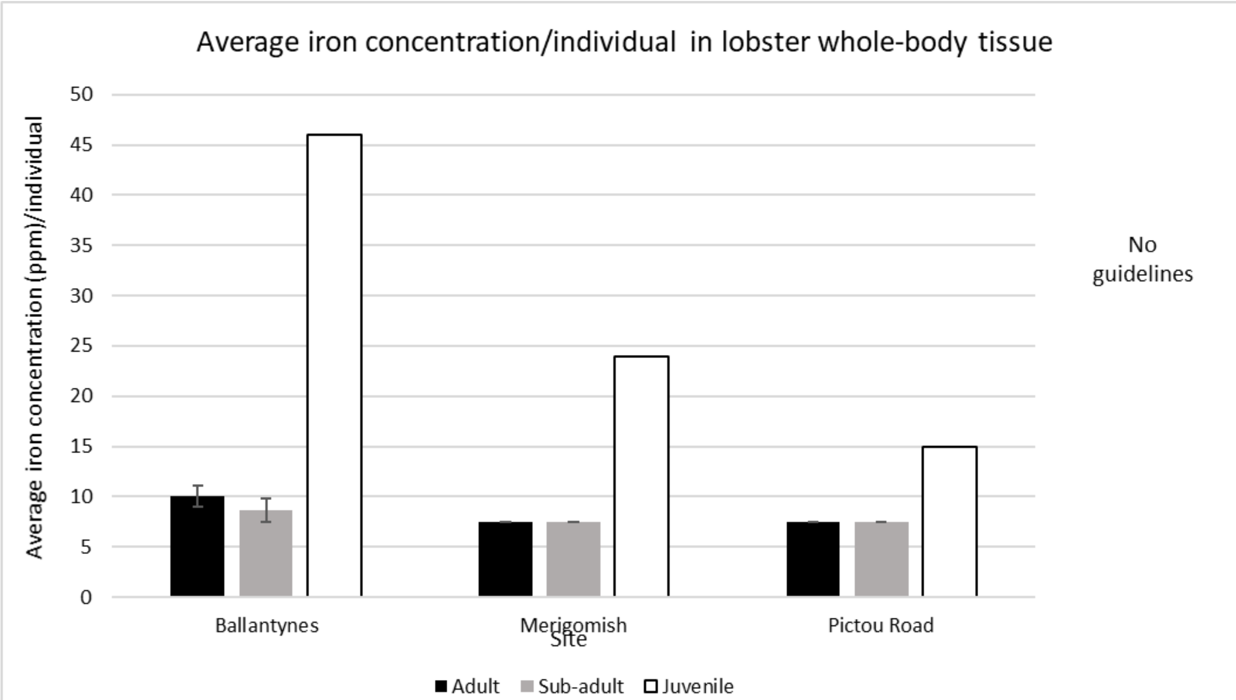

Figure 8. The average copper concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The range of iron concentration (1.62-162 ppm) that was detected in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) from Puerto Rico coastal waters is not displayed on this graph. Error bars represent standard error.

<u>Manganese</u>

There was a reverse bioaccumulation pattern observed in the lobster age groups at each site, where the average manganese concentration decreases as lobsters mature (Figure 9). This was unexpected, as mature lobsters have had more time to accumulate metals and therefore are expected to have higher levels than juveniles. It is possible that a few outliers are driving the elevated levels, however, because juvenile tissues were pooled for analysis it is impossible to know individual variation. There was evidence (.015) that subadults had significantly higher levels of manganese than adults (Table 8). Among adults, there was evidence (.001) that manganese concentrations from Pictou Road were significantly higher than those from

Merigomish (Table 8). Juveniles from Merigomish contained the highest levels of manganese, while juveniles from Ballantynes contain the lowest.

No regulatory guideline levels regarding manganese concentrations were identified. Hall et al. (1978) reported a range of 0.5-0.6 ppm in the claw and tail tissues of *H.americanus*, which most of the average concentrations in our lobster samples exceeded. However, manganese levels in adults and subadults were found to be within the range (0.16-5.06 ppm) detected in shellfish tissue from Puerto Rico (refer to the aluminum results section) reported in the National Marine Fisheries Service study (U.S ATSDR, 2003). Manganese levels in all juvenile samples exceeded this range, however only minimally at Ballantynes. Although there are elevated levels in juveniles, manganese levels in adult tissues seem to be typical of what is reported in other studies and it is not likely to be of concern.

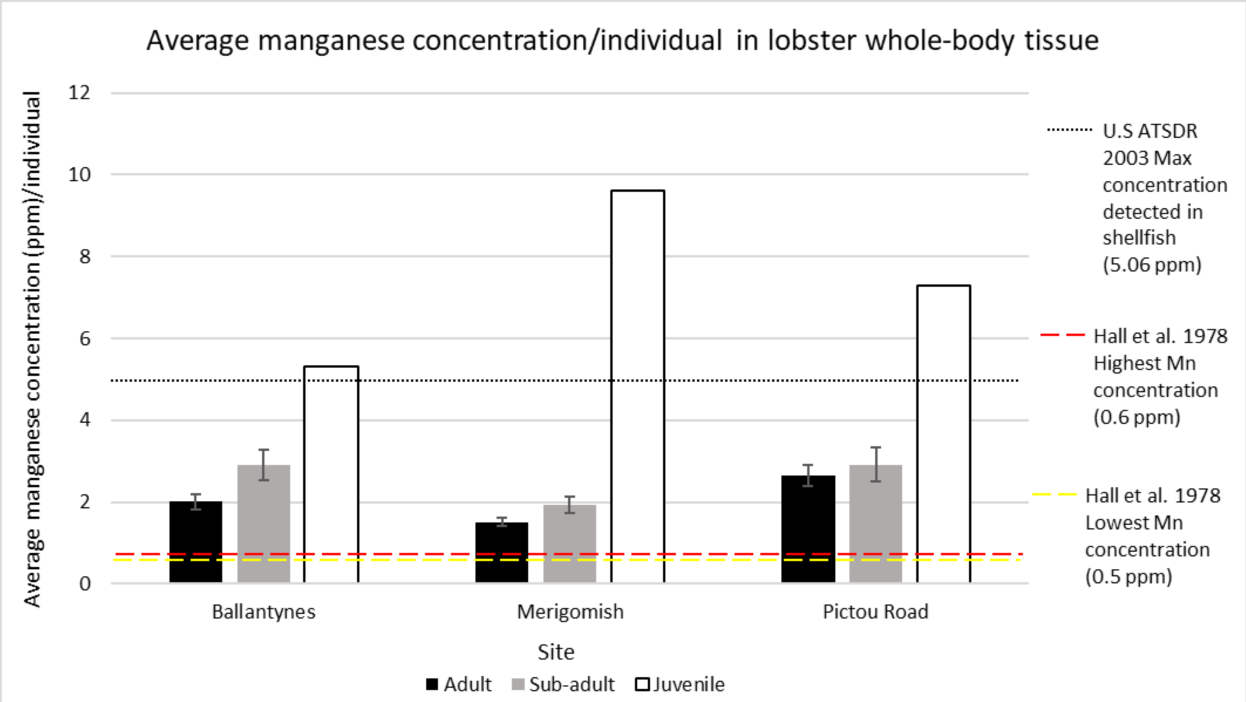

Figure 9. The average manganese concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.5-0.6 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 0.16 (not displayed on graph)-5.06 ppm in shellfish

(spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Error bars represent standard error.

Mercury

A bioaccumulation effect was observed with mercury levels at all sites, except for Ballantynes where subadults had slightly higher levels (Figure 10). As expected, juveniles had the lowest levels at all sites. There was no evidence of a significant difference (.320) in mercury levels between adults and subadults (Table 8). There was no evidence (.066) of a significant difference in mercury levels in both adult and subadult lobsters among sites, however there was evidence (.028) that mercury levels in adults from Pictou Road were significantly higher than those from Ballantynes and Merigomish (Table 8). Pictou Road is generally impacted by anthropogenic and industrial activity in the area, but was also the receiving waters of mercury-containing effluent from a former chlor-alkali plant (Canso Chemicals Ltd.) that was associated with the Northern pulp and paper mill (Government of Canada, 2010). Thus, higher levels of mercury at Pictou Road is expected.

The mercury levels in all lobster samples were considerably below the CFIA action level (0.5 ppm) that is permitted in fish products, above which it will be rejected from Canadian commercial use (CFIA, 2012). Our results are also all below the range (0.2-0.3 ppm) reported in the study conducted by Hall et al. (1978), where they tested for mercury concentration in claw and tail tissues from *H.americanus* collected from U.S coastal waters. The National Marine Fisheries Service survey reported a range of 0.018-0.049 ppm detected in shellfish tissues from Puerto Rico (refer to the aluminum results section) (U.S ATSDR, 2003). The mercury concentrations in our lobster samples mostly fell within this range with only a few exceedances in adults and sub-adults, although only minimally. Our results were also similar to the range

(<0.01-0.04 ppm) reported by Walker et al. (2013a) who analyzed *C.irroratus* hepatopancreas tissues from Sydney Harbour, NS. Stewart et al. (2019) reported that the mercury concentration detected in American lobsters in commercial markets typically have levels below 0.2 ppm, which is supported by our results. Overall, the mercury concentration in our lobster samples are below all known guideline levels and similar to the reported mercury range in biota tissue from other studies, thus, is not considered to be a contaminant of concern in lobster tissues.

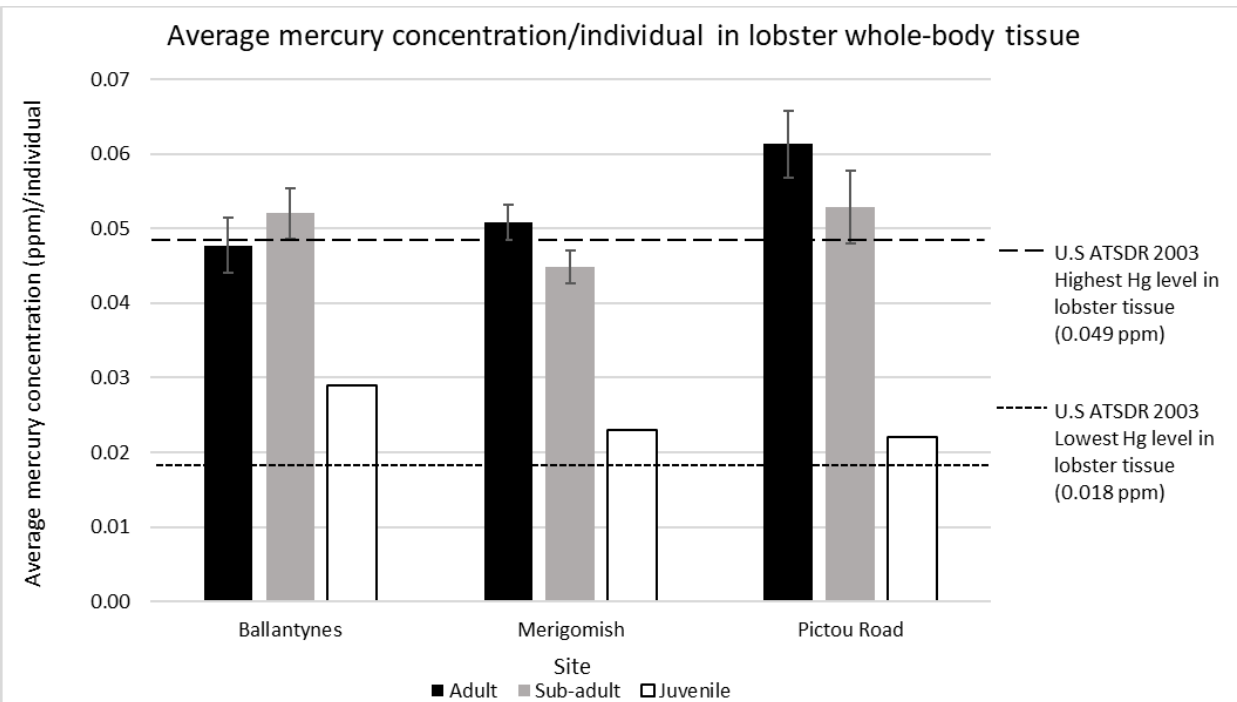

Figure 10. The average mercury concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Puerto Rico survey detected a range of 0.018-0.049 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. The Hall study reported a range of 0.2-0.3 ppm (not displayed on graph) in *H.americanus* claw and tail tissues from U.S coastal waters. Walker et al. (2013a) reported a range of <0.01-0.04 ppm (not displayed on graph) in *C.irroratus* tissues from Sydney Harbour, NS. Error bars represent standard error.

Selenium

Selenium was detected in all lobster ages at all sites; however, no bioaccumulation effect was observed (Figure 11). There was evidence (.000) that selenium levels in subadults were significantly higher than those in adults (Table 8). Concentrations in juveniles were similar to those in adults and sub-adults, and even exceeded the concentration in adults from Ballantynes, although only minimally. There was no evidence (.991) that suggested a significant difference in selenium levels among sites (Table 8). Selenium levels were fairly consistent across all sites.

There were no guideline levels identified for selenium concentrations in aquatic biota tissues. Compared to reference studies, the range of selenium in our lobster samples fell within the range (0.2-2.0 ppm) reported by Hall et al. (1978) who analyzed *H.americanus* claw and tail tissues from U.S coastal waters and also the range (0.43-1.16 ppm) reported by the National Marine Fisheries Service study who analyzed shellfish tissues (refer to the aluminum results section) from Puerto Rico (U.S ATSDR, 2003). After comparing the selenium levels in our lobster samples to the reference studies, it does not appear to be a contaminant of concern.

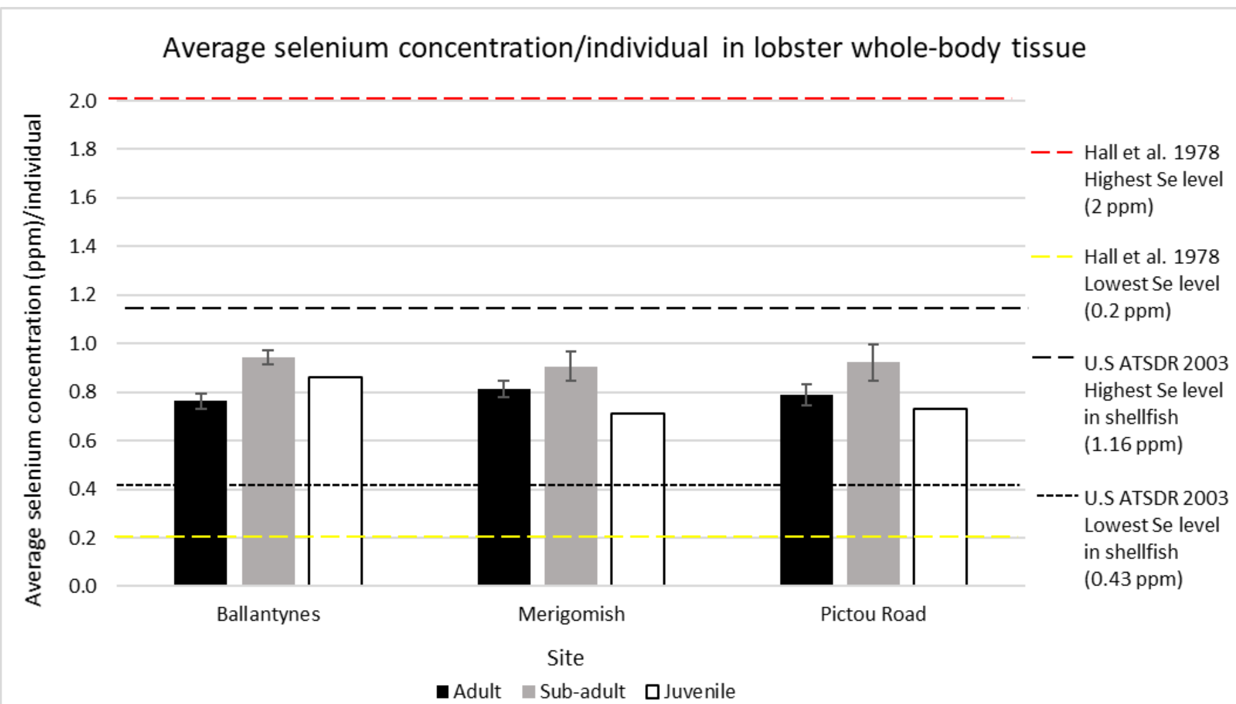

Figure 11. The average selenium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Puerto Rico survey detected a range of 0.43-1.16 ppm in shellfish (spiny lobster (*Panulirus argus*) and the

blue land crab (*Cardisoma guanhumi*)) tissues. The Hall study reported a range of 0.2-2.0 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. Error bars represent standard error.

Silver

A bioaccumulation effect with silver in lobster tissues was observed at all sites, although adults and subadults had similar levels from Ballantynes (Figure 12). There was evidence (.018) that silver levels in adults were significantly higher than subadults (Table 8). Juveniles had the lowest levels at all sites. There was evidence (.000) that silver levels in adults and subadults from Ballantynes were significantly lower than those from Merigomish and Pictou Road (Table 8).

There were no regulatory guideline levels identified for silver concentrations in aquatic biota tissues. Our results were instead compared to reference studies. Hall et al. (1978) reported a range of 0.4-0.5 ppm in *H.americanus* claw and tail tissues from U.S coastal waters, which was only slightly exceeded by levels in adults from Merigomish and Pictou Road. The National Marine Fisheries Service study reported a range of 0.07-0.19 ppm in shellfish tissues from Puerto Rico (refer to the aluminum results section) (U.S ATSDR, 2003). All levels in adults and subadults exceeded this range and silver levels in juveniles from Pictou Road minimally exceeded. Although the silver concentrations in some of our lobster samples exceeded the ranges reported in the reference studies, it was minimal. It would be beneficial to be able to refer to a regulatory guideline level to determine the actual degree of contamination, however, it does not appear that silver is a contaminant of concern in this case.

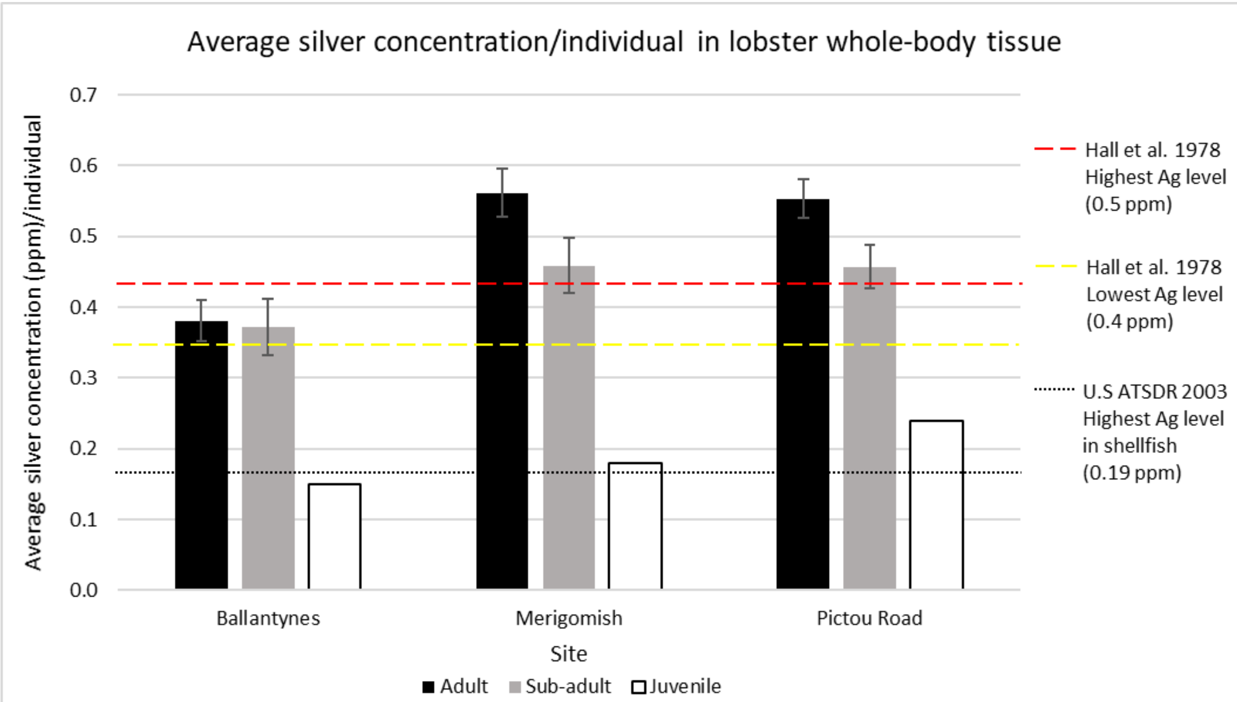

Figure 12. The average silver concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.4-0.5 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 0.07-0.19 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Error bars represent standard error.

Strontium

A reverse bioaccumulation effect was observed with strontium levels in lobster tissues at all sites, except for Pictou Road (Figure 13). Juveniles from Merigomish had the highest levels of strontium, followed by juveniles from Ballantynes. It is possible that a few outliers are driving the elevated levels in juveniles, but because juvenile tissues were pooled for analysis it is impossible to know individual variation. There was evidence (.001) that subadults had significantly higher levels of strontium than adults (Table 8). There was no evidence (.181) of a significant difference in strontium levels in lobsters among sites (Table 8). There were no regulatory guideline levels or reference studies identified that looked at strontium levels in aquatic biota tissues. Thus, it is unknown whether strontium is at concerning levels in lobster tissue, although it is not typically a contaminant of concern.

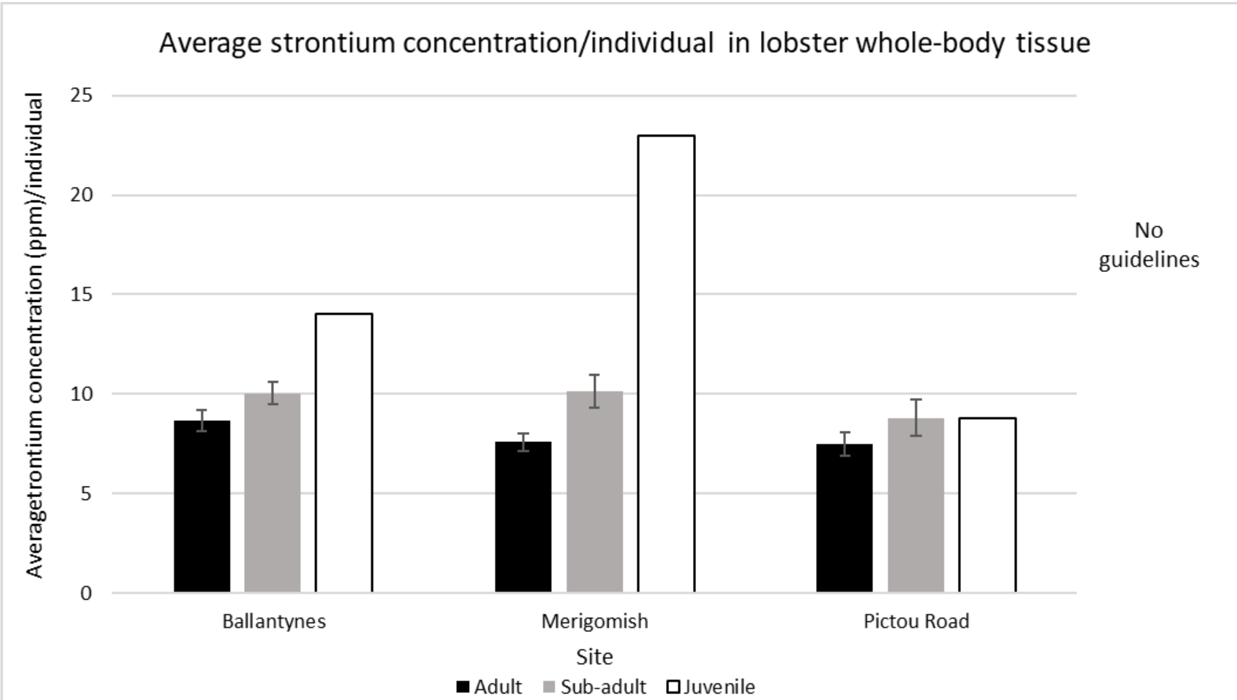

Figure 13. The average strontium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Error bars represent standard error.

<u>Zinc</u>

A bioaccumulation effect was observed with zinc levels in lobster tissues from all sites, where adults generally had higher levels and juveniles had the lowest, except at Ballantynes where subadults had slightly higher levels than adults (Figure 14). There was no evidence of a significant difference (.062) in zinc concentration between adults and subadults (Table 8). There was evidence (.000) that zinc levels in adults and subadults from Ballantynes were significantly lower than those from Pictou Road and Merigomish. Further, there was evidence (.000) that zinc levels adults from Ballantynes were significantly lower than those from Pictou Road and Merigomish.

The survey conducted by Hall et al. (1978) reported a zinc concentration range of 20-30 ppm in *H.americanus* claw and tail tissue from U.S coastal waters. Our results are similar to this range, with only adults from Merigomish and Pictou Road exceeding the upper limit. The National Marine Fisheries Service survey reported a zinc concentration range of 5.41-96.6 ppm in shellfish tissues (refer to the aluminum results section) from Puerto Rico (U.S ATSDR, 2003). All average zinc concentrations in our lobster samples were within this range and well below the upper limit. Our zinc levels were similar to what Walker et al. (2013a) reported in *C.irroratus* hepatopancreas tissues from Sydney Harbour, NS, ranging from 11.7-28.9 ppm. Overall, zinc concentrations in our lobster samples were similar to what was reported in the reference studies and are likely not of concern.

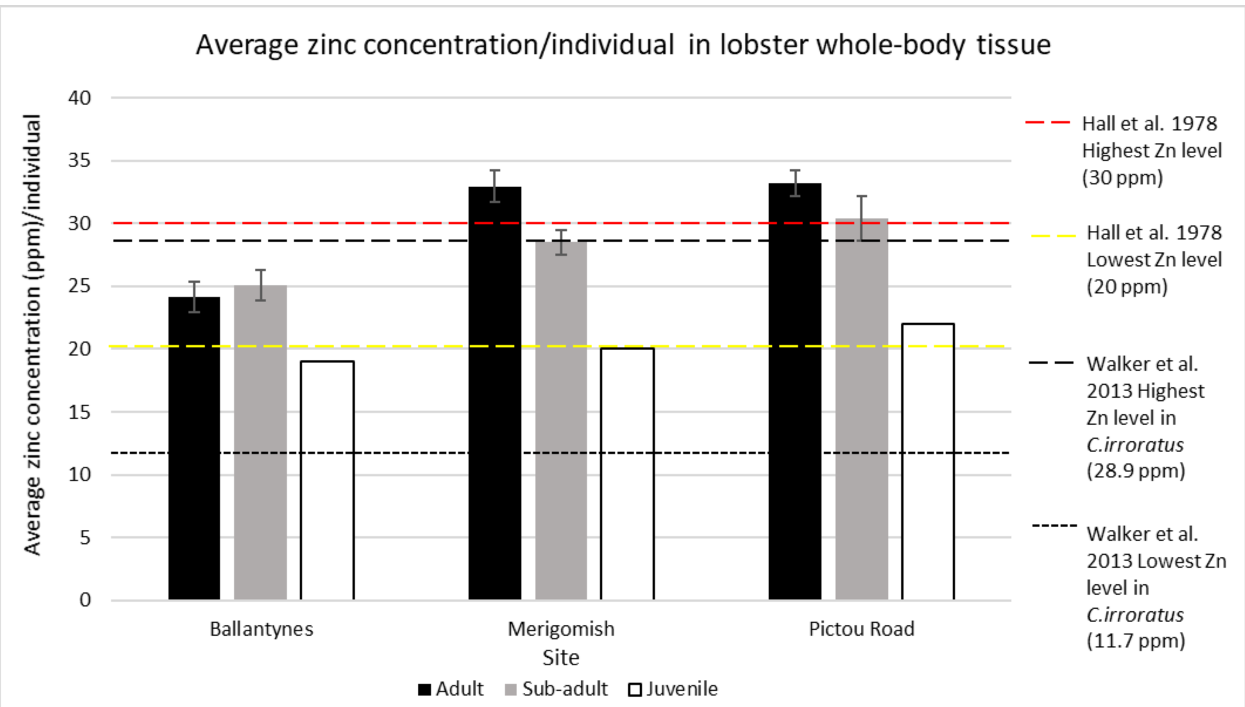

Figure 14. The average zinc concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 20-30 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 5.41-96.6 ppm (not displayed on graph) in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Walker et al. (2013a) reported zinc concentrations in *C.irroratus* from Sydney Harbour, NS, ranging from 11.7-28.9 ppm. Error bars represent standard error.

MeHg

A clear bioaccumulation pattern was only observed with lobsters from Ballantynes, where juveniles had the lowest MeHg levels and adults had the highest (Figure 15). At Merigomish and Pictou Road, the MeHg levels in juveniles were slightly higher than the sub-adult concentrations. This finding was not expected, as mature lobster age groups have had more time to accumulate and therefore should have higher levels. It is curious that levels in juveniles from Merigomish and Pictou Road are more elevated compared to Ballantynes and would be worth further investigation. There was evidence (.009) that adults contained significantly higher levels of MeHg than subadults (Table 8). There was no evidence (.829) of a significant difference of MeHg levels among sites (Table 8). However, there was a single outlier (0.221 ppm) in the adult samples from Pictou Road that was considerably higher than the average MeHg concentrations in the adult samples (Figure 16).

The MeHg concentrations for all lobster samples were below the CFIA action level (0.5 ppm) which is the guideline level for MeHg in fish muscle tissues, above which fish products (including lobsters) will be rejected from Canadian commercial use (CFIA, 2012). The average MeHg concentrations were also considerably below the CCME tissue residue quality guidelines (33 ppm) for the protection of the wildlife consumer of aquatic biota (CCME, 2000). The National Marine Fisheries Service study reported a single detection of 0.019 ppm in shellfish tissues (refer to the aluminum results section) from Puerto Rico (U.S ATSDR, 2003). This MeHg level is similar to our results, although the concentrations in adult samples and juveniles from Merigomish and Pictou Road are slightly higher. Our results show MeHg levels in lobster whole-body tissues, but it would be interesting to determine levels in hepatopancreas tissues. Overall, MeHg levels in our lobster tissues were well below the guideline levels and are not considered to be a concern.

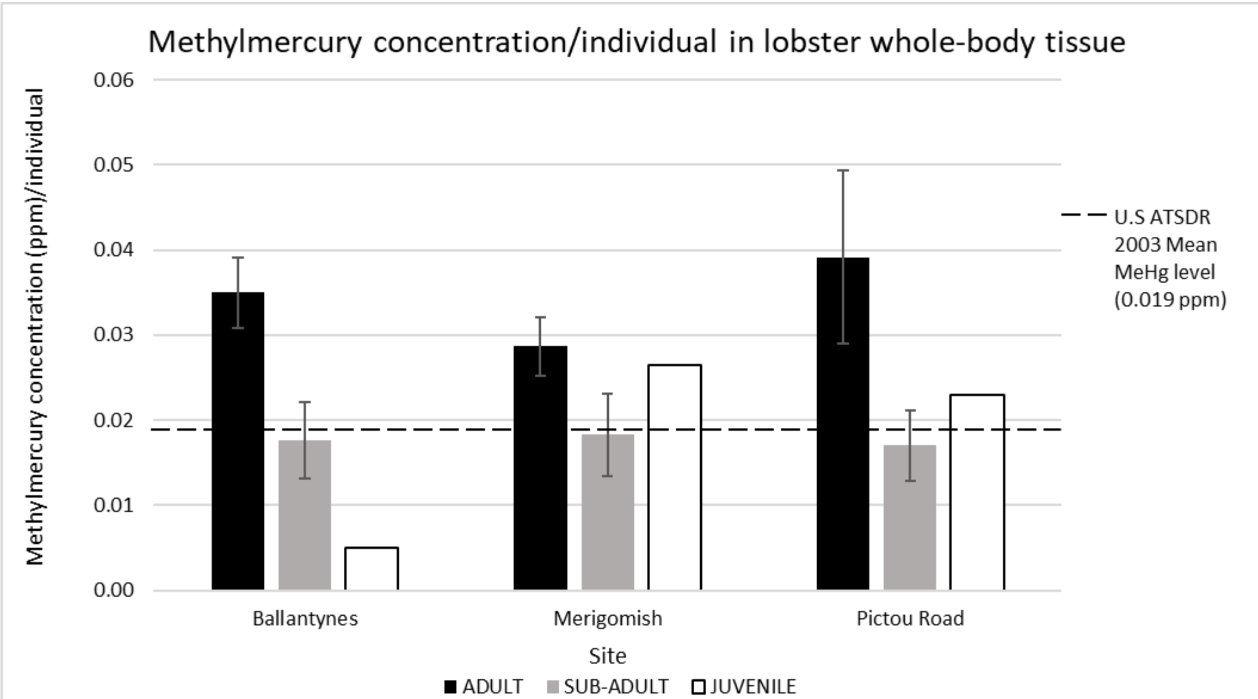

Figure 15. The average MeHg concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. U.S ATSDR (2003) reported an average MeHg level of 0.019 ppm. Error bars represent standard error.

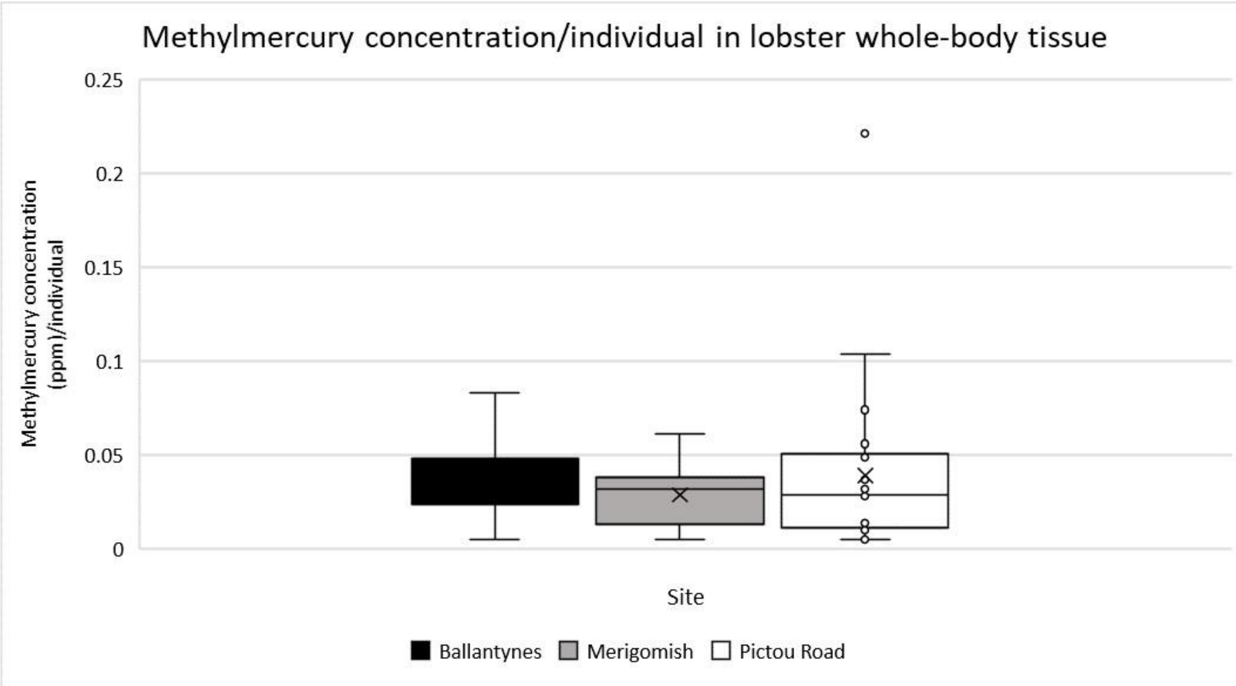

Figure 16. The average MeHg concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait.

PAHs

The only detection of PAHs was in adult hepatopancreas tissue samples from Pictou Road (Figure 17). Further, only two PAH congeners (pyrene and fluoranthene) were detected. Notably, the most potent and hazardous PAH congener (benzo[a]pyrene) was not detected in any of the samples. Fluoranthene levels were slightly higher than pyrene levels at Pictou Road. Please note that statistical analyses could not be performed because 1) there was low detection at all sites and 2) the samples were composed of pooled tissues that would violate the statistical test assumptions. There were no recommended fluoranthene or pyrene guideline levels for tissue residue quality guideline values for the protection of aquatic life (CCME, 1999). A study conducted by Walker et al. (2013a) determined the range of PAH concentrations (<0.05-0.14 ppm) in *C.irroratus* hepatopancreas tissues from Sydney Harbour, NS. The PAH concentrations in our lobster samples are within this range. Walker et al.'s (2013a) results were relatively low compared to other studies (Ernest et al. 1999; Sirota et al. 1984, as cited in Walker et al. (2013a)) conducted in eastern Canada. Thus, the levels detected in our lobster samples can also be considered low after comparison to reference studies.

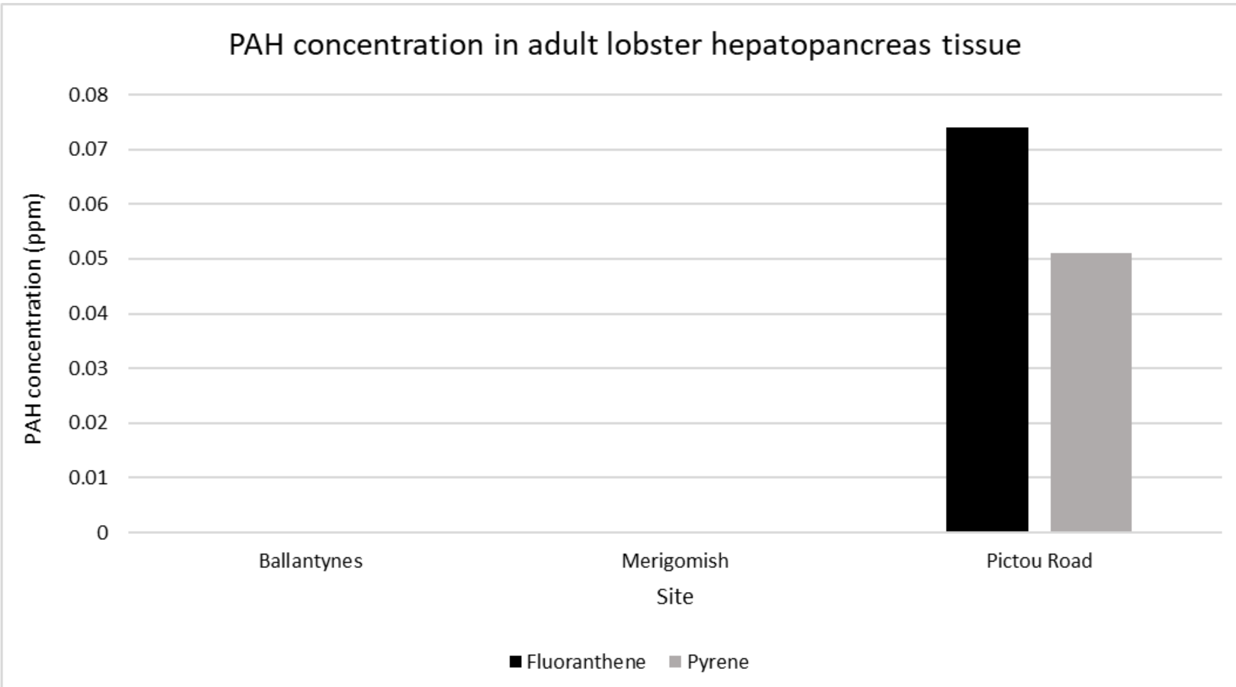

Figure 17. PAH concentrations in *H.americanus* hepatopancreas tissues collected from three sites in the Northumberland Strait. Note: there were no remaining tissues leftover to submit for PAH analysis for subadults from Ballantynes and adults from Merigomish.

PCDD/Fs

The PCDD/F concentrations in the lobster hepatopancreas tissue samples were measured by Maxxam analytics, after which they calculated the individual PCDD/F congener TEQ concentrations ($TEQ_{individual}$). The total TEQ concentrations (TEQ_{Total}) for PCDD congeners and PCDF congeners in each lobster sample were then calculated, averaged, and graphed. Adult and sub-adult PCDD/F concentrations were similar to each other at each site, whereas levels in juveniles were relatively lower (Figure 18 and 19). There was evidence that suggested both PCDD (.002) and PCDF (.005) levels in adult samples from Pictou Road were significantly higher than Ballantynes and Merigomish (Table 8). Higher PCDD/F concentrations at Pictou Road were expected, as several anthropogenic activities occur in this area and it is likely that adult lobsters have accumulated contaminants. Sub-adult and juvenile hepatopancreas tissues were both pooled prior to analysis, therefore statistical tests could not be performed. The PCDD/F TEQ_{Total} concentrations were also all below the CCME Canadian tissue residue guideline values (TEQ_{mammal}= 0.71 ppt; TEQ_{bird}= 4.75 ppt) for the protection of wildlife consumers of aquatic biota (CCME, 2000). The PCDD/F TEQ_{Total} concentrations in our lobster samples were also considerably below the CFIA action level (20 ppt) for 2,3,7,8- Tetra CDD which is the guideline level for fish protein, above which fish products (including lobster) are rejected from Canadian commercial use (CFIA, 2012). The PCDD/F congener 2,3,7,8- Tetra CDD is known to be the most potent and hazardous congener, thus it is promising our results are below this guideline value. Organic contaminants tend to have higher accumulation rates in lobster hepatopancreas tissues compared to the whole-body tissues (King and Chou, 2003). Therefore, the PCDD/F levels detected in our lobster samples represent the highest PCDD/F levels possible to consume. Overall, the lobster samples from all sites were below all guideline values and are not considered to be a concern.

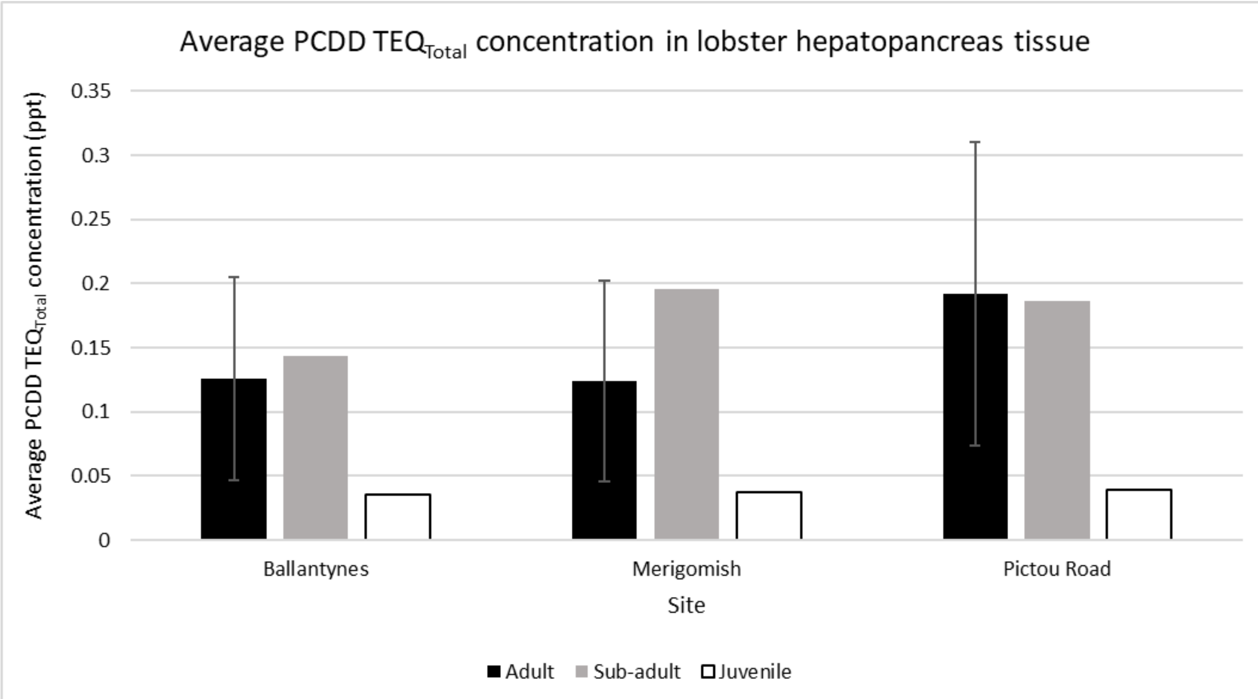

Figure 18. The average PCDD TEQ_{total} concentrations in *H.americanus* hepatopancreas tissues collected from three sites in the Northumberland Strait. Guidelines not displayed on graph: CCME TEQ_{mammal} (0.71 ppt) and TEQ_{bird} (4.75 ppt) (CCME, 2000), CFIA action level (20 ppt) for 2,3,7,8- Tetra CDD (CFIA, 2012). Error bars represent standard error.

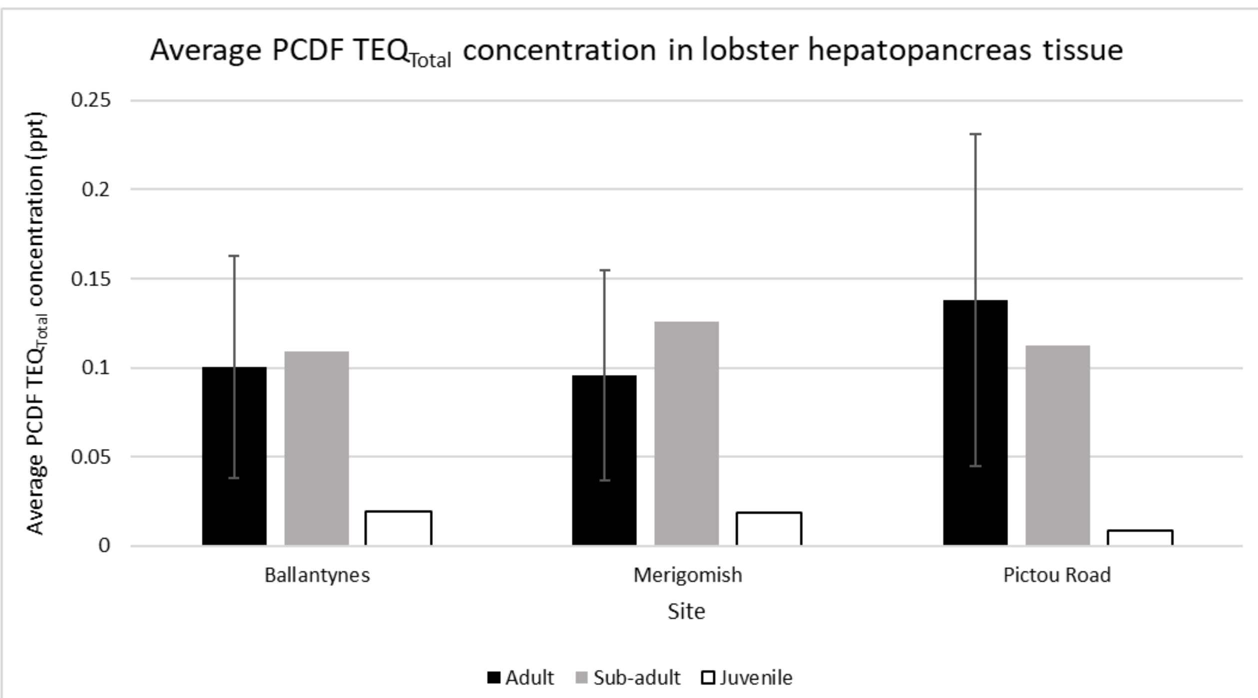

Figure 19. The average PCDF TEQ_{total} concentrations in *H.americanus* hepatopancreas tissues collected from three sites in the Northumberland Strait. Guidelines not displayed on graph:

CCME TEQ_{mammal} (0.71 ppt) and TEQ_{bird} (4.75 ppt) (CCME, 2000), CFIA action level (20 ppt) for 2,3,7,8- Tetra CDD (CFIA, 2012). Error bars represent standard error.

Discussion

This study's primary objective was to determine the contaminant concentrations in lobster tissues from various sites to serve as a baseline for the future remediation at Boat Harbour. This was completed for various metals and organic contaminants in different lobster age groups from three sites in the Northumberland Strait. We expected adults to accumulate higher levels of contaminants, as they have had a longer timeframe to accumulate, however this was not always the case. Notably, a reverse bioaccumulation effect was observed with juveniles that contained higher levels of aluminum, iron, manganese, and strontium than adults or sub-adults. It is unknown why this would be the case; however, it is possible these are normal levels in lobsters at this life stage. There is a lack of research regarding contaminant burdens in juvenile lobsters, likely because the small amounts of tissue make it difficult to analyze. The bioaccumulation effect, where mature lobsters contain higher levels of contaminants compared to the immature lobsters, was mostly observed with MeHg, PCDD/Fs, and possibly PAHs, but also with certain metals (arsenic at Ballantynes site, cadmium, copper, mercury, silver, and zinc). There was no one age group that was predominantly more contaminated; it varied depending on the contaminant. Several contaminants (boron, manganese, selenium, and strontium) were significantly higher in subadults than in adults. There was also no one site that was found to have higher contamination than the others; it varied depending on the contaminant. Pictou Road was expected to have higher levels of contaminants, but occasionally levels at Ballantynes and Merigomish exceeded those at Pictou Road. Contaminants were mostly below regulatory guideline levels and within the contaminant ranges reported by reference studies, with a few exceptions. Notably, arsenic concentrations from all sites exceeded the CFIA action level for fish tissues. However, arsenic levels are known to be generally elevated in Nova Scotia due to natural and anthropogenic sources.

In summary, we established a baseline for contaminant concentrations in lobster tissues that can be compared to future surveys during and after Boat Harbour remediation. We also determined the differences between the three lobster age groups, the differences between the three sites, and observed the bioaccumulation effect observed with several contaminants in lobsters. There is a considerate lack of data of current contaminant burdens in lobster tissues in Atlantic Canada and regulatory guidelines regarding levels permitted in lobster tissues. This gap of knowledge is surprising, as lobster is a valuable commercial product that is economically important in Nova Scotia and widely consumed by the public. The lack of guidelines restricted us from accurately assessing the degree of contamination in most of our lobster samples. It is highly recommended that more applicable guideline values be developed for comparisons against contaminant concentrations in marine biota and especially lobsters.

Acknowledgements

I would like to extend my thanks to NS Lands for generously funding this project. A special thanks to for their useful and constructive recommendations on this project. I wish to thank for assisting with the lobster collections. Assistance provided by was greatly appreciated. Finally, I would like to express my gratitude to the fishing captains , and their crews for welcoming us on board and assisting with the lobster collections.

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Appendix

Graphs: metals

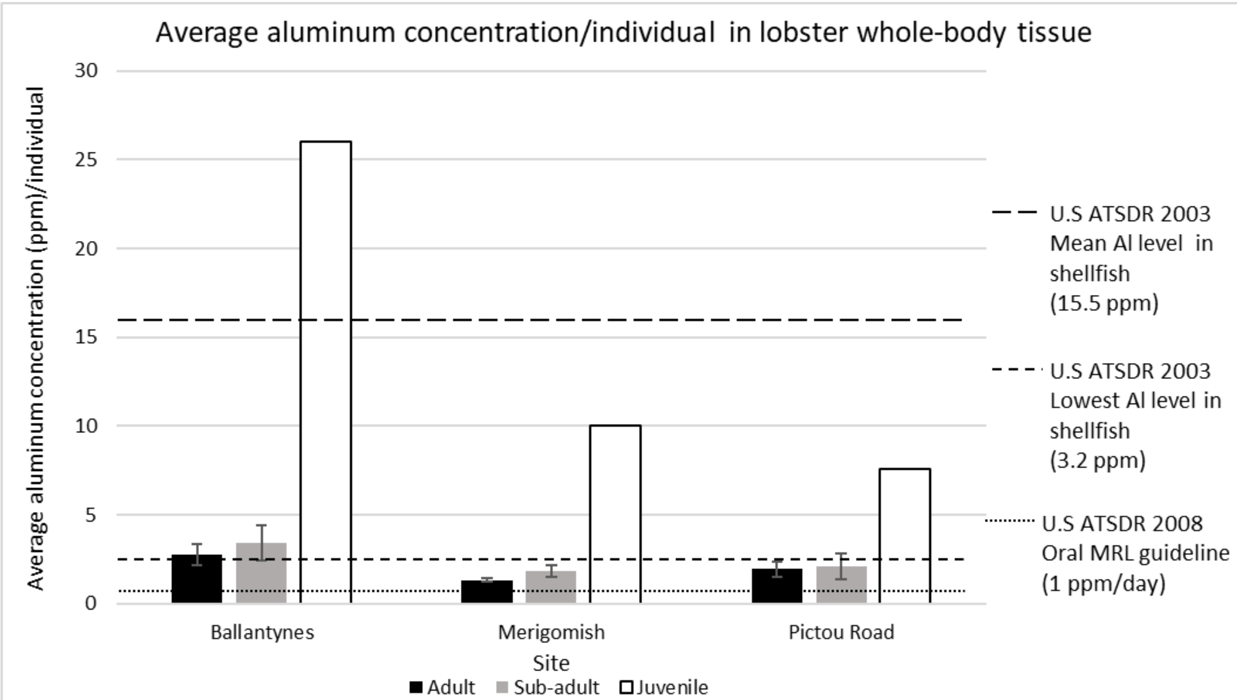


Figure 1. The average aluminum concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The U.S ATSDR (2008) guideline (1 ppm/day) is the minimal risk level (MRL) at which, if exposed to aluminum orally, will likely not have adverse effects over an intermediate-duration (15-364 days). The U.S ATSDR (2003) survey reported a range of 3.2-43.9 ppm (highest level not displayed on graph) with an average 15.5 ppm aluminum level in shellfish: spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*) collected from Puerto Rico coastal waters. Error bars represent standard error.

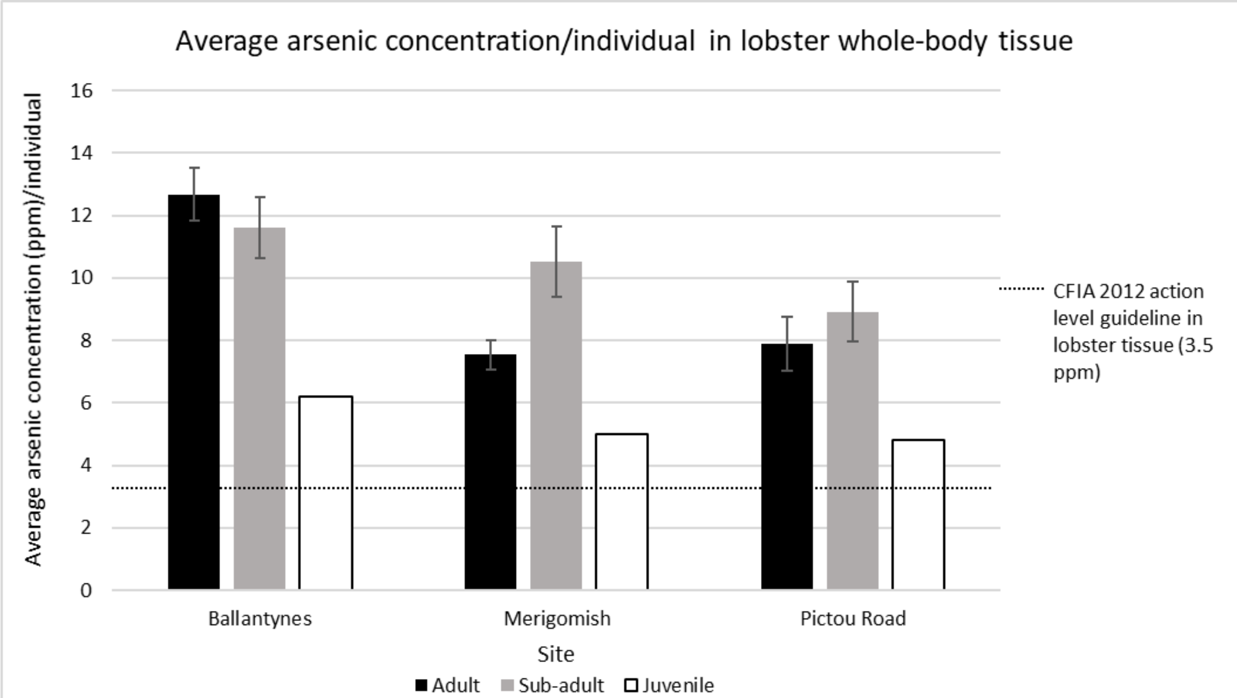


Figure 2. The average arsenic concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Fish products that exceed the Canadian Food Inspection Agency (CFIA) action level guideline (3.5 ppm) will be rejected from Canadian commercial use. Error bars represent standard error.

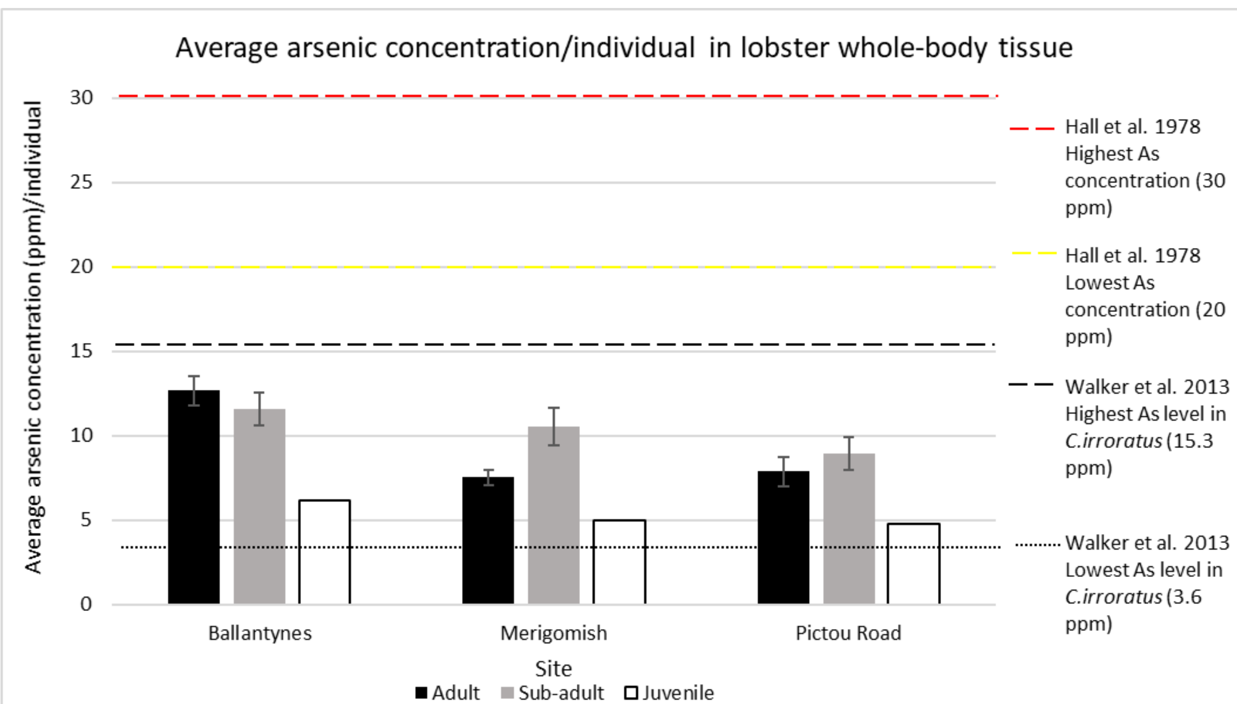


Figure 3. The average arsenic concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Hall et al. (1978) survey

reported a range of 20-30 ppm in *H.americanus* claw and tail tissues from U.S coastal regions. Walker et al. (2013a) reported a range of 3.6-15.3 ppm in crab hepatopancreas tissue collected from Sydney Harbour, NS. Error bars represent standard error.

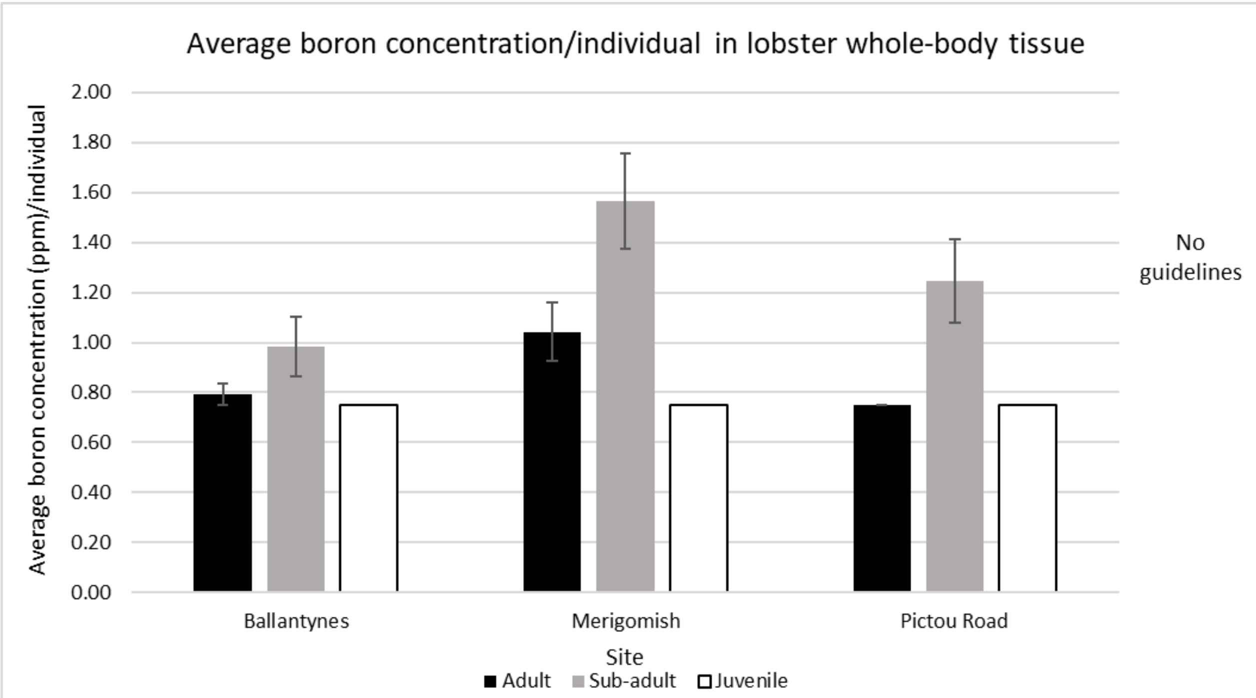


Figure 4. The average boron concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Error bars represent standard error.

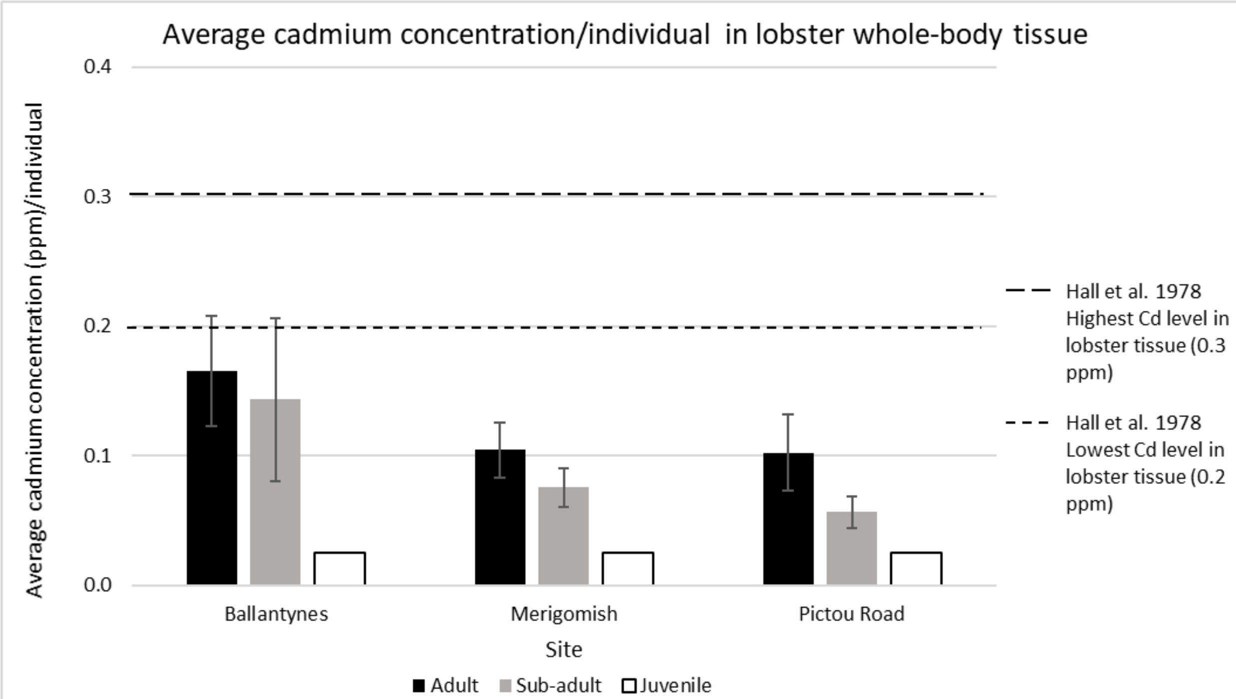


Figure 5. The average cadmium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.2-0.3 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. Error bars represent standard error.

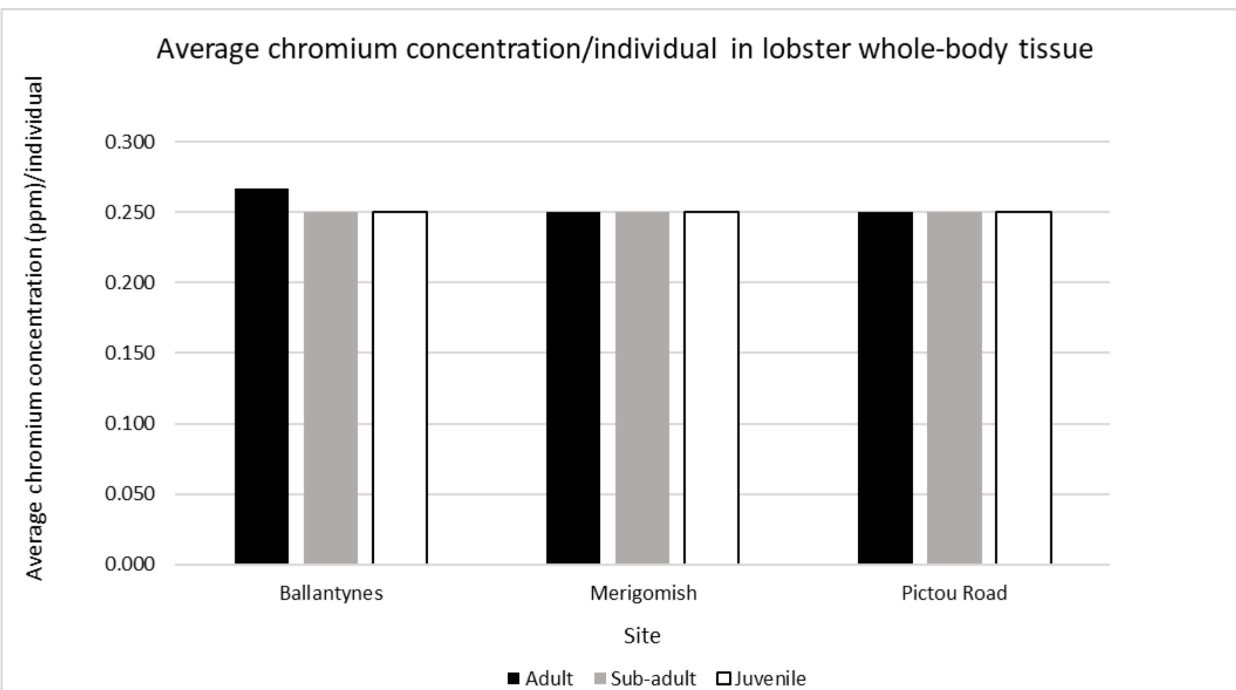


Figure 6. The average chromium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study

reported a range of 0.1-0.2 ppm (not displayed) in *H.americanus* claw and tail tissues from U.S coastal waters. The range (0.076-1.29 ppm) detected in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) claw and tail tissues collected from Puerto Rico coastal waters is not displayed on the graph. Error bars represent standard error.

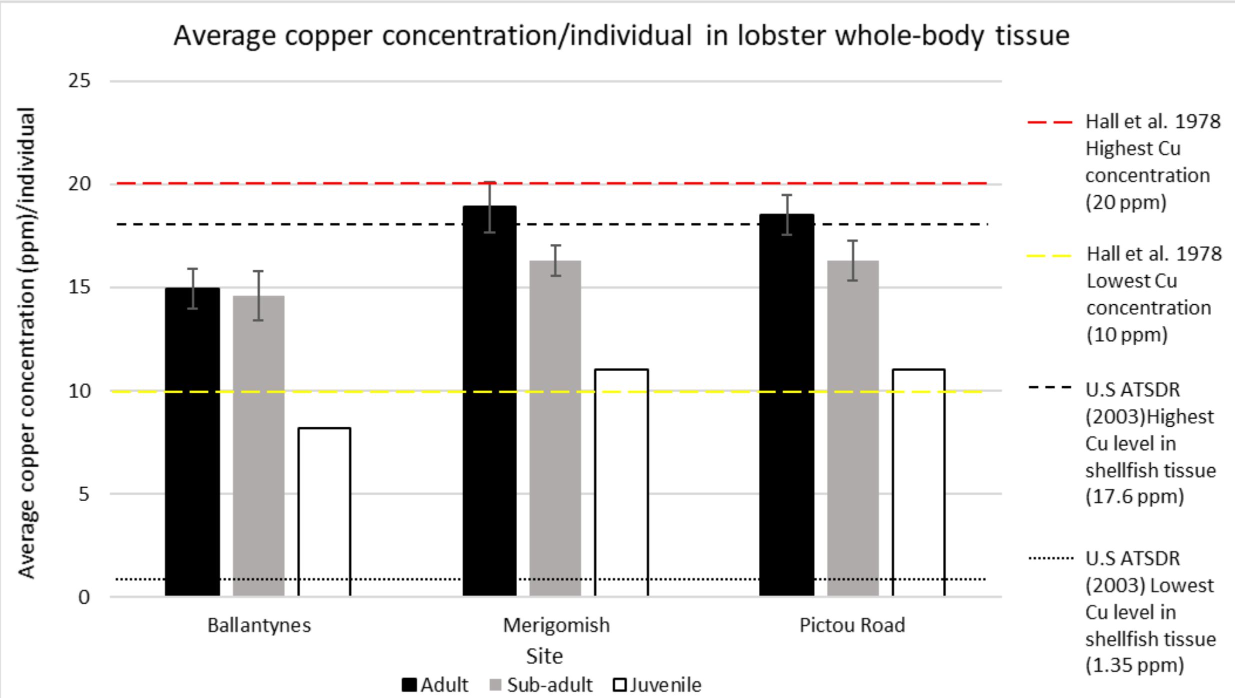


Figure 7. The average copper concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 10-20 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 1.35-17.6 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Error bars represent standard error.

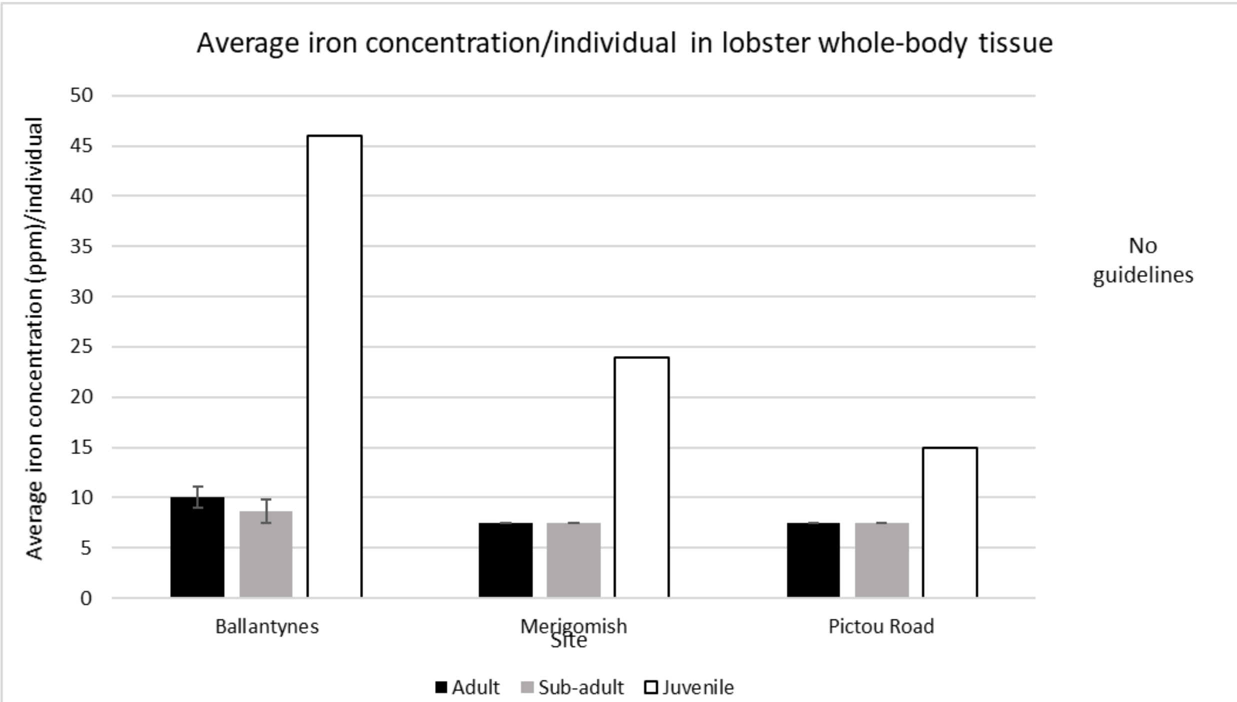


Figure 8. The average copper concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The range of iron concentration (1.62-162 ppm) that was detected in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) from Puerto Rico coastal waters is not displayed on this graph. Error bars represent standard error.

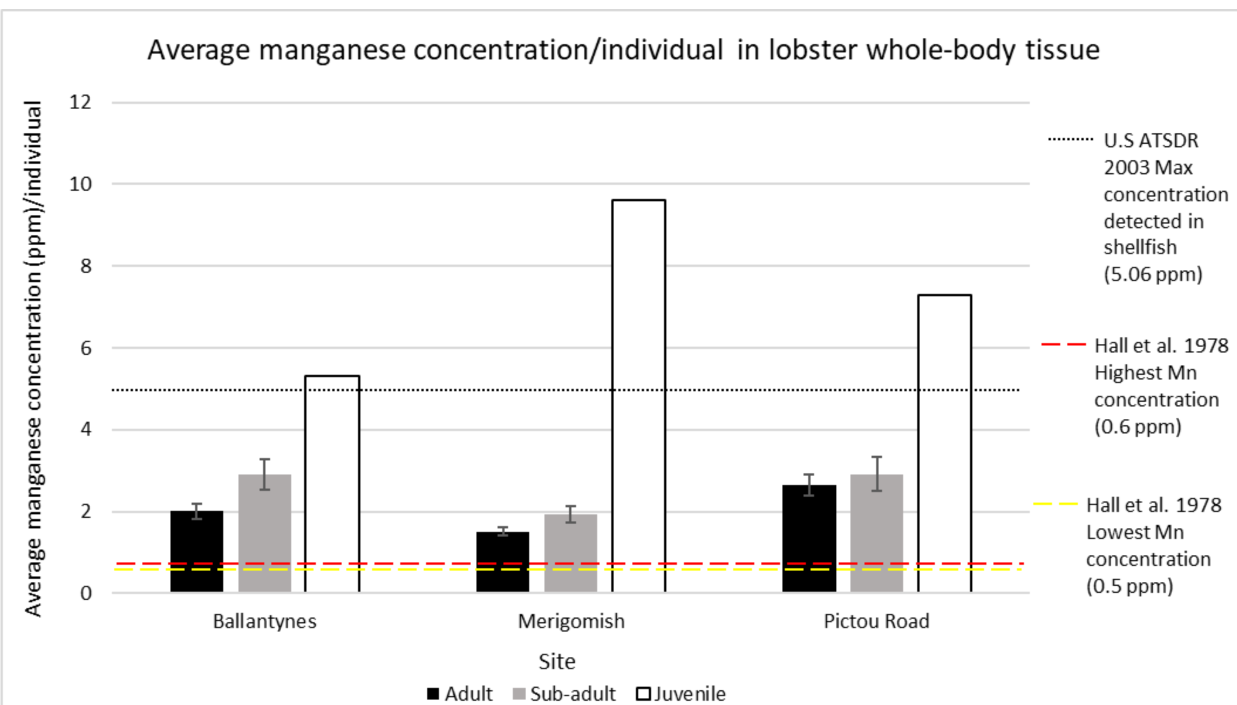


Figure 9. The average manganese concentration in *H.americanus* whole-body tissues (excluding

the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.5-0.6 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 0.16 (not displayed on graph)-5.06 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Error bars represent standard error.

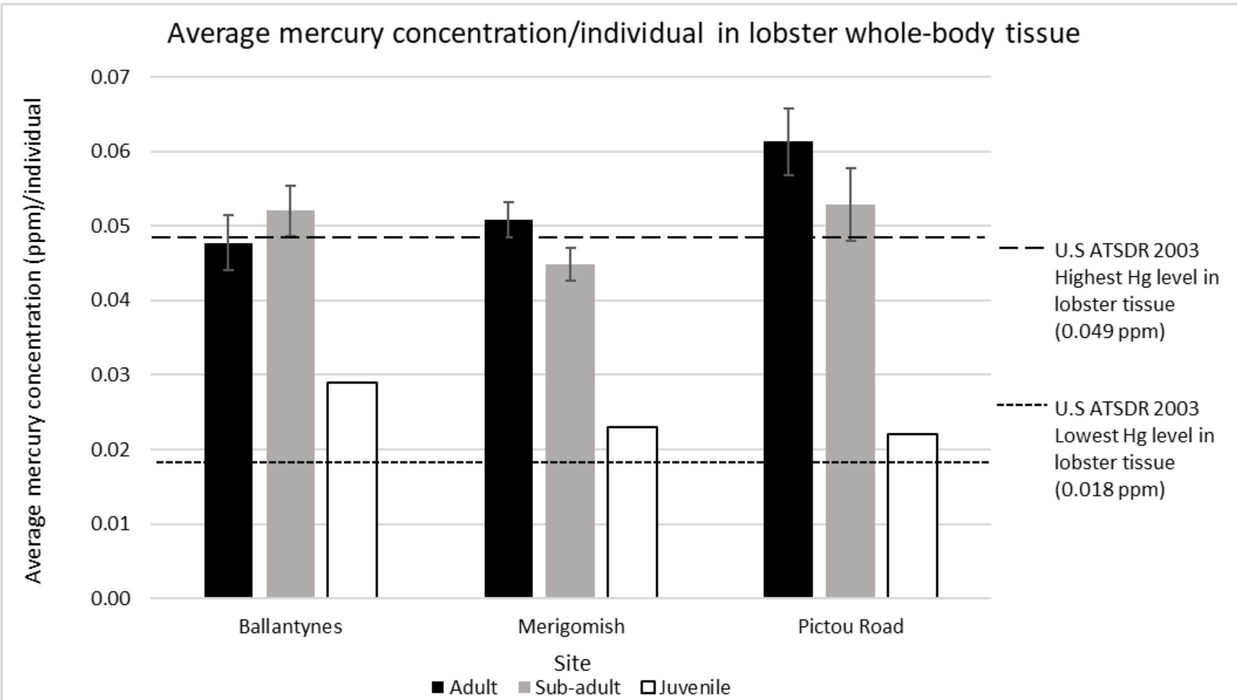


Figure 10. The average mercury concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Puerto Rico survey detected a range of 0.018-0.049 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. The Hall study reported a range of 0.2-0.3 ppm (not displayed on graph) in *H.americanus* claw and tail tissues from U.S coastal waters. Walker et al. (2013a) reported a range of <0.01-0.04 ppm (not displayed on graph) in *C.irroratus* tissues from Sydney Harbour, NS. Error bars represent standard error.

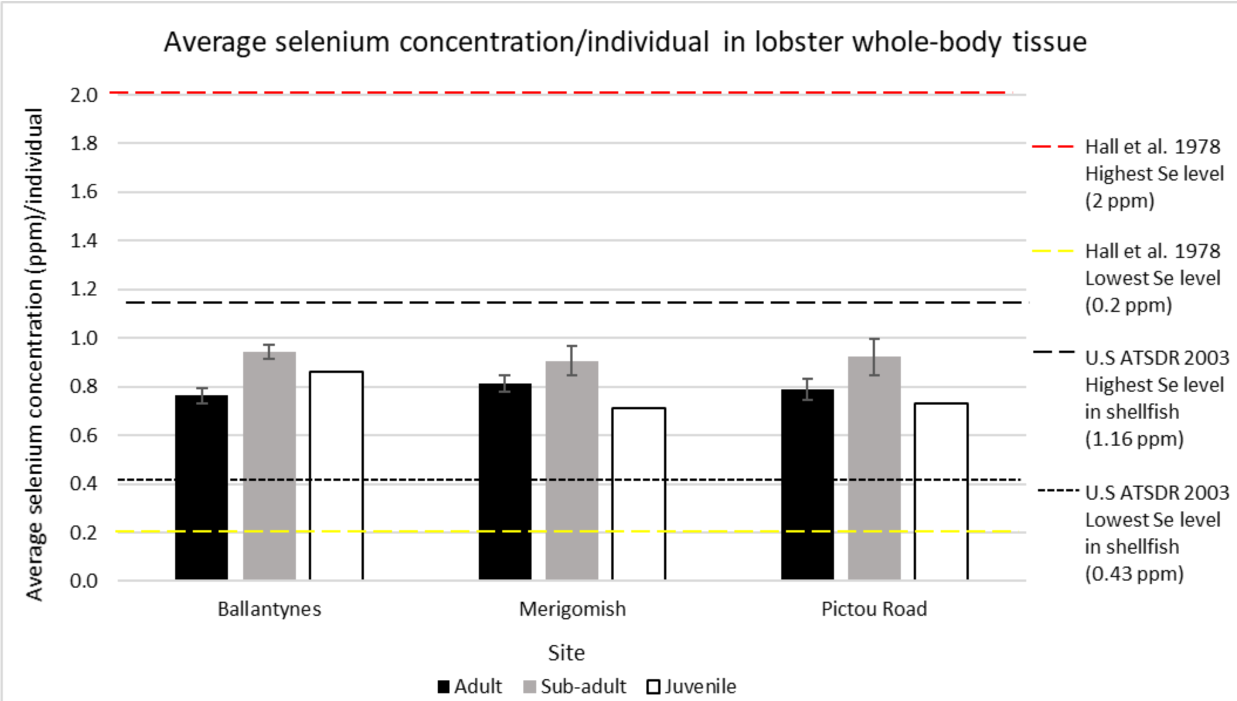


Figure 11. The average selenium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Puerto Rico survey detected a range of 0.43-1.16 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. The Hall study reported a range of 0.2-2.0 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. Error bars represent standard error.

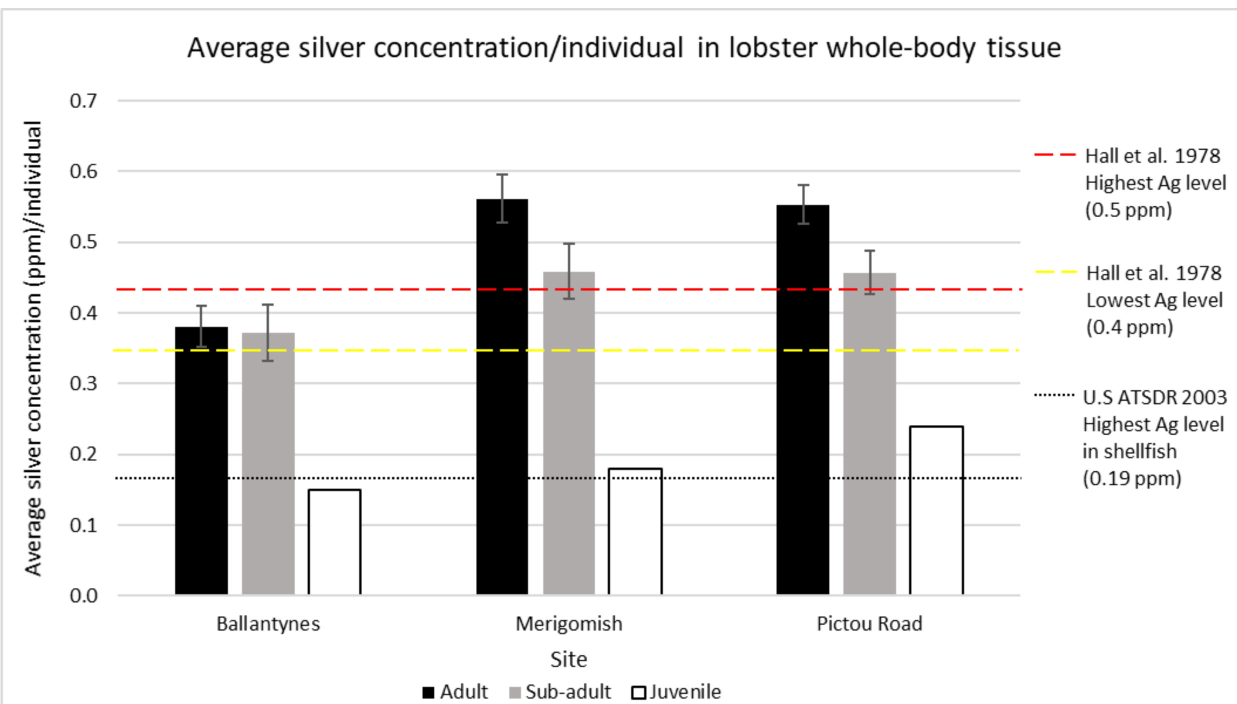


Figure 12. The average silver concentration in *H.americanus* whole-body tissues (excluding the

hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 0.4-0.5 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 0.07-0.19 ppm in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Error bars represent standard error.

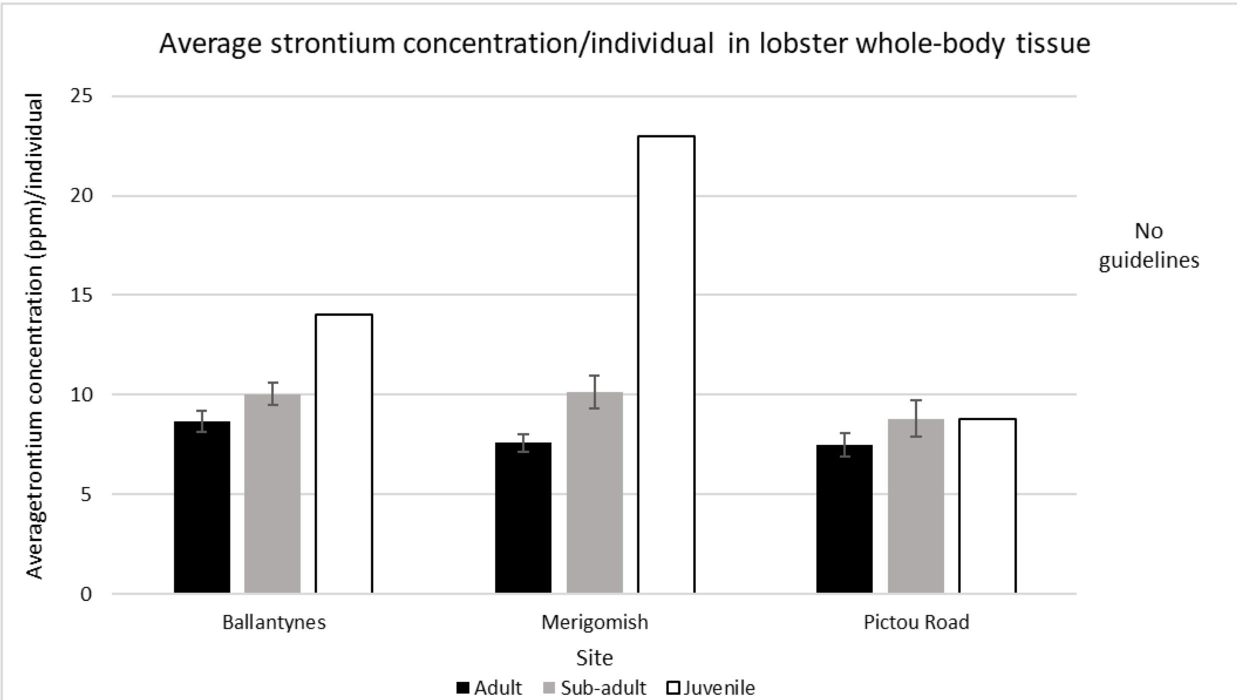


Figure 13. The average strontium concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. Error bars represent standard error.

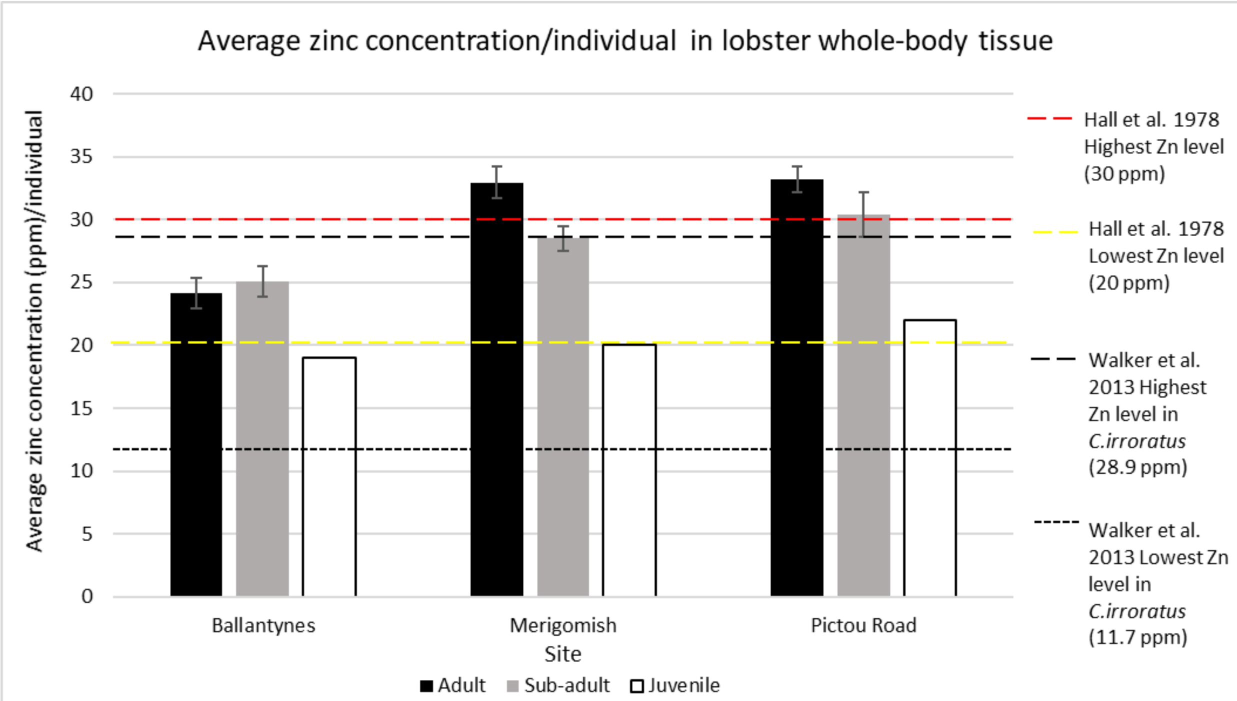


Figure 14. The average zinc concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. The Hall study reported a range of 20-30 ppm in *H.americanus* claw and tail tissues from U.S coastal waters. The Puerto Rico survey detected a range of 5.41-96.6 ppm (not displayed on graph) in shellfish (spiny lobster (*Panulirus argus*) and the blue land crab (*Cardisoma guanhumi*)) tissues. Walker et al. (2013a) reported zinc concentrations in *C.irroratus* from Sydney Harbour, NS, ranging from 11.7-28.9 ppm. Error bars represent standard error.

Graphs: organic contaminants

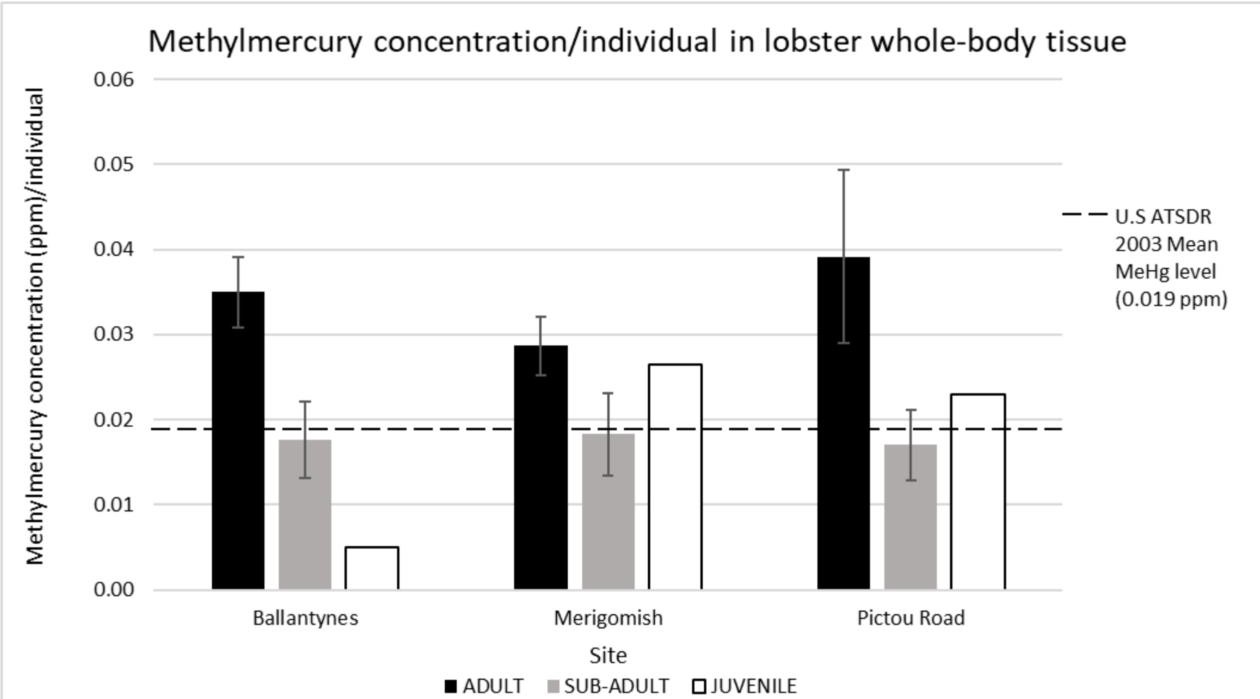


Figure 15. The average MeHg concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait. U.S ATSDR (2003) reported an average MeHg level of 0.019 ppm. Error bars represent standard error.

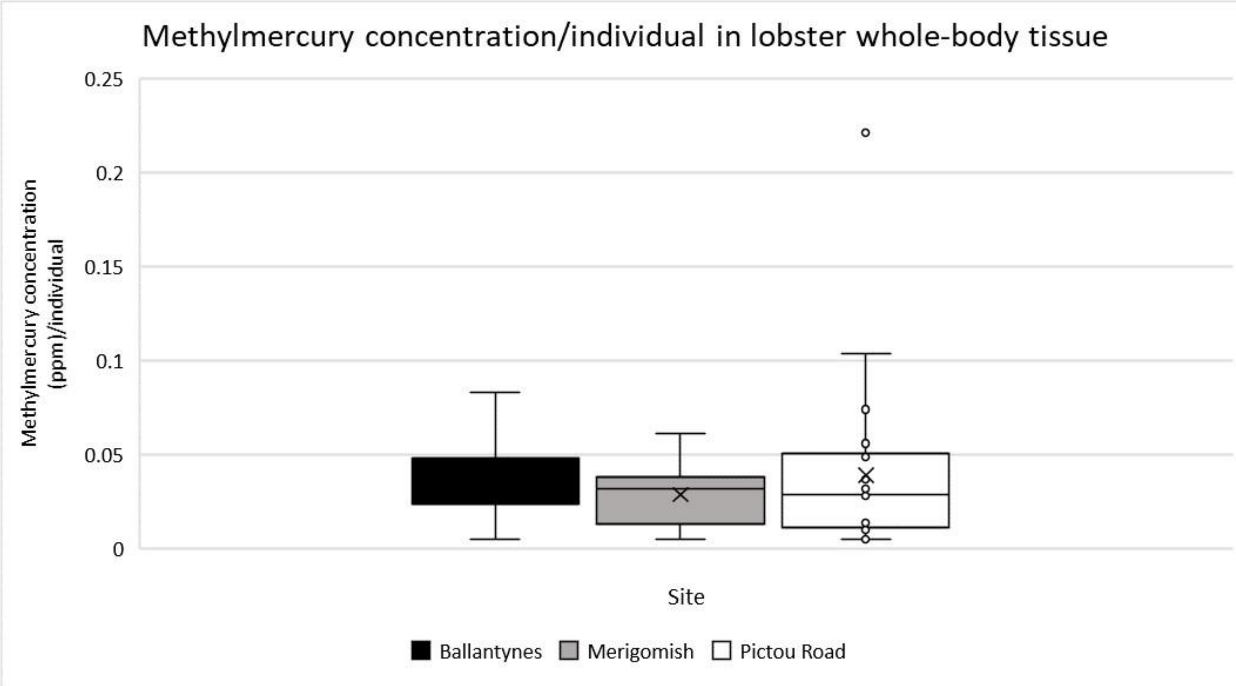


Figure 16. The average MeHg concentration in *H.americanus* whole-body tissues (excluding the hepatopancreas) collected from three sites in the Northumberland Strait.

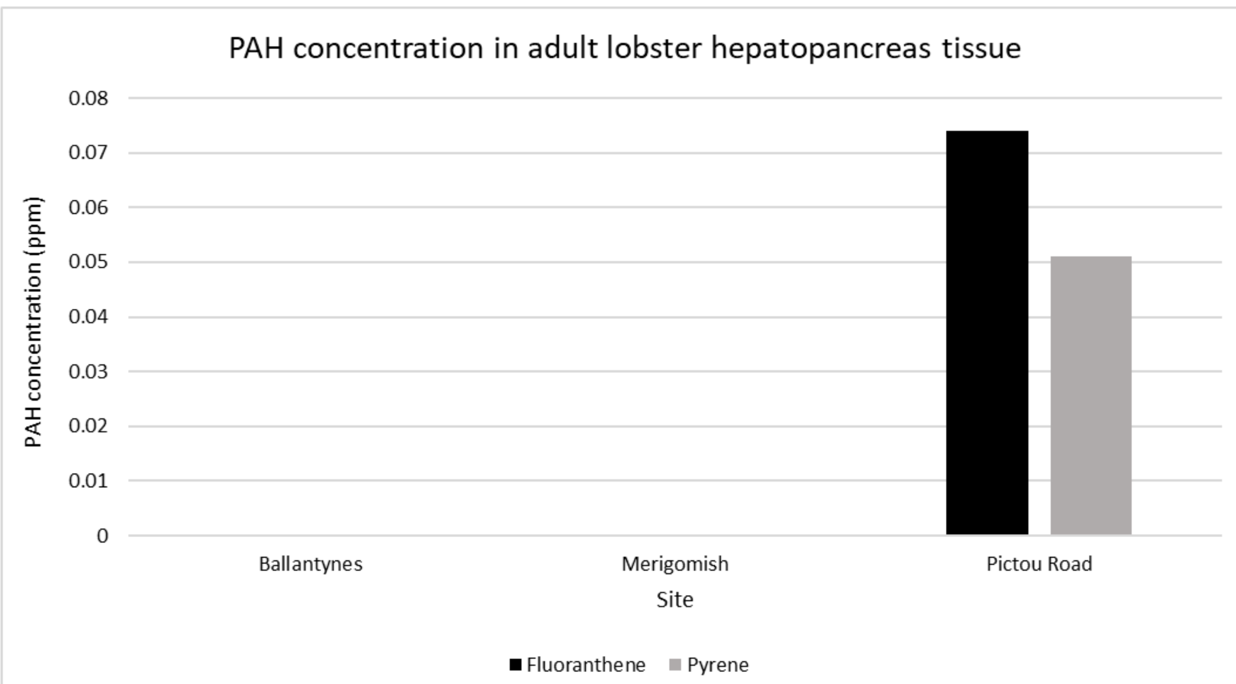


Figure 17. PAH concentrations in *H.americanus* hepatopancreas tissues collected from three sites in the Northumberland Strait. Note: there were no remaining tissues leftover to submit for PAH analysis for subadults from Ballantynes and adults from Merigomish.

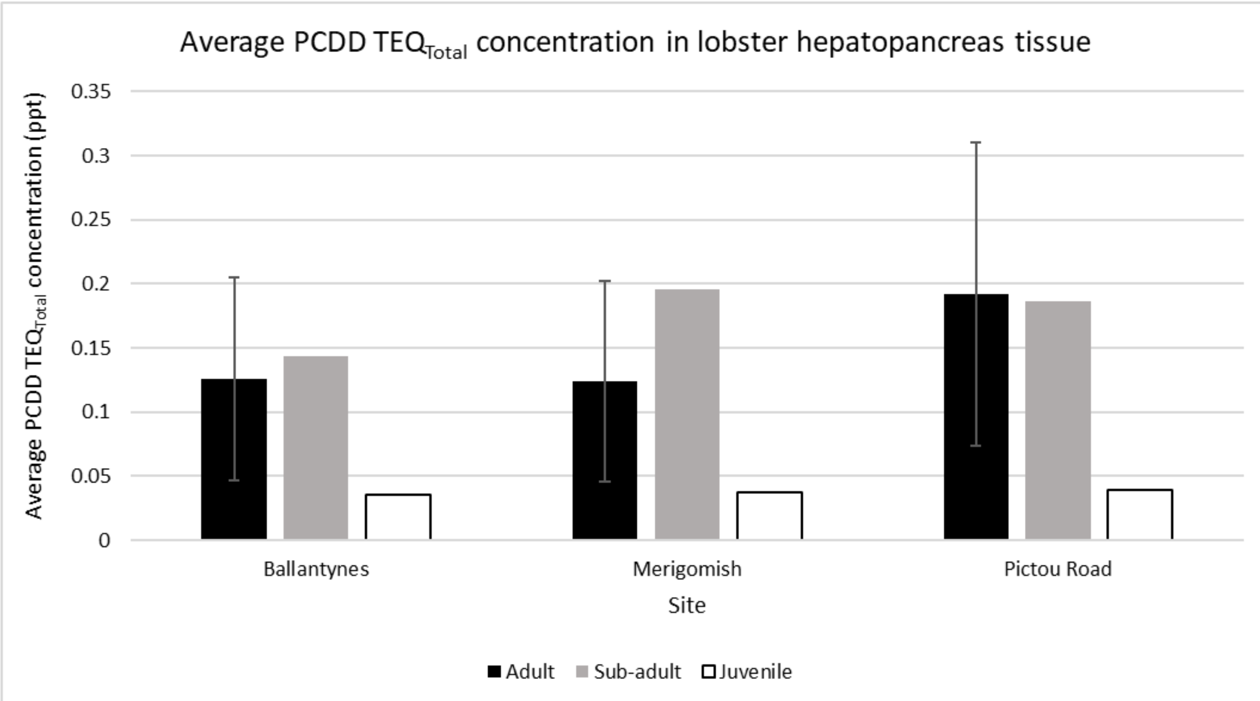


Figure 18. The average PCDD TEQ_{total} concentrations in *H.americanus* hepatopancreas tissues collected from three sites in the Northumberland Strait. Guidelines not displayed on graph: CCME TEQ_{mammal} (0.71 ppt) and TEQ_{bird} (4.75 ppt) (CCME, 2000), CFIA action level (20 ppt) for 2,3,7,8- Tetra CDD (CFIA, 2012). Error bars represent standard error.

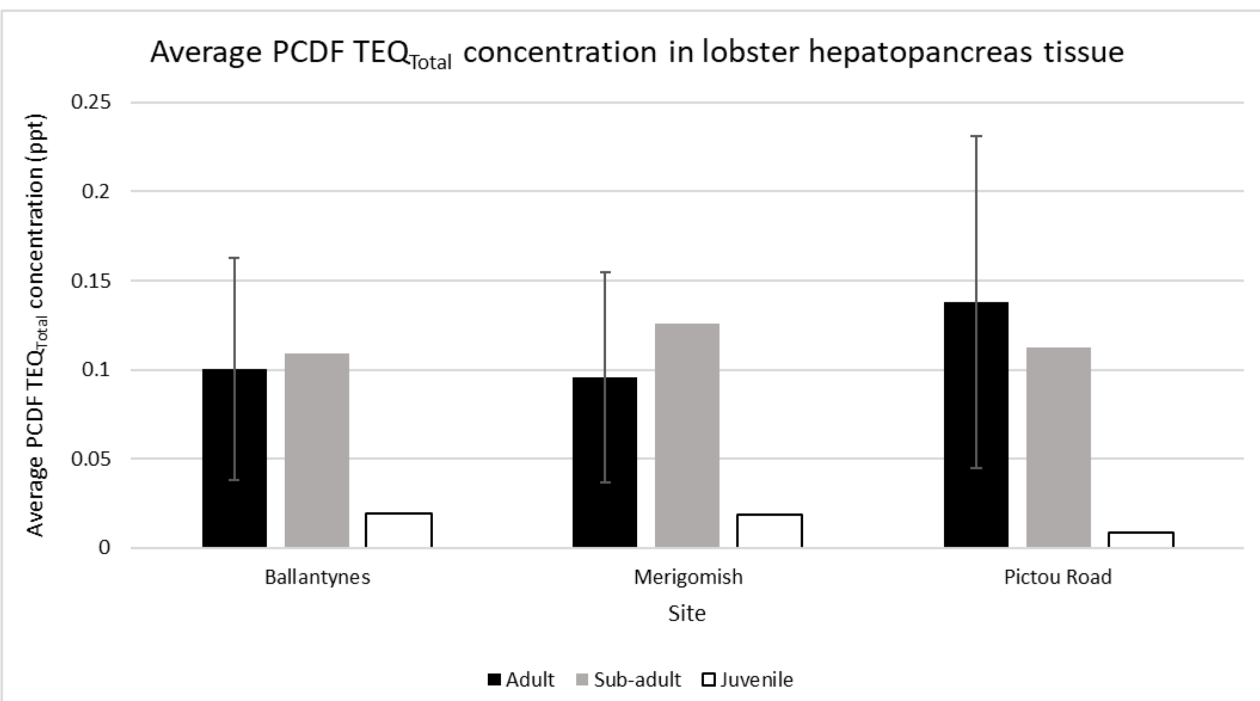


Figure 19. The average PCDF TEQ_{total} concentrations in *H.americanus* hepatopancreas tissues collected from three sites in the Northumberland Strait. Guidelines not displayed on graph: CCME TEQ_{mammal} (0.71 ppt) and TEQ_{bird} (4.75 ppt) (CCME, 2000), CFIA action level (20 ppt) for 2,3,7,8- Tetra CDD (CFIA, 2012). Error bars represent standard error.

Summary of contaminant results

Table 1. Summary of metal concentrations (ppm) in adult lobster whole-body tissues (wet weight)

Metal	Range			Average			Frequency of detection		
	Bal.	Mer.	Pic.	Bal.	Mer.	Pic.	Bal.	Mer.	Pic.
Aluminum (Al)	ND-8.8	ND-2.8	ND-10	1.88	0.15	0.87	6/20	1/19	3/20
Antimony (Sb)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Arsenic (As)	6.3-23	5.5-13	3.7-18	12.68	7.54	7.89	20/20	19/19	20/20
Barium (Ba)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Beryllium (Be)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Boron (B)	ND-1.6	ND-2	ND	0.08	0.49	ND	1/20	5/19	0/20
Cadmium (Cd)	ND-0.66	ND-0.32	ND-0.53	0.16	0.10	0.09	14/20	14/19	11/20
Chromium (Cr)	ND-0.58	ND-0	ND-0	0.03	ND	ND	1/20	0/19	0/20
Cobalt (Co)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Copper (Cu)	7-23	13-34	12-27	14.93	18.89	18.50	20/20	19/19	20/20
Iron (Fe)	ND-20	ND	ND	4.45	ND	ND	5/20	0/19	0/20
Lead (Pb)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Lithium (Li)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Manganese (Mn)	1.1-4.8	0.77-2.7	1.3-5.5	2.01	1.51	2.64	20/20	19/19	20/20
Mercury (Hg)	0.023-0.093	0.031-0.071	0.035-0.1	0.05	0.05	0.06	20/20	19/19	20/20
Molybdenum (Mo)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Nickel (Ni)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Selenium (Se)	0.56-1	0.61-1.1	ND-1.2	0.76	0.81	0.78	20/20	19/19	19/20
Silver (Ag)	0.23-0.78	0.27-0.89	0.33-0.78	0.38	0.56	0.55	20/20	19/19	20/20
Strontium (Sr)	4.2-14	5.5-12	3.9-15	8.64	7.59	7.46	20/20	19/19	20/20
Thallium (Tl)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Tin (Sn)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Uranium (U)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Vanadium (V)	ND	ND	ND	ND	ND	ND	0/20	0/19	0/20
Zinc (Zn)	15-39	22-41	26-42	24.15	32.95	33.20	20/20	19/19	20/20

Abbreviations for sites: Bal. (Ballantynes), Mer. (Merigomish), Pic. (Pictou Road)
Note: not detected (ND)
Note: Only 19 adult lobsters from Merigomish were submitted for analysis

Table 2. Summary of metal concentrations (ppm) in subadult lobster whole-body tissues (wet weight)

Metal	Range			Average			Frequency of detection		
	Bal.	Mer.	Pic.	Bal.	Mer.	Pic.	Bal.	Mer.	Pic.
Aluminum (Al)	ND-11	ND-3.8	ND-8.4	2.82	0.97	1.09	5/10	3/10	2/10
Antimony (Sb)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Arsenic (As)	8.6-18	4.4-16	3.8-14	11.60	10.53	8.92	10/10	10/10	10/10
Barium (Ba)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Beryllium (Be)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Boron (B)	ND-1.6	ND-2.4	ND-1.9	0.46	1.34	0.87	3/10	7/10	5/10
Cadmium (Cd)	ND-0.69	ND-0.16	ND-0.13	0.14	0.07	0.04	8/10	7/10	5/10
Chromium (Cr)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Cobalt (Co)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Copper (Cu)	9.9-22	12-20	11-21	14.59	16.30	16.30	10/10	10/10	10/10
Iron (Fe)	ND-19	ND	ND	1.90	ND	ND	1/10	0/10	0/10
Lead (Pb)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Lithium (Li)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Manganese (Mn)	1.8-5.7	1.3-3	1.7-5.9	2.91	1.93	2.91	10/10	10/10	10/10
Mercury (Hg)	0.037-0.067	0.036-0.058	0.027-0.081	0.05	0.04	0.05	10/10	10/10	10/10
Molybdenum (Mo)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Nickel (Ni)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Selenium (Se)	0.8-1.1	0.54-1.1	0.59-1.5	0.94	0.91	0.92	10/10	10/10	10/10
Silver (Ag)	0.19-0.57	0.29-0.67	0.31-0.59	0.37	0.46	0.46	10/10	10/10	10/10
Strontium (Sr)	8.4-14	7.9-17	6.6-15	10.04	10.12	8.80	10/10	10/10	10/10
Thallium (Tl)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Tin (Sn)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Uranium (U)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Vanadium (V)	ND	ND	ND	ND	ND	ND	0/10	0/10	0/10
Zinc (Zn)	20-31	24-35	23-41	25.10	28.50	30.40	10/10	10/10	10/10

Abbreviations for sites: Bal. (Ballantynes), Mer. (Merigomish), Pic. (Pictou Road)
Note: not detected (ND)

Table 3. Summary of metal concentrations (ppm) in juvenile lobster pooled whole-body tissues (wet weight)

Metal	Range			Average			Frequency of detection		
	Bal.	Mer.	Pic.	Bal.	Mer.	Pic.	Bal.	Mer.	Pic.
Aluminum (Al)	NA	NA	NA	26.00	10.00	7.60	1/1	1/1	1/1
Antimony (Sb)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Arsenic (As)	NA	NA	NA	6.20	5.00	4.80	1/1	1/1	1/1
Barium (Ba)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Beryllium (Be)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Boron (B)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Cadmium (Cd)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Chromium (Cr)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Cobalt (Co)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Copper (Cu)	NA	NA	NA	8.20	11.00	11.00	1/1	1/1	1/1
Iron (Fe)	NA	NA	NA	46.00	24.00	15.00	1/1	1/1	1/1
Lead (Pb)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Lithium (Li)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Manganese (Mn)	NA	NA	NA	5.30	9.60	7.30	1/1	1/1	1/1
Mercury (Hg)	NA	NA	NA	0.03	0.02	0.02	1/1	1/1	1/1
Molybdenum (Mo)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Nickel (Ni)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Selenium (Se)	NA	NA	NA	0.86	0.71	0.73	1/1	1/1	1/1
Silver (Ag)	NA	NA	NA	0.15	0.18	0.24	1/1	1/1	1/1
Strontium (Sr)	NA	NA	NA	14.00	23.00	8.80	1/1	1/1	1/1
Thallium (Tl)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Tin (Sn)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Uranium (U)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Vanadium (V)	NA	NA	NA	ND	ND	ND	0/1	0/1	0/1
Zinc (Zn)	NA	NA	NA	19.00	20.00	22.00	1/1	1/1	1/1

Abbreviations for sites: Bal. (Ballantynes), Mer. (Merigomish), Pic. (Pictou Road)
Note: range of concentrations is not applicable (NA) as there was a single concentration detected/metal/site
Note: not detected (ND)

Table 4. The detection limit (DL) reported by Maxxam Analytics Inc. for metals and MeHg in all lobster ages

Metals	Detection Limit (DL)
Aluminum (Al)	2.5
Antimony (Sb)	0.5
Arsenic (As)	0.5
Barium (Ba)	1.5
Beryllium (Be)	0.5
Boron (B)	1.5
Cadmium (Cd)	0.05
Chromium (Cr)	0.5
Cobalt (Co)	0.2
Copper (Cu)	0.5
Iron (Fe)	15
Lead (Pb)	0.18
Lithium (Li)	0.5
Manganese (Mn)	0.5
Mercury (Hg)	0.01
Methylmercury (MeHG)	0.005
Molybdenum (Mo)	0.5
Nickel (Ni)	0.5
Selenium (Se)	0.5
Silver (Ag)	0.12
Strontium (Sr)	1.5
Thallium (Tl)	0.02
Tin (Sn)	0.5
Uranium (U)	0.02
Vanadium (V)	0.5
Zinc (Zn)	1.5

Table 5. The detection limits (DL) reported by Maxxam Analytics Inc. for PAH congeners in all lobster ages

PAH congeners	Detection Limit (DL)
1-Methylnaphthalene	0.05
2-Methylnaphthalene	0.05
Acenaphthene	0.05
Acenaphthylene	0.05
Anthracene	0.05
Benzo(a)anthracene	0.05
Benzo(a)pyrene	0.05
Benzo(b)fluoranthene	0.05
Benzo(b/j)fluoranthene	0.1
Benzo(g,h,i)perylene	0.05
Benzo(j)fluoranthene	0.05
Benzo(k)fluoranthene	0.05
Chrysene	0.05
Dibenz(a,h)anthracene	0.05
Fluoranthene	0.05
Fluorene	0.05
Indeno(1,2,3-cd)pyrene	0.05
Naphthalene	0.05
Perylene	0.05
Phenanthrene	0.05
Pyrene	0.05

Note: The DL was 1.2 for sub-adult samples from Ballantynes

Table 6. Summary of PCDD/F TEQ_{Total} concentrations (ppt) in lobster hepatopancreas tissues from the Northumberland Strait region

Lobster age	PCCD/F	Range TEQ_{Total} (ppt)			Average TEQ_{Total} (ppt)		
Adults		Bal.	Mer.	Pic.	Bal.	Mer.	Pic.
	PCDD	0.3712-1.5749	0.3867-1.7912	0.5588-2.7300	0.8813	0.867	1.3435
	PCDF	0.3969-1.8615	0.2979-1.5859	0.7088-2.6359	1.0074	0.9567	1.3802
Subadults							
	PCDD	NA	NA	NA	0.0504	0.0684	0.0653
	PCDF	NA	NA	NA	0.0545	0.0630	0.0563
Juveniles							
	PCDD	NA	NA	NA	0.0082	0.0088	0.0092
	PCDF	NA	NA	NA	0.0064	0.0061	0.0029

Abbreviations for sites: Bal. (Ballantynes), Mer. (Merigomish), Pic. (Pictou Road)
Note: not applicable (NA) indicates pooling of tissue samples (subadults and juveniles)

Table 7. The Total Equivalence Factors (TEFs) for the PCDD/Fs (Van den Berg et al., 2006)

PCDD/F	TEF
2,3,7,8-Tetra CDD	1
1,2,3,7,8-Penta CDD	1
1,2,3,4,7,8-Hexa CDD	0.1
1,2,3,6,7,8-Hexa CDD	0.1
1,2,3,7,8,9-Hexa CDD	0.1
1,2,3,4,6,7,8-Hepta CDD	0.01
Octa CDD	0.0003
2,3,7,8-Tetra CDF	0.1
1,2,3,7,8-Penta CDF	0.03
2,3,4,7,8-Penta CDF	0.3
1,2,3,4,7,8-Hexa CDF	0.1
1,2,3,6,7,8-Hexa CDF	0.1
2,3,4,6,7,8-Hexa CDF	0.1
1,2,3,7,8,9-Hexa CDF	0.1
1,2,3,4,6,7,8-Hepta CDF	0.01
1,2,3,4,7,8,9-Hepta CDF	0.01
Octa CDF	0.0003

Statistical outputs

Table 8. Results from the two-way ANOVA and one-way ANOVA test with Tukey's HSD test

	Two-way ANOVA (adult and subadult lobsters)					One-way ANOVA (adult lobsters only)	
		Main Effects P-values		Within Main Effects Comparisons			
Contaminant	Overall Model	Age	Site	Most contaminated age	Relative Site Contamination	P-value	Relative Site Contamination
Aluminum (Al)	.135	.338	.031	--	B>M=P	.095	--
Antimony (Sb)	--	--	--	--	--	--	--
Arsenic (As)	.000	.187	.000	--	B>M=P	.000	B>M=P
Barium (Ba)	--	--	--	--	--	--	--
Beryllium (Be)	--	--	--	--	--	--	--
Boron (B)	.000	.000	.001	Subadult	M>B=P	.009	M>B=P
Cadmium (Cd)	.316	.299	.105	--	--	.306	--
Chromium (Cr)	.642	.489	.618	--	--	.384	--
Cobalt (Co)	--	--	--	--	--	--	--
Copper (Cu)	.016	.073	.027	--	M=P>B	.017	M=P>B
Iron (Fe)	.012	.407	.011	--	B>M=P	.005	B>M=P
Lead (Pb)	--	--	--	--	--	--	--
Lithium (Li)	--	--	--	--	--	--	--
Manganese (Mn)	.000	.015	.000	Subadult	B=P>M	.001	P>M*
Mercury (Hg)	.047	.320	.066	--	--	.028	P>B=M
Molybdenum (Mo)	--	--	--	--	--	--	--
Nickel (Ni)	--	--	--	--	--	--	--
Selenium (Se)	.019	.000	.991	Subadult	--	.609	--
Silver (Ag)	.000	.018	.000	Adult	M=P>B	.000	P=M>B
Strontium (Sr)	.012	.001	.181	Subadult	--	.229	--
Thallium (Tl)	--	--	--	--	--	--	--
Tin (Sn)	--	--	--	--	--	--	--
Uranium (U)	--	--	--	--	--	--	--
Vanadium (V)	--	--	--	--	--	--	--
Zinc (Zn)	.000	.062	.000	--	M=P>B	.000	P=M>B
Methylmercury (MeHg)	.136	.009	.829	Adult	--	.938	--
PAHs	--	--	--	--	--	--	--
PCDD	--	--	--	--	--	.002	P>B=M
PCDF	--	--	--	--	--	.005	P>B=M

Note: No statistical tests were performed on juvenile's due to pooled tissue samples
Note: No statistical tests were performed for PAHs due to pooled samples for all lobster ages
Note: No statistical tests were performed for PCDD/F levels in subadult tissues due to pooled tissue samples
*Pictou Road is significantly higher than Merigomish, but Ballantynes is not significantly different from either site

Additional figures

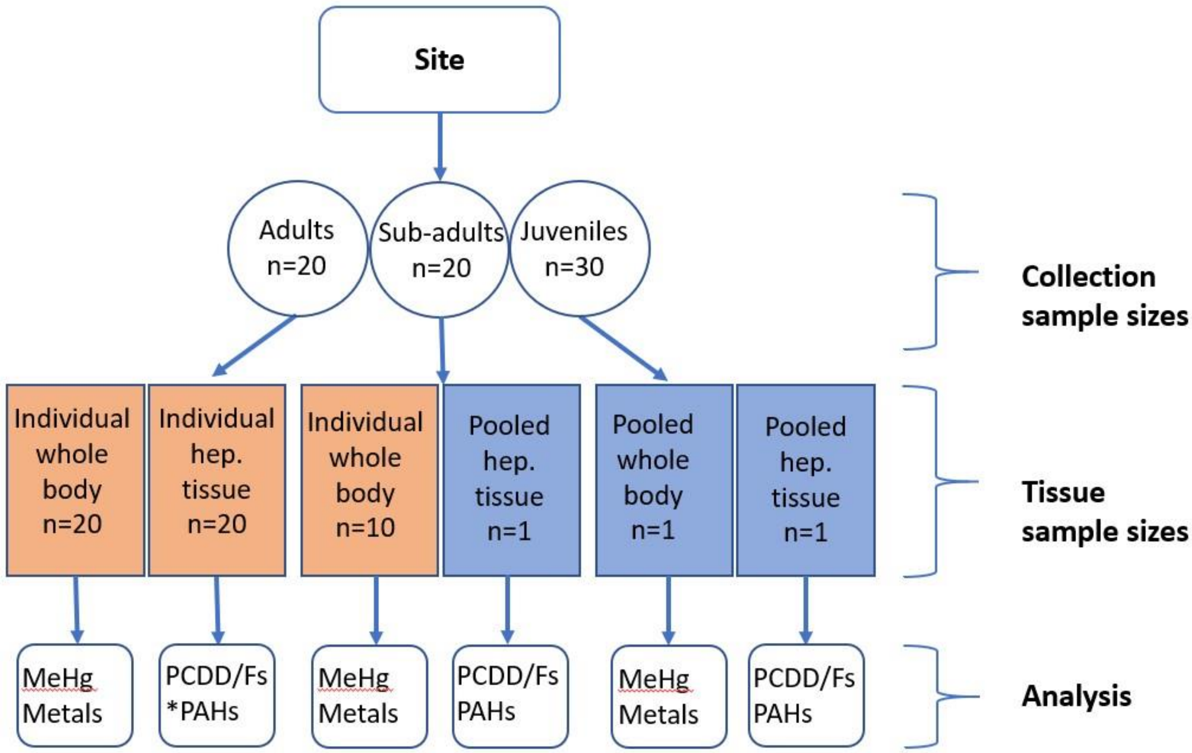


Figure 20. The sample sizes of lobsters collected from all sites, the tissue samples sizes submitted for each analysis (individual tissue samples highlighted in pink and pooled tissue samples highlighted in blue), and the respective.
Note: hep. (hepatopancreas)
Note: "*PAHs" indicates pooled adult hepatopancreas tissue for PAH analysis (n= 1)

Figure 21. The three lobster collection sites used for the baseline study in the Northumberland Strait; Pictou Road, Merigomish, and Ballantynes Cove.

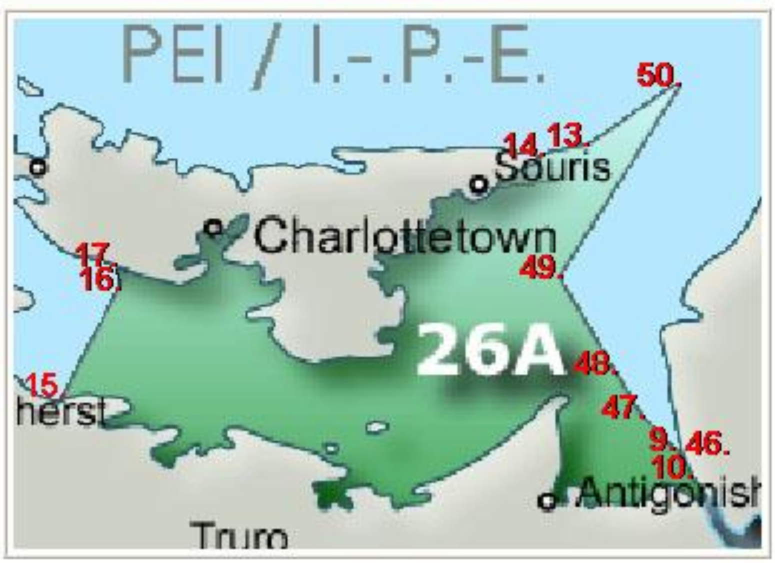


Figure 22. The fishing district 26A located in the Northumberland Strait (Government of Canada, 2009)

Scientific license for lobster collections

DEPARTMENT OF FISHERIES AND OCEANS
GULF REGION

LICENCE TO FISH FOR

Scientific purposes

LICENCE NO.: SG-RHQ-18-062

Pursuant to Part VII, Section 52, of the *Fishery (General) Regulations*, this licence is issued to **Jim Williams, Professor** of **St. Francis Xavier University**, 2320 Notre Dame Ave., Antigonish, Nova Scotia, B2G 2W5, (902) 867-3320.

This licence is issued for the purpose of:

Studying treated affluent. In January 2020, treated pulp and paper effluent will stop flowing into Boat Harbour, in Pictou harbour, Nova Scotia. For the last 60 years, this body of water has been dammed off from tidal influence, and used as a final settling pond for an effluent treatment facility. After 2020 a complete remediation of Boat Harbour and surrounding lands will be initiated. All contaminated sediments will be removed and disposed of, and Boat Harbour will be opened up again, and returned to a tidal estuary. There is concern about the project among fishermen from the area; partly because treated effluent will be released into the Northumberland Strait via a proposed pipeline and diffuser system; and there are fears residual contaminants from Boat Harbour may be released when tidal flow is restored. Our research is designed to obtain a thorough "before" picture of contaminants in lobsters from the area, so that we have the capacity to detect any changes that come about as a result of this project. We want to collect sub-adult lobsters, carapace length 55-70 mm, as well as juvenile lobsters, CL 15-35 mm. Contaminants will be measured in these animals, along with some commercially sized market lobsters that we will purchase from the fishermen.

The reason we are analysing three size classes of lobsters is that the contaminants (dioxins and furans, and heavy metals such as cadmium, mercury) are known to bio accumulate, which means that the older an organism is, the higher the body burden of contaminants. Adult lobster are also known to travel considerable distances, which can make assessing regional contaminants challenging. Sub-adult and juveniles travel less, so contaminants levels may reflect local conditions better. We are also trying to develop a bioassay or test for effects of contaminated sediment on juvenile lobster behaviour. This could be a very useful screening tool to use in this project, and others that involve contaminated sediment.

THE FOLLOWING CONDITIONS APPLY TO THIS LICENCE:

The following persons are authorized to carry out activities under the authority of this licence:

Name	Organization	Telephone
Ella Maltby	M.Sc. student, St. Francis Xavier University	(902) 318-2739
Dr. Russell Wyeth	St. Francis Xavier University	(902) 318-0250
Michael Gerhartz	Easy Dive Canada ltd.	(902) 345-2215
Kevin Prosper	Fisherman, Brittney D	(902) 921-0396
Anthony Nicholas	Fisherman, Miss Sierra	(902) 759-0548
John Gavin	Fisherman, Game Changer	(902) 872-0906

AUTHORITY TO FISH

Fishing activities carried out under the authority of this licence shall only be conducted under the direct supervision of the licence holder or authorized individuals as listed above. The licence holder is responsible to ensure that an authorized individual is present during any fishing activity authorized under this licence. Persons working under the authority of this licence shall carry a copy of the licence while conducting fishing activities and while in possession of fish caught or fishing gear used for fishing under the authority of this licence. The operator of a vessel or persons authorized to carry out fishing activities shall produce this licence upon request by a fishery officer or fishery guardian for inspection.

AREA OF ACTIVITIES

Fishing activities carried out under the authority of this licence shall only be conducted in the following areas:

The first site is the mouth of Pictou harbour, in what is known as Pictou Road. This is in the zone where effluent has been released for the last 60 years, and we would expect that contaminants are will be highest in this region. We will be going out with a local fisherman, Anthony Nicholas, as part of his normal fishing activity, and collecting the sublegal lobsters from his traps. The juvenile lobsters from this site will be collected by scuba.

In order to have some reference sites to compare results with, we are also sampling at a site approximately 20 km to the east, off Big Island, which will have similar geology but should be well outside of any influence of effluent. At this site, we will be accompanying Kevin Prosper, as part of his normal fishing activity, to collect the sub-adult lobsters. The juveniles will be collected by scuba.

Our third site is Ballantynes Cove, approximately 60 km to the east, which should be completely away from any industrial influence. We will be accompanying John Gavin, as part of his normal fishing activity, at this site to collect the sub-adults. Ballantynes Cove is also where we will be collecting our juveniles that we will develop the bioassay with, and all juveniles will be collected by scuba (30 for contaminants sampling, 36 for bioassay development). All lobsters collected for contaminants work will be placed in coolers on crushed ice, and driven directly after collection to Maxxm laboratories in Dartmouth, NS for the contaminants analysis. We will be collecting 20 sub-adults and 30 juveniles because contaminants are measured in the hepatopancreas of the lobster, and there is a minimum amount of grams needed to carry out the analysis. The juveniles used in the bioassay experiments will be held in the animal care facility at StFX. Because lobsters held in our facility could pick up some disease or parasite from other organisms, all juveniles will be euthanized after use.

See Annex B

SPECIES

Only the minimum number of species required to complete the survey or supply research samples shall be retained as specified below. All other organisms shall forthwith be returned to the place from which they were taken and where they are alive in a manner that causes them the least harm.

Species	Size	Number to be Caught and Sampled		
		Caught	Released	Retained
American Lobster	CL 55-70 mm	60	0	60
American Lobster	CL 15-35 mm	126	0	126

SAMPLES

No collection activity shall occur when water temperatures exceed 20 degrees Celsius in order to minimize the stress on fish due to high water temperature.

The specimens will be released as soon as they are identified, counted and measured. At each of our three sites, we will accompany commercial fishermen during their normal fishing activities, and select 20 sub-adults

(CL 55-70) from their catch. These lobsters will be held in a cooler on crushed ice, and as soon as the boat docks, we will deliver the cooler directly to Maxxam laboratories in Dartmouth, NS for contaminants analysis. At each of the three sites, we will also be collecting 30 juveniles (CL 15-35) by scuba. These will also be held on ice in coolers, and delivered directly to Maxxam laboratories. The reason we need more juveniles than sub-adults is that contaminants in lobsters are generally measured in the hepatopancreas (known as the tamale), and there is a minimum amount required to carry out the analysis. The anaylsis of these lobsters will give us an excellent "before" picture of contaminants in lobsters from this region of the Northumberland Strait. In Ballantynes Cove, we will also be collecting 36 juveniles for use to develop a bioassay. These lobsters will be housed in three separate recirculation tanks (12 in each) in our animal care facility. In one tank, the lobsters will be housed on clean sediment. In the other two tanks, the lobsters will be held on sediment that has been "spiked" with a medium and a high concentration of contaminants. After three months, these lobsters will be tested for three different behavioural measures, the tailflip escape response, use of shelter, and foraging. If we see reduced performance in either treatment compared to the control lobsters, we can develop a biological test for the toxicity of sediments, which will have ecologically relevant findings that affect survival of juvenile lobsters. All juveniles will be euthanized after use by the Clove Oil method.

PROTECTION OF MARINE MAMMALS AND NORTH ATLANTIC RIGHT WHALES

Reducing the amount of rope floating on the surface of the water

No rope attaching a trap to a primary buoy shall remain floating on the surface of the water after the trap has been set.

If fishing with a primary and secondary buoy:

- A maximum of 2.7 meters of rope shall be used when attaching a primary buoy to a secondary buoy.

Note: A primary buoy is defined as a buoy or other floating device attached to a trap. A secondary buoy is defined as a buoy or other floating device attached to a primary buoy.

Requirement to report lost gear

While fishing under this licence, the licence holder/operator shall report lost gear to Fisheries and Oceans Canada. The following information shall be declared by email: DFO.GLF.Gear-Engins.GLF.MPO@dfo-mpo.gc.ca within 72 hours of noticing that the gear has been lost:

a) sequence number of tag attached to the **gear** that has been lost;
b) vessel registration number or VIN
c) latitude and longitude of last known position of lost **gear**; and
d) date the **gear** was last fished.

Marine Mammal Interaction Reporting

a) The licence holder/operator shall provide information regarding all lethal and non-lethal marine mammal interactions during fishing trips;

b) For the purpose of subsection a), lethal and non-lethal interactions include bycatch, collision and all sightings of marine mammals entangled in fishing gear;

c) The licence holder/operator must complete the DFO Marine Mammal Interaction Form and it must be submitted as per the instructions provided on the form.

Reporting sightings of whales

The licence holder/operator must report any sightings of live and free-swimming whales to 1-844-800-8568 or xmarwhalesightings@dfo-mpo.gc.ca.

DISPOSITION OF RETAINED FISH

Where the retention of fish is authorized in the "SPECIES" section of this licence, it shall not be used for human consumption and shall not be sold.

GEAR

To prevent the transfer of disease and non-native organisms into water bodies, it is mandatory that all gear and equipment (including waders, nets, electrofishing cathode, anode, and buckets) that go in the water be cleaned, disinfected and decontaminated before transferring from one body of water to another.

You are authorized to use the following fishing gear:

Gear Type	Specifics	Mesh Size	Number of Units	Tended?
lobster fishing traps			As per regulatory and condition of licence requirements of commercial fisher in LFA 26A	No
Scuba Gear	Normal Compressed air tank		2	Yes
Small Handheld Dip net		1 cm square	1	Yes

GEAR IDENTIFICATION

All fishing gear that is set and left unattended shall be identified with the name of the licence holder, contact telephone number, and licence number that shall be painted on or otherwise securely affixed to a tag, float or buoy attached to the gear and be legible and readily visible at all times without the necessity of raising the gear from the water.

VESSEL IDENTIFICATION

Activities carried out under the authority of this licence shall only be conducted using the following fishing vessel:

Vessel Name	VRN
Brittany D	156388
Miss Sierra	159260
Game Changer	161847

PERIOD OF ACTIVITY

This licence is valid from **May 20, 2018** to **September 30, 2018**.

NOTIFICATION REQUIREMENTS

Prior to commencing activities authorized under the authority of this licence, the licence holder or delegate must provide the Field Supervisor at the nearest Conservation and Protection office with the time and the location the activities are to be carried out and the details of the activities. Annex "A" is a list of all Conservation and Protection offices in the Gulf Region.

REPORT REQUIREMENTS

A summary report on the project activities must be submitted to the Chief, Licensing, Fisheries and Oceans Canada, P.O. Box 5030, Moncton, NB, E1C 9B6 within 4 weeks of the expiry date of this licence.

ISSUED AT MONCTON, NB

May 15, 2018

Date

Martin Bégère

DFO Authorized Person

Signature of Licence Holder

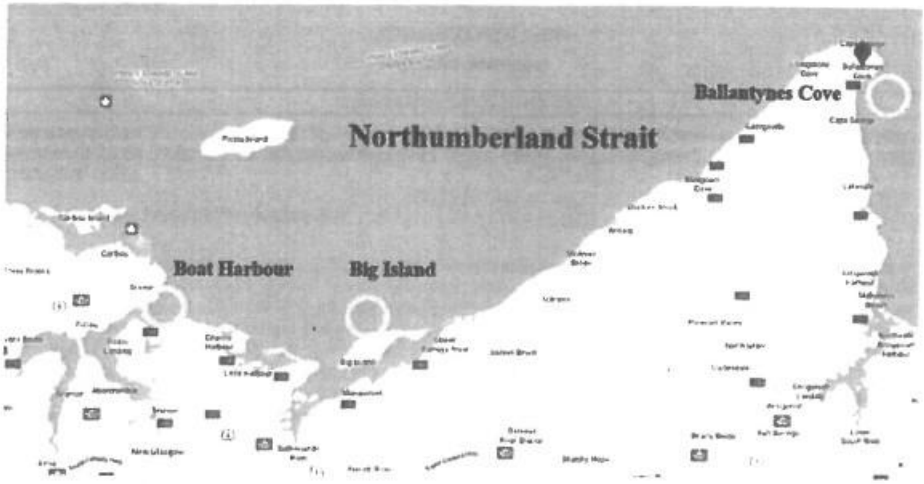
Licence not valid unless signed by DFO Authorized Person and Licence Holder.

ANNEX "A"

Field supervisors are to be notified of all fishing activities before they take place.

Office	Telephone	Facsimile
NOVA SCOTIA		
Antigonish	(902) 863-1142	(902) 863-7072
Chéticamp	(902) 224-4213	(902) 224-2579
Pictou	(902) 485-8667	(902) 485-1117
NEW BRUNSWICK		
Baie Ste-Anne	(506) 228-4263	(506) 228-6246
Beresford	(506) 542-7485	(506) 542-7480
Caraquet	(506) 727-3038	(506) 727-4616
Charlo	(506) 684-2202	(506) 684-2103
Grand Sault	(506) 473-3993	(506) 473-3947
Néguac	(506) 776-3307	(506) 776-1182
Renous	(506) 622-5992, 6315	(506) 622-0129
Richibucto	(506) 523-4606	(506) 523-8274
Shédiac	(506) 533-5030, 5033	(506) 533-5031
Shippagan	(506) 336-6474	(506) 336-6429
South Esk	(506) 773-3268	(506) 773-7015
PRINCE EDWARD ISLAND		
Alberton	(902) 853-2297	(902) 853-3822
Charlottetown	(902) 566-7831	(902) 626-4999
Souris	(902) 687-1485	(902) 687-3590
Summerside	(902) 888-4001	(902) 888-4003

ANNEX B


Ballantynes Cove
Northumberland Strait
Boat Harbour
Big Island