NOVA SCOTIA
Environment

Comment Index

Realignment of Marine Drive (Highway 316)

Publication Date: April 29, 2021

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NOVA SCOTIA

Department of Environment
and Climate Change

Suite 2085
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File No: 40100-30-314

Date: March 24, 2021

To: Environmental Assessment Branch

From: Air Quality Unit

Subject: Realignment of Highway 316, Pieridae Energy Project

Introduction

Further to your request, the Air Quality Unit provides the following comments with respect to the Air Quality sections of the Class I Environmental Assessment Registration Document (EARD), titled “Environmental Assessment Realignment of Marine Drive Highway 316 Environmental Assessment Registration Goldboro LNG Project, Pieridae Energy (Canada) Limited”, dated March 2021, for the above-mentioned project:

Comments

1) Given the historic mining activity and resultant contamination in the area, the proponent should conduct ambient air monitoring during construction of the road to ensure effectiveness of dust control measures. Monitoring results should be compared to relevant ambient air quality criteria. In the absence of Nova Scotia adopted ambient air quality criteria, the proponent should utilize criteria from Federal and/or other Provincial jurisdictions. A proposed Ambient Air Monitoring Plan should be included in the Application for Approval under the Activities Designation Regulations. This plan should include but not be limited to sampling locations, parameters to be measured, monitoring methods, protocols and frequency.

2) Any Environmental Assessment Approval issued for this project should include a Condition that requires the proponent to monitor noise at the request of the Department.

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NOVA SCOTIA

Environment

Date: March 29, 2021

To: Environmental Assessment, Nova Scotia Environment

From: Climate Change Unit

Subject: Realignment of Marine Drive Project

Climate Change Mitigation

The proposed LNG facility is expected to be a major source of greenhouse gas emissions in Nova Scotia. Part of the original Environmental Assessment approval of the Goldboro LNG facility included the condition to prepare and receive approval for a Greenhouse Gas Management Plan. That plan is still outstanding.

The current proposal to re-align the highway is not expected to significantly change the overall greenhouse gas emissions profile associated with the project.

Climate Change Adaptation

The proponent noted that climate change and severe weather will be considered in the Project design; particularly in the engineering of the water management infrastructure. Projections for climate data can be found at climatedata.ca. For advice on which climate projections to use for this context, please contact the Canadian Centre for Climate Services at Environment and Climate Change Canada. https://www.canada.ca/en/environment-climate-change/services/climate-change/canadian-centre-climate-services.html Other guidance on climate change adaptation considerations can be found in the Nova Scotia Climate Change EA Guide (2011).

NOVA SCOTIA

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MEMORANDUM

DATE: **March 30, 2021**

TO:

FROM: **Manager Protected Areas and Ecosystems**

SUBJECT: **Realignment of Marine Drive, Environmental Assessment**

The Protected Areas and Ecosystems Branch have reviewed the Environmental Assessment Application for the Realignment of Marine Drive.

Protected Areas and Ecosystem Comments:

As there are no protected areas in the vicinity of this project, no impacts to protected areas are anticipated.

Health Canada Santé Canada

Environmental Health Program
Regulatory Operations and Regions Branch
1505 Barrington Street, Suite 1817
Halifax, NS B3J 3Y6

March 30, 2021

Jeremy Higgins
Policy, Planning and Environmental Assessment
Nova Scotia Environment and Climate Change
1903 Barrington St. Suite 2085
Halifax, NS, B3J 2P8

Subject: Health Canada's Response – Review of the Realignment of Marine Drive Highway 316 Environmental Assessment Registration Document[1]

Dear Mr. Higgins,

Thank you for your e-mail dated March 4, 2021 requesting Health Canada's review of the above-mentioned Environmental Assessment (EA) Registration document[1] with respect to issues of relevance to human health. Health Canada has reviewed the document and is providing the following information with respect to noise, air quality, water quality, and country foods.

<u>Atmospheric Environment:</u>

Noise:

The registration document states:

"*A Provincial Guideline was developed to facilitate the evaluation of noise pollution in the environment and establish acceptable sound levels. (…) The guidelines for acceptable equivalent continuous sound levels (Leq) are: Leq of 65 dBA between 0700 to 1900 hours; Leq of 60 dBA between 1900 to 2300 hours; and Leq of 55 dBA between 2300 to 0700 hours.*"

The document also states:

[1] Pieridae Energy Canada Limited Environmental Assessment Registration for the Realignment of Marine Drive Highway 316. 2021. November.

Sent by e-mail to EA@novascotia.ca; Jeremy.Higgins@novascotia.ca

"*If required, noise monitoring at receptor location(s) will be conducted in response to complaints.*"

While the project is located in Nova Scotia (NS) and NS has developed a provincial guideline for acceptable sound levels, Health Canada (HC) encourages proponents to consult its guidance for evaluating noise impacts on human health (Health Canada, 2017)[2], including national and international standards..

- HC recommends the use of Percent Highly Annoyed (%HA), a widely accepted indicator of the human health effects of long-term project noise exposure (more than one year).

- For night-time noise associated with a project, HC recommends considering the World Health Organization's (WHO) guidelines regarding sleep disturbance. The WHO's recommended annual average night-time noise level (Ln) is 40 dBA outdoors[3]. HC also recommends adjustments to these guidelines if there are sensitive receptors, such as nursing homes, located in the vicinity of the proposed project.

- HC recommends additional noise guidelines on interference with speech comprehension if there are receptors such as schools located in the vicinity of the proposed project.

- If noise complaints are received, the proponent should consider implementing additional mitigation, in addition to noise monitoring at receptor locations.

For more information on HC's guidelines relating to project noise and the use of these guidelines, please see:

Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. http://publications.gc.ca/pub?id=9.832514&sl=0

Air Quality:

The registration document states:

"*Emissions will be generated during the following construction activities: use of heavy construction equipment such as excavators, earth movers, dump trucks and graders to prepare the Site; use of heavy construction equipment to handle fill material including dumping, grading and compaction; movement of construction vehicles over unpaved road that will generate dust; operation of construction equipment that will generate exhaust emissions containing TSP, CO,*

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[2] Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

[3] World Health Organization (WHO). 2009. Night Noise Guidelines for Europe. Hurtley, C. (Ed)

CO2, NO2, SO2 and volatile organic compounds (VOCs); paving the road will generate polycyclic aromatic hydrocarbons (PAHs); and painting lines on the road will generate VOCs."

and:

"*Pieridae will implement a dust management plan for the Goldboro LNG Project. Due to its vicinity, this program will also benefit the Realignment Project. The plan also includes the implementation of a complaint protocol and follow up procedures. This will also apply to the Realignment Project.*"

- The proponent should consider ensuring that the complaint process does not only address dust, but the other fumes and air pollutants listed above as well. If complaints are received, the proponent should consider establishing additional mitigation measures for fumes as well as dust.

For additional information, please review Health Canada's guidance on air quality:

Health Canada. 2016. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Air. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. http://publications.gc.ca/pub?id=9.802343&sl=0

Drinking/ Recreational Water Quality:

The registration document identifies drinking water wells in the vicinity of the project. It is noted in *Table 8.0-1 Summary of Mitigation and Monitoring Commitments*:

"*A detailed pre-construction inventory of water wells within 500 m of the highway centreline. Pre and post-blast well surveys if blasting is required within this buffer zone.*"

and:

"*Post-construction well water monitoring if required (dependent on results of initial well survey).*"

- The registration document does not detail the type of water quality monitoring that will be conducted. The proponent should consider ensuring that monitoring includes both chemical and biological water quality, including of baseline and post-construction conditions.

Additionally, the document does not identify whether any waterbodies in the vicinity of the project are used for recreational purposes. The document states:

"*Eight (8) watercourse crossings (i.e., Crusher Brook, Betty's Cove Brook and 6 unnamed small tributaries) are located along the Realignment.*"

and:

"*Surface water was identified as a VEC based on the effects that construction, operation and maintenance may have on surface waterbodies, watercourses, and wetlands within and adjacent to the road corridor.*"

- The proponent should consider whether any nearby waterbodies are used for recreational purposes. If complaints are received, the proponent should consider establishing additional mitigation measures.

- Additionally, the proponent should consider establishing a communication plan to inform recreational water users in the event of contamination caused by an accident or spill.

For additional information, please review Health Canada's guidance on water quality.

Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Water Quality. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. http://publications.gc.ca/pub?id=9.832511&sl=0

Country Foods:

The registration document states:

"*Band members from the Paq'tnkek, Millbrook and Indian Brook First Nations are known to have also been involved in resource harvesting in the lands and waters near the ROW.*"

However, the document does not discuss whether any country foods are hunted, trapped, fished, or gathered from the area that may be impacted by the proposed project. If animals or plants present in the vicinity of the project are consumed by humans, there may be potential for impacts to country foods from accidents such as a fuel spill or from deposition of contaminants in dust or fumes.

- If there is the potential for impacts to country foods from the project, the proponent should consider establishing mitigation measures as well as a process to ensure that any complaints are collected and addressed. If complaints are received the proponent should consider implementing additional mitigation measures.

- Additionally, the proponent should consider preparing a response plan in the event of an accident or malfunction with the potential to impact country foods.

For additional information, please review Health Canada's guidance on country foods.

Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Country Foods. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. [*http://publications.gc.ca/pub?id=9.855584&sl=0*](http://publications.gc.ca/pub?id=9.855584&sl=0)

Health Canada advises that additional information related to the above topics be provided to the Nova Scotia Department of Environment and Climate Change for review. Health Canada would then be available to provide further support to the Department only if specific concerns regarding potential risks to human health related to this project arise in the future.

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

Sincerely,

Physical Sciences Officer
Health Canada, Atlantic Region

cc: , Manager, Environmental Health Program, Health Canada, Atlantic Region

Sent by e-mail to EA@novascotia.ca; Jeremy.Higgins@novascotia.ca

Impact Assessment Agency of Canada
Agence d'évaluation d'impact du Canada

Suite 200
1801 Hollis Street
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Bureau 200
1801 rue Hollis
Halifax, NE B3J 3N4

Date: March 31, 2021

To: Environmental Assessment Officer, Nova Scotia Environment

From: Environmental Assessment Officer, Impact Assessment Agency of Canada

Subject: Realignment of Marine Drive (Highway 316) Project

The federal environmental assessment process is set out in the *Impact Assessment Act* (IAA). The *Physical Activities Regulations* (the Regulations) under IAA set out a list of physical activities considered to be “designated projects.” For designated projects listed in the Regulations, the proponent must provide the Agency with an Initial Description of a Designated Project that includes information prescribed by applicable regulations (*Information and Management of Time Limits Regulations*).

Based on the information submitted to the Province of Nova Scotia on the proposed Realignment of Marine Drive (Highway 316) Project, it does not appear to be described in the Regulations. Under such circumstances the proponent would not be required to submit an Initial Description of a Designated Project to the Agency. However, the proponent is advised to review the Regulations and contact the Agency if, in its view, the Regulations may apply to the proposed project.

The proponent is advised that under section 9(1) of the IAA, the Minister may, on request or on his or her own initiative, by order, designate a physical activity that is not prescribed by regulations made under paragraph 109(b) if, in his or her opinion, either the carrying out of that physical activity may cause adverse effects within federal jurisdiction or adverse direct or incidental effects, or public concerns related to those effects warrant the designation. Should the Agency receive a request for a project to be designated, the Agency would contact the proponent with further information.

The proposed project may be subject to sections 82-91 of IAA. Section 82 requires that, for any project occurring on federal lands, the federal authority responsible for administering those lands or for exercising any power to enable the project to proceed must make a determination regarding the significance of environmental effects of the project. The Agency is not involved in this process; it is the responsibility of the federal authority to make and document this determination.

The proponent is encouraged to contact the Agency at (902) 426-0564 if it has additional information that may be relevant to the Agency or if it has any questions or concerns related to the above matters.

Thank you,

Environmental Assessment Officer, Atlantic Regional Office
Impact Assessment Agency of Canada / Government of Canada
Emily.Gregus@canada.ca / Tel: 902-229-7825

Agente d'évaluation environnementale, région de l’Atlantique
Agence d’évaluation d’impact du Canada / Gouvernement du Canada
Emily.Gregus@canada.ca / Tel: 902-229-7825

NOVA SCOTIA

Fisheries and Aquaculture

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

Date: April 7, 2021

To: Nova Scotia Environment

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

Subject: Realignment of Marine Drive (Hwy 316) - Environmental Assessment

Thank you for the opportunity to review the Realignment of Marine Drive (Hwy 316) documents.

The Department of Fisheries and Aquaculture has the following comments:

- There are no processing facilities or buying stations are in the proposed project area.
- One proposed shellfish operation and eight shellfish aquaculture sites are within 25km of the project site.
- Shifting the highway will affect driving times for some commercial Lobster fishers.
- Pieridae Energy Ltd. expects that brook trout and American eel will be affected by the project and has proposed a fish salvage program in response. The Department would be interested in reviewing the proponent’s plan before such a program begins.

NOVA SCOTIA
Agriculture

60 Research Drive
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Bible Hill, Nova Scotia
B6L 2R2

Date: April 7, 2021

To: Nova Scotia Environment

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

Subject: Realignment of Marine Drive (Hwy 316) – Environmental Assessment

Thank you for the opportunity to review the Realignment of Marine Drive (Hwy 316) documents.

Given that there is no active agriculture production within 5 km of the proposed site, the Department of Agriculture has no concerns with the proposal.

Lands and Forestry

M E M O R A N D U M

TO: NS Department of Environment

FROM: Department of Lands and Forestry

DATE: April 8, 2021

RE: Marine Drive EA Comments

The Department of Lands and Forestry (herein the Department) provides the following comments on the above project:

Crown Lands:

A portion of the new road crosses Crown land (PID 35044366). It is anticipated that the Department of Transportation and Active Transit will be requesting the transfer of administration and control for the new road from the Department of Lands and Forestry.

Any power poles or associated transmission lines that fall outside the anticipated transfer to the Department of Transportation and Active Transit, which includes any water crossings, will require approvals (easement/licence) from the Department of Lands and Forestry-Land Administration Division.

Wildlife, Wildlife Habitat and Species-at-Risk:

The Department has the following concerns:

1) **Extensive Area of Wetland Alteration**

The preferred realignment option outlined for Highway 316 will result in the loss of considerably more wetland (7.3 ha) than the other two alternate routes (1.6 and 2.2 ha) and is likely to alter the hydraulics of a far more extensive area of wetland on either side of the highway. This will result in a high net loss of area and function of wetlands. Alternative routes would result in considerably less wetland alteration (< 1/3) and as a result would have less of an impact on the species-at-risk (SAR) and Species of Conservation Concern (SOCC) birds in the area, many of which rely on wetlands and wetland fringe area for nesting.

It is suggested in Appendix A that the preferred route (green) was selected due to lowest habitat loss (29 ha vs 35 and 36 ha). However, the habitat to be impacted by the alternative routes is already heavily disturbed and has much lower habitat value than the extensive wetland area to be impacted by the preferred route. Wetlands support a wide range of ecological functions and NS has a goal of preventing no net loss in area of function of wetlands as per the *Nova Scotia Wetland Conservation Policy*.

2) Alteration of Wetland of Special Significance (WSS 22)

Wetland 22 has multiple occurrences of SAR designated under the *Nova Scotia Endangered Species Act (ESA)*, including at least four (4) occurrences of Blue Felt Lichen, records for the endangered Canada Warbler (listed under the ESA and the federal *Species at Risk Ac*t), and several species of wetland associated SOCC birds. Thus, Wetland 22 is designated as a Wetland of Special Significance (WSS). Wetland 22 will be altered by the construction of the Marine Drive realignment. The *Nova Scotia Wetland Conservation Policy* indicates that Government will not support or approve alterations to a WSS except for alterations deemed to provide necessary public function.

Wetland 22 will be further altered by the proposed laydown area expansion (laydown area 3) that would result in the infilling of large portion of Wetland 22. ***This proposed development will impact a wetland known to support SAR and alter a large area of a Wetland of Special Significance.***

3) Lichen Surveys

Lichen surveys must be undertaken by surveyors accepted by the Director of Wildlife, Department of Lands and Forestry to have demonstrated the qualifications and experience necessary to accurately identify lichen to species as per Section 4(b)i of the At-Risk Lichen Special Management Practice available here: https://novascotia.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_BFL_At-Risk-Lichens.pdf.

The EA states that the lichen surveys were undertaken by McCallum Environmental Ltd. but does not provide the name of the biologist who undertook the surveys. The Department requires the name of the lichen survey biologist be provided with their credentials to ensure they meet the accepted standards. If surveys were undertaken by an unapproved surveyor, they will need to be repeated and additional mitigation applied should further species of conservation concern be identified.

The Department offers the following recommendations for consideration as conditions for project approval:

1) Prior to commencement of the Project, the Approval Holder shall provide Nova Scotia Department of Lands and Forestry, Wildlife Division with digital way points and shape files showing precise locations for wetlands and species listed under the *Species at Risk Act* and/or *Endangered Species Act* as well as all S1, S2 and S3 listed species under the Atlantic Canada Conservation Data Center, identified during field work within the area of the Project. The data provided to the Department of Lands and Forestry must include date, species, observer name and habitat description. Written confirmation from the Department of Lands and Forestry is required indicating all GIS data has been provided in an appropriate format.

2) The Approval Holder shall clear vegetation outside of the breeding season for most bird species (April 15 to August 30), unless otherwise authorized in writing by the Department.

Vegetation clearing shall be recorded in a daily log that shall be available for review by the Department indicating the date and time of the clearing operation and the contractor.

3) Should a raptor nest be observed on-site, the Department of Lands and Forestry, Wildlife Division should be contacted to determine a suitable no-disturbance buffer until the nest becomes inactive. Raptors and owls breed and nest from February to August and are protected under the *Nova Scotia Wildlife Act*.

4) A 100 m no-disturbance buffer must be applied to all occurrences of Blue Felt Lichen identified on site as per the *At-Risk Lichens Special Management Practices* https://novascotia.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_BFL_At-Risk-Lichens.pdf. No roads, trails, clearing or other disturbance shall occur within this 100 m buffer. Tree removal within the 100 m buffer would only be allowed in exceptional circumstances following written approval by the Department of Lands and Forestry. If a 100 m buffer cannot be applied, a written submission to Wildlife Division, Department of Lands and Forestry outlining a rationale for disturbing a lichen buffer is required.

5) It appears as many as 18 abandoned mine openings are in the development footprint at the western end of the road realignment. Calls of unidentified *Myotis sp.* bats were recorded on Anabat detectors during surveys in 2018 and 2020 and could potentially be roosting in abandoned mines. All abandoned open mines must be assessed for potential use by bats prior to disturbance. Should any prove to be suitable for use by bats, additional monitoring must be undertaken and mitigation implemented to ensure Myotis sp. are not killed, injured, or disturbed, nor the dwelling destroyed, disturbed or interfered with in compliance with the *Nova Scotia Endangered Species Act*.

6) Monitoring protocols established for SAR and SOCC birds, bats, and the mainland moose for the Goldboro LNG Project shall be expanded to include the footprint of the Marine Drive Highway 316 Realignment.

7) **Prior to commencement of the Project, the Approval Holder shall develop, in consultation with the Department of Lands and Forestry, a Wildlife Management Plan to address the following points**:

   a) Detail a clear approach for providing training and identification information in the form of photos and descriptions of SAR species and sensitive habitat features (e.g. raptor nests) to personnel working on site and the procedures to follow should SOCC or SAR species be encountered on site.
   b) Detail effective management responses and procedures for what to do when a species at risk is observed within the approved operational area. The plan should include specific responses for encounters with mainland moose, wood turtles and snapping turtles and their nests, and SAR birds and their nests.
   c) Establish a clear communication procedure for reporting observations of SAR and SOCC species and unexpected observations on site to project managers and to the Wildlife Division, Department of Lands and Forestry.
   d) Provide a plan to demonstrate how the proponent will address changes to SAR listings during the operational duration of the project. Additional biodiversity and

SAR surveys may be required periodically to ensure no impacts to SAR or biodiversity under revised and updated legislation.

e) Provide a plan detailing how the occurrences of Blue Felt Lichen will be protected on site and monitored for health and condition throughout the duration of the project.
f) Detail measures to manage non-native (alien invasive) plant species and noxious weeds during all Project phases.
g) Provide a plan for human-wildlife conflict training to avoid bear and coyote interactions and measures to be taken should an encounter occur. The plan should include measures to mitigate attracting nuisance wildlife to the site.

Prior to commencement of the Project, the Approval Holder must obtain approval of the Wildlife Management Plan from the Department of Lands and Forestry. **The Wildlife Management Plan must be implemented as approved.**

NOVA SCOTIA

Environment & Climate Change
Inspection, Compliance & Enforcement Division

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Date: 07-Apr-21

To: Environment Assessment Branch, Nova Scotia Environment

From: Environment Inspector, NSECC, Inspection, Compliance & Enforcement Division

Subject: Realignment of Marine Drive (Hwy 316) Project

- Any watercourse alterations will require a Notification or Approval as per the Activities Designation Regulations (ADR).

- Watercourse alterations done under Notification/Approval will have to be installed as per the Nova Scotia Watercourse Alteration Standard unless otherwise approved by NSE.

- Watercourse alterations done under Notification/Approval will have to be designed by a certified sizer and installed by a certified installer.

- Wetland Alteration(s) will require an Approval under the ADR.

- An Erosion and Sedimentation Control plan must be submitted and accepted by NSE prior to construction.

NOVA SCOTIA

Environment

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Date: April 08, 2021

To: Environmental Assessment Officer, Nova Scotia Environment and Climate Change

From: Regional Engineer, Inspection, Compliance and Enforcement Unit

Subject: Realignment of Marine Drive (Hwy 316) Project

I had limited time to review, so only have the following comments:

- The document relies heavily on Transportation and Active Transit (previously TIR) documents and specifications. For erosion and sediment control (e.g., Section 2.10.2) they should also include Nova Scotia Environment's *Erosion and Sedimentation Control Handbook for Construction Sites*.

- In Section 4, under the Activities Designation Regulation there is also the possibility of watercourse alteration permits, and potentially a quarry approval if they require blasting and additional material from outside of the roadway.

I believe all other concerns could be addressed via the Environmental Assessment terms and conditions, if approved, and additional regulatory approvals and authorizations.

NOVA SCOTIA
Department of Transportation
and Active Transit

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Bus: 902-424-2297
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tpwpaff@novascotia.ca

Date: April 8, 2021

To: Nova Scotia Environment

From: Chief Engineer

Subject: Environmental Assessment
Realignment of Marine Drive (HWY 316)
Environmental Assessment Registration
Goldboro LNG Project
Pieridae Energy (Canada) Limited

Transportation and Active Transit staff have reviewed and prepared the attached comments on the Environmental Assessment Registration for the Realignment of Marine Drive (HWY 316) as part of Pieridae Energy Ltd.'s Goldboro LNG Project.

Sincerely,

Chief Engineer

General Comments

1. The general location of the proposed road realignment is acceptable to NSTAT.

2. The preliminary profile provided appears generally reasonable for this stage of project development, however; refinements would be expected through the detailed design review process.

3. As part of the detailed design review and approval process, detailed design plans shall be provided to NSTAT for review at key stages of design development (50%, 90%, 100%) and shall be in compliance with NSTAT standards, TAC guidelines and generally accepted best practices for road design. The road design shall be based on a design speed of 80 km/h and Major Collector (Type E) Functional Classification, WB-21 Design Vehicle and include widened paved shoulders for active transportation in compliance with NSTAT's AT guidelines. Design plans shall include, but are not limited to, the following: Plan-Profile Drawings, Cross Sections, Drainage Design & Stormwater Management Plans, Standard Details (as required), Design Checks Package (for intersection sight distance measurements, truck turning templates, drainage calculations, etc.), Signage and Pavement Markings Plans, and any other plans as required to construct the project in accordance with the design intent.

4. If contaminated soils/groundwater/surface water or sulphide bearing material (as defined by the Contaminated Site Regulations or Sulphide Bearing Material Disposal Regulations, respectively) are encountered during construction on the road, they are to be removed from the full right-of-way corridor and managed off-site in accordance with the regulations.

Section 2.2 - The Roadway, Intersections, Page 7

1. There is a reference to Appendix B for a detailed road design (plan and profile Figure B-2) and approximate cut and fill areas (Figure B-3), however there is no label for Figure B-2 or B-3.

Table 2.7.1 - Construction Activities: Finishing Page 13

1. Any work zones created on any provincially owned roads will need to comply with the relevant portion of the Nova Scotia Temporary Workplace Traffic Control Manual. Table 2.7.1 identifies excavation activities which will require Traffic Control Plans. These plans will need to be approved by the Traffic Authority.

Table 5.3-1 - Projected 2013, 2017 and 2024 Background DHV's, Page 68

1. The methodology and explanation with regards to Design Hourly Volumes (DHV) is not consistent. The table footnotes indicate a specific methodology, and this is not consistent with the previous paragraph's explanation. Additionally, DHV's appear to be compared with Annual Average Daily Traffic (AADT), however; these are not values that can be compared directly. Also, there are statements made about volumes being low to moderate, while also stating AADT volumes for busy two-lane roads.

Section 6.6.3 - Mitigation Measures: Operation and Maintenance Phases, Page 96 and Table 6.6-1 "Residual Effects – Terrestrial Wildlife", Page 98

1. This section indicates the possibility of reducing speed limits due to the possibility of wildlife collisions. Restricting speed limits will not be appropriate for this purpose, however; if there is a significant possibility of wildlife collisions, warning signs could be erected as per Departmental Policy.

2. The speed limit for the new alignment should be kept at 80 km/h and have appropriate curve warning signage installed where necessary. Due to low traffic volumes, the justification for a climbing lane should be expanded upon.

Section 6.14.4 - Vehicular Collisions, Page 126

1. This section references a Traffic Management Plan which pertains to lights and warning lights in a contingency plan. There is another reference to the plan in the questions in Section 7.0 (specifically Question 14). These references should be expanded upon.

MEMO

To: **EA Officer**

Fr: **Environmental Health, NSECC**

Date: **April 8, 2021**

Subject: **Highway 316 Realignment EARD**

The Environmental Health Program has undertaken a public health focused review of the above-noted EARD, and we are pleased to provide the following comments related to the proposed realignment of Hwy 316.

Groundwater

The EARD describes potential adverse effect to groundwater related to the proposed undertaking which may impact drinking water wells located nearby. Adverse groundwater effects may include impacts to well water quality and quantity related to a number of activities associated with the proposed undertaking, and is described in the EARD.

Access to a reliable and safe supply of drinking water is fundamental to good health. Adverse impacts to drinking water quality can contribute to acute and chronic disease in exposed individuals. Adverse effect to water quantity in wells could force individuals to source alternative drinking water supplies that are unsafe for human consumption.

Recommendation:

Approval of the proposed undertaking should be contingent on the proponent developing a plan for the identification, investigation, and mitigation of adverse impacts to well water quality and quantity associated with the project, including replacement of wells that are adversely impacted. The plan should include,

- Baseline testing of wells for water quality and quantity prior to construction.
- Monitoring and testing of well water quality and quantity during construction and post-construction for a specified time period.
- Development of a Complaints Handling Procedures for the proponent to receive and respond to residents’ complaints related to well water impacts.
- Commitment from the proponent to investigate and mitigate, in a timely manner, adverse well water impacts related to the project, including well replacement where necessary.

Acoustic Environment

Section 6.4, page 87 of the EARD discusses the adverse impacts of noise on nearby receptors. Here the authors describe that the degree to which noise impacts receptors is largely dependent on the degree to which noise exceeds normal or background levels in a particular area, and less dependent on the overall magnitude of the noise.

Citing Cowan, 1994, the report states,

> In general, the more a new sound exceeds the previously existing ambient noise level, the less acceptable the new sound will be judged by those hearing it. A new source of sound will be perceived as more aggravating in a quiet area than it would be in an area with more ambient background sound

In determining the level of significance of residual noise impacts the authors adopt *NSE Guidelines for Environmental Noise Measurement and Assessment (2005).* These guidelines describe the maximum acceptable noise levels for specific time periods throughout the day. They do not consider the degree to which predicted or actual noise levels exceed normal background noise levels.

Recommendation:

Given the location of the proposed undertaking is positioned in rural or semi-rural area, adopting noise guidelines that considers the degree to which noise exceeds normal levels would offer greater protection against negative noise impacts among residents. Health Canada has published such guidance titled *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise.* A link to the document is pasted below.

https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidance-evaluating-human-health-impacts-noise.html

Regards.

NOVA SCOTIA
Environment

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

Date: April 9, 2021

To: Nova Scotia Environment

From: Resource Management Unit – Contaminated Sites

Subject: Realignment of Marine Drive (HWY 316) Project

Contamination identified in soil, sediment and surface water will have to be Notified assessed/delineated and managed according to the Contaminated Sites Regulations.

Contaminated media which can't be managed on-site must be transported to an approved treatment or disposal facility.

If conditional closure is requested, written consent must be obtained from any affected 3rd party property owners.

Date: 2021-04-09

To: Nova Scotia Environment & Climate Change

From: Nova Scotia Office of L’nu Affairs

Subject: Goldboro LNG Project - Realignment of Marine Drive (Highway 316)

The Nova Scotia Office of L’nu Affairs (OLA) has reviewed the Environmental Assessment Registration Document (EARD) for the proposed Goldboro LNG - Realignment of Marine Drive (Highway 316) Project, submitted by Pieridae Energy Limited on March 10, 2021. The following review considers whether the information provided 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 5.3.4 First Nations Communities (p.68)
This section states that a Mi’kmaq Ecological Knowledge Study (MEKS) was prepared for the EA for the proposed Goldboro LNG Facility in 2013. The Nova Scotia Office of L’Nu Affairs (OLA) understands that the 2013 MEKS was not undertaken in accordance with the Assembly of Nova Scotia Mi’kmaw Chief’s MEKS Study Protocol. We also understand that the 2013 MEKS is considered out of date as the Assembly’s Protocol states that a new MEKS is required where a previous MEKS for the same study area is more than five years old.

Given the above, there is insufficient information to determine whether the proposed Realignment of Marine Drive Highway 316 Project will potentially adversely impact established and/or asserted Mi’kmaw Aboriginal and Treaty rights.

Section 5.3.5 Heritage/Archaeological Resources (p. 69)
This section states that “based solely on the desktop review, without field verification, no registered heritage/archaeological resources were identified within the Realignment ROW. However, eight areas with moderate potential for undiscovered archaeological resources are within the proposed ROW. These EPAs are associated with all mapped watercourses, which have potential for Indigenous resources and with possible historic mining sites within one section of the proposed Realignment ROW”.

As part of the mitigation measures for cultural and archaeological resources offered in Section 6.13.3, the Proponent states that continued engagement with representatives of the Indigenous community (KMKNO) will occur.

Given the moderate potential for undiscovered archaeological resources within the proposed Realignment ROW, OLA recommends that prior to construction, the Approval Holder work with CCH and the KMKNO to develop an archaeology and heritage resources monitoring and contingency plan. This recommendation aligns with the EA Term and Condition 5.5 for the Goldboro LNG – Natural Gas Liquefaction Plant and Marine Terminal Project which was approved in 2014.

Section 6.7.3 Terrestrial Habitat and Flora – Mitigation Measures (p. 101)
Potential adverse impacts to generally asserted Aboriginal and/or Treaty Rights (ATR) and/or general concerns that potential introduction of non-native and invasive plant species that may have an adverse effect on the abundance and diversity of native flora including at-risk Blue felt lichen.

Section 6.8.2 Wetlands – Potential Interactions and Effects (p. 106)
Potential adverse impacts to generally asserted ATR and/or general concerns related to wetland function and species diversity at 32 impacted wetlands (including one WSS) within the Study Area.

Section 6.9.2 Aquatic Environment – Potential Interactions and Effects (p. 116)
Potential adverse impacts to generally asserted ATR and/or concerns that construction, operation, and maintenance may result in adverse effects on fish and fish habitat.

Section 6.10.2 Species at Risk – Potential Interactions and Effects (p. 121)
Potential adverse impacts to generally asserted ATR and/or general concerns that construction activities may result in adverse effects on species at risk including mortality. Effects may extend to adjacent lands.

Section 6.12.2 Traditional Use of Lands and Resources – Potential Interactions and Effects (p. 123)
This section states that extensive engagement with the Mi’kmaq of Nova Scotia has been completed related to this project and that based on the feedback obtained through this engagement as well as information contained in the 2013 MEKS that there are no anticipated significant adverse effects on traditional use of land and resources. This statement does not align with information received from the Mi’kmaq of Nova Scotia through the Crown consultation process.

The Mi’kmaq of Nova Scotia have advised that this area has been used for traditional purposes such as hunting, fishing, and gathering. Given the potential for adverse impacts to Rights and/or potential concerns outlined above, OLA recommends that any mitigation and/or environmental management plans, particularly for native flora, wetlands, fish and fish habitat, and species at risk, be developed in coordination with the Mi’kmaq.

Section 7.2 Consultation with the Mi’kmaq of Nova Scotia (p. 133)
This section that both Sipekne’katik and Millbrook are part of the Assembly of Nova Scotia Mi’kmaq Chiefs. This statement is incorrect. Millbrook and Sipekne’katik both consult outside the Assembly (KMKNO). OLA has previously provided advice and assistance to Pieridae Energy Ltd. regarding engagement with the two communities that consult outside the Assembly. Given this, it is recommended that any terms or conditions that relate to the Mi’kmaq of Nova Scotia clearly state that they apply to communities that engage outside the Assembly as well as the Assembly communities.

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

April 9, 2021

Environmental Assessment Officer
Nova Scotia Environment and Climate Change
1903 Barrington St., Suite 2805
Halifax, NS   B3J 2P8

RE: Realignment of Marine Drive (Highway 316), Goldboro LNG Site, Guysborough County Nova Scotia

Environment and Climate Change Canada (ECCC) has reviewed the Environmental Assessment Registration for the proposed realignment of Marine Drive (Highway 316) submitted by Pieridae Energy in relation to the Goldboro LNG Project. The following comments are offered for consideration in the environmental assessment:

Wildlife and Wildlife Habitat

ECCC-01: General

Section 3.4 Effects Assessment, quote: "*The environmental effects assessment was conducted in a stepwise fashion involving:*

- *Prediction and assessment of Project-related environmental effects;*
- *Identification of mitigation measures (avoidance, mitigation, compensation, offsetting); and*
- *Determination of residual effects and their significance.*"

Section 3.4.3. Mitigation Measures, further describes quote: "*In those instances where an adverse effect is unavoidable and cannot be mitigated to insignificant levels, options for compensation /offsetting were investigated.*"

It remains unclear how these principles have been applied in the environmental assessment (EA) of this project since these steps where not fully described in the registration document or appendices.

For example, Appendix A – Review of Realignment Alternatives, describes three different alternative routes; however, it does not appear that avoidance of species at risk (SAR) and their habitats was considered as part of the decision-making process for the preferred route selection. While it is stated in Appendix A that "*effects can be effectively mitigated/compensated*", mitigation measures and compensation plans associated with habitat loss have not been included for review.

The EPP is also referenced as mitigation throughout the report however, it is also not included for review as part of the EA.

In the absence of this information, ECCC-CWS cannot assess whether potential impacts have been adequately mitigated, and significance determinations cannot be justified.

Recommendation: ECCC-CWS recommends that all reference documents used to justify significance determinations be provided for review as part of the EA.

ECCC-02: Migratory Birds

Migratory birds, their eggs, nests, and young are protected under the *Migratory Birds Convention Act* (MBCA). Migratory birds protected by the MBCA generally include all seabirds (expect cormorants and pelicans), all waterfowl, all shorebirds, and most landbirds (birds with principally terrestrial life cycles). The list of species protected by the MBCA can be found at https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legal-protection/convention-act.html. Bird species not listed may be protected under other legislation.

Under Section 6 of the *Migratory Birds Regulations* (MBR), it is illegal to disturb, destroy or take a nest or egg of a migratory bird; or to be in possession of a live migratory bird, or its carcass, skin, nest or egg, except under authority of a permit. It is important to note that under the MBR, no permits can be issued for the disturbance or harm of migratory birds caused by development projects or other economic activities.

Furthermore, Section 5.1 of the MBCA describes prohibitions related to depositing substances harmful to migratory birds:
"5.1 (1) No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area.
(2) No person or vessel shall deposit a substance or permit a substance to be deposited in any place if the substance, in combination with one or more substances, results in a substance – in waters or an area frequented by migratory birds or in a place from which it may enter such waters or such an area – that is harmful to migratory birds."

It is the responsibility of the proponent to ensure that activities comply with the *Migratory Bird Convention Act* and regulations. In fulfilling its responsibility for MBCA compliance, the proponent should take the following points into consideration:

- Information regarding regional nesting periods can be found at: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods.html. Some species protected under the MBCA may nest *outside* these timeframes. For active nests or birds caring for pre-fledged chicks discovered during project activities *outside* the regional nesting period, risks can be minimized by measures such as the establishment of vegetated buffer zones around nests, and minimization of activities in the immediate area until nesting is complete and chicks have naturally migrated from the area.

- While most migratory bird species construct nests in trees (sometimes in tree cavities) and shrubs, several species nest at ground level (e.g., Common Nighthawk, Killdeer, sandpipers), in hay fields, pastures or in burrows. Some species may nest in caves and cliff ledges (e.g., Barn Swallow).
- Some bird species may nest in stockpiles of overburden material (e.g., Bank Swallow).
- Some species may nest near headponds or impoundment areas created by restricted flow pathways caused by beaver dams, historical infilling, and/or restricted hydrology.

It is incumbent on the proponent to identify the best approach, based on the circumstances, to complying with the MBCA. Further information can be found at: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html

Recommendation: It is understood that the proponent plans to conduct clearing activities outside of the regional nesting period (April 10-August 31). Construction activities resulting in changes of water levels (e.g. beaver dam removal, infilling of wetlands, placement of culverts) should also be scheduled outside of the regional migratory bird nesting season to avoid potential impacts (e.g. drying out of habitat or flooding of nests) on ground-nesting birds.

Recommendation: If there is a delay between clearing activities and access road construction activities, some ground nesting species of migratory birds, including the threatened Common Nighthawk, may be attracted to previously cleared areas for nesting. In such a case, nest surveys of the cleared areas may be carried out successfully by skilled and experienced observers using appropriate methodology. Should any nests or unfledged chicks be discovered, it is expected that these are protected by an appropriate-sized buffer.

ECCC-03: Noise

Anthropogenic noise produced by construction and human activity can have multiple impacts on birds, including causing stress responses, avoidance of important habitats, changes in foraging behaviour and reproductive success, and interference with songs, calls, and communication. Activities that introduce loud or random noise into habitats with previously low levels of anthropogenic noise are particularly disruptive.

Recommendation: Include mitigation measures for operational activities that could introduce very loud and random noise disturbance (e.g. blasting) during the migratory bird breeding season (e.g. prioritize construction works in areas away from natural vegetation while working during the migratory bird breeding season; high disturbance activities should be scheduled outside the migratory bird breeding season; equipment and vehicles should be kept in good working order and well muffled).

ECCC-04: Lighting

In Atlantic Canada, nocturnal migrants and night-flying seabirds (e.g. storm-petrels) are the birds most at risk of attraction to lights. Attraction to lights may result in collision with lit structures or with other birds. Disoriented birds are prone to circling a light source and may deplete their energy reserves and either die of exhaustion or drop to the ground where they are at risk of depredation.

Recommendation: In order to minimize the risk to migrant birds, ECCC-CWS recommends that proponents avoid or restrict the time of operation of exterior lights such as spotlights and floodlights during construction and operation; their glow can draw birds from far away especially on humid, foggy or rainy nights. It is recommended that lights are turned off when the risk to birds is greatest (e.g. migration periods). Lighting for the safety of the employees should be shielded to shine down and only to where it is needed. LED lighting fixtures are generally less prone to light trespass.

ECCC-05: Species at Risk – General

Section 33 of the *Species at Risk Act* (SARA) prohibits damaging or destroying the residence of a listed threatened, endangered, or extirpated species. For migratory birds SAR, this prohibition immediately applies on all lands or waters (federal, provincial, territorial and private) in which the species occurs.

In federal EA, ss.79(2) of SARA requires that persons responsible for an EA to: 1) identify adverse effects on all listed species, including species of Special Concern 2) if the project is carried out, ensure that measures are taken to avoid or lessen those effects; and, 3) monitor them. While there is no federal EA for this project, ECCC advocates a similar approach for the provincial EA.

For species which are listed as Special Concern, or not yet listed under SARA, listed under provincial legislation only, or that have been assessed and designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), it is best practice to consider these species in assessing environmental effects as though they were listed under SARA.

Recommendation: As part of the EA, ECCC-CWS recommends that the proponent present technically feasible mitigation measures consistent with best available information including any Recovery Strategy, Action Plan or Management Plan (final or proposed version). In instances where habitat for SAR cannot be avoided, the proponent should clarify why avoidance is not possible, as well as, provide a discussion of conservation allowances if appropriate, see ECCC's *Operation Framework for Use of Conservation Allowances* (2012) available at: https://www.canada.ca/en/environment-climate-change/services/sustainable-development/publications/operational-framework-use-conservation-allowances.html. Note: Where the impacted SAR habitat is wetland, compensation recommended in the *Federal Policy on Wetland Conservation in Canada* and/or as required under NS's provincial wetland policy may be appropriate.

ECCC-CWS also recommends that the province be contacted for advice on SAR under their responsibility (e.g. non-migratory birds such as raptors, bats, reptiles, amphibians, plants and lichen).

ECCC-06: Avian SAR - Canada Warbler

Appendix F, Biophysical Report 2020, section 8.2.2.2, quote: "*Of the two SAR avifauna observed, all were observed within the proposed Highway 316 Re-alignment footprint…Breeding and foraging habitat for Canada Warbler was observed both within the footprint and outside. Although breeding habitat for Canada Warbler is expected to be altered, habitat is present within the Study Area, outside the RoW footprint and outside the Study Area.*"

Recommendation: Since Canada Warbler is a bird SAR listed as Threatened on Schedule 1 of SARA, ECCC-CWS recommends that steps to avoid, minimize/lessen impacts, including indirect impacts on their habitat, be clearly described and justified in the EA.

The Canada Warbler Recovery Strategy (2016) is available at: https://species-registry.canada.ca/index-en.html#/consultations/2730.

ECCC-07: Avian SAR - Barn Swallow

Appendix F, Biophysical Report 2020, section 8.2.2.2, quote: "*Barn swallows were observed in PC5, however, breeding habitat (e.g. bridges, abandoned buildings, barns, etc.) was not present with the footprint. No breeding habitat for Barn Swallows was observed within the Study Area*". However, Appendix I, Table I2, Avian Species at Risk and Species of Conservation Interest, states that "*Suitable nesting habitat exist*" for Barn Swallow. These statements should be clarified.

While Barn Swallow commonly nests on human-made structures, a small proportion of Barn Swallows still nest in natural settings such as caves and underneath cliff ledges (Brown and Brown 1999). Abandoned mine openings available on site may also provide nesting habitat.

Recommendation: ECCC-CWS recommends that the EA clarify whether Barn Swallow habitat and residences occur on site, and include a discussion of how these may be impacted and avoided. It should be noted that A Barn Swallow (*Hirundo rustica*) Residence description (GoC 2019) is available at: https://species-registry.canada.ca/index-en.html#/species/1147-790#residence_description

ECCC-08: Avian SAR- Bank Swallow

Certain species of migratory birds, such as Bank Swallow, may nest in large piles of soil left unattended/unvegetated. To discourage this, the proponent should consider measures to cover or to deter birds from nesting in these large piles of unattended soil during the breeding season.

For a species such as Bank Swallow, the period when the nests would be considered active would include not only the time when birds are incubating eggs or taking care of flightless chicks, but also a period of time after chicks have learned to fly, because Bank Swallows return to their colony to roost. A Bank Swallow Residence Description (GoC 2019) is available at: https://species-registry.canada.ca/index-en.html#/documents/3521

The GoC guidance document "*Bank Swallow (Riparia riparia) in Sandspit and Quarries*" (GoC 2020) offers advice in preparing mitigation measures in the management of stockpiles during construction activities: https://species-registry.canada.ca/index-en.html#/documents/1602

ECCC-09: Other SAR – Bats

EA Registration (Page 27), quote: "*Previous site investigations between 2005 and 2013 have revealed multiple "unmapped" abandoned mine openings (AMOs)(Figure 5.1-4)…the greater Goldboro area, including the Local Study Area, has been the subject of gold mining activities for well over 100years. Several mine were established in the region*."

Additional information on the abandoned mine openings in the project area would be useful in the assessment of potential impacts on bats. In terms of monitoring activity, it appears that recorders were set up near two of the mine openings (though not at the right time to detect spring emergence); it is unclear how many other mine openings should be investigated.

Bat surveys conducted each year commenced late (i.e. end of August in 2018 and mid-July in 2020) and did not cover spring emergence and summer breeding periods (i.e. May through July). Monitoring locations selected did not include any of the ROW associated with the highway realignment.

Recommendation: Prior to any clearing activities, ECCC-CWS recommends monitoring for bat maternity roosts at the appropriate time of year. Acoustic recorders should be deployed similarly to avian survey protocols (e.g. optimizing sites for minimum clutter and targeting features such as edges and wetlands, where possible). The attached survey protocols (Olson, 2017) are recommended in identifying potential maternity roosts.

Bats SAR are under provincial responsibility and ECCC-CWS defers to their advice. It is recommended that provincial staff responsible for bats, Donald Sam (Donald.Sam@novascotia.ca) be contacted for advice.

ECCC-10: Other SAR - Wood Turtle

EA Registration, s. 6.6.2, Quote: "*The loss of ponds, wetlands and riparian areas in the Project area will result in habitat loss for species such as amphibians and turtles*…"

Based on habitat and range, it is indicated that Snapping Turtle listed as Special Concern and Wood Turtle listed as Threatened on Schedule 1 of SARA may be present; however, no mitigation measures were listed to avoid impacts on individuals of these species.

Recommendation: The EA and any EPP documents should be updated to consider the Wood Turtle Recovery Strategy (2020): https://species-registry.canada.ca/index-en.html#/consultations/2864 and, the Snapping Turtle Management Plan (2020): https://species-registry.canada.ca/index-en.html#/species/1033-710#management_plans.

Wood Turtle-Individuals

It is understood that clearing activities are proposed to occur after August 31. If present, Wood Turtles could be vulnerable to heavy machinery during that period; September is the pre-overwintering period when they are in the forest. Hatchlings can emerge from nests in early September to early October.

Recommendation: If Wood Turtles are present at this site, ECCC recommends that clearing occur no earlier than mid-October to avoid risk of destruction of individual Wood Turtle.

Turtles SAR are under provincial responsibility and ECCC-CWS defers to their advice. It is recommended that provincial staff responsible for Wood Turtle, Jolene Laverty (Jolene.Laverty@nova.scotia.ca) be contacted for advice.

ECCC-11: Other SAR – Lichen:

EA Registration s.6.7.2, Habitat Loss/Alteration, quote: "*Blue Felt Lichen, a federally and provincially listed SAR, has been confirmed as present within the ROW*".

It is understood that several populations of Blue Felt Lichen (SARA listed Special Concern) were observed within Wetland 22 and study area, and will be directly and possibly indirectly impacted by the proposed project. ECCC-CWS is concerned with project's impacts on the several Lichen SAR/SOCC found on site.

As mitigation, the EA indicates that a Management Plan for Blue Felt Lichen observed within the ROW will be developed, in addition to the a "Blue Felt Lichen Conservation and Research Plan (including, if required, lichen translocation and monitoring)"; however, these plans have not been provided for review as part of the EA.

In the absence of mitigation plans, ECCC-CWS cannot adequately assess likely success of proposed measures to mitigate impacts and cannot support the proponent's conclusion that effects are "insignificant". Note: There have been several recent proposed development projects in NS directly impacting Blue Felt Lichen and cumulative impacts on this SAR are a concern.

As stated above, it is unclear how avoidance of SAR was considered in the Alternatives assessment for the RoW.

Recommendation: ECCC-CWS recommends that the Proposed Management Plan for Blue Felt Lichen be consulted in the development of mitigation strategies to avoid direct and indirect impacts: **https://species-registry.canada.ca/index-**

en.html#/consultations/3645. ECCC also requests that mitigation strategies such as the "Blue Felt Lichen Conservation and Research Plan" be provided for review as part of the EA.

Lichen SAR are under provincial responsibility and ECCC-CWS defers to their advice. It is recommended that provincial staff responsible for Lichen, (Donald.Sam@nova.scotia.ca) be contacted for advice.

ECCC-12: Wetlands

EA Registration, Executive Summary - Conclusion, Quote: "*Unavoidable impacts on wetlands and watercourses will be minimized based on best management practices as well as compensation and offset measures, where required*."

ECCC advocates for the conservation of wetlands in areas where wetland losses have already reached critical levels (e.g. NB, NS, PEI, southern Ontario, Prairies) and for regionally important wetlands, and recommends that project effects on wetlands be avoided, where they cannot be avoided they should be minimized, and for residual impacts there should be compensation to mitigate the effects.
ECCC recommends the development of a Wetland Compensation Plan that fully describes the mitigation hierarchy, including:

- Identification of wetlands potentially affected by the project,
- A detailed description of potential effects, and the reasons why avoidance and minimization of impacts were determined to be not possible, and
- Identification and justification of proposed offset ratios. As a measure to compensate for the lost habitat function for wetland associated landbird SAR and SOCC in instances where such habitat cannot be avoided, ECCC-CWS recommends the use of conservation allowances as a third step in the mitigation hierarchy of avoidance, mitigation and compensation.

Recommendation: Since many wetland dependent SAR are likely to be affected by this project, ECCC would appreciate an opportunity to review the Draft Wetland Compensation Plan as part of its SARA mandate.

ECCC-13: Fuel Leaks/Spills and Wildlife Emergency Response Plan

The proponent must ensure that all precautions are taken by the contractors to prevent fuel leaks from equipment, and that a contingency plan(s) is prepared in the case of spills. Furthermore, the proponent should ensure that contractors are aware of section 5.1 MBCA prohibitions.

Provisions for wildlife response activities should be identified in contingency plans (e.g. Oil Spill Prevention and Response Plan including a Wildlife Response Plans) to ensure that pollution (e.g. oil spill) and non-pollution incidents (e.g. collisions) affecting wildlife are effectively and consistently mitigated. Draft ECCC guidance is available for consideration (see attached *Draft Guidelines for Effective Wildlife Response Plans*, 2020).

ECCC-CWS expects to be contacted within 24 hours in the event of mortality of an individual migratory bird SAR or 10 or more migratory birds.

ECCC-14: Clarifications and Recommended Edits:

EA Registration Document, Table 4.1-1 (page 24) – "Relevant Environmental Regulatory Requirements", ECCC-CWS recommends the following edits and clarifications:

- Add that migratory birds, **their nests**, eggs and young are protected under the MBCA. Remove the statement "Not listed as game birds"; The list of species protected by the MBCA can be found at https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legal-protection/convention-act.html.
- Add section 5(1) and 5(2) of the Migratory Bird Regulations (MBR) prohibiting the deposit of a deleterious substances in areas frequented by migratory birds.
- Add the Migratory Bird Regulations prohibitions which prohibit disturbance, destruction, or taking of a nest or egg of a migratory birds; or to be in possession of a live migratory bird, or its carcass, skin, nest or egg, except under authority of a permit.

EA Registration Document, Table 5.1-1 - Pieridae Field Studies (Page 26), no date is included for Avifauna surveys; similar to the other VECs, Avifauna survey dates should be included in this table.

Section 6.5.3 Mitigation Measures (Avifauna) – Construction Phase (Page 91), it is unclear why this section is separated into 'Construction Phase' and 'Construction / Operation and Maintenance'. The mitigation measure "Vegetation clearing will be avoided during the nesting seasons (April 10-August 31)" is recommended for both construction and construction / operation and maintenance phases; recommend combining the two subsections.

Water Quality

ECCC-015: General

The proponent should be aware of Section 36(3) of the *Fisheries Act* which prohibits "anyone from depositing or permitting the deposit of a deleterious substance of any type in water frequented by fish, or in any place under any conditions where the deleterious substance, or any other deleterious substance that results from the deposit of the deleterious substance, may enter such water".

It is the responsibility of the proponent to ensure that activities are managed so as to prevent the release of substances deleterious to fish. In general, compliance is determined at the last point of control of the substance before it enters waters frequented by fish, or, in any place under any conditions where a substance may enter such waters.

I trust the above comments will be of assistance. Please feel free to contact me at stephen.zwicker@canada.ca if you have any questions.

Yours truly,

Environmental Assessment Section
Environmental Protection Operations Directorate – Atlantic

cc: M. Breau

Environment and Climate Change Canada
Environnement et Changement climatique Canada

DRAFT

2020

GUIDELINES FOR EFFECTIVE WILDLIFE RESPONSE PLANS

Canada

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Aussi disponible en français

EXECUTIVE SUMMARY

Environment and Climate Change Canada's Canadian Wildlife Service (ECCC-CWS) is responsible for the management and conservation of Migratory Bird populations and Species at Risk. As part of this mandate, ECCC-CWS provides recommendations on how government, industry, Response Organizations, and other stakeholders plan for Wildlife response activities. The *Guidelines for Effective Wildlife Response Plans* outlines the rationale, objectives, and process for developing, implementing and evaluating the efficacy of Wildlife response planning for pollution and non-pollution incidents. This document supports the standardization of the planning process and understanding of ECCC-CWS recommendations around various planning elements. The purpose of this document is to guide federal, provincial, territorial, and regional government, industry, Response Organizations, and other stakeholders in developing Wildlife Response Plans that consider all aspects of planning throughout the full life cycle of an incident with regards to Wildlife specific to ECCC-CWS' mandate.

TABLE OF CONTENTS

LIST OF ACRONYMS

CWA	*Canada Wildlife Act*
DFO	Department of Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
ECCC-CWS	Environment and Climate Change Canada's Canadian Wildlife Service
ICP	Incident Command Post
ICS	Incident Command System
MBCA	*Migratory Bird Convention Act, 1994*
MBR	*Migratory Bird Regulations*
MBS	Migratory Bird Sanctuary
MBSR	*Migratory Bird Sanctuary Regulations*
NWA	National Wildlife Area
PCA	Parks Canada Agency
RP	Responsible Party
SARA	*Species at Risk Act*
WRP	Wildlife Response Plan
WRO	Wildlife Response Organization

DEFINITIONS

CWS Co-ordinator: A person who leads and implements regional Wildlife emergency preparedness and response on behalf of ECCC-CWS and represents ECCC-CWS's policies and interests when liaising and integrating with other federal and provincial/territorial government departments and other stakeholders involved in the response during Wildlife Emergencies. CWS Co-ordinators may also fulfill some of the on-site roles of responder.

CWS Responder: Emergency response personnel that provide on-site support on behalf of ECCC-CWS, as directed by the CWS Co-ordinator, during Wildlife Emergencies.

Lead Agency: The governmental authority that regulates or has legislative authority over the responsible parties' response and is responsible for overseeing the appropriateness of the response.

Migratory Bird: As defined in the *Migratory Birds Convention Act, 1994*, a migratory bird referred to in the Convention, and includes the sperm, eggs, embryos, tissue cultures and parts of the bird of species listed under Article 1 of the Convention (Government of Canada 2017).

Non-Pollution Incident: An uncontrolled or unexpected Wildlife injury or mortality event other than a pollution incident.

Pollution Incident: The release or deposit of a substance that is harmful to Wildlife into an area or waters that are frequented by Wildlife or into a place from which the harmful substance may enter an area or waters frequented by Wildlife.

Resource Agency: Any department or agency, other than the Lead Agency, that has jurisdiction or interest in the response, which provides support to the Lead Agency.

Response Organization: Any qualified person or organization that has been certified and designated by the Minister of Transport to carry out emergency response activities (as per the revised *Canada Shipping Act* (2001)). In Canada, there are four Response Organizations (ROs) as follows: Atlantic Emergency Response Team, Eastern Canada Response Corporation Ltd., Western Canada Marine Response Corporation, and Point Tupper Marine Services Ltd.

Responsible Party: Any person or organization who might be responsible for the source or cause of an environmental emergency and/or a Wildlife Emergency.

Species at Risk: As defined in the *Species at Risk Act* (S.C. 2002, c.29), an extirpated, endangered or threatened species, or a species of special concern.

Wildlife: In this document, "Wildlife" means 1) all Migratory Birds; and/or 2) all individuals of Species at Risk listed in Schedule I of SARA that are under the jurisdiction of Minister of Environment (with the exception of individuals of Species at Risk that are located on lands administered by Parks Canada).

Wildlife Emergency: A Pollution or Non-pollution Incident that results or may result in an immediate and/or long-term harmful effect on the life or health of Wildlife and/or their habitat.

Wildlife Response Plan: A document that outlines the initial and ongoing Wildlife-related strategies that are needed to support any Wildlife response objectives that may occur at the onset of a pollution or non-pollution incident.

Wildlife Response Organization: Organizations that provide expertise, capabilities and trained personnel to undertake one or several aspects of response, including planning, implementation and reporting of activities related to Wildlife Emergencies. Wildlife Response Organizations (or representatives thereof) are authorized under applicable federal, provincial, and/or territorial legislation to capture, transport, clean, rehabilitate, euthanize, and release Wildlife.

1.0 INTRODUCTION

Environmental protection legislation in Canada at the federal, provincial or territorial level contains provisions to have approved contingency plans in the event of an environmental emergency for construction, operation or decommissioning activities that may impact the environment. Projects undergoing an environmental assessment may include additional conditions upon approval to develop and implement an environmental protection plan. All contingency plans/environmental protection plans for which a threat to Wildlife is identified may have specific sections dedicated to Wildlife response in order to be in compliance with applicable federal, provincial, or territorial legislation.

Environment and Climate Change Canada's Canadian Wildlife Service (ECCC-CWS) oversees and/or leads Wildlife Emergency response activities in association with ECCC responsibilities under the *Migratory Birds Convention Act, 1994* (MBCA), *Migratory Birds Regulations* (MBR), *Migratory Bird Sanctuary Regulations* (MBSR), *Species at Risk Act, 2003* (SARA), the *Canada Wildlife Act, 1985* (CWA), and *Wildlife Area Regulations*. Through these pieces of legislation, ECCC-CWS is responsible for management and conservation of all Migratory Birds and Species at Risk under its jurisdiction (hereafter "Wildlife") and how they are managed during a pollution or non-pollution incident. Therefore, this document applies to Wildlife that is located on federal lands or on lands under the authority of the Minister of the Environment. This includes Wildlife that are the subject of an order of the Governor in Council under SARA to protect the species, its critical habitat or habitat that is necessary for its survival or recovery. In the case of Migratory Birds, this document also applies to those found on non-federal lands in the provinces and territories. The document does not however apply to any Wildlife, including aquatic species, located on any lands or in any waters administered by the Parks Canada Agency (see also Section 2 for further details regarding Species at Risk). This document does not apply to species under the jurisdiction of Fisheries and Oceans Canada (DFO) which includes fish, marine mammals, marine turtles, and marine plants, as defined in sections 2 and 47 of the *Fisheries Act*.

1.1. SCOPE

Wildlife Emergencies, in the context of this document, include Pollution or Non-pollution Incidents that result or may result in an immediate and/or long-term harmful effect on the life or health of Wildlife and/or their habitat. Pollution Incidents with potential harm to Migratory Birds and Species at Risk are prohibited under the *Migratory Birds Convention Act* (MBCA) and the *Species at Risk Act* (SARA). Non-pollution Incidents are uncontrolled or unexpected Wildlife injury or mortality events other than a pollution incident, which may include things such as disease outbreaks, mass strandings, or other unexplained Wildlife deaths. The degree to which any Pollution or Non-Pollution Incident may be deemed a Wildlife Emergency is dependent on a number of factors such as the scope and severity of the incident (e.g. numbers of animals or area of habitat impacted), the likelihood of an incident expanding, potential for impacts to Species at Risk, and potential link to human health, among other factors. The appropriate level of response expected to incidents should be reasonable and commensurate with the risks. ECCC-CWS is responsible for informing various aspects of response to Wildlife Emergencies, including the development and implementation of Wildlife response strategies and activities.

During an incident, Responsible Parties (RPs) must demonstrate their ability to safely, efficiently, and effectively respond in a manner that incorporates measures designed to avoid or minimize harm to Wildlife, while managing the public's understanding of response decisions and activities. For planned operations with a potential to impact Wildlife (e.g., oil removal from wreckages), the Lead Agency is deemed responsible for implementing Wildlife response appropriate to that incident.

Wildlife Response Plans (WRPs) are documents that formalize the guidance and strategy for responding to incidents with potential to impact Wildlife. A WRP should include the following elements:

- The objectives of implementing a WRP with respect to managing or preventing harm to Wildlife and Wildlife habitat during a pollution or non-pollution incident.
- A description of the incident management structure for Wildlife response and how it is integrated into an incident-specific response command system (e.g., an Incident Command Post [ICP]).
- Background information on responsibilities of the RP as well as regulatory requirements, permits, and authorizations to engage in Wildlife response activities.
- Information on Wildlife resources known or potentially impacted by an incident.
- A description of Wildlife response procedures to be implemented immediately following an incident (e.g., deterrence and dispersal, surveillance).
- A description of the operational structure and implementation of ongoing Wildlife response efforts throughout all phases of an incident.
- Procedures for information management and communication, including to key stakeholders (e.g., local communities, hunters).
- Safety, security, and training requirements for personnel, equipment, and facilities required to support Wildlife response activities.

The purpose of this document is to guide federal, provincial/territorial, and regional government, industry, Response Organizations, and other stakeholders in developing a WRP that considers all aspects of planning throughout the full lifecycle of an incident. This document outlines the attributes that are necessary for effective implementation of Wildlife Emergency response. Proponents should keep in mind that the guidance provided within this document is developed by ECCC-CWS for Wildlife specific to their mandate. As such, proponents developing comprehensive WRPs should also consult with other federal and provincial/territorial agencies which are responsible for other wildlife (e.g., mammals, reptiles, amphibians and some bird species not under the jurisdiction of the MBCA).

2.0 REGULATORY REQUIREMENTS

2.1 APPLICABLE LEGISLATION

ECCC-CWS is responsible for ensuring that all Wildlife response activities are coordinated, enacted, and carried out in compliance with applicable federal law. Federal legislation applicable to Wildlife response include:

- ***Migratory Birds Convention Act* (MBCA)—**Section 5 of the *Migratory Birds Convention Act* prohibits the deposit of harmful substances into waters or areas frequented by Migratory Birds, unless authorized under the *Canada Shipping Act*. Section 6 of the *Migratory Birds Regulations* of the *Migratory Birds Convention Act* prohibits the disturbance, destruction, or possession of Migratory Birds, their occupied nests, or eggs. ECCC regulates killing, capture of and harm to Migratory Birds as outlined in the MBR. Only Migratory Bird species listed under Article 1 of the MBCA are protected under the regulations, and permits may be issued to authorize the permit holder to undertake activities that could affect those species (Government of Canada 2017).
- ***Species at Risk Act* (SARA)—**Section 32 of the *Species at Risk Act* prohibits the destruction, possession, harm, capture, or harassment of a species listed on Schedule 1 as Threatened or Endangered. Section 33 prohibits the destruction or damage of a residence of wildlife listed on Schedule 1 as Threatened or Endangered, or Extirpated (if there are plans to reintroduce the species). Prohibitions apply to federal lands, as well as to non-federal lands for species protected under the MBCA.
- ***Canada Wildlife Act* (CWA)—**The *Canada Wildlife Act* allows for the establishment of National Wildlife Areas (NWA), which protect wildlife habitat in Canada. Wildlife Emergencies that occur on or impact species within a NWA will require permits under the Wildlife Area Regulations for individuals, organizations, and agencies to enter an NWA and participate in response activities.

Further to these Wildlife specific pieces of legislation, other environmental protection legislation in Canada at the federal, provincial or territorial level contain additional provisions which require approved contingency plans in the event of an environmental emergency for construction, operation or decommissioning activities that may impact the environment. Projects undergoing an environmental assessment may require the development and implementation of an environmental protection plan, conditional upon approval.

Where contingency plans/environmental protection plans identify a threat to Wildlife, ECCC-CWS considers a WRP to fulfill some of these requirements if contingency and emergency response planning efforts adequately address the identified Wildlife issues.

ECCC-CWS recommends that strategic WRPs be developed prior to incidents for activities or areas where the potential for, or associated risk of a Wildlife Emergency is high (see Section 3.2 for more details). These strategic plans may be stand-alone plans or be components (or annex) to overarching response plans (e.g., operators' facilities response plans). Incident-specific WRPs are routinely developed as part of the ICP to standardize and document Wildlife response activities during an incident (Section 3.2). Both approaches are in keeping with international standards for Wildlife response planning (IPIECA 2014).

2.2 PERMITS AND AUTHORIZATIONS

As part of Wildlife Emergency response, Wildlife Response Organizations (WROs) are often responsible for undertaking response activities involving direct interaction with Wildlife including the capture, collection, transport, and care/rehabilitation, release, and/or euthanasia of impacted Wildlife. Some WROs operating in Canada may retain annual permits that allow certain levels of immediate response, assuming permits are renewed and standards are maintained. Qualifications of these organizations to perform certain activities are assessed during the permit application process. Otherwise, a WRO will work with ECCC-CWS to obtain incident-specific permits for aspects of Wildlife Emergency response requiring authorizations. Other qualified individuals, working for or contracted by WROs, Response Organizations, the Responsible Party, or government agencies, may also apply for permits, as required. Permit and authorization requirements are summarized in Table 1.

With respect to Species at Risk under SARA legislation, the responsibility for implementing SARA in Canada lies with the Ministers responsible for Environment and Climate Change Canada (ECCC), Parks Canada Agency (PCA), and Fisheries and Oceans Canada (DFO). PCA is responsible for issuing permits for activities affecting any SARA-listed species on lands administered by the Agency, including Migratory Birds. Fisheries and Oceans Canada (DFO) is responsible for issuing permits for aquatic species (fish, as defined in section 2 of the *Fisheries Act*, or a marine plant, as defined in section 47 of that Act), other than species in waters found on federal lands administered by the PCA. ECCC is responsible for issuing permits for all listed species not described above. This includes for all Wildlife on federal land and any land affected by a SARA protection order, and for Migratory Birds wherever they are found.

Table 1. Wildlife-related Permits and Authorization Requirements that may be issued by ECCC-CWS during a Wildlife Emergency.

Wildlife	Permit Type	Activities that Require Permits or Authorization	Permit Holders
Migratory Birds (including SARA-listed species)	Scientific (Collection)	• possession • transportation • collection/capture • treatment/rehabilitation/care • euthanasia	Individuals of WROs are generally permitted for most activities. Subcontractors or independent contractors may be permitted for specific activities through one or several permits.
	Capture and band	• capturing • banding • using auxiliary markers (e.g., color bands and GPS transmitters) • collection of biological samples	
SARA-listed Wildlife (including non-Migratory Birds, mammals, reptiles, and amphibians)	Authorizations under section 73	• collection, transportation or treatment of SARA-listed species on federal lands OR SARA-listed Migratory Birds wherever they occur • impacts to designated critical habitat on federal lands • notification for impacts to designated critical habitat not on federal lands	SARA permits are issued on site and situation specific basis and must be discussed early in response activities, as appropriate.
National Wildlife Areas (NWAs) and Migratory Bird Sanctuaries (MBSs)	Scientific (Collection)	• operations occurring on NWA and MBS	NWA and MBS permits are issued on a site-specific basis and will be developed early in response activities.

Note: the permitting process and the types of activities requiring permits is subject to change periodically as regulations are updated. Individuals/organizations should seek up to date advice on permitting from ECCC-CWS permit officers.

3.0 ELEMENTS OF WILDLIFE RESPONSE PLANNING

3.1 WILDLIFE RESPONSE WITHIN THE INCIDENT COMMAND SYSTEM

Any activities with potential to result in a Wildlife Emergency may warrant immediate implementation of response actions. Increasingly, within industries or the Government of Canada, emergency incidents are managed and structured using the Incident Command System (ICS) approach, including the establishment of an Incident Command Post (ICP) for major incidents. It is therefore recommended to stakeholders to use Incident Command System (ICS) for emergency response. Wildlife experts, such as ECCC-CWS, may be situated in the Environment Unit of the Planning Section within an ICP. The Environment Unit would develop and refine response plans as well as incident-specific tactics. Depending on the scale of the incident and scope of potential or actual impacts to Wildlife, ECCC-CWS may assist in establishing a Wildlife Branch which is typically situated within the Operations Section of the ICP (IPIECA 2014; Figure 1). A Wildlife liaison position may also be staffed to facilitate the dissemination of planning and operational information between the Environment Unit and the Wildlife Brach. WRPs may also be developed and used for Wildlife Emergencies that are not managed with an ICP or a Wildlife Branch.

The WRP should identify, schematically, the structure and function of the Wildlife Branch and its integration into the Operations Section of the ICP, as well as how it liaises with other ICP sections (e.g., Planning). The WRP should anticipate structuring and scaling the Wildlife Branch according to how the incident is expected to proceed.

It is essential to identify and implement Wildlife response activities within the first 48 hours of an incident. These response activities are formalized within a WRP to structure and guide response activities. The RP is responsible for the development of WRPs, to address all of the procedures and strategies required to mount an effective Wildlife response. During an incident, ECCC-CWS will provide advice to support the Wildlife response consistent with the components outlined in Section 4. However, the RP typically leads the development of a WRP and may contract the WRO to develop it on their behalf to ensure the WRP is operationally feasible. While ECCC-CWS does not have the authority to assign, recognize, or approve specific WRPs, ECCC-CWS may provide advice to the Lead Agency, the RP, and WROs regarding the direction and content of a WRP, based on available science and expertise. A WRP does not necessarily equate with statutes and regulations; rather, developing a WRP identifies actions that support compliance with the MBCA, MBR, MBSR, SARA, and the CWA. A WRP receives formal approvals within an ICP through sign-off by the Incident Command and RP.

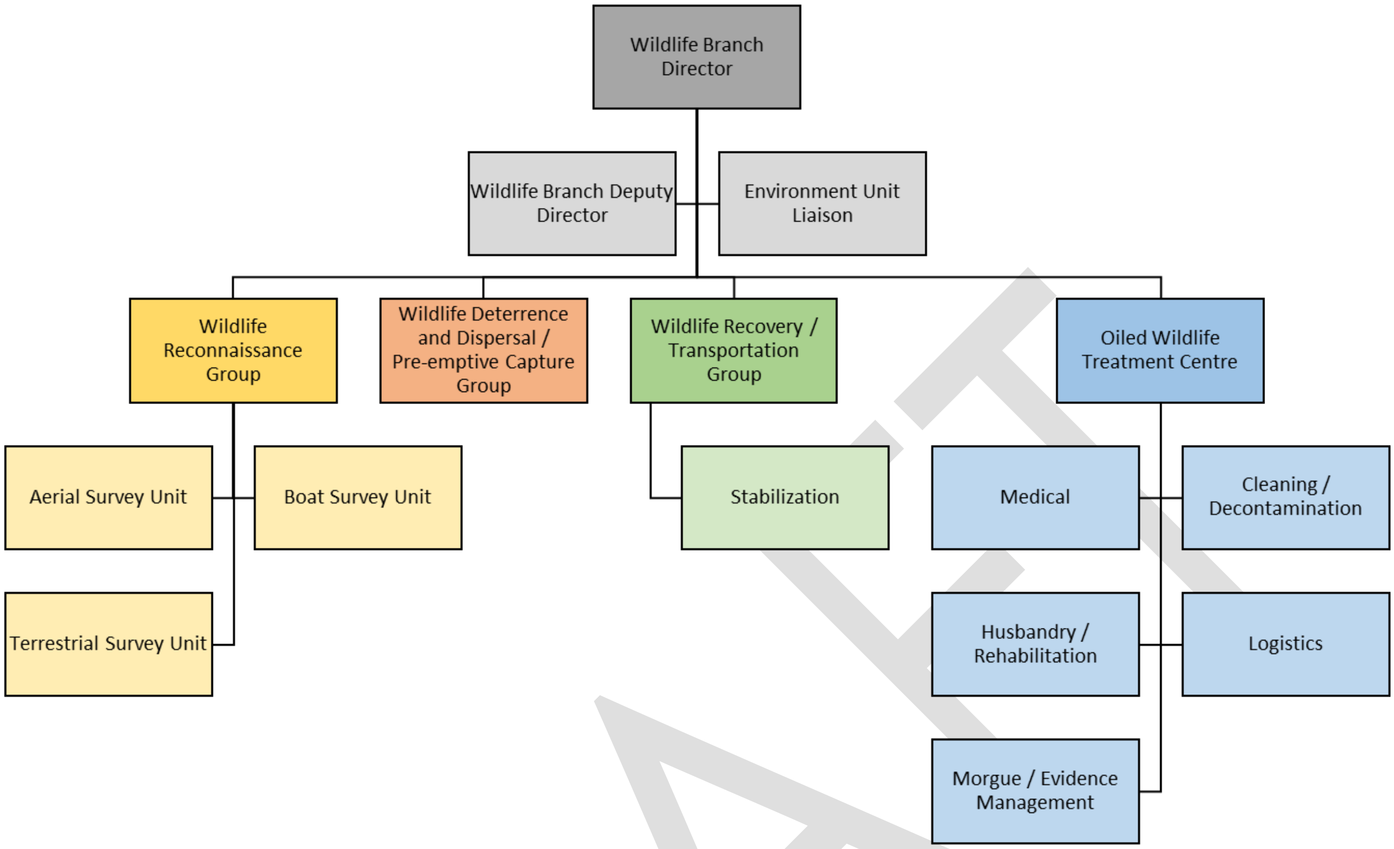

Figure 1. Example of a scalable Wildlife Branch within an Incident Command System setting (adapted from IPIECA 2014).

3.2 TYPES OF WILDLIFE RESPONSE PLANS

There are two main types of WRPs, strategic response plans and incident-specific response plans (described below). ECCC-CWS may support the development of various WRPs, including providing technical expertise, permit support, incident-specific guidance. However, WRP approvals are the responsibility of the RP and the Incident Commander (or Unified Command).

3.2.1 Strategic Response Plans

Strategic response plans are often created for specific activities, where there is a recognized risk of a Wildlife Emergency, or for designated areas or specific locations which may warrant special planning considerations (e.g. protected areas, geographic response areas). Strategic WRPs describe the likely activities to be enacted during a response, but may lack incident specific actions or tactical plans which may only be developed once the parameters of the incident are known or tested. Thus strategic WRPs are refined and adapted throughout the incident based on incident-specific considerations (Hebert and Schlieps 2018).

Activity-specific Plans - Accidents or malfunctions that may occur at certain types of facilities or infrastructure (e.g., oil-handling facilities, offshore petroleum platforms, liquid natural gas marine terminals), projects (e.g., exploratory drilling), or routine activities (e.g., transport of oil by rail or vessel) have an associated increased risk for Wildlife Emergencies. However, given the static nature of these sites, the characteristics of a pollution or non-pollution incident and the procedures for mounting a response can be anticipated to a certain degree. Industries or other stakeholders determine whether it is appropriate to develop strategic WRPs to structure a response that aligns with internal policies and procedures (e.g., industry best practices, contract with WROs), and incorporates site-specific considerations for implementing effective response actions (e.g., pre-determined Wildlife rehabilitation areas, standardized methods for Wildlife surveillance). As with other types of plans, activity-specific WRPs need to be adaptable and scalable, depending on the nature of the incident. Activity-specific WRPs should be reviewed and revised on a regular basis to accommodate changes to infrastructure, activities, and operational procedures, and to reflect current guidance on Wildlife response planning. In cases where activity-specific plans are identified for development, ECCC-CWS can review and provide recommendations on WRP components based on site-specific information.

An example of an activity-specific WRP is one that is developed as part of planned vessel salvage or oil recovery activities, where there is potential for impacts to Wildlife. In the case of a planned salvage, the initial draft of the WRP should be developed and approved in advance of initiating salvage activities. As with other incidents, the WRP will evolve over the course of the salvage to address specific response conditions.

Area-specific Plans - Wildlife emergencies can also occur in land tenures or aquatic areas of significant biological importance, with specific management objectives, and/or where there is otherwise concerted interest in having a response plan in place (e.g., protected areas, geographic response areas). As with activity-specific plans, the procedures for mounting a response to a pollution or non-pollution event may be anticipated and planned for to a certain degree. Land managers may determine it is appropriate to develop strategic WRPs to structure a response that aligns with land management objectives. Stakeholders' input that incorporate site-specific considerations for implementing effective response actions should be considered. Area-specific WRPs need to be adaptable and scalable, depending on the nature of the incident. Land managers need to identify zones of higher sensitivity that are to be protected and those of lower sensitivity to allow an efficient response (access points for machinery, ICP, response personnel, etc.). WRPs should be reviewed and revised on a regular basis. In cases where area-specific plans are identified for development, ECCC-CWS can review and provide recommendations on WRP components based on site-specific information.

3.2.2 Incident-specific Response Plans

The most common type of WRP is typically one that is developed in the early phases of a Wildlife Emergency as part of the ICS and is specific to the incident (IPIECA 2014). Incident-specific WRP, sometimes referred to as Wildlife Management Plans, take into account the actual circumstances of a specific incident, particularly factors related to scope of the incident (e.g., quantity, location and dispersion of pollution), environmental considerations (e.g., weather), and seasonal considerations (e.g., Wildlife abundance and distribution). A comprehensive strategic WRP may fulfil most of the information needs for an incident specific plan, but might require further details on implementation given the available resources, weather, and time of year.

For incidents where an RP has been identified, the RP has the first responsibility for initiating effective countermeasures to a Wildlife Emergency and has financial responsibility for damage and cleanup costs incurred during an incident. Upon the establishment of an ICP, the RP and Incident Command will outline planned Wildlife response activities. ECCC-CWS will contribute to the development of an incident-specific WRP by participation in the Wildlife Branch (or Environment Unit) of the ICP, or by reviewing plans and providing expert advice to individuals working within the ICP. Here, ECCC-CWS may provide guidance on the scope of a WRP and direct the RP, or its contracted response personnel, towards resources that support its development. In particular, ECCC-CWS will inform on any Wildlife response activities that require authorization (i.e., permits), or technical expertise. ECCC-CWS will review and make recommendations on a WRP and subsequent iterations, but the Incident Command ultimately approves the plan. For incidents where an RP has not been identified, ECCC-CWS may contribute to the development and implementation of a WRP.

3.2.3 Plan Development

It is important to recognize that Wildlife Emergency response and WRP development is an iterative process that will evolve as an incident unfolds. A WRP should be structured and implemented in a way that it is adaptable and scalable over the course of an incident, and may accommodate needs for post-incident monitoring.

The Wildlife Branch will determine the appropriate level of response based on specific needs of the incident. The need for greater or fewer resources, equipment, facilities, and response personnel will be based on incident-specific factors including:

- The present and future geographic extent of the incident,
- The species, numbers of individuals, and types of habitats present in the geographic extent,
- The known or potential risk for injury or mortality, and
- The timeframe for which incident response actions are implemented.

Plans that are developed prior to an incident may also consider tiered response planning to appropriately manage various degrees or types of Wildlife Emergencies. *Wildlife Response Preparedness* (IPIECA 2014) describe tiered response planning in more detail.

3.3 HABITAT CONSIDERATIONS FOR RESPONSE PLANNING

The various habitats occupied by Wildlife require different considerations with regards to response planning. For emergency response involving pollutants such as oil, the key variable in a response plan is the presence of bodies of water that may act as a carrier for oil discharged into the environment, causing oil to spread over large areas where Wildlife may become affected. In Canada, habitats occupied by Wildlife requiring similar response approaches during an emergency response involving oil or other pollutants can be grouped into the following three main landscape categories: a) marine and open water, b) aquatic, and c) terrestrial.

3.3.1 Marine and Open Water

Pollution incidents that occur in the marine environment or large freshwater bodies of open water tend to affect Wildlife that spend a high proportion of their time on the water, such as alcids and waterfowl. The effect on Wildlife is influenced by the location of the incident, persistence and toxicity of the contaminants, and duration of the incident. In seasons and areas of high concentrations of vulnerable Wildlife, the number of impacted individuals may reach the thousands, even when a relatively low volume of contaminant is discharged. Affected Wildlife may eventually come ashore either alive or dead, requiring systematic search and collection effort on accessible shorelines. Oil discharged offshore may eventually travel inshore and reach the coastline, affecting other Wildlife communities associated with aquatic habitats (see Section 3.3.2). A Wildlife response in the marine and open water landscape focuses on preventing Wildlife from utilizing the affected area, recovering affected individuals if they come to shore, and assessing the impact of the incident on Wildlife (Table 2).

3.3.2 Aquatic Habitats

For the purpose of this document, aquatic habitats consist of any land saturated with water long enough to take on the characteristic of an ecosystem and promote aquatic processes, such as salt marshes, wetlands, fens, lagoons, and bogs, but also include small ponds, creeks, rivers, tidal flats, marshes, and reed beds, or any combination of such categories. Unlike the other landscapes, aquatic habitats are vulnerable to activities that occur both on land and in the marine environment. During an oil spill response, aquatic habitats are priority areas for protection as they can trap large quantities of oil, are difficult to clean, and can take years or decades to recover due to the retention of contaminants in these environments. Because of the large variety of aquatic habitats and biotypes that they accommodate, removing oil or other contaminants from the environment and operationalizing a Wildlife response may be complex. Rivers will carry and spread pollutants over potentially large distances, and shorelines may be inaccessible. Wildlife diversity may be high and include a mix of aquatic (waterfowl, shorebirds, inland waterbirds) and terrestrial [landbirds] Migratory Bird species and Species at Risk from a variety of groups, including mammals, birds, amphibians, reptiles, plants, and fish. Additional survey effort and resources may be required for reconnaissance and surveillance surveys as well as collecting affected individuals. Small lakes and ponds may be attractive for large concentrations of Migratory Birds during migration, molting, and staging periods and may require extended resources to exclude Wildlife from the area. In addition to deterrence activities, a Wildlife response in aquatic habitats may also focus on prioritizing protection and containment strategies to minimize the spread of oil to key habitats, denying Wildlife access to impacted habitats, pre-emptive capture to relocate unoiled individuals (e.g., Species at Risk), recovery of affected individuals, and assessing the effect of the incident on Wildlife (Table 2).

3.3.3 Terrestrial Habitats

Pollution discharged into a terrestrial landscape where a body of water is absent will be limited in spread and affect a small area in relation to the released volume. Pollution incidents in a terrestrial landscape are usually limited to a point source (e.g., truck, rail, pipeline, oil storage facility), however, the species and types of incident interactions among terrestrial Wildlife may be diverse, as there is potential for impacts to birds, mammals, reptiles, and amphibians. A Wildlife response strategy in a terrestrial landscape may focus on excluding Wildlife from the affected area, pre-emptive capture to relocate unoiled individuals (e.g., Species at Risk), recovering affected individuals, and assessing the impact of the incident on Wildlife.

Table 2. Key activities/strategies for Wildlife response based on major landscape types. This table is meant as a guide to highlight some potential key differences in approaches, but should not be considered as a checklist for all incidents. Refer to text for details.

	Landscape Categories		
Response Strategy/Activity	**Marine/ Open water**	**Aquatic**	**Terrestrial**
Reconnaissance and surveillance surveys	X	X	X
Wildlife deterrence	X	X	X
Wildlife exclusion		X	X
Prioritize habitats for protection	X	X	X
Pre-emptive capture of Wildlife		X	X
Recovery of affected individuals	X	X	X
Assessing impacts to Wildlife	X	X	X

3.4 DETECTING SIGNS OF OILING IN AVIAN SPECIES

In planning for Wildlife Emergency and preparation of a WRP, it can be important to consider target species and how detectable oiled (or injured) Wildlife may be. The ability to detect oiled Wildlife will help in planning several of the actions to be taken during a response, notably initial Wildlife impact assessment (Section 4.5.2), reconnaissance and surveillance surveys (Sections 4.5.3 and 4.5.4), and Wildlife capture (Section 4.5.7). Detecting oiled Wildlife is best done by experienced observers, such as WRO, but understanding of oiled Wildlife detection can benefit all aspects of response planning and implementation. Here we provide guidance for detecting signs of oiling in avian species.

Under normal conditions, typical bird behaviour will vary by the species, the habitats they occupy, as well as time of year and weather conditions. Generally, birds that spend a great deal of time on the surface of the water are typically seen resting on the water (e.g., loons, grebes, scoters, alcids, and cormorants). Piscivorous species (e.g., loons, grebes, alcids), will normally dive and surface repeatedly over time. Some species, like gulls, will move between resting on the water to being flight bound to using land to feed or rest. Species that are common in shore environments, like shorebirds, dabbling ducks, and cormorants are typically quite obvious on rocks or beaches, and would be expected to be quite mobile/active.

Birds that have come into contact with oil may have obvious oiling indications, including coating, discoloured feathers, or feathers having a wet or ragged appearance (i.e., disruption of feather structure). Heavily oiled birds or individuals oiled below the waterline may also appear as though they are sitting low on the water (when compared with normal species posture), struggling to maintain buoyancy. Oiled birds have increased potential to lose buoyancy and thermoregulatory properties of their feathers. Accordingly, it is common to see oiled birds focused intently on preening themselves in order to maintain buoyancy and reduce heat loss; this may be most apparent while birds are on the water. Diving or dabbling species may appear to be foraging less than expected (although this should be assessed by experienced observers). Birds may also exhibit changes in flushing behaviour, being less inclined to fly when disturbed. Birds might also congregate near or on shore, or strand and rest on structures (e.g., vessels, buildings, platforms); this includes species that would not normally be expected to use these habitats or those that have contacted oil in the intertidal environment. In nearshore or shoreline environments, birds may also use shallow waters to reduce risk of drowning or take advantage of coastal vegetation to camouflage or reduce risk of predation while they try to preen or recover. Observations of behavioral changes in birds are sometimes the key indicators of oil impacts.

Detecting birds contaminated with oil is particularly difficult for aquatic birds with dark plumage that remain on the water and far from shore. Under these circumstances, it may be appropriate to determine a probable rate of contamination using appropriate indicator species. Ideally, indicator species are common throughout the incident area, share similar life history attributes, are sensitive to oiling, and signs of oiling are readily observable. The contamination percentage determined for indicator species only provides an estimation of the contamination percentage for the other species in the incident area. This type of assessment is likely to underestimate the actual contamination rate of the most vulnerable aquatic species, such as sea ducks and alcids, and overestimate the contamination of the more coastal species, such as geese and dabbling ducks (Lehoux and Bordage 1999). Additional details on how to assess rates of oiling for indicator species is provided in *ECCC-CWS Technical Guidance and Protocols for Migratory Bird Surveys for Emergency Response in Canada* (2020a).

4.0 COMPONENTS OF A WILDLIFE RESPONSE PLAN

A WRP is a plan that describes the objectives and methods for undertaking Wildlife Emergency response, specific to an area and pollution or non-pollution event. The aim of a WRP is to avoid or minimize injury or harm to Wildlife during pollution and non-pollution incidents.

The following section outlines attributes that should be considered within a WRP (IPIECA 2014; Hebert and Schlieps 2018). An annotated WRP template is provided as an example in Appendix A, to be adapted and scaled based on the nature of individual Wildlife Emergencies. A checklist of activities that should be completed within the first 0-72 hours of an incident involving Wildlife is provided in Appendix B.

4.1 INTRODUCTION

The Introduction section of the WRP provides the basis and rationale for how a Wildlife response will be handled. The Introduction will provide a general description of the types of issues that will be addressed by the WRP. Where appropriate, the Introduction will describe how this WRP interfaces with various aspects of an ICP, including other response plans that WRP activities may interact with.

4.2 AGENCY NOTIFICATION PROCEDURES

The Agency Notification Procedures section outlines the agencies, organizations, and other technical specialists that will be identified during incidents involving Wildlife response. Where appropriate, this section will describe how agency notifications operate within the incident-specific ICS structure, as well as any intra- and interdepartmental communication requirements.

4.3 REGULATORY REQUIREMENTS

The Regulatory Requirements section provides a brief description of the applicable Wildlife legislation, where it applies, and whether supporting permits or authorizations are required to support a Wildlife response. In most cases, incidents involving Wildlife will need to consider the MBCA, the SARA, and possibly the CWA (see Section 2), as well as other provincial or territorial legislation. Additional permits and authorizations may also be required outside the regulatory authority of ECCC-CWS.

4.3.1 Permits and Authorizations

For any Wildlife Emergency involving the development of a WRP, the plan will identify any WROs or contracted subject-matter experts that will be engaged to support Wildlife response activities. Authorized organizations or individuals must have the training and resources necessary to meet Wildlife response requirements. Where permits or authorizations are identified, this section will highlight:

a) What the authorization is for,
b) The issuing agency,
c) Activities that are authorized,
d) Who holds authorization to conduct those activities,
e) If a technical specialist or qualified professional is required to supervise or participate in the authorized activity (e.g., ECCC-CWS or a WRO supervision of Migratory Bird deterrence activities), and
f) Reporting requirements, if any, for these authorizations.

With respect to strategic WRPs prepared in advance for specific activities or areas, this section will also identify permits which are already in place and relevant information on renewal and reporting cycles.

4.4 RESOURCES-AT-RISK

The WRP will outline potential Wildlife resources-at-risk from the incident's current and reasonably foreseeable impacts. The resources-at-risk section of the WRP will describe:

- The geographic extent for which resources are being identified,
- Migratory Bird sensitivities,
- Species at Risk sensitivities,
- Important habitats for consideration and protection:
  - critical habitat,
  - protected areas,
  - colonial nesting areas,
  - general nesting areas,
  - seasonal stopover, molting, or staging areas,
  - Important Bird Areas, and
  - other important habitat features such as estuaries.

The characterization of resources-at-risk should consider seasonal presence, abundance, life stage, and habitat associations for different species. Where available, incident-specific observations should be referenced in the description of resources-at-risk to characterize current conditions.

4.5 WILDLIFE MANAGEMENT AND RESPONSE

This section will describe the nature of Wildlife management and response activities that are, or will be undertaken as part of the incident. The nature and scale of a WRP will depend on the incident, and the known or potential impacts to Wildlife.

For the early phases of an incident, the WRP should include, at minimum, a description of the initial approaches for Wildlife impact assessment (e.g., reconnaissance and monitoring activities). This section of the WRP will be revised as an incident evolves. Where appropriate, aspects of Wildlife management and response may warrant stand-alone plans that could be appended, and referenced in this section (e.g., detailed plans for Wildlife rehabilitation).

4.5.1 Operational Objectives

This section briefly describes the primary objectives for the activities that will be implemented during the operational period(s) this plan is expected to apply towards until its next iteration. Objectives will consider the ethical considerations in context with situational, technical, and financial feasibility of implementation (IPIECA 2014). Objectives will change based on Wildlife concerns as well as personnel and equipment resource availability. These objectives form the basis for the nature and scope of activities described in this section of the WRP.

4.5.2 Initial Wildlife Impact Assessment (0 to 24 Hours)

In order to effectively plan for and direct Wildlife response efforts, an initial Wildlife impact assessment needs to be conducted as early in the incident response as possible, to determine:

- Existing information on Wildlife,

- Real-time estimates of Wildlife impacts,
- Projection of potential impacts to Wildlife,
- Initial Wildlife response recommendations, and
- Initial resource, personnel, equipment, and facility requirements.

As with all phases of a response, the Initial Wildlife Assessment must be completed in consideration of the health and safety of response personnel and adhere to all incident-specific health and safety requirements (see Section 4.7).

4.5.3 Reconnaissance Surveys (24 to 48 Hours)

Reconnaissance surveys should be conducted in a timely manner on a large geographic scale to assess the outer limits of the incident. These surveys serve to obtain current information on impacted habitats, areas of special concern (e.g., colonial nesting areas) and the abundance and distribution of Wildlife within the general area of the incident, recognizing that Wildlife movements may extend beyond the geographic limits of the incident area. Initial reconnaissance surveys should take place as early in the response as possible to determine current conditions and inform potential response priorities and strategies. In all cases, reconnaissance should extend, at minimum, to the expected geographic limits of the incident area, recognizing those boundaries may change as the incident progresses. Reconnaissance surveys may be conducted on a recurring basis to inform response activities (e.g., deterrence and dispersal, Wildlife capture), or if the situation of the incident changes (e.g., following a storm). Reconnaissance surveys help identify the most suitable approaches for the surveillance or monitoring phase of the response. Reconnaissance may occur from land, boat, or air. Reconnaissance surveys are not systematic and the goal is not to precisely assess Wildlife densities but rather to conduct informal surveys to rapidly assess the distribution of impacted, or potentially impacted, Wildlife and habitats for a prompt response.

Primary objectives of reconnaissance surveys are to:

- Determine the geographic scale of the incident,
- Identify Wildlife and habitats that have already been impacted,
- Estimate abundance and distribution of Wildlife with potential to be impacted,
- Evaluate key habitats of importance to Wildlife with potential to be impacted,
- Develop appropriate response strategies,
- Inform response locations and strategies to avoid or mitigate future impacts, and
- Inform suitability of various methods (e.g., shore, boat, or air-based surveys) for subsequent monitoring for the duration of the incident.

If impacts to Wildlife or their habitats are known or anticipated, an approach for systematically surveying and monitoring Wildlife should be developed and articulated in the WRP (see Section 4.5.4). Standardized protocols have been developed for conducting systematic Migratory Bird surveys during an emergency response in Canada and are summarized in the *ECCC-CWS Technical Guidance and Protocols for Migratory Bird Surveys for Emergency Response in Canada* (2020a). The following stages of a Wildlife response should be developed and implemented by trained and qualified personnel under the supervision of the Wildlife Branch Director and/or Wildlife Technical Specialist(s).

4.5.4 Surveillance (Monitoring) Surveys (48 Hours Onwards)

If impacts to Wildlife or their habitats are known or anticipated, Wildlife Branch will develop a systematic surveillance (monitoring) survey program with an appropriate temporal and geographic scope. If surveillance is required, the RP will secure qualified personnel to develop and execute the program and who will report to Wildlife Branch Director and/or Wildlife Technical Specialist(s). The methods and general approach(es) may be described in strategic WRPs and ECCC-CWS can advise on survey design and implementation for incident-specific WRPs, consistent with *ECCC-CWS Technical Guidance and Protocols for Migratory Bird Surveys for Emergency Response in Canada* (2020a).

Primary objectives of surveillance surveys are to:

- Refine the identification of Wildlife and habitats in the impacted area,
- Refine estimates of abundance and distribution of Wildlife in the impacted area,
- Estimate bird density
- Estimate number of dead/moribund Migratory Birds affected by incident,
- Provide ongoing evaluation of key habitats of importance to Wildlife with potential to be impacted,
- Identify areas where affected Migratory Birds can be collected, and
- Inform other response activities such as Wildlife deterrence and dispersal.

Implemented throughout the response in accordance with the plan, data collected during surveillance provides critical response information and can also be used to document damage assessment following the incident.

4.5.5 Deterrence and Dispersal (0 to 48 Hours)

For some incidents, deterrence and dispersal can be an effective means to deter Wildlife from moving into or near the incident area and coming into contact with contaminants. Use of dispersal techniques can also be an effective means to exclude Wildlife from impacted areas throughout the response phase.

Deterrent devices used to disperse Wildlife include both visual and auditory techniques and range in their effectiveness depending on the species, number of individuals, time of year, and habitat where the incident occurs.

If proponents plan to use deterrence and dispersal tactics during a Wildlife Emergency, this should be described in a WRP, and ECCC-CWS should be consulted to provide guidance on effective tactics for species, seasons, and habitats. If deterrence or dispersal is required or recommended, the RP will retain a qualified and, if applicable, authorized WRO to develop and execute a Wildlife deterrence and dispersal program. Guidelines and protocols to conduct activities related to deterrence and dispersal are outlined in *ECCC-CWS Guidelines on the Use of Bird Deterrence and Dispersal Methods for Occurrences related to Pollution and Non-pollution Incidents in Canada* (Beaumont and Bolduc, in prep). Deterrence will be conducted only by appropriately trained personnel, and under direct guidance and supervision (as required) from the Wildlife Branch Director and/or Wildlife Technical Specialist(s). A WRP may also outline protocols for Wildlife Technical Specialists in the field to monitor and document (e.g., datasheets) the use and effectiveness of deterrence and dispersal so that updates may be made to subsequent WRPs. ECCC-CWS may provide guidance on deterrence and dispersal strategies and may also supervise deterrence and dispersal techniques for habitats or species that are particularly sensitive to these types of response measures (e.g., in proximity to breeding colonies). Strategic WRPs may outline a set of applicable techniques for a particular industry or facility, whereas an incident-specific WRP may then specify actions to be put in place given the species observed and environmental conditions at the time (e.g., weather).

4.5.6 Exclusion, Pre-emptive Capture, and Relocation

WRPs often implement measures designed to pre-emptively limit the potential for Wildlife to become impacted during pollution incidents. Often, marine, aquatic and terrestrial Wildlife can be excluded from areas that are known or have potential to become impacted through a combination of mechanical and physical techniques designed to dissuade habitat use (e.g., visual or acoustical deterrents, fence or net installation, physical habitat modification). Pre-emptive Wildlife capture and relocation similarly seeks to collect Wildlife before they are impacted during a Wildlife Emergency. Planning for Wildlife collection requires considerations for capture, transport, holding, and release strategies. If pre-emptively captured Wildlife need to be contained for a period of time, a WRO authorized to carry out these activities must be identified to provide appropriate species-specific housing, nutritional support, and medical care (if necessary) for a potentially extended period. Guidance and protocols on pre-emptive capture and care for Wildlife during a pollution incident are described in *ECCC-CWS' Guidelines for the Capture, Transport, Cleaning, and Rehabilitation of Oiled Wildlife* (2020b). Where appropriate, the WRP should describe plans for Wildlife collection and relocation activities.

4.5.7 Wildlife Capture, Transport, Rehabilitation, Release, and/or Euthanasia

This section of the WRP will be broken down into detailed phases, each of which are described briefly in Table 3. Planning for these activities may evolve over the course of the incident to include details on the number of monitoring and field staging facilities, recovery procedures and facilities, as well as coordination of rehabilitation personnel.

The RP should retain a qualified and authorized WRO to develop and implement these phases of Wildlife response. These programs will adhere to *ECCC-CWS' Guidelines for the Capture, Transport, Cleaning, and Rehabilitation of Oiled Wildlife* (2020b), *Guidelines for Establishing and Operating Treatment Facilities for Oiled Wildlife* (2020c), as well as an area-specific or incident-specific health and safety plan. Not all phases will be applicable or readily implemented during a response, but all may be considered as options when developing a strategic WRP, and later refined in an incident-specific WRP.

Table 3. Phases of Wildlife Capture, Transport, Rehabilitation, and Release

Phase	Objectives
Pre-emptive Capture	• The capture of Wildlife that is at risk of being impacted by oil • Transport of Wildlife to a holding facility
Capture	• The capture of impacted Wildlife • Transport of Wildlife to field stabilization or Oiled Wildlife Treatment Centre
Field Stabilization	• Physical evaluation • Removal of gross contaminants • Thermoregulatory support • Fluid therapy and nutritional support • Address life threatening conditions • Euthanasia evaluations based on established criteria and best practices
Transportation	• Transport of oiled animals from field or field stabilization to an Oiled Wildlife Treatment Centre
Processing	• Evidence collection • Birds given individual, temporary band • Feather/fur sample • Photograph • Individual medical record
Intake	• Medical examination, triage, and treatment plan development • Critical care concerns addressed • Euthanasia evaluations based on established criteria and best practices
Triage	• Ongoing euthanasia and treatment plan evaluation based on medical health status
Euthanasia	• Euthanize Wildlife that are assessed by the WRO as not being good candidates for rehabilitation or survival
Stabilization	• Fluid, nutritional and medical stabilization of impacted animals • 48–72 hours period • Prepare animals for cleaning process
Cleaning	• Removal of all oil/contaminants from an impacted animal by washing • Removal of the cleaning agent by rinsing • Drying cleaned and rinsed animal
Conditioning	• Restoring waterproofing and physical condition
Release	• Federal banding of individual animals • Consider additional tracking devices on some birds to track post-release • Release of cleaned, waterproof animals into a clean environment
Post-release Monitoring	• Determining the effectiveness of rehabilitation of Wildlife impacted during a pollution incident • Monitoring the clean Wildlife's condition and activities • Following short-term and long-term survival and breeding status following rehabilitation

4.5.8 Wildlife Carcass Collection Procedures

Dead Wildlife should be removed from the environment to avoid attracting scavengers to the site and secondary contamination of Wildlife. The responsibility for the collection and documentation of dead Wildlife is primarily the responsibility of the Wildlife Branch and is completed under the supervision of authorized organizations (e.g., Wildlife Enforcement Directorate) and personnel with appropriate permits. Protocols for Wildlife collection, storage and documentation will be developed. Wildlife recovery personnel will retrieve dead Wildlife as part of daily activities. Dead Wildlife observed by the public can be reported to a 24-hour hotline (see Section 4.6.1). Members of the public must not pick up dead Wildlife but rather report them to the hotline. The Wildlife Branch will work with the Public Information Officer to develop appropriate messaging.

Carcass collection information will be used to:

- Refine the geographic scale of the incident,
- Determine the cause of death if the source is unknown,
- Minimize damage and exposure to unaffected Wildlife by removing affected Wildlife from the environment,
- Minimize potential for harm or exposure by the public who participate in hunting activities or are supporting aspects of the response,
- Support appropriate response strategies for the treatment of affected birds,
- Help obtain a minimum number of casualties for damage assessment purposes, and
- Obtain specimens/samples for legal enforcement activities.

These procedures will also outline requirements necessary for proper chain of custody and storage of specimens. Chain of custody, and other record-keeping forms, will be attached as appendices to the WRP.

4.5.9 Waste Management

Plans for decontamination and disposal of waste materials will be developed. Waste and secondary pollution should be minimized at each step of the Wildlife response. During the various phases of Wildlife cleaning (holding pen, carcass wrapping), waste will be created. Washing Wildlife will cause waste water (oil with detergent), which will need to be managed (through existing Waste Management Plans or by establishing additional plans as needed). Medical waste (e.g., syringes and gloves) should be considered. The response plan will identify the legislation and the authorities responsible for waste management.

4.5.10 Demobilization

Regardless of the scale of a Wildlife Emergency, the WRP will describe any processes or considerations for demobilizing Wildlife response activities. As appropriate, demobilization will be scaled in accordance with the size of Wildlife response (e.g., decreased intake of oiled Wildlife) and must be approved by the Incident Command.

This section of the plan will discuss, as applicable:

- Processes for demobilizing equipment, facilities, and personnel,
- Processes for ongoing involvement in the ICP or post-response impact assessment and monitoring,
- Processes for chain of custody of data to support enforcement decisions, and
- Processes by which the RP can continue to receive advice and support from ECCC-CWS.

4.6 INFORMATION MANAGEMENT AND REPORTING

This section of a WRP should describe how information collected throughout the operational periods of the WRP would be managed, organized, vetted, and reported on. It should include:

a) the type of data being collected (e.g., inventory, photos, videos, GIS),

b) the personnel that will collect, organize, and vet the data,
c) the process for maintaining data records during and after the incident
d) the process for integrating Wildlife data and activities into an incident information system (often referred to as the Common Operating Picture) within an ICP,
e) who data will be reported to, including the type and frequency of reports (e.g., daily email tabular summaries to the Environment Unit Leader), and
f) how information is disseminated to agencies responsible for overseeing response.

4.6.1 Wildlife Reporting From the Public (Wildlife Hotline)

Within the initial phases of an ICP being established where there are potential impacts to Wildlife, ECCC-CWS should ensure that reports of impacted Wildlife are directed to the Environment Unit by way of a 24-hour hotline (or other reporting mechanism created for an incident). The contact information and instruction to the public for the 24-hour hotline, should be outlined in the WRP. This may include the use of already existing environmental emergencies reporting systems, or the development of new hotlines as required for the scale of the incident. The Wildlife hotline may also serve as a platform to relay incident-specific safety information to the public (e.g., avoiding direct contact with oiled Wildlife).

4.6.2 Media Relations

Media statements help to inform the public and raise awareness regarding Wildlife concerns and treatment, as well as public safety. The WRP should identify how Wildlife response activities will be reported to the public through media statements, and who within the Environment Unit or Wildlife Branch are responsible for informing them. Generally, the Technical Specialist, Environment Unit Lead, Wildlife Branch Director, and the Public Information Officer will jointly develop these statements. Where appropriate, public statements involving Wildlife will also be vetted and approved by the ECCC-CWS' technical specialists, Media Relations, and the Regional Director.

4.6.3 Permits Reporting

Certain permits which may be issued prior to or during an incident may also have reporting requirements. Most ECCC-CWS issued permits require reporting of activities within 30 days of the permit expiry.

4.7 HEALTH AND SAFETY

Responder safety is of paramount importance when initiating Wildlife response activities. Activities recommended and implemented as part of a WRP will adhere to the incident-specific safety plan and be identified in consultation with the Incident Safety Officer. A brief overview of safety considerations and requirements will be described in the WRP, with specific mention of Wildlife responder personal protective equipment, zoonoses, and site safety and security (including areas off limits to Wildlife responders). This section will evolve over the course of the incident.

4.7.1 Personal Protective Equipment

For Wildlife management and response activities proposed in a WRP, responders will have appropriate training and equipment for safely operating in shoreline, marine, or aerial environments (depending on incident location and response activities) and for oiled Wildlife handling within a rehabilitation setting. Responders will have appropriate equipment and clothing to operate for extended periods and that protects against environmental exposure or incident-specific conditions. Basic personal protective equipment recommended for Wildlife management and monitoring activities include:

- Eye protection (e.g., sunglasses, goggles, safety glasses, or face shield)
- Oil resistant rain gear or oil protective clothing (e.g., coated Tyvek, Saranex, etc.)
- Water and oil resistant hand protection (e.g., neoprene or nitrile rubber)
- Waterproof and oil resistant non-skid boots; steel-toes may be required under the incident-specific safety plan
- Hearing protection (muff or ear plug type)
- Personal flotation device when working on, near, or over water
- Air monitoring device when appropriate
- Specific gear appropriate for work where personnel are or may be submersed in water (wet suits, dry suits, survival gear)

The above list should not be considered comprehensive or applicable to all incidents. Additional incident-specific and specialized equipment may be required for other aspects of Wildlife response and will be developed in consultation with WROs and the Incident Safety Officer.

4.7.2 Zoonoses

Zoonoses are infectious diseases that may be transmitted between animals and humans under natural conditions. Personnel handling or coming into contact with Wildlife are at risk of zoonotic disease exposure. Veterinarians, technicians, response personnel, Wildlife handlers, and other animal care personnel who come into direct or indirect contact with Wildlife and any body fluids are at risk of contact with disease agents that may have zoonotic potential. The WRP will describe biosecurity practices that will be employed in all aspects of Wildlife response to reduce risk of disease transmission.

4.7.3 Biosecurity

Biosecurity is a set of preventative measures that reduce the risk of transmission of infectious diseases, domestic pests, and invasive species. Where there is potential for response measures (both overall incident response and Wildlife-specific response) to contribute to issues involving biosecurity, the WRP will outline a suite of measures to control for these risks.

4.8 PERSONNEL REQUIREMENTS

There are many personnel that could be involved in various aspects of WRP implementation. Certain roles, responsibilities, or authorized activities require various types of training or technical expertise. Where applicable, the WRP will specify which activities individuals with specific training or expertise can complete. This may include outlining training standards and or experience that may be required for specific industries, areas, or facilities. Industries and Response Organizations should consult with regional ECCC-CWS staff for guidance on relevant standards.

4.9 FACILITY AND EQUIPMENT REQUIREMENTS

As part of planning and implementing Wildlife response measures outlined in a WRP, specific equipment and facility requirements may need to be developed. The level of detail of these requirements will vary by the scale of the incident and may be more appropriately described in documents appended to the WRP. Components of equipment and facility considerations may include:

- The type and amount of equipment required
- Means of transportation to support Wildlife response elements
- Requirements for utilities, waste management, and security
- The nature of equipment or facility requirements (e.g., temporary, mobile, permanent)
- Sources of supplies if known

Additional information to support equipment and facility planning are outlined in *ECCC-CWS' Guidelines for Establishing and Operating Treatment Facilities for Oiled Wildlife* (2020c).

5 EVALUATING WILDLIFE RESPONSE

5.1 EVALUATION AND REVIEW

WRPs should be implemented and evaluated for their effectiveness within a context of adaptive management, where the results are used to refine future iterations (IPIECA 2014, Hebert and Schlieps 2018). Following a Wildlife Emergency, WRP developers and implementers should debrief on strengths and weaknesses of the plan, lessons learned, and gaps or areas for improvement (particularly for strategically developed activity- or area-based WRPs). Evaluation of the WRP should consider a) ease of implementation, b) efficiency of implementation, c) areas of practice that were or were not included, and d) whether the WRP supported the desired ecological outcome(s), business and legal requirements. ECCC-CWS may be consulted in this review and assist with recommendations for refinement.

5.2 EMERGENCY EXERCISES

Emergency exercises are important for testing the effectiveness of WRPs, identifying potential gaps, and ensuring activity-, area- or incident-specific considerations are planned for in advance of an actual incident occurring (IPIECA 2014). Exercises also allow for government and industry partners to work together and familiarize themselves with the personnel and resources available to support Wildlife response activities. Exercises can also be an excellent means to provide training, or to test certain response strategies in a controlled setting.

Emergency exercises can take place in several formats: notifications, tabletop, field drills, and participation in the Environment Unit or Wildlife Branch of an ICP. Each exercise will be planned with specific Wildlife response focused objectives in mind, and may center on testing particular aspects of the WRP. WRPs should be updated and revised to incorporate identified gaps and lessons learned into the plans.

6 CUSTODIAN

The custodian for the *Guidelines for Effective Wildlife Response Plans* and any amendments thereto is the:
Director General, Regional Operations Directorate
ECCC-CWS
ECCC

The approval of future updates is vested to the Director General, Regional Operations Directorate, ECCC-CWS.

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APPENDIX A: EXAMPLE TEMPLATE OF A WILDLIFE RESPONSE PLAN

APPENDIX B: EXAMPLE CHECKLIST OF WILDLIFE EMERGENCY ACTIVITIES

Table B.1. Example Checklist of Activities to Undertake within the initial 0-72 hours of a Wildlife Emergency (adapted from Hebert and Schlieps 2018)

Timeline	Responsibility	Action
0-24 Hours	Incident Command/ Unified Command	• Ensure appropriate notifications to relevant government departments and branches • Activate an authorized WRO
	Environment Unit	• Compile existing information on Wildlife • Complete a Resources-at-risk form (i.e., ICS 232) • Initiate Initial Wildlife Assessment • Initiate deterrence and dispersal strategy
24-48 Hours	Incident Command/ Unified Command	• Establish a Wildlife Branch under the Operations Section of the ICP • Designate a Wildlife Branch Director
	Environment Unit and/or Wildlife Branch	• Mobilize the WRO • Continue Initial Wildlife Impact Assessment • Conduct Reconnaissance Survey • Refine deterrence and dispersal strategy • Develop Wildlife Branch organization chart • Establish a Wildlife Hotline • Initiate incident-specific WRP • Initiate requests for resources (personnel, supplies, facilities, equipment) • Identify Wildlife response health and safety requirements • Ensure ongoing notifications and updates to relevant government department contacts • Identify subject matter experts that might support the ICP
48-72 Hours	Wildlife Branch and/or WRO	• Coordinate with the WRO to implement the WRP • Develop plan for ongoing monitoring • Conduct Surveillance and Monitoring Surveys • Determine locations for field stabilization • Establish field staging areas • Refine incident-specific WRP • Develop internal and external communications with the public information officer and departmental communications personnel • Ensure ongoing notifications and updates to departmental contacts

Bat Specific Guidance for Evaluating Environmental Assessments in Canada

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1.0 Introduction

This guidance document was prepared to provide information needed to assist federal environmental assessment staff, and proponents of developments, in addressing concerns related to bats that may arise during the environmental assessment processes. Content presented in this guidance document was based on a review of available Best Management Practices, standards, scientific literature, and expert opinion. This document highlights information that may be important for evaluating a broad-range of bat-related concerns that may arise. However, individual projects have their own unique challenges and objectives, and environmental assessment practitioners should review additional information sources, as needed, to address project specific concerns. Information presented in this document does not replace or supersede existing Best Management Practices and standards, or the need for qualified professionals to oversee the completion and evaluation of Environmental Assessment projects. Where applicable, original sources should be reviewed for more comprehensive information.

2.0 Gathering Preliminary Information

Before developing a survey proposal, proponents should have compiled relevant information regarding landcover and the distribution and diversity of bats and bat habitat in the region (Holroyd and Craig 2016*a*, *b*). Landcover data (e.g., ecosystem mapping products, forest cover maps, remote sensing resources, etc.) are important for delineating biologically relevant study areas, and for determining what bats have potential to occur in an area. Developing a list of known and potential bat species, or habitats, is needed to identify risk factors, as well as to design appropriate survey protocols. For example, the results of this preliminary review could affect:

(1) The assessment of what species have potential to be affected by the project.
(2) Required survey effort (e.g., more heterogeneous landscape will typically require more effort).
(3) Whether focused surveys are needed to identify and survey key habitat features, such as habitat used for roosting and hibernation.
(4) Relative importance of different habitat features (e.g., habitat features used by Species at Risk may require more survey effort).
(5) The survey effort needed to detect species of interest (rare species require more survey effort).
(6) The species that will need to be included in acoustic bat call classification.
(7) The adequacy of acoustic detection for identifying the presence of species of concern (e.g., the presence of two acoustically similar species may require the use of capture to confirm presence).
(8) If capture is being used, whether genetic techniques are recommended to confirm the identity of two morphologically similar species (e.g., Little Brown Myotis vs. Yuma Myotis).

Sources for developing a list of potential species and known occurrences may include: a review of government databases, peer-reviewed literature, grey literature (including other environmental assessments), academic institutions, citizen science programs (e.g., Neighbourhood Bat Watch), as well as consultation with biologists and regulators.

Most bats are wide ranging and occupy a diversity of habitats within their range. Therefore, the list of potential species should be based on occurrence data and range maps that cover a wide region of the province, as well as the availability of habitat that may support species that have not yet been inventoried within the study region. Bat inventories are incomplete in many regions, and the possibility of extralimital occurrences should be considered in study designs and analyses. In addition, some species appear to be expanding their North American range, or have been persistently overlooked, and should be considered when suitable habitat is present, and their range extends into neighbouring provinces or states (Lausen 2015*a*). For example, the Canyon Bat (*Parastrellus hesperus*) and the Mexican Free-Tailed Bat (*Tadarida brasiliensis)* is believed to have been acoustically detected in southern BC (Ommundsen et al. in press, Sarell 2014); a single record of the Big Free Tailed Bat (*Nyctinomops macrotus*) has been documented along the Sunshine Coast of BC; and Evening Bats (*Nycticeius humeralis*) may occur near the Ontario boarder in the vicinity Point Pelee (van Zyll de Jong 1985, Naughton 2012). Yuma Myotis (*Myotis yumanensis*) and/or California Myotis (*Myotis californicus*) may occur in western Alberta (Lausen 2013, 2014). Townsend's big-eared bat (*Corynorhinus townsendii*) and Fringed Myotis (*Myotis thysanodes*) are not known to occur in Alberta, but they occur in Montana, and suitable habitat may occur along the Milk River and in the Rocky Mountains (C. Lausen pers. comm.).

In addition to a review of existing information on bats and bat habitat, a preliminary site survey should be completed to identify potential habitat features that require special attention. It is recommended that identification of these features occurs early in project planning, so that potential project impacts can be avoided before additional mitigation is required. Identification of potential habitat features is important for the design of surveys, including the need for site-specific surveys and the selection of survey locations. Some potentially important features that should be identified include (Keeley and Tuttle 1999, Holloway and Barclay 2000, Taylor and Tuttle 2007, Jantzen and Fenton 2013, Stone et al. 2015, Holroyd and Craig 2016*a*, *b*)

- Water bodies, wetlands, watercourses
- Riparian habitat
- Coulees or other eroded habitats
- Ocean shorelines and peninsulas
- Artificial water sources suitable for bats to drink from (e.g., dugouts; some water troughs; water hazards in golf courses)
- Forest, tree patches, or solitary trees (especially old decaying trees)
- Forest edges and tree rows
- Ridges
- Topographic highs (especially for wind energy developments, where these features will increase the relative height of turbines)
- Caves and mines

- Cliffs, rock outcrops, exposed bedrock, talus, and other karst topography
- Buildings and Bridges
- Sources of artificial lighting attracting swarms of insects
- Any critical habitat for bats as defined under the Species at Risk Act and associated publications
- Any other habitat feature known to be important for local bat species

Depending on the nature of the project, appropriately timed surveys may be required to assess the use of any of the features identified during the information search and preliminary site visit. Locating projects farther from features attractive to bats may be important for mitigating the risk of mortality or disturbance.

3.0 White-Nose Syndrome Decontamination and Prevention

White-nose syndrome is a disease caused by the introduced fungus *Pseudogymnoascus destructans*, and is responsible for mass mortality of hibernating bats in affected regions of Canada and the United States (Turner et al. 2011, Leopardi et al. 2015). In Canada, the disease primarily affects Little Brown Myotis, Northern Myotis, and the Tri-colored Bat, but has potential to affect other species as it spreads to new regions (COSEWIC 2013). Transmission of the disease is likely primarily from bat-to-bat or bat-to-environment-to-bat (Coleman et al. 2015). However, long-distance dispersal of the disease has likely been facilitated by human activities, such as by spreading spores found on contaminated equipment, or unintentional transportation of infected bats (e.g., unintentional transport in recreational or long-haul vehicles)(Coleman et al. 2015, British Columbia Ministry of Environment 2016).

Adherence to accepted protocols for preventing and slowing the spread of white-nose syndrome is necessary for all projects in Canada that involve the capture and handling of bats, or that involve entry into roosts or hibernacula. Proponents are to consult regional guidelines on appropriate measures, and ensure they are up-to-date on any new developments. To ensure compliance, protocols and prevention measures should be clearly communicated to all project participants that have potential to encounter bats, roosts, hibernacula, or contaminated equipment. Up-to-date protocols and additional information should be obtained from the Canadian Wildlife Health Cooperative (http://www.cwhc-rcsf.ca/wns_resources.php), and federal and provincial authorities (e.g., Standard Operating Procedures for Minimizing White Nose Syndrome Transmission [BC MOE and BC FLNRO 2016]).

Proposals involving the capture and handling of bats, or the entry into roosts or hibernacula, should include a statement acknowledging adherence to the appropriate protocol(s). A description of key activities and measures for preventing the spread of the disease should also be included to help verify that appropriate measures have been integrated into project plans. Project plans should also demonstrate that there is an understanding of the known or likely range of white-nose syndrome relative to the project area, because this will have important implications for required prevention protocols. Bat survey equipment (or any equipment entering hibernacula) that has been used in areas with white-nose syndrome should not subsequently be used in areas where the disease does not yet occur. Guidelines for preventing the spread of disease and parasites in aquatic habitats may also apply if capture occurs over water, or personnel are travelling through aquatic environments.

4.0 Permitting and Data Sharing

Appropriate permits, regulatory approvals, and land access permission need to be in place prior to commencement of work. Proponents should contact the appropriate federal, provincial or territorial wildlife agencies for information related to requirements for the work being completed.

All areas of Canada where bats are found have potential to have one or more species of bat listed as Endangered or Threatened under the Species at Risk Act (SARA). Proponents should review applicable SARA prohibitions and permitting requirements well in advance of beginning any activities affecting bats or bat habitats within federal jurisdictions. SARA permitting may be required for some methods used to survey bats. For example, SARA permits will generally be required within federal jurisdictions when surveys involve capture or handling of living or dead bats, or when roosting or hibernating bats have potential to be disturbed. SARA prohibitions and permitting requirements may also apply to project development and mitigation decisions that have potential to affect bats or bat habitats, and should be reviewed early during the planning stage for a project.

Many aspects of bat biology and conservation are poorly understood, and collection of high-quality, well-documented ecological data has potential to greatly improve the management of bats in Canada. Data and collection methods should be provided to applicable agencies, as a condition of permitting or regulatory approvals, for inclusion in appropriate databases. Whenever appropriate and permissable, this data should be made available to support research and monitoring programs in Canada.

5.0 Developing Baseline and Monitoring Surveys

5.1 Setting Objectives

Clear objectives should be established prior to developing pre-construction and monitoring surveys, and clearly stated as part of the environmental assessment process (Kunz et al. 2007, Holroyd and Craig 2016*a*, *b*). These objectives will dictate the methods that will need to be used, as well as minimum requirements for the quantity and quality of data being collected. The objectives of the project will influence the duration and appropriate timing of surveys, locations of surveys, the amount of spatial replication needed, appropriate sampling designs, and the degree of standardization required for replicate surveys. Thus, careful consideration of objectives is an important first step for developing surveys plans and determining the adequacy of study designs.

Objectives vary from project to project, and should be based on several factors, such as:

- Provincial and federal regulatory requirements and best practices.

- Habitat features or risk factors identified during earlier stages of the project that require follow-up studies.
- Review of relevant scientific and grey literature.
- Issues identified after consultations, such as those with regulators, biologists, resource managers, first nations, and others who are familiar with the region.
- Identified knowledge gaps where additional information could help guide site selection, mitigation, and risk assessment.
- Project-specific activities or actions that require monitoring to evaluate its effect (e.g., monitoring to document the effectiveness of an intended mitigation action).

Some common objectives include (Lausen et al. 2010, Holroyd and Craig 2016*a*, *b*):

Pre-construction / Baseline surveys

Among the primary goals of pre-construction surveys are to collect data needed to support project siting decisions, risk assessments, development of mitigation measures, and to characterize baseline conditions needed to support post-construction monitoring. Some of the common objectives of pre-construction surveys include:

- Quantifying baseline bat activity (e.g., using acoustic detection to calculate an index of bat activity) to evaluate relative use of different habitats or features in the project area, possibly to help support and evaluate project siting decisions or impact predictions.
- Document baseline conditions within or near the study area, and at control sites, to support studies of environmental impact that may occur after the project is completed (e.g., to support a BACI study design; Section 5.2)
- Compiling a species inventory (species presence / not detected); needed to identify potential species that may be impacted.
- Locating and confirming use of high value habitat features, such as roosts and hibernacula.
- Validating predictions of habitat suitability mapping.
- Determining the seasonal and nightly timing of bat activity (e.g., determining the magnitude and timing of migration for each species or species group).
- Identifying potential regional migration corridors.
- Identifying site-specific travel corridors and movement patterns (e.g., do bats frequently fly along or between certain habitat features?).

Post-construction / Monitoring surveys

- Ongoing monitoring (of both Project and control sites) to evaluate whether there are changes in the bat community following project construction (e.g., changes in bat activity, occupancy, species composition, etc.)

- Evaluating the effectiveness of applied mitigation (i.e., comparing sites with applied mitigation to control sites without mitigation).
- Determining whether a mine is an active bat dwelling (roost or hibernacula) prior to closure or reclamation.
- Document bat mortality caused by a project, and to validate the accuracy of the original risk assessment.
- Estimate searcher efficiency and carcass removal so that correction factors can be applied to fatality estimates.

5.2 Study Design and Science-based Decision Making

Impact predications and conclusions developed as part of Environmental Assessments should adhere to scientific fundamentals, and based on data collected using valid science-based protocols and procedures (Hanson et al. 2009). Analyses using statistical methods may be needed to provide empirical support for project conclusions, and to reduce the subjectivity that often occurs with purely qualitative comparisons. However, the application of statistical methods will not be appropriate unless data are collected using valid data collection techniques that are consistent with the assumptions of the statistical test being applied (Anderson 2001). Therefore, before developing or evaluating survey plans, it will first be necessary to understand the statistical analyses techniques that will be used to analyze the data, and the underlying assumptions that affect how data needs to be collected. Data collection techniques that introduce substantial bias may be inappropriate for statistical analysis, and could prevent valid inferences about bat communities or project effects that occur beyond the specific sites being surveyed. Often, some form of random sampling will be required to avoid introducing bias into the site selection process. The placement of detectors along linear corridors (e.g., roads, trails, cutlines) is a common practice, but these sites often have activity levels atypical of the surrounding habitats, representing a form of biased sampling that may be inappropriate for some analyses (Anderson 2001, Jantzen and Fenton 2013).

Appropriate analyses techniques will vary by project objectives. While some objectives can be addressed without the use of statistical analyses, others may require a comprehensive experimental design before valid conclusions can be reached. The need for statistical analyses should be considered whenever comparisons are being made, such as among different time periods or locations. Suitable control sites (e.g., comparable sites where a treatment has not occurred) are often necessary to support analyses. A Before-After-Control-Impact (BACI) study design has often be used to examine environmental impacts or the effectiveness of mitigation, and may be suitable for studies involving bats (Kunz et al. 2007, Hanson et al. 2009, Arnett et al. 2013*a*). The BACI design (among others) requires standardized, unbiased data collection techniques throughout the pre and post construction surveys, or before and after the application of a mitigation technique. Sampling designs, such as the spatially balanced sampling approach suggested by Rodhouse et al. (2011), have been developed for bats that may be appropriate for some statistical applications. Review of survey designs by bat biologists and qualified statisticians (or biologists qualified in statistical analysis) are recommended prior to initiating a sampling program.

5.3 Variation and Sampling Effort

There are multiple sources of variation that need to be accounted for when developing survey plans. These include both spatial variation (i.e., differences among survey locations) and temporal variation (i.e., differences among time periods). Spatial variability includes variation among regions, sites (e.g., wetland vs. upland forest), and within-site variation (e.g., two different positions along the same habitat feature; variation among different heights at the same site; variation among different directions at the same monitoring point). Temporal variability includes within-night variation (e.g., early vs. late night), as well as variation among nights, seasons, or years. An important consideration when developing and evaluating surveys is to ensure that the study occurs during the correct time periods, over sufficient durations, and covers a wide enough geographic range to accurately characterize the bat community within the area of interest (Hayes et al. 2009). Minimum requirements will depend on study objectives and the complexity of the landscape being examined. In general, there should be sufficient temporal and spatial replication and survey effort to:

- Appropriately characterize the bat community across the study area to a level of detail suitable for meeting project objectives.
- Have acceptable probability of detecting focal species, especially rare species that may be difficult to detect.
- Provide enough spatial and temporal replication to estimate bat activity levels (or other parameters) with enough precision that biologically meaningful differences can be detected when statistical tests are being used. This may require establishment of control sites, in addition to impact sites.

Guidelines or standards have been developed to guide minimum survey efforts for some industries, most notably for the wind energy and mining sector. However, surveys should be designed to ensure survey effort and methodology are appropriate for meeting project objectives, which in some situations may require exceeding available guidelines. Thus, it will always be necessary to establish appropriate objectives prior to developing bat surveys. Survey effort should also be based on the size of the Project footprint, the anticipated extent and magnitude of the impact, and the identified risk factors. Existing guidelines and recommendations may need to be modified to ensure they are suitable for meeting the objectives of the intended project, and comply with all regulatory requirements and guidelines. If results are going to be used for comparing among sites or time periods, a power analysis is recommended to ensure sampling is adequate to achieve the desired precision needed to detect biologically meaningful results (Hayes et al. 2009).

5.3.1 Geographic Variation

Sampling Design

Bat activity varies substantially across heterogeneous landscapes, and surveys need to be designed to capture enough of this variation to adequately characterize the bat community and address project objectives. Several habitat features are attractive to bats (see Section 2.0 for a list), and focusing surveys around these locations will likely yield the greatest number of detections per unit of sampling effort

(Britzke 2003, Weller and Lee 2007, Loeb et al. 2015). Targeting high value habitats may be justified in situations where the primary goal is to maximize detections, such as for species inventories. In addition, certain features are often the focus of mitigation, so their inclusion in survey plans may be important for meeting one or more study objectives (e.g., surveys of potential roosts or hibernacula). However, biased sampling, such as targeting only high value habitats, has important limitations that may prevent the data from being used to meet some project objectives. In particular, biased sampling will typically violate fundamental assumptions of statistical methods (i.e., that the sample is representative of the population being examined), potentially preventing valid statistical inferences about the population of interest (Anderson 2001)(see Section 5.2).

Regardless of whether statistical approaches are being considered, it may be necessary to sample a broad range of habitats, and locations, to gain a more complete understanding of species-specific patterns of habitat use within the project area. Sampling a diversity of habitats and locations, possibly including areas outside the project area, may be important for determining a typical (or median) level of bat activity, against which higher and lower value habitats can be identified (Holroyd and Craig 2016*b*, *a*). This is important for project siting decisions, because projects should typically avoid locations where bat activity is high relative to local or regional norms.

Sampling Effort

A potentially important component of study design is to ensure that surveys have enough replication to account for within site variation, especially if precise site-specific activity levels are important (Hayes 1997). Bat detectors commonly have short detection ranges (Section 6.1.7) and distances of >50 m have been associated with significant variation in bat activity (Britzke 2003, Fischer et al. 2009, Adams et al. 2012). If site-specific activity levels are important, two or more monitoring stations may be necessary at a site to account for within site variation and provide reasonable estimates of bat activity or occupancy (Britzke et al. 2013).

Bats in Canada often have large home-ranges spanning several kilometers, and individuals may infrequently pass near detection or capture equipment. Those species that are abundant may be easily detected or captured, and reliable activity estimates or occupancy measures may be acquired with relatively few nights of surveys (Weller and Lee 2007, Skalak et al. 2012). However, other species may require considerable effort just to be detected, and capture may be exceptionally difficult. For example, Skalak et al. (2012) found the common species were detected within a couple nights of acoustic detection, but rare species required more than 45 night of continuous sampling just to be detected (Table 5-1). Likewise, Weller and Lee (2007) found that the average number of nights required to capture individual species using mist-nets ranged from as little as 1.5 nights of surveys, up to 44.9 nights.

Survey requirements based on studies with different bat species, habitats, or objectives, will not necessarily be appropriate for environmental assessment projects in Canada, but could be used as a general guide for whether survey effort is reasonable (Table 5-1). The survey effort needed to provide activity estimates with a given precision varies by region and time of year, but multiple days of recordings, using multiple detectors, are generally required to obtain reliable estimates. If fewer sampling locations are used, a greater number of nights will typically be required. When possible, preliminary data should be collected and used to estimate the minimum survey effort required to achieve metrics with a suitable level of precision and accuracy. For capture surveys, Weller and Lee (2007) provide recommendations for deciding minimum survey effort. Methods should always be developed with consideration of the project objectives. In some situations, continuous, long-term monitoring at stationary locations may be required to meet project objectives (e.g., migration monitoring; assessing winter habitat use), while for other objectives, regular rotation of detectors within the study area may be more optimal.

Table 5-1. Summary of selected studies documenting minimum survey effort needed to meet study-specific objectives.

Study	**Summary**
Hayes (1997)	Based on data collected in Oregon, Hayes (1997) indicated that biased activity estimates are likely to result from acoustic surveys lasting fewer than 6 to 8 nights.
Weller and Lee (2007)	Found that individual bat species in northwestern California required an average of between 1.5 to 44.9 nights of surveys to be captured using mist net equipment. A minimum of 61 surveys were required to achieve a 95% probability of capturing 8 of the 9 species in their study area. The authors reported that 4 focal sites / 10 km^2 provided a relatively complete inventory, but this required *a priori* knowledge of where the most effective netting sites were located. Capture success was greatest (and required survey effort lowest) when surveys occurred latter in the summer, and targeted the most productive habitats.
Skalak et al. (2012)	Individual detector stations at their study site in southern Nevada detected most common species within 2-5 nights of surveys, but rare species required more than 45 nights of continuous sampling, using multiple detectors, to be recorded. As a general guideline, the authors recommended deployment of at least 6 detectors in different habitats across a study area, for approximately 30 nights each, if the objective is to detect less common species with relatively small landscape. *Note: This recommendation was based on their study in the Mojave Desert, where they used 7-9 detectors, with each detector between 2 km and 6 km from other detectors. Data was collected from June 2008 to August 2009.*
Froidevaux et al. (2014)	Found that most bat species (i.e., >90%) in 1 km^2 forest plots in Switzerland could be detected within 4 nights of sampling, based on 4 survey locations each having detectors at multiple heights. The authors indicated that 2 acoustic survey locations could be used instead if sampling occurs over 11 nights.

Law et al. (2015)	Found that sampling Australian insect-eating bats beyond 5 to 6 nights provided few benefits for improving precision of activity estimates from acoustic recordings, and indicated that using three detectors for two nights, or two detectors for three nights, would account for spatial variability around a monitoring point.
Loeb et al. 2015	The North American Bat Monitoring Program specifies a minimum of 4-nights, and at least 2 locations, for passive acoustic surveys; however, this protocol was designed for regional monitoring rather than to meet project-specific monitoring objectives.

Note: Information found in these sources will not be applicable to all projects and may not be sufficient for meeting project objectives or regulatory requirements. The original source should always be carefully reviewed to ensure the objectives, spatial and temporal extent, habitats, and bat communities are comparable to the projects for which the information will be adapted.

5.3.2 Variation with Height

Different vertical strata within forests have different bat activity levels, timing of activity, and species composition (Kalcounis et al. 1999, Hayes and Gruver 2000, Froidevaux et al. 2014). Therefore, studies attempting to compare bat diversity, or the timing or magnitude of bat activity among sites, may need to sample multiple heights to gain a complete understanding of habitat use.

Surveys completed as part of wind energy projects need to monitor for activity within the rotor swept area of turbines, because this is where the primary risk to bats will occur. Some species of bats are more likely to be detected at turbine height, and taller turbines have been found to have higher bat mortality (Barclay et al. 2007, Baerwald and Barclay 2009). Detectors that are raised to sample within the rotor swept area of turbines (e.g., ≥ 30 m above ground) are better able to predict bat fatalities at wind energy facilities, and may be required as part of pre-construction survey requirements (Baerwald and Barclay 2009, Lausen et al. 2010, Holroyd and Craig 2016*b*).

5.3.3 Temporal Variation in Bat Activity

5.3.3.1 Within-Night Variation in Activity

There are typically two peaks of bat activity during a night: one peak occurs shortly after sunset, and another (usually smaller) peak occurs shortly before sunrise (Hayes 1997; Kunz 1973). However, the timing of activity will depend on factors such as geographic location, habitat structure, proximity of roosts and other important resources, reproductive status, energy requirements, weather, insect availability, and night length (Kunz 1973, Kalcounis et al. 1999, Feldhamer et al. 2001, Chruszcz and Barclay 2003, Talerico 2008, Skalak et al. 2012). Depending on these factors, actual nightly activity may show two peaks, a single peak after sunset, consistent activity throughout, or some other pattern (Kunz 1973, Hayes 1997). Different species, populations, or individuals will have their own unique activity patterns, which will vary from site-to-site (Skalak et al. 2012). Bats in the far north may have a single peak in activity during mid-summer when nights are short, but then exhibit a bimodal activity pattern once nights become longer (Talerico 2008). Uncommon species may only be detected at certain times of the night, and may require continuous recording throughout the night to be detected (Skalak et al. 2012).

Given the variation in the timing of nightly activity, full-night recordings throughout the period of interest are recommended for passive acoustic surveys, and may be a regulatory requirement in some jurisdictions (See Section 8.0 . Full night surveys increase the likelihood of detecting rare species, and provide more robust metrics of activity (e.g., passes / detector night) that will allow comparisons between sites or studies. Measures such as 'passes/hour' that do not account for nighttime variation in bat activity are problematic, or unusable, when comparing among studies or sites where bat activity patterns may be different.

5.3.3.2 Night-to-Night Variation

Bat activity at individual locations often varies substantially over consecutive nights, possibly encompassing a several-fold difference in activity levels (Hayes 1997). Several factors can affect night-to-night bat activity, but weather appears to be particularly important. For example, low temperatures can greatly reduce bat activity, especially once temperatures drop sufficiently to slow insect activity (Hayes 1997, Erickson and West 2002). Wind can affect activity patterns by causing insects – and bats – to concentrate in sheltered locations, such as along the leeward side of forest edges (Barclay 1985, Verboom and Spoelstra 1999). Migratory bat monitoring at wind energy facilities (which are in areas with high wind exposure) generally find that activity (and fatalities) decreases during nights with high wind speeds (Arnett et al. 2008, Baerwald and Barclay 2011). Activity is generally low during rainy weather, but may spike before and after the passage of storm fronts (Arnett et al. 2008). Because of high night-to-night variation in bat activity, multiple nights of surveys may be required. Conducting surveys during optimal weather conditions is recommended for short duration surveys (e.g., warm, dry, and low winds) (see Section 6.8) (Fischer et al. 2009).

5.3.3.3 Seasonal Variation

Bats undergo several events that strongly affects their distribution and abundance at different times of the year. These include hibernation, spring migration, gestation, birth and raising of young, volancy and weaning of young, fall migration, and mating / swarming. The magnitude of activity during each of these periods will depend on the configuration and quality of important resources (e.g., hibernation, roosting, foraging, and drinking habitat) used during these events, and the proximity of travel corridors.

Migratory bats typically show a peak in activity along migration routes during the late summer and fall, approximately from mid-July to early October in Canada (Cryan 2003, Lausen 2007, Arnett et al. 2008, Baerwald and Barclay 2011). Spring migratory activity appears less pronounced than Fall migration, but varies by region and species (Cryan 2003, Lausen 2007, Arnett et al. 2008, Baerwald and Barclay 2011). Migratory bats (Silver-haired Bats, Hoary Bats, and Eastern Red Bats) begin arriving in Canada by late March (Lausen 2007; pers. obs.), although some Silver-haired Bats are year-round residents in southern BC (Lausen 2015*b*). Acoustic bat detections will generally peak around the time pups begin to fledge because of the increase in the number of echolocating bats, and the heighted energy demands of nursing mothers (Barclay 1989). However, activity may decrease in some regions soon after young fledge because bats will begin to disperse away from maternity colonies. Fall swarming is a period of high bat activity lasting much of the late summer and early fall, peaking around August – September for some species and regions in Canada (Schowalter 1980, Burns and Broders 2015*a*). Swarming often occurs near known hibernacula, and is associated with mating activity. The timing of seasonal events varies by year, region, and species, and whenever possible, should be based on multi-year regional dataset, and/or data collected during earlier stages of a project.

Because of seasonal changes in activity, surveys are only relevant for describing activity, and species presence/diversity, at the time of year the survey was completed. Some species may only be detected during a portion of the year, such as if they migrate through an area but do not actually reside there for breeding. Continuous monitoring, using multiple detectors, will be needed if the objective is to characterize changes in bat activity at different times of the year (e.g., for studies of migration monitoring). In addition, long-term monitoring, encompassing the winter hibernation period, is recommended when an accurate assessment of winter habitat use is required (e.g., for mine closures), because bat activity in winter is more sporadic and it may be difficult to detect bats.

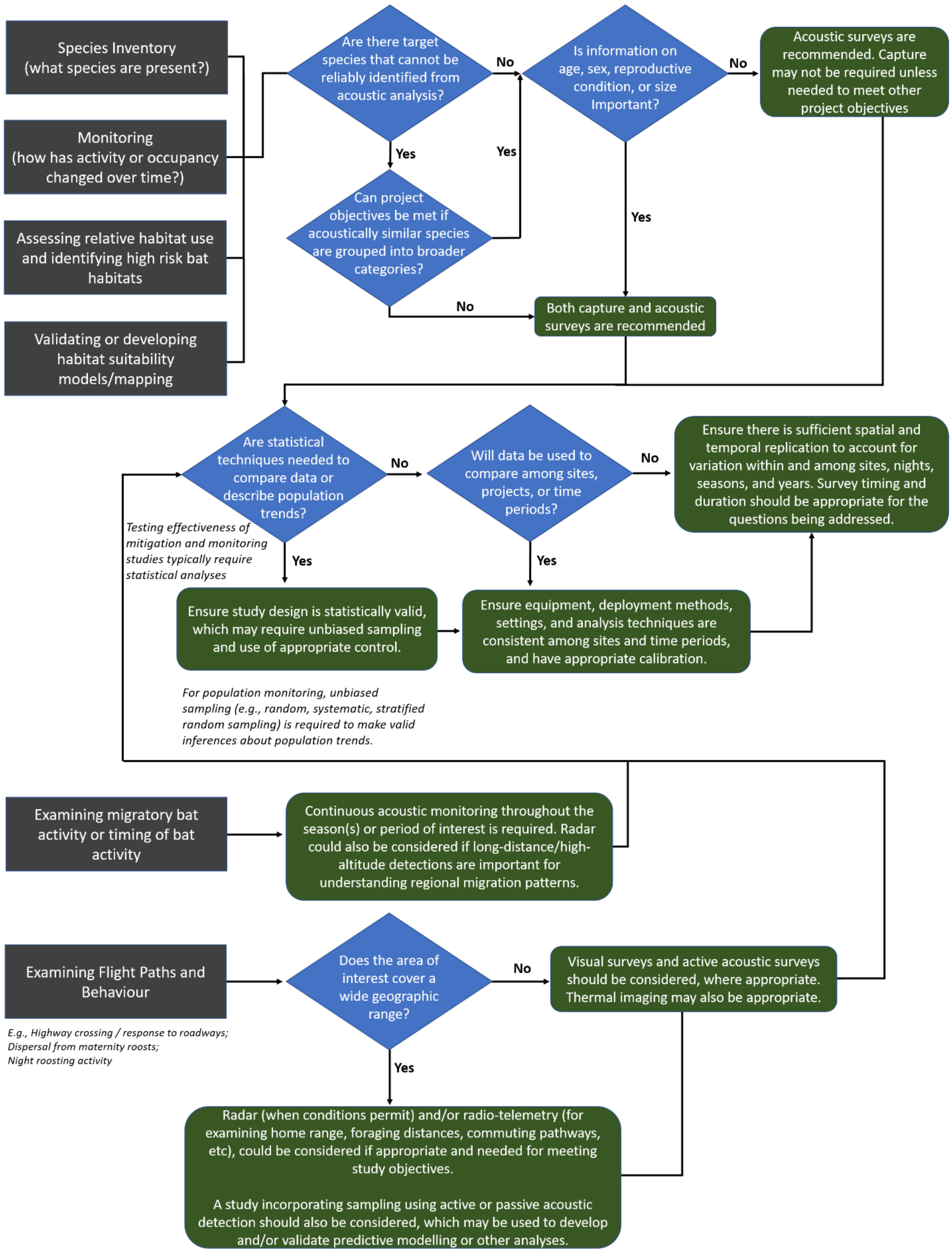
5.3.3.4 Year-to-Year Variation

Year-to-year (interannual) variation in the median timing of pregnancy and subsequent life-history events can range by as much as 3 – 4 weeks depending on the year (Barclay 2012), which can affect the suitability of timing windows for surveys and mitigation, such as those designed to coincide with fall migration. Even among the same year, the timing of reproduction may span a period of up to over a month within some colonies (Krochmal and Sparks 2007, Barclay 2012). The timing of emergence from hibernation, parturition, and weaning may all occur earlier during years that are warm and have abundant insect prey, compared to cold years when food is scarce (Racey and Swift 1981, Ransome and McOwat 1994, Coleman and Barclay 2011). Weather patterns, and the availability and distribution of resources, also changes from year-to-year, which could affect the distribution of bats across the landscape. For example, bats may be much more concentrated around available water sources during dry years compared to wet years (Geluso and Geluso 2012). As water features are often used as survey sites, the concentration of bats at available drinking water could be misinterpreted as a sign of population growth.

Multi-year studies are typically recommended, or required, to provide more reliable estimates of bat activity and diversity, and to provide information on year-to-year variability (See Section 8.0 for existing guidelines in different jurisdictions). For pre-construction surveys, multiple years of data collection are especially important if reliable baseline activity and occupancy estimates are needed as a basis for comparing the results of the post-construction monitoring program. Post-construction surveys should last several years to account for year-to-year variation. Suitable controls (e.g., comparable sites where project impacts or other experimental treatments are not anticipated to occur) will often be required for monitoring programs, and other studies, to account for temporal variation in bat activity.

5.4 Survey techniques

The chosen bat survey techniques should be appropriate for meeting project objectives, and developed with input from qualified bat biologists and applicable government agencies. All survey methods have limitations that may result in them being unsuitable for meeting some objectives (Section 6.0). A potential decision process is shown in Figure 5-1, but project-specific requirements may differ from those shown. Best practices and regulatory guidelines should be reviewed for minimum requirements. More invasive techniques, such as capture, should only be considered when less invasive methods are insufficient for meeting project Objectives, and there is a clear conservation benefit from using such methods.



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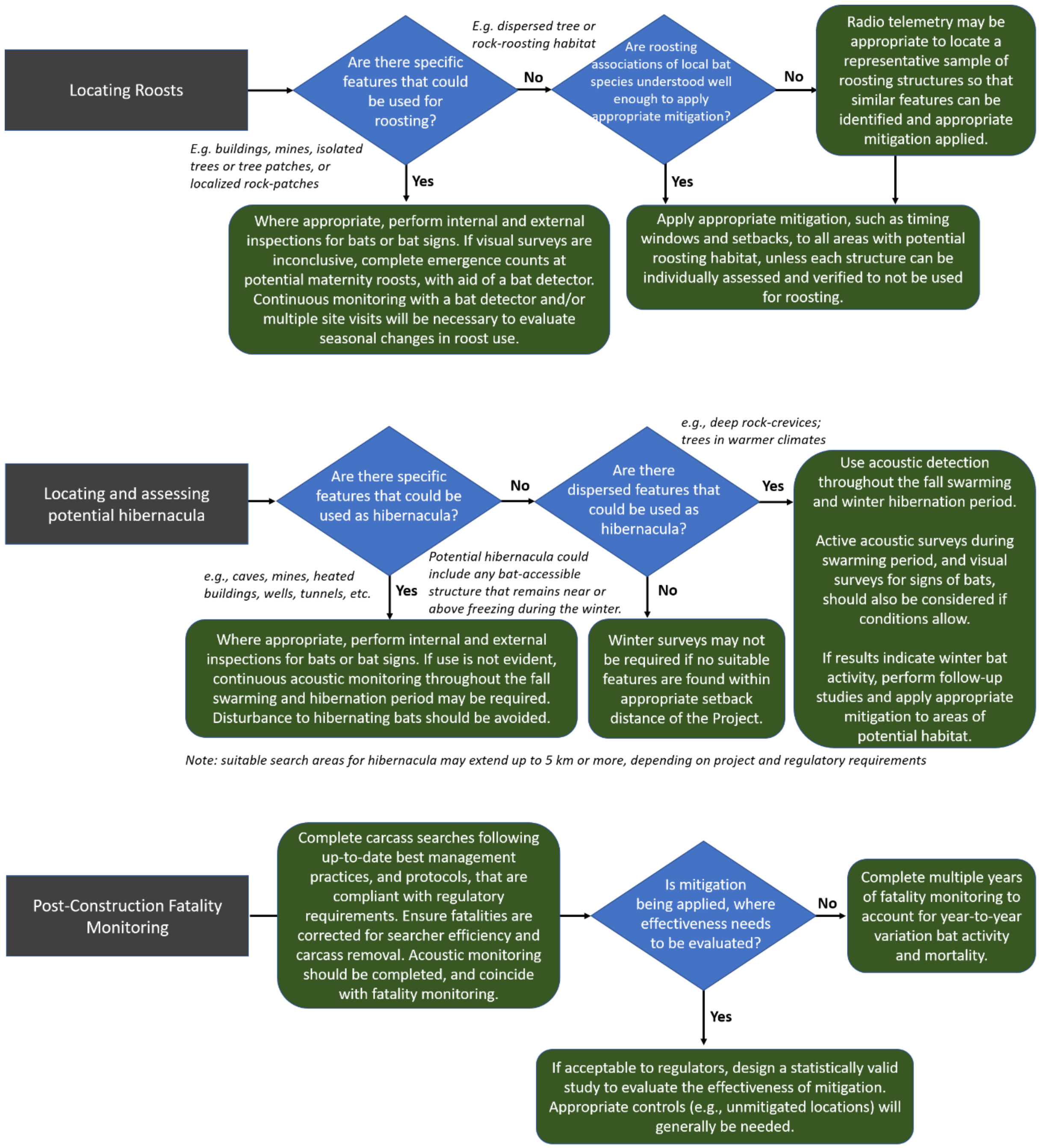

Note: These are general guidelines only. May differ depending on project-specific requirements, applicable best management practices, and regulatory guidelines.

Figure 5-1. Common objectives and possible decision processes for evaluating the adequacy of survey methods.

6.0 Capabilities and Limitations of Survey Methods

6.1 Acoustic Surveys

All bats in Canada use echolocation to navigate their environment and capture prey. Although calls used for echolocation are generally at too high a frequency for people to hear, they are at a sufficiently high intensity to be recorded by specialized equipment capable of detecting and processing ultrasound (i.e., bat detectors). Large amounts of recorded data can be collected, and analyzed later by a qualified biologist. Technology used for recording and analyzing bat echolocation data has been advancing quickly, and acoustic surveys have become among the most common method for inventorying and monitoring bats in Canada. Although acoustic surveys are not appropriate for all potential objectives, they have several advantages that often make them an important (or primary) component of baseline and monitoring studies. Some of these advantages include (Hayes et al. 2009, Parsons and Szewczak 2009, Britzke et al. 2013):

- Methods are non-invasive. Acoustic studies have negligible effect on the behaviour and health of bat populations, and do not risk facilitating the transmission of disease (unless people or equipment are entering roosts/hibernacula).
- Facilitate sampling a greater timeframe than is typically feasible with direct capture.
- Multiple detectors can be placed throughout the study area, or rotated, to achieve more spatial replication than would be feasible with direct capture.
- Two or more detectors can be set to simultaneously monitor different areas, allowing results to be compared under similar conditions.
- More likely to detect species that are difficult to capture, such as those able to detect and avoid capture equipment, or that typically fly above the height of capture equipment.
- Microphones can be elevated to sample bat activity at heights well beyond what would be possible with capture methods (such as by hoisting microphones on meteorological towers).
- Echolocation data can typically be identified to species, or species-groups, which may be sufficient to meet study objectives (less information than capture, but more than radar).
- The deployment of detectors is easier to standardize across locations and survey crews, which may result in more reliable and less biased results to support monitoring programs and other analyses.
- Unlike methods requiring capture, acoustic surveys are not constrained by the availability of suitable capture locations (e.g., ‘pinch-points’ where nets can be set).
- Metrics based on echolocation data (e.g., passes / night) are well suited for comparing activity (or occupancy) among sites, years, and studies, provided consistent and standardized methods and equipment are used.

There are nonetheless important limitations and challenges that need to be considered when developing or evaluating study designs. Acoustic surveys can differ markedly in the equipment being used, deployment methods, and analysis techniques. Failure to use standardized, consistent, and statistically robust approaches can lead to results that are difficult to interpret and misleading. Furthermore, bats have unique characteristics that require special consideration when designing surveys. Among the most important of these are how bats use habitats. Rather than establishing discrete breeding territories, such as occurs with many songbirds, bats are wide ranging and share resources with many other species and individuals. There is substantial geographic and temporal variation in activity that needs to be considered when designing acoustic surveys (Section 5.3).

Specific limitations and considerations for evaluating the appropriateness of study designs are discussed in subsequent sections, and include the following:

- Acoustic survey methods based on fixed-location detectors cannot distinguish unique bats from repeated passes by one or more individuals. Therefore, this method cannot be used to determine the density of bats, the number of bats detected, or relative abundance (Frick 2013).
- Not all bat echolocation calls can (or should) be classified to species. Many must be classified into broader groups of bats with similar echolocation calls.
- Acoustic data does not provide any detail regarding the age, sex, reproductive status, or morphology of bats being detected, which may be useful for understanding risk factors and examining project effects (e.g., the presence of many reproductive female bats may suggest the presence of nearby maternity colonies).
- The detectability of bats depends on call intensity and frequency (lower frequencies travel farther), which will result in some species (or individual bats) being easier to record than others (Adams et al. 2012, Britzke et al. 2013). This will prevent accurate diversity measures from being calculated based on echolocation data.
- Vegetation structure and environmental conditions will affect the detectability of bat echolocation calls, which may confound comparisons among different locations or studies. For example, echolocation calls travel a shorter distance in areas with more vegetation (Patriquin et al. 2003).
- Bat detection equipment (receivers, microphones and accessories) differ in their ability to detect and record bat echolocation data. This can make comparisons to results based on different equipment unreliable (Adams et al. 2012).
- Differences in setup can have substantial effects on the quantity and quality of data recorded. For example, changing the direction of a directional microphone (such as those used on some Anabat units) mid-way through a study could greatly affect the number of bats recorded (Weller and Zabel 2002, Britzke et al. 2010).
- Sensitivities of equipment can change throughout time as equipment begins to wear, requiring regular testing and calibration. Project plans need to be robust enough to account for routine equipment failure.
- There are multiple ways to define a bat pass, and these methods can have a large influence on the reported results. Inconsistent protocols used among studies make comparisons problematic.
- The true error rate of acoustic call identification is typically unknown, and valid tests of accuracy may not be feasible due to inherent bias in most available call libraries.

- Rare or unexpected species can easily go undetected because of misclassification, especially for species that do not produce reliably diagnostic calls.
- There is a lack of complete and accurate reference materials on which to base acoustic call identification, which is likely leading to wide variation in the quality and consistency of call identification among operators.
- While potentially a valuable tool, the widespread use of auto-ID software has, in some cases, resulted in the dissemination of low-quality, non-validated survey results, which could lead to poor management decisions.

6.1.1 Passive and Active Sampling

The most common method for acoustic surveys in Canada is to use passive sampling, where stationary detectors are placed in various locations that are preprogramed to record bat activity for set periods. Typically, these units record data throughout the night (e.g., sunset to sunrise) and often for multiple days. This is the required method for most baseline and monitoring studies for wind energy projects in Canada and is also applicable to many other studies. Data from stationary detectors are typically used to calculate activity indices, which can be used for standardized monitoring studies and for comparing activity among sites or projects.

Another option is to complete active surveys during the night, where an observer continuously records bat activity along a transect, and/or completes a series of short duration recordings (or monitoring periods) at predetermined positions along a transect. This latter approach is superficially similar to point-count surveys commonly completed for songbirds. However, unlike songbirds, bats do not appear to establish discrete breeding territories, and it is not possible to calculate density or relative abundance indices from most acoustic bat surveys. Transect surveys and short-duration stationary listening periods have a high cost per unit effort, and the shorter sampling durations typical of these methods is likely to result in fewer observations (Coleman et al. 2014). Active surveys are especially poor options for detecting uncommon species that require prolonged monitoring periods to detect, and may fail to adequately characterize heterogenous bat activity patterns (Stahlschmidt and Brühl 2012). However, active surveys may be appropriate for some objectives, such as if many spatial replicates are needed to assess movement patterns that would be impractical to obtain using fixed-point detectors (e.g., movement patterns relative to highway crossings; Berthinussen and Altringham 2015). Active surveys may also be appropriate options where stationary detectors are impractical to deploy, such as for offshore developments (Holroyd and Craig 2016*b*).

The advent of detectors with advanced recording and storage capabilities have made walking transects and short-duration stationary surveys uncommon in Canada. However, driving transects are a component of the North American Bat Monitoring Program, a program designed to monitor bat populations across North America (Loeb et al. 2015). Driving transects involve attaching a microphone to the roof of a vehicle and recording bats along a road transect during the night, while driving at a predetermined speed (Loeb et al. 2015). Repeat detections of the same bat is avoided by driving faster than bats are capable of flying. Although driving transects can provide useful data needed for monitoring, they have major limitations that make them poor options as the only means of monitoring bats. Road transects are biased in favour of species that commonly forage along edges or in openings, and will underestimate species that avoid openings, and/or have weak echolocation calls (e.g., Northern Myotis; Long-eared Myotis). Some bat species are known to avoid roads, especially larger, will-lit roads with greater traffic volume (Altringham and Kerth 2016). Changes in road use over time could affect monitoring results irrespective of the status of the regional bat population. Driving transects also only provide a snapshot of bat activity at one moment in time, so cannot be used to infer the absence of bats, or activity level, at any specific location along the route. Driving transects, if completed, should be augmented with other, less-biased, methods for acoustic detection, and limitations of the survey methods should be clearly stated.

6.1.2 Activity and Relative Abundance Indices

Acoustic surveys using stationary detectors, or walking transects, can provide an index of bat activity (e.g., passes / night). However, this is not necessarily correlated to the actual number of individuals, and therefore, is a weak substitute for relative abundance (Hayes et al. 2009). Multiple passes could represent unique bats, or fewer individuals passing by the microphone multiple times (Frick 2013). In some habitats – such as small wetlands or clearings, a single bat may be recorded tens – or even hundreds - of times in a single night. Every site will have a different probability of having repeated detections, so activity indices are an unreliable surrogate to compare the relative abundance of bats among sites. Nonetheless, areas with consistently more bat activity may represent higher value habitat for bats, and consistent changes in bat activity may signal a change in the size of the bat population or the ability of habitat to support them (Hayes et al. 2009, Britzke et al. 2013). Activity data incorporating multiple days of surveys and/or multiple detection locations may also be analyzed using occupancy modelling, which addresses some of the statistical problems associated with activity data, such as imperfect detection probability (Yates and Muzika 2006, Gorresen et al. 2008, Weller and Baldwin 2012, Clement et al. 2014*b*). However, analyses using occupancy may be less likely to detect project impacts than those using activity (Law et al. 2015).

Driving transects, such as those used by the North American Bat Monitoring Program, can avoid recording the same individual multiple times by driving faster than bats are capable of flying (e.g., 32 km/h) (Loeb et al. 2015). This potentially allows the calculation of an index of relative abundance, but not actual abundance, since the size of the detection window (i.e., volume of airspace being sampled) is unknown and variable, and many bats may go undetected (Patriquin et al. 2003, Duchamp et al. 2006, Britzke et al. 2013).

6.1.3 Analysis and Species Identification

The identification of bat echolocation recordings has unique challenges that are important to understand when planning surveys and analyzing or reviewing results. Unlike territorial or mating calls, such as those made by birds or amphibians, bat echolocation calls are meant to provide functional information needed to navigate their environment and to localize prey – they do not need to advertise species identity and generally have simpler structure (Barclay 1999). Each species (and individual) can vary the vocalizations they use for different activities (e.g., foraging, commuting, drinking, social interactions) and for responding to different environmental conditions (e.g., vegetation cover, presence of other bats, obstacles, etc.) (Obrist 1995, Barclay et al. 1999, Murray et al. 2001, Barclay and Brigham 2004, Broders et al. 2004). This variation makes it difficult to establish a single set of criteria that will allow reliable species identification under all conditions.

Identifying and managing uncertainty is an important component of acoustic call analysis. For example, the Northern American Bat Monitoring Program requires species to be identified using two different methods (e.g., using both automated and manual species identification; or using different automated classification methods) (Loeb et al. 2015). Manual review of automated classifications is recommended, and at a minimum, unexpected and rare species should be manually reviewed by an experienced biologist (Fritsch and Bruckner 2014, Loeb et al. 2015). It is expected that many bat calls will not be identifiable to species regardless of the analysis method used (Barclay 1999), and reports failing to incorporate uncertainty into discussions and analyses should be reviewed carefully. Likewise, reports of the presence or absence of rare or unexpected species should include a discussion of the criteria used to base the identification, if such identifications are important for the assessment.

Bats have a range of echolocation calls, and often a portion of these calls have properties that overlap significantly with those of other species (Table **6-1**). Some species groups have echolocation calls that have substantial overlap, and attempts to classify these calls to species can introduce unacceptably high error rates (Frick 2013, Rydell et al. 2017). Species that typically have diagnostic calls, may still have a range of vocalizations that could be confused with other species (Britzke et al. 2011), and the likelihood of false positives will generally increase with the size of the dataset being analyzed. Several high-quality recordings, showing diagnostic sequences, will typically be needed to provide confidence in new species records. For many species, acoustic records documenting range expansions will need to be followed up with capture before they can be deemed reliable.

Table 6-1. Species in Canada that can be identified based on acoustic analyses.

Common Name	Reliably identifiable?	Ability to Acoustically ID
<16 kHz Bats		
Spotted Bat (*Euderma maculatum)*	Often	Steep, low frequency calls generally diagnostic
Big Free-tailed Bat (*Nyctinomops macrotis)*	Often	Echolocates at a frequency unlikely to be confused with Canadian species when well recorded. Confusion with Hoary Bats or flying squirrels is possible if sequences are short or poor quality (Lausen 2015a). Not known to be a regular visitor to Canada.

16 – 20 kHz Bats		
Hoary bat (*Lasiurus cinereus)*	Often	Well-recorded passes are typically reliably diagnostic, but some higher frequency (higher clutter) passes may be confused with Silver-haired Bats or Big Brown Bats. In areas where flying squirrels occur, short, poorly recorded sequences can be confused.
~25 kHz Bats		
Silver-haired bat (*Lasionycteris noctivagans)*	Occasionally	Most calls are difficult or impossible to tell apart from Big Brown Bats and Mexican free-tailed bats, but some calls reliably diagnostic.
Big brown bat (*Eptesicus fuscus*)	Occasionally	Most calls are difficult or impossible to tell apart from Silver-haired Bats, Mexican Free-tailed Bats, and from Pallid Bats, but some calls reliably diagnostic.
Mexican Free-tailed Bat (*Tadarida brasiliensis)*	Occasionally	Newly documented to be a regular summer resident in areas of SW B.C. (Ommundsen et al. *in press*); easily confused with Big Brown Bats or Silver-haired Bats, but some calls appear to be diagnostic (Lausen 2015a). Most easily differentiated when longer sequences of calls are recorded as their pattern of pulse shapes differs from other 20-25kHz bats.
Townsend's Big-eared Bat (*Corynorhinus townsendii)*	Often	Call structure and presence of harmonics typically result in diagnostic call sequences when well-recorded.
Pallid Bat (*Antrozous pallidus)*	Occasionally	Confusion with Big Brown Bats, Long-eared Myotis, and Fringed Myotis may occur. Social calls are generally diagnostic.
Fringed Myotis (*Myotis thysanodes)*	Occasionally	Steep, low frequency calls are distinctive, but Long-eared Myotis can occasionally produce similar sequences, potentially making acoustics unreliable for establishing new species records, especially when few passes are recorded. Also, easily confused with Pallid Bats.
Long-eared Myotis (*Myotis evotis)*	Occasionally	Can often be identified from other Myotis based on steep shape, long frequency sweeps, and minimum frequency. However, overlap in call properties occurs with Northern Myotis and Fringed Myotis, potentially making acoustics unreliable for establishing new species records.

Keen's Myotis (*Myotis keenii)*	No	Indistinguishable from Long-eared Myotis. This species has been taxonomically downgraded to be a subspecies or morphological eco-type of Long-eared Myotis (Lausen et al. 2016)
Eastern Red Bat (*Lasiurus borealis)*	Often	When recorded in open (uncluttered) environments, passes tend to have a distinctive pattern that is reliably diagnostic. However, many passes are easily confused with 40 kHz Myotis, especially Little Brown Myotis when recordings are made in clutter, such as forested environments. Over-reliance on automated identification may produce many Little Brown Myotis passes incorrectly identified as red bats due to pulse shape similarities in moderate to high clutter environments.
Evening Bat (*Nycticeius humeralis)*	Occasionally	When a long enough sequence of calls can be recorded, a diagnostic sequence pattern can distinguish it from Tricolored and Eastern Red Bat. In high clutter, its calls can also be confused with Myotis.
Little Brown Myotis (*Myotis lucifugus)*	Occasionally	When flying in the open, often produce flatter calls than seen in other species of Myotis. However, in many situations, cannot be differentiated from other species of 40 kHz Myotis.
Long-legged Myotis (*Myotis volans)*	No	Some calls may have upsweeps at the beginning of the call that is believed to be diagnostic of the species, but these are rarely encountered. Most calls cannot be reliability differentiated from other species of 40 kHz Myotis.
Western Small-footed Myotis (*Myotis ciliolabrum)*	Possibly	Most calls cannot be reliability differentiated from other species of 40 kHz Myotis. However, some individuals may be identifiable when recording in open environments in areas with low diversity of 40kHz Myotis species; call shape may allow it to be differentiated from Little Brown Myotis in some situations.
Northern Myotis (*Myotis septentrionalis)*	No	Most calls cannot be reliability differentiated from other species of 40 kHz Myotis.
Eastern Small-footed Myotis (*Myotis leibii)*	Possibly	Most calls cannot be reliability differentiated from other species of 40 kHz Myotis, although pulse shape in open recording environments may allow this species to be differentiated.

Tri-colored Bat (*Perimyotis subflavus)*	Occasionally	Can typically be identified to species, but confusion is possible with Eastern Red Bats.
45-50 kHz Bats		
California Myotis (*Myotis californicus*)	No	Difficult to differentiate from Yuma Myotis especially in a high clutter environment.
Yuma Myotis (*Myotis yumanensis)*	Occasionally	Can produce very low slope calls that may be diagnostic of the species, but in moderate to higher clutter it is difficult to differentiate from California Myotis and occasionally 40 kHz Myotis.
Canyon Bat (*Parastrellus Hesperus)*	Often	Well recorded sequences have a characteristic pattern that may be reliable for species identification (Lausen 2015a). In western Canada, where this species has been acoustically documented, poor quality recordings may be confused with lower clutter pulse shapes of Yuma Myotis.

Note: All species have calls that cannot be identified when recordings are degraded or have short sequences. These calls should be classified into broader categories (see Loeb et al. 2015 for a list of broad species groupings). New species records should be based on well recorded sequences containing reliably diagnostic elements. Information presented here are general guidelines only, and may change as new techniques are developed and tested, or new information becomes available.
Source: (Humboldt State University Bat Lab 2011*a*, *b*, Keinath 2011, Lausen 2015*a*, C. Lausen Pers. Comm. 2017)

A generally-accepted approach for classifying bat calls is to identify some of the calls to species groups, containing one or more species that have similar call properties (see Loeb et al. 2015 for some common species groupings)(Frick 2013). Leaving a portion of bat passes unidentified may increase the reliability and confidence in remaining species identifications (O'Farrell et al. 1999, Broders et al. 2004). Often some proportion of the calls can still be reliably identified to species, which can provide useful information to support species occurrence and richness measures. However, acoustic surveys may have limited use for monitoring individual species that have many calls that are grouped into broader species categories. For example, acoustic surveys may have limited value for monitoring Northern Myotis, which has echolocation calls very similar to Little Brown Myotis. Acoustic surveys are especially poorly suited for confirming the presence or absence of rare species whose vocalizations could be confused with more common species.

Acoustic identification techniques are quickly advancing, but few standards have yet to be widely adopted (Britzke et al. 2013). Comprehensive reference materials (e.g., literature and call libraries) used to guide classifications are not widely available, and much of what is available have deficiencies that may lead different operators to reach different conclusions on call identity. Specialized training is needed to become competent at acoustic call identification, but even then, operators may have a wide variation in skill levels. At a minimum, acoustic identification projects should be overseen by a biologist with a strong understanding of the biology and distribution of bats in the study region, and who have specialized training (e.g., relevant coursework or workshops) and experience with acoustic bat identification.

Call classification is typically based on comparison of recorded calls to reference recordings, either using expert opinion or statistical approaches (Parsons and Szewczak 2009). However, reference recordings are often based on hand-released bats, and may not reflect the full range of vocalizations that free-flying bats will make in natural settings (Parsons and Szewczak 2009, Britzke et al. 2013). Clean, high-fidelity recordings are typically selected for a call library, but these may not be representative of the many low quality, noisy, or short sequences that may need to be identified from actual field recordings (Lemen et al. 2015). Furthermore, bat echolocation calls may vary by region and habitat, which makes reference recordings, and software or analyses techniques based on those recordings, potentially unreliable for supporting the identification of some species when they are encountered under different conditions (Obrist 1995, Barclay and Brigham 2004). In particular, bats tend to have different call properties depending on the degree of structural clutter in their environment (Broders et al. 2004), and failing to account for this variation may lead to inaccurate species identifications (Britzke et al. 2013). Error rates calculated based on reference recordings from hand hand-released bats, or bats from other regions or habitat types, will also be unreliable (Britzke et al. 2013, Clement et al. 2014*a*, Lemen et al. 2015). The true error rate of acoustic classification is unknown for most studies, and would be impractical (or impossible) to determine for most individual projects. Nonetheless, collection of reference recordings for call libraries can provide valuable data needed to support regional bat monitoring programs.

6.1.4 Automated Species Identification

A variety of software tools can be used to aid species identification. Software designed to automatically identify bat echolocation recordings (e.g., Bat Call ID, EchoClass, Kaleidoscope Pro, and SonoBat) have been designed with the objective of improving the efficiency and consistency of acoustic data analysis (Loeb et al. 2015). Filters can also be developed to remove noise, or identify calls that pass some user-specified criteria, thereby automating some, or all, of the classification process. Each software package, or different versions of the same software, have potential to reach different conclusions regarding species identification. The same software versions and analysis methods should be used throughout a monitoring project, unless all years are reanalyzed using the same methods, or it can be demonstrated that the use of different software or versions does not introduce bias.

Auto-identification software and filters use various statistical methods to aid classification, but are still based on metrics and parameters derived from call libraries. Thus, limitations of call libraries will still affect the classification accuracy of auto-identification software, as well as the accuracy of any measures of probability or goodness of fit that the software provides (Lemen et al. 2015).

Automated classification may be important for large scale monitoring programs where the number of recordings are prohibitively large to permit call-by-call inspection by an experienced operator, and where the use of standardized criteria is important for comparing data among different locations or years. However, in most situations, automated identification software should not be used as a substitute for oversight and validation by experienced bat biologists, especially for industrial projects where reported results may affect development and mitigation decisions (Rydell 1991, Fritsch and Bruckner 2014, Rydell et al. 2017). Low agreement on species identification has previously been demonstrated among different automated species identification software packages, suggesting potentially high error rates for at least some of the available options (Lemen et al. 2015). Furthermore, the low agreement among software packages suggests that operators and reviewers should be skeptical of reported accuracy rates that some software packages provide.

Validation of results by highly experienced operators is important for removing false positives and correcting classification errors (Fritsch and Bruckner 2014), although this approach could introduce potential operator bias that auto identification software was meant to avoid (Russo and Voigt 2016). Following up automated identification with manual ID by an experienced operator may decrease identification error, but is still likely to be ineffective for difficult-to-identify species, such as often occurs in the genus Myotis (Rydell et al. 2017). Misuse of auto-identification software – such as if inexperienced consultants conduct the analysis with inadequate oversight – could result in misleading results and poor management decisions (Fritsch and Bruckner 2014, Lemen et al. 2015, Russo and Voigt 2016, Rydell et al. 2017). **Reports and proposals involving automated species identification should include a clear description of methods used, including software packages and versions (including species classifier version, if applicable), settings (including accuracy and filter settings, if applicable), and quality management approaches used to make final species identifications.** Criteria used to make final species identifications should be included as part of this summary. Using both automated classification, and manual identification by a biologist qualified to acoustically identify bat echolocation recordings, is recommended for analyzing bat survey data collected for environmental assessments in Canada (see Loeb et al. 2015).

6.1.5 Detection equipment

Several different technologies are available for monitoring bats, and each has its own specifications that affect its ability to detect bats and how it can be used for field studies. Differences in a detector's sensitivity to ultrasound, frequency response, and directionality can have substantial effects on the detection range and amount of recorded data (Adams et al. 2012). Methods used to mount detectors, or to provide weatherproofing (e.g., 'BatHat' commonly used for some Anabat units), will also have a large effect on the amount of data collected (Britzke et al. 2010). These differences make comparisons among studies using different equipment problematic, and need to be considered when designing surveys and interpreting results (Britzke et al. 2010, Adams et al. 2012). Likewise, changing equipment, or setup, mid-way through a monitoring program has potential to greatly undermine the program's ability to reliably evaluate changes in bat activity. This might become a concern, for example, if environmental consultants change mid-way through a project and do not replicate previous methods, or if aging equipment is replaced with more modern technology. Many of these problems can be prevented by thoroughly documenting the setup and equipment used, calibrating equipment at regular intervals following a well-documented procedure, and ensuring equipment will be available for the entire length of a project.

Environmental studies typically require equipment that can record prolonged periods of echolocation data. Most modern technology with this ability either record bat echolocation calls as zero crossing files, and/or as full spectrum recordings (such as .wav files)(Britzke et al. 2013). Zero-crossing methods sample the frequency of the sound wave at set intervals, providing a simplified and compressed representation of the frequency sweep of the original call (Parsons and Szewczak 2009). This procedure can greatly reduce storage requirements, and consumes less power to process, thereby extending battery life. However, zero-crossing files do not preserve all the detail of the original sound, and some information that would be useful for species identification, such as amplitude, is typically lost. Full spectrum recordings preserve properties of the original sound, but can subsequently be converted to zero-crossing. For some practical applications, zero-crossing provides sufficient detail for identification, and can be faster to work with than .wav recordings (Britzke et al. 2013, Clement et al. 2014*a*). The lower cost of zero-crossing units make them attractive for projects with limited budgets, or that require many detectors. Recording in zero-crossing may also be possible with lower power consumption than full spectrum, allowing deployment for longer durations before batteries need to be replaced. However, collection of only zero-crossing files will prevent the use of analysis methods and software specifically designed for full spectrum recordings (e.g., Sonobat), which may be better able to differentiate some species complexes. Full spectrum recordings are generally recommended when the priority is to maximize species-level classifications, or to identify calls that may be masked among background noise (Ontario Ministry of Natural Resources 2011). Recording technologies that are not well suited for continuously recording echolocation data over long periods (e.g., heterodyne and time-expansion detectors) are no longer appropriate for most studies completed as part of environmental assessments.

6.1.6 Equipment setup and software configuration

Equipment settings and setup procedures can have a strong influence on the level of bat activity being recorded. Having consistent, standardized, and clearly described setup procedures is particularly important if data are being used to compare among studies, sites or time periods. Sudden changes in equipment, setup procedures, settings, or analysis methods mid-way through a monitoring project can render results meaningless.

The decision of how to orient a directional microphone can greatly affect the number of bats that are detected (Weller and Zabel 2002, Duchamp et al. 2006, Britzke et al. 2010). Even small differences in height (e.g., ground vs. chest height) will also affect the number of bats detected (Weller and Zabel 2002). Weatherproofing can negatively affect the performance of detection equipment, effectively changing the detection distance and directionality of the microphone (Britzke et al. 2010).

Bat detection equipment has numerous settings that affect how the device detects and processes bat calls. For example, most devices have settings for gain/sensitivity, which affects the detection range of the equipment. Some devices have onboard settings that determine when detected sound triggers a recording rather than being discarded as noise. More stringent settings will decrease the number of unwanted recordings, but may also result in poor quality bat passes being discarded, leading to lower reported activity rates.

Decisions about how to define a bat pass may have substantial effects on the reported bat activity, and thus has important implications for equipment setup, data analyses, and reporting (Britzke et al. 2013). Some of the important considerations include: 1) the minimum number of bat calls required to be considered a pass, 2) the allowable time between calls (TBC) before being considered a new pass, and 3) the maximum duration of a sequence of calls before being considered a new pass. Detection equipment, or accompanying software, have settings that can be used to decide when a new file is created, and these files are often used as a surrogate for bat passes. If appropriate settings are used, these files may approximate accepted definitions of a bat pass (Britzke et al. 2013). However, commonly used equipment settings may not be consistent with recommended standards for defining a pass. For example, some software (e.g., that accompanying Anabat units) have historically defaulted to using a 5-second TBC for breaking call sequences into files (Britzke et al. 2013, Loeb et al. 2015). This default may have been commonly used for defining passes reports as part of industry surveys, and have been used to base previous guidelines (e.g., Lausen et al. 2010, Government of Alberta 2013). However, this default may be arbitrary when applied to bats in Canada, and is often not consistent with definitions used in the scientific literature. A better standard would be to follow the North American Bat Monitoring Program protocols for defining a bat pass. This protocol defines a pass as a sequence of call with ≤ 2 seconds of silence between successive calls, and not lasting more than 15 seconds; if calls have more than 2 seconds of silence between them, or if passes exceed 15 seconds, then it is considered a new pass/file (Loeb et al. 2015). In addition, the authors recommend a minimum sequence of three search-phase calls (i.e., the more uniform calls that bats use to scan their environment while flying) for species-level identification, but passes with fewer calls can be classified into broader species categories.

Analyzing passes based on recorded files will become problematic when a file contains multiple species or individuals, especially if automated identification software is used. In these cases, operators must either manually correct files to reflect multiple detections, or accept the loss of potentially important information. **To allow comparisons among studies, it is important that proposals and reports containing acoustic information include a clear description of settings, assumptions, and procedures used to define a bat pass.** Regardless of the methods used to define a pass, a consistent definition should be used throughout a project, and methods should be clearly described when reporting results. Proponents are encouraged to review the North American Bat Monitoring Program guidelines, which provides detailed recommendations regarding equipment settings, installation methods, and analyses of bat echolocation data (Loeb et al. 2015).

6.1.7 Sound Transmission and Implications for Assessing Habitat Use

Transmission of ultrasound is affected by attenuation from the atmosphere and structural components of the environment, and thus varies among forest types and by vegetation density (Patriquin et al. 2003). Bats will be increasingly more difficult to detect as vegetation cover increases, and recorded calls will tend to be more fragmented and difficult to identify (Patriquin et al. 2003, Britzke et al. 2013). This can potentially lead to incorrect conclusions regarding bat activity and relative habitat use if not factored into study design and analysis (e.g., by ensuring vegetation structure is consistent among sites and years, or using statistical methods than can incorporate different probabilities of detection). Changes in vegetation throughout a monitoring program should be considered when designing monitoring studies as it will confound potential analyses. For example, placing stations directly in sites that will have substantial regrowth, such as cutlines or cutblocks, may be a poor option because it will be difficult to differentiate a real population change from a decrease in detectability as vegetation regenerates.

The detection range of bat detectors is generally short, even under ideal field conditions (Limpens 2004, Adams et al. 2012). Bats with high-amplitude, low-frequency calls (e.g., Hoary Bats) may have a detection range of greater than 10 m, and up to approximately 40 m or more, with commonly used acoustic equipment (Limpens 2004, Lausen et al. 2010). However, smaller bats with low-amplitude calls (e.g., many Myotis) may have a detection range much less than 10 m, and possibly down to under 1 m (Limpens 2004, Adams et al. 2012). This range means that detectors placed near ground level may miss most bats foraging near the canopies of tall forests, or flying through the rotor swept area of industrial-scale wind turbines. Because detectors only sample bats within their immediate vicinity, they will not necessarily provide information on the use of adjacent habitats. For example, detectors placed along cutlines are primarily sampling bats using the forest edge, which may be a different community than those occupying the forest interior (Jantzen and Fenton 2013). Multiple detectors may be needed to monitor the entrances to roosts or hibernacula to ensure they are within the detection range of bats entering or leaving the structure.

The detection range of detectors in winter can approach zero if ice accumulates on the microphones, leading to an inability of the equipment to detect bats even though it is otherwise fully operational (C. Lausen Pers. Com.). This is more likely to occur when a wind screen is attached to a microphone, because these can retain moisture that will freeze. Failure to use detection equipment appropriate for winter conditions can render results unreliable, potentially resulting in erroneous conclusions about winter bat activity and incorrect management decisions. Thus, reports involving winter bat work should include a description of methods used to ensure microphones remained operational during the winter monitoring period.

6.2 Capture Surveys

The capture of bats is the primary method for collecting information on age, sex, size, reproductive condition, and other measures, which can provide valuable information for understanding how bats are using habitats in a project area (Kunz et al. 2009*b*). Capture may also be the only reliable method for confirming the presence of species that do not have reliably diagnostic echolocation calls. Most studies that involve capturing bats use mist-nets, which are fine-filament nets that are strung along potential flight corridors and entangle bats that fly into them (see Vonhof 2006 and Kunz et al. 2009*b* for more details on capture methods). Harp traps are also occasionally used for some research projects, and may be effective for situations where there are narrow flyways or where many bats are expected to be captured. Harp traps typically have two tiers of harp-like vertical strands of fishing-line, which stops the bats forward momentum and causes them to fall into a holding bag.

Sites selected for capture must be in locations where bats will concentrate their activities, and where nets/traps can be concealed, such as across trails, cutlines, water courses, or along/across other sources of open water. Harp traps typically require narrow flyways, which may not be commonly encountered in field settings. Netting or harp-trapping the entrance to roosts or hibernacula may also be effective for capturing bats, but priority should be given to less invasive approaches for studying bats using these features and will seldom be justified for surveys completed as part of environmental assessments. Because capture locations are inherently biased, capture cannot be used to examine the relative importance of different habitat features found at a site.

Samples of DNA can be extracted from captured bats and used to verify and document species identifications, or used as part of other research programs. Reference recordings can be obtained from hand released bats, and used to improve or test acoustic identifications. Capture is also a necessary component of radio-telemetry studies.

The number and diversity of species captured will depend on the equipment and locations where sampling occurs (Vonhof 2006, Weller and Lee 2007, Kunz et al. 2009*b*). Some species, particularly the smaller more maneuverable species, may be more effectively captured using harp traps, or extra-fine filament nets (i.e., monofilament nets). Species that fly closer to the canopy (e.g., Hoary Bats, Silver-haired Bats) may be more effectively captured using stacked (or triple-high) nets that reach greater heights. The probability of capturing certain species will be strongly influenced by whether preferred habitat for that species is present near the netting site (Vonhof 2006). For example, nets placed near aquatic environments are typically highly successful, but will be biased towards those that forage more heavily on aquatic insects (e.g., Little Brown Myotis). Likewise, nets placed in habitats with abundant rock features are more likely to capture species that roost in rock-crevices, while nets placed in predominately forested habitats may capture proportionately more tree-roosting bats.

Capture surveys are not suitable for all objectives. They are complementary to acoustic monitoring or bat inventories, but provide only coarse data for comparing bat activity among regions or habitats, or for use in monitoring studies. Capture probabilities vary markedly depending on the species, habitat, weather conditions, quality of netting locations, skill of surveyors, and proximity to roosting locations. Bats can regularly switch roosting locations, and capture success will change from night-to-night depending on weather conditions, food availability, and where nets are set relative to active roosts (Vonhof 2006, C. Olson pers. obs.).

Limitations and considerations for evaluating the appropriateness of capture surveys include:

- Capture and handing of bats may pose a risk for the transmission of disease, especially if project participants do not comply with approved decontamination protocols.
- Capture will cause some level of disturbance and stress to bats, and in rare cases, may result in injury or death of captured individuals. Thus, capture should only be used when the potential benefits will clearly outweigh risks.
- Studies involving capture require a high level of training, experience, and competency to avoid stress and injury to bats, as well as to birds and other wildlife that may be caught inadvertently and need to be extracted from mist-net equipment. Many nights of field-training by a qualified biologist will generally be needed to become proficient at capture.
- Capture typically requires animal care approval and generally has more rigorous permitting requirements than acoustic surveys or other non-invasive survey methods.
- Capture surveys are difficult to standardize across years, sites, and observers, so will typically only provide coarse data needed to analyses trends or relative habitat suitability.
- Bats may learn to avoid nets, preventing repeated surveys at the same location within short time periods.
- Capture success depends on the availability and quality of capture locations. Sites will vary in their suitability for capture, and not all sites will have suitable capture locations (e.g., many open grasslands). This may prevent the capture of target species, and makes comparisons among sites unreliable.
- Some species are more difficult to catch than others. Results will be biased towards species that are more easily captured, while potentially missing others entirely.
- Because of the higher labor requirements, it is more difficult to monitor for prolonged periods, and across multiple sites, than with acoustic surveys.

Surveys involving capture may be a valuable addition to a survey design, and can provide much needed bat inventory data for a region, provided data are collected by a qualified biologist and results are made available to other researchers. Whenever possible, those conducting capture surveys should collect, at a minimum, data on sex, reproductive status, age, forearm length, and mass. Even if these data are not required for a project, they may contribute much needed data to understand and monitor regional bat populations. Some bat species can be difficult to visually identify, even by an experienced biologist. Photos and tissue samples are recommended to support identification of difficult species. Tissue (or guano) samples can be used to genetically ID most bat species, or used to support other research projects relating to bats. For simple species identification, a wing swab may be sufficient and is relatively non-invasive compared to biopsy punches.

Capture surveys should not be used unless there is a clearly defined objective and rationale. Bat capture surveys must always be done under supervision by a qualified bat biologist, capable of efficiently extracting birds and bats from net. Appropriate permits are required, and personnel handling bats should have up-to-date rabies vaccinations and titer testing. Guidelines of the American Society of Mammalogists should be reviewed for additional considerations and minimum standards, and incorporated into permit applications and approvals (Gannon and Sikes 2007). Rigorous adherence to white-nose syndrome decontamination and prevention protocols are necessary for all projects involving capture (Section 3.0).

6.3 Radio-telemetry and tracking

Bats are cryptic and frequently occupy structures that are difficult to locate (e.g., tree or rock crevices). Radio-telemetry is often the only effective means of locating roosts and hibernacula, as well as for examining how individual bats or colonies use habitat (e.g. home range size, foraging locations, distances travelled)(Amelon et al. 2009, O'Mara et al. 2014, Collins, J. 2016). Radio-telemetry requires attachment of a radio-transmitter to a bat, typically by gluing it to the interscapular region of the back, and then tracking the bat post-release with use of a directional radio-antenna.

A widely accepted guideline is that the combined mass of any structure attached to a bat (including transmitter, glue/harness, and antenna) should be no more than 5% of the bat's (pre-pregnancy) mass (Aldridge and Brigham 1988). This constraint means that suitable tracking devices in Canada range from about 0.25 g (for the smallest species) to 1.75 g (for the largest species). Radio-transmitters can be made small enough for all bat species in Canada. GPS technology is also becoming small enough for potential use on Canada's larger bats, but additional advancements of the technology will be needed before it becomes a suitable alternative to radio-telemetry.

Transmitters typically fall off on their own, or are groomed off by bats, after a few days or weeks, and available evidence suggests that at least some species can accommodate the extra load (Hickey 1992, Neubaum et al. 2005). However, because of the difficulty in tracking individual bats for prolonged periods, the long-term effect of radio tagging on survival and reproduction is still unknown for most species (O'Mara et al. 2014). As a precaution, radio-telemetry should be limited to situations where there is a clear need and resultant management benefit from its use, and/or where important knowledge gaps are being addressed that will aid management efforts for this species over a larger region.

Limitations and additional considerations for evaluating the potential use of radio-telemetry include (Amelon et al. 2009, O'Mara et al. 2014):

- Capturing, handling, and attachment of transmitters can cause stress for affected bats. How this affects survival and reproductive success (including overwinter survival of adults and pups) is poorly understood. Handling bats will also increase the risk of disease transmission if proper decontamination and prevention protocols are not followed, or prove inadequate.
- Bats must be captured prior to transmitter attachment, which for some species or locations may be very difficult, potentially making tracking infeasible or prone to small sample size.

- Because this method is time consuming and potentially cost-prohibitive, it may be difficult to achieve robust sample sizes that are representative of the whole population.
- Requires a high-degree of training and skill to properly attach transmitters and locate bats. Inexperienced biologists and consultants may cause unnecessary stress for bats, or fail to meet study objectives.
- The small size of bats limits the size of transmitters or tracking devices that can be used, which puts constraints on the battery size, transmitter strength, attachment methods, and the technology used.
- Transmitters typically fall off within a few days or weeks, or batteries die, which limits their use for long-term monitoring/tracking.
- Transmitters have a short range (typically <1 km in forested environments), and signals may not be detectable at all if bats are occupying caves or deep rock crevices. Bats roosting or hibernating in deep rock crevices may be difficult or impossible to track.
- Depending on the species, or season (e.g., spring and autumn migration/dispersal periods), the long-distance movements of bats may make locating signals difficult and may require aircraft support.
- Capture, handling, and attachment of a transmitter has potential to alter behaviour.
- Access restrictions on private land, and lack of access in remote areas, can make locating roosts difficult. In some areas, locating bats can be labour intensive and/or require use of an aircraft.

In addition to radio-tagging, banding, Passive Integrated Transponder (PIT) tagging, and light tagging have been used to mark bats for various purposes (Kunz et al. 2009*b*). However, these methods are potentially invasive and it is doubtful they would be needed for addressing common objectives of industrial surveys, so special justification would be needed before they are used. Banding allows recaptured bats to be identified, which could be used to collect data on bat movement patterns, age distribution, longevity, and possibly to obtain a coarse estimate of abundance. Banding programs have been associated with high levels of wing injuries and population declines; newer methods using bands specifically designed to reduce injuries to bats may be less invasive, but should only be used when there is special justification that outweigh potential risks (Ellison 2008, Kunz and Weise 2009). Light tagging has been used to examine movement patterns and foraging behavior, and for assisting with the collection of reference recordings for echolocation calls, which may be needed to support acoustic analysis (Kunz and Weise 2009). Light tags will fall off on their own after a few days or weeks, and illumination may last hours or weeks depending on the technology used. Light tagging has potential to affect behaviour, and increase antagonistic behaviours among bats (Hoxeng et al. 2007). PIT tags are permanent transponders injected under the skin that allow automatic detection when a tagged bat comes within close range of a receiving antenna. They have been used for studying activity of bats at roost sites, as well as for other long-term studies that depend on repeated observations of the same individual.

6.4 Radar

Radar is not a common or widely accepted method of inventorying bats in Canada, but has potential for addressing questions that few other methods can achieve. The primary benefit of the technology is the ability to detect and track multiple objects at considerable distances and heights, far exceeding the detection range of acoustic detectors (Hayes et al. 2009). Radar can be used to obtain information on the timing, direction, velocity, altitude, density, and behaviour of bats (Hayes et al. 2009, Cryan et al. 2014).

Radar may be particularly useful for wind energy projects, where the primary risk is from bats flying high above the ground, and where large scale bird and bat movements may affect siting and mitigation decisions. The ability to detect birds and bats over a large area makes radar particularly promising as a means of examining potential migratory pathways. However, studies using radar as part of pre-construction assessments for wind energy facilities have not necessarily been able to provide an accurate prediction of risk (Kunz et al. 2007, Hein et al. 2013). The ability of radar (or acoustic detection) to predict risk at wind energy facilities may be limited by the potential for the turbines themselves, and associated habitat alterations, to attract bats and alter flight activity within a region (Kunz et al. 2007).

Several limitations prevent the use of radar as the primary means of surveying bats in Canada. Some of these include (Hayes et al. 2009, Larkin and Diehl 2012):

- Difficulty differentiating small birds and bats, especially for bats flying along straight-line trajectories, which may be common for migratory bats.
- Unable to provide species-level identification for most bats
- Unable to detect bats flying within or near vegetation, making it of limited use for studies of bats in forests, which may include many non-migrating bats.
- Radar signals can be obstructed by topographic features, so may be poorly suited for studies of low-flying bats in hilly or rugged terrain.
- Performance decreases for objects closer to the ground, especially when far away.
- Limited ability to determine how many individuals are responsible for a radar echo.

Thermal imagery and acoustic detection can be used to ‘ground truth’ radar data, but only within the limited detection range of these technologies. Radar should generally not be used as the only means of surveying bats in Canada, but may be combined with other methods to provide additional detail about the timing and locations of flight activity (Government of Alberta 2013, Holroyd and Craig 2016*b*).

6.5 Direct Observation and Visual Surveys

Direct observation is a common method for determining use and monitoring bats at known roosts and hibernacula, and could potentially be used to collect information on how bats are using habitat during the night (Hayes et al. 2009). Exit counts to estimate roosting colony size, and other visual surveys, can make use of bat detectors, video recorders, infrared cameras, night vision goggles, or other equipment to increase the amount of information collected and improve the accuracy of results.

Visual surveys are most effective if there are localized features that have potential to be used by bats, such as buildings, bridges, rock-fields, tree patches, caves, and mines (see Section 2.0 . If there is a known roost, it may also be useful to observe their behaviour at night to see how they are dispersing from these features to evaluate potential risk factors (e.g., see Russell et al. 2009). Tree and rock crevices can occasionally be identified and monitored using visual surveys, but these features are often highly cryptic and are likely to be missed if the search area is large. Radio-telemetry may be used to locate roosts prior to conducting visual surveys. Direct observation should only be completed when structures can be accessed safely and without risking damage or alterations to the structure. Adherence to WNS decontamination and prevention protocols is essential whenever people or equipment enter roost or hibernacula (Section 3.0).

Common visual survey methods include:

- **Counts within hibernacula:** Large hibernacula, such as caves, mines, and buildings can often be entered, allowing some hibernating bats to be directly observed and counted. Bats may show high fidelity to cave and mine hibernacula, and visual surveys have been used to monitor bats in Canada. However, human entry into hibernacula will often disturb bats, causing some to emerge from hibernation and expend limited energy reserves, leading to lower over-winter survival. Entry into hibernacula may be appropriate to document use so that appropriate mitigation can be applied, but repeated entry should be avoided once use has been confirmed. Bats may only be present during some periods of the year, so visual surveys may need to be repeated at multiple different times to be effective. Bats will not always be visible, so visual surveys combined with continuous monitoring using bat detectors will be necessary to support conclusions of non-use.
- **Counts or inspections within roosts:** In some cases, it may be possible to enter large roost structures, such as buildings, caves, and mines, and directly count the number of roosting bats that are visible (Kunz et al. 2009*a*). Entering roosts may be appropriate for documenting initial use of a structure, and for determining species identity, but will have limited use for monitoring populations. Bats regularly move within and among roosts, and changes in the number of visible bats do not necessarily reflect changes in the number of bats occupying the structure. A portion of bats may not be visible, and estimating numbers of bats in large clusters can be problematic, resulting in inaccurate estates of population size. Entering roosts may disturb bats, and how this affects reproductive success is largely unknown. Disturbance should be minimized, and repeated visits should not occur once use has been confirmed. Roost entry should only be considered if there is a clear management need, and preference should be given to exit counts if appropriate for meeting project objectives.
- **Inspections for visible signs of bats:** Observations of bat feces (guano) can be used to determine whether a structure has been used by bats, and a sample can be collected and sent for genetic testing to determine species identity. Guano is often found on the floor or ground below a roost, as well as stuck on the sides of buildings or vegetation near areas being used as roosts. Searching for signs of guano can often be done without disturbance to bats, such as by accessing structures at

times when bats are absent, or by searching areas that will not disturb bats. Not all bats leave visible signs, so this method cannot be used to confirm the absence of bats.

- **Exit (Emergence) Counts:** The size of bat maternity colonies is often estimated by counting bats as they emerge from their roost in the evening. Exit counts involve one or more observers stationed at a suitable vantage point outside of the roost and then counting bats as they emerge. Re-entering bats will also need to be counted to avoid double counting the same individual. Surveys typically start about 30 minutes before sunset and continue until the number of emerging bats stops for a specified period (e.g., 10 minutes). Exit counts can be an effective tool for monitoring roost use, as well as for determining whether a structure is being used for roosting. Repeated visits, at multiple times during the spring and summer, will be needed to account for night-to-night variation in roost use. Emergence counts could be also be complemented with pre-dawn re-entry counts to provide additional information on use, but are typically less reliable because pre-dawn activity is more variable and weather dependent (Collins, J. 2016).

6.6 Roost and Hibernacula Surveys

6.6.1 Hibernacula

Hibernacula are locations where bats roost during the winter when they are undergoing periods of hibernation (i.e., controlled reduction in body temperature and metabolic rate). The full range of structures used for hibernation are poorly understood for bats in Canada, but previous research has shown some species may use rock-crevices, caves, mines, tunnels, old hand-dug wells, and buildings (Schowalter 1980, Whitaker and Gummer 1992, Lausen and Barclay 2006*a*, Brown et al. 2007, Randall and Broders 2014, Lausen 2015*b*, CWHC Atlantic Region unpublished data 2017). Trees may also be used in warmer climates, such as occurs in southern British Columbia (Lausen 2015*b*, Holroyd and Craig 2016*a*). Structures used for hibernation likely have stable, cool temperatures, but remain near or above freezing while being used for hibernation (Webb et al. 1996, Tuttle and Kennedy 2011).

Several bat species in Canada (especially of the genus Myotis) engage in swarming behaviour, which is a period of high bat activity at certain locations during the late summer and fall that is associated with mating. Swarming behaviour has most often been observed near hibernacula, although it is not necessarily the case that bats will hibernate in locations where they swarm, and not all hibernacula will be accompanied by swarming activity (Fenton 1969, Schowalter 1980). The importance of swarming sites for mating and other potentially beneficial social interactions suggests they are likely important resources regardless of whether they are also used for hibernation (Glover and Altringham 2008, Burns and Broders 2015*b*). Therefore, surveys designed to evaluate the use and importance of a site for supporting overwintering bats should consider activity during both the swarming and hibernation period.

Individuals of at least some species of bats may become active and fly outside their hibernaculum during warm winter nights, thereby allowing them to be surveyed with acoustic detectors (Lausen and Barclay 2006*a*, Burles et al. 2014). However, infrequent arousal periods and low night time activity levels will potentially make bats difficult to detect during the winter. In addition, bats may switch locations during the winter, so some hibernacula may only be used during certain periods. Continuous monitoring during the fall swarming and winter hibernation period, combined with visual surveys when permissible, will be needed to evaluate whether a site is being used by hibernating bats. In the case of mines or caves, detectors can be placed inside all mouths of the mine or cave, or at pinch points, such that bats must fly by detectors to leave the structure (Ontario Ministry of Natural Resources 2011, Holroyd and Craig 2016*a*). If hibernacula have potential to occur, but are highly dispersed (such as for areas with abundant karst topography) then multiple detectors should be distributed in suspected high-suitability locations and set to monitor activity throughout the winter. Appropriate weather proofing and regular testing is necessary because ice buildup on microphones can prevent bat detection, often with no obvious signs that this has occurred (C. Lausen pers. com.). Additional guidance for hibernacula surveys may be obtained from Sherwin et al. 2009 and Holroyd and Craig 2016*a*.

Bats that hibernate in Canada can potentially migrate hundreds of kilometers between summer breeding ranges and winter habitat, and potentially within a short amount of time. For example, a Little Brown Myotis in western Canada has been observed to move well over a hundred kilometers in less than a week during fall migration (Schowalter et al. 1979). Combined with high year-to-year variation in the timing of migration (Section 5.3.3.4), this suggests that bat activity within a project area during early spring or late fall is not necessarily an indicator of winter habitat use. Likewise, use of rock-crevices during the early spring or late fall does not necessarily indicate they are hibernacula. Nonetheless, high levels of activity in the late summer and fall could indicate swarming behaviour, suggesting the presence of a nearby hibernaculum. Observations of rock-roosting and high bat activity during the early spring and late fall should be followed up with appropriately timed winter surveys to assess the potential for over-wintering bats. In some cases, winter habitat use can be verified by visual inspection, provided regulations and health and safety concerns do not prevent entry. However, hibernating bats may not be visible, so continuous acoustic monitoring during the fall swarming and winter hibernation period is generally required to support conclusions that a site is not used by hibernating bats. Two years of surveys indicating non-use are recommended prior to closure of mines (Holroyd and Craig 2016*a*).

6.6.2 Maternity Roosts

Roosts occur in a wide variety of structures, such as buildings, bridges, bat houses, living or dead trees (including tree stumps), caves, mines, rock-crevices, and erosion holes (Nagorsen and Brigham 1993, Keeley and Tuttle 1999, Barclay and Kurta 2007, Lausen 2007, Mering and Chambers 2014). Each species has unique habitat preferences, with some specializing on a subset of available roosts (e.g., rock crevices, or trees), and others opportunistically taking advantage of a variety of available roost options, depending on what is available in their environment. No bats in Canada modify the structure of their roosts, so are entirely reliant on structures already in their environment. Large permanent structures (e.g., caves, mines, buildings, bridges) tend to be used for long duration, and potentially over many years, while smaller and more temporary structures tend to be used for much shorter periods (Lewis 1995).

Several studies have shown that bats often show fidelity to roost areas, even if individual roosts are only used for short periods. Roosts in smaller, more abundant, and/or more ephemeral structures, such as tree and rock crevices, may only be used for short durations (e.g., as few as 1 or 2 days) before bats switch to a different roost (mothers will carry non-volant pups) (Lewis 1995, Lausen and Barclay 2002, Willis and Brigham 2004). The use of a potentially large number of roosts appears to be important for maintaining social cohesion in some species, and may allow bats to adapt to changing environmental conditions and thermoregulatory requirements (Willis and Brigham 2004, 2007, Patriquin et al. 2010, Olson and Barclay 2013). Bats occupying larger and more permanent structures typically switch roosts less often, and use fewer roosts throughout the breeding season. However, these bats still occasionally use alternative roosts, and may benefit from the availability of multiple diverse roost types within their environment (Lewis 1995).

Frequent roost switching among a large network of roosts means that even extensive surveys may not be adequate to predict where bats are roosting during project activities occurring on a later date, especially for tree and rock-roosting bats. Nonetheless, tree and rock-roosting bats often remain loyal to specific roosting home ranges (Willis and Brigham 2004, Broders et al. 2006, Lausen 2007, Henderson and Broders 2008, Poissant 2009), so identifying multiple locations where bats are roosting may help delineate 'roosting areas' requiring special mitigation (Holroyd and Craig 2016*a*, *b*). Alternatively, known tree or rock roosts could be buffered by a suitable margin (e.g., based on published roosting home range sizes) to encompass most roosts that would be used by a bat or bat colony.

Identifying candidate wildlife trees (e.g., larger diameter decaying trees with visible cavities) has been used to evaluate potential tree-roosting habitat for bats (e.g., Ontario Ministry of Natural Resources 2011). While older forests, and areas with a greater density of large diameter decaying trees, are more likely to be used by bats, the selection of individual roost trees can be highly variable, and visual searches are likely to miss most trees suitable for roosting (Crampton and Barclay 1998, Kalcounis-Ruppell et al. 2005, Barclay and Kurta 2007, C. Lausen Pers. Comm.). Radio-telemetry is generally the only reliable method of locating roosts in trees and rock-crevices, but is still unlikely to result in all potential roosts being located. Surveys for trees that have potential to serve as bat roosts (e.g., those that contain cavities, knot holes, cracks, splits, or loose bark) may be useful if the goal is to evaluate the relative potential of different forest units within a project area to support bats.

Because roosts in tree and rock crevices tend to be used for short durations, changes in use of individual structures will not provide useful information about the size of the population. Many visits (or continuous monitoring) will be needed to assess whether the structure is being used by bats, and even then, would not be a reliable indicator of whether the structure would be used in the future. Large, permanent roosts or hibernacula, such as buildings, caves, and mines tend to be used more consistently by bats, and have been included in bat monitoring programs (Lewis 1995, Loeb et al. 2015).

Most emphasis for roost protection has been placed on maternity roosts, which are structures used by pregnant or lactating mothers for raising their pups, or hibernacula, which are roosts used by bats during the winter. Night roosts, which are structures used during the night between foraging bouts, generally receive less attention, but may have a strong effect on habitat suitability and patterns of habitat use. Bridges, in particular, may be important as night roosts because of their ability to retain heat, and their presence could affect the use of nearby foraging habitat (Perlmeter 1995, Adam and Hayes 2000). Daytime surveys and emergence counts would not be adequate to evaluate use of night roosts, although guano accumulation, urine, and eviscerated insect parts may indicate use. Properly timed acoustic and visual surveys would be needed if assessing night roosting is a project objective (such as might be important if a project occurs near a bridge).

6.7 Fatality Surveys and Monitoring

Carcass searches are used to monitor post-construction mortality that may arise from projects where there is an identified risk of direct fatalities. They are the primary means of validating fatality risk assessments based on pre-construction monitoring, and for evaluating the adequacy and effectiveness of applied mitigation measures (Barclay and Baerwald 2015). To date, the wind energy sector has been the primary focus of mortality monitoring, and most guidelines and regulations relate to that sector. However, similar methods could be applied to other sectors where direct mortality is expected, such as for road kill surveys at locations where suspected bat travel corridors intersect roadway developments (e.g., at water course crossings)(Russell et al. 2009).

Carcass searches typically consist of searching for bats along fixed-width linear, circular, or spiral transects that are spaced to cover the entire area within a specified distance from the turbine. Surveys are also designed to estimate correction factors to account for searcher efficiency (the ability of different observers to find carcasses) and carcass removal (the loss of carcasses to scavengers, or other causes, before searches occur).

Fatality monitoring has at least three major challenges, which affects survey design and analysis (Strickland et al. 2011):

- **Carcass Removal / Scavenging:** Because there is a delay between when a bat is killed and when a search occurs, there is an opportunity for animals and insects to scavenge the carcass before it is found. The proportion of carcasses that are scavenged may be large, so a correction factor must be applied to prevent underestimating actual fatality rates. To avoid unacceptably high scavenging rates, it is important that searches occur at regular intervals, typically at least every week. Shorter search intervals may be needed if the average carcass removal time is less than the search interval (Holroyd and Craig 2016*b*).
- **Searcher efficiency:** Bats are small and generally have low contrast with ground cover, making them difficult for observers to locate. The proportion of carcasses that are found will vary depending on the skill of the observer, ground cover, and methods used. Carcasses are especially difficult to locate in areas with structurally complex or heterogeneous ground cover (e.g., tall vegetation, high levels of debris, numerous obstacles). While searcher efficiency frequently exceeds 50% (i.e., over half the carcasses are found) in areas with structurally simple ground cover, this can drop to 20% or less in areas where search conditions are more challenging (Arnett

2006, Baerwald and Barclay 2009, Mathews et al. 2013, Smallwood 2013). The use of dogs can greatly increase searcher efficiency when search conditions are difficult, and reduce search times (Arnett 2006, Mathews et al. 2013). Searcher efficiency will decrease as transect spacing increases.

- **Search area:** Search area increases exponentially with increasing distance from the turbine. Thus, it quickly becomes impractical to search increasing distances, and some balance between data quality and search effort will be required. Guidelines in Canada typically require search areas to extend over a minimum radius of at least half the maximum height that the turbine blades will reach, but typically not less than 50 m (Government of New Brunswick 2011, Ontario Ministry of Natural Resources 2011, Barclay and Baerwald 2015, Holroyd and Craig 2016*b*). This search radius appears to encompass the fall zone of most bats (likely >90% in most areas) (Kerns et al. 2005, Hull and Muir 2010, Smallwood 2013). Increasing the search radius might increase the number of bats detected. However, because search area increases exponentially with distance from the turbine, minor increases in search radius (e.g., 65 m instead of 50 m) will substantially increase the amount of effort required to complete surveys. If few carcasses are found beyond 50m, this added effort may be better devoted to increasing the number of turbines searched, or increasing search intervals. If the distribution of fatalities suggests that bats may be missed beyond the area searched, then a larger search area or statistical correction factors should be considered. Note that birds may require a greater search area than required for bats (Hull and Muir 2010, Smallwood 2013).

At a minimum, reported fatality rates need to be corrected for searcher efficiency and carcass removal using protocols acceptable to Environment Canada or other applicable regulatory agencies. A variety of statistical methods are available to make corrections, and the most appropriate correction method may vary from project to project depending on local conditions and search procedures being used (Holroyd and Craig 2016*b*). Correction factors are based on searcher efficiency and carcass removal trials conducted as part of the post-construction monitoring surveys. Separate trials are required for each season, and some method of accounting for variability in habitat or visibility will be required (such as by including a representative sample of each habitat/visibility class, or conducting separate trials).

Environmental practicioners should refer to regulatory guidelines and applicable best management practices for appropriate protocols for completing work at wind energy facilities. Comprehensive guides for conducting surveys at wind energy facilities have been prepared, that may provide additional information on conducting these studies (e.g., Strickland et al. 2011, Holroyd and Craig 2016*b*).

6.8 Weather Conditions

Weather conditions will have a strong influence on bat activity and survey results. Bat activity is particularly low during periods of cold weather, wind or rain, but may spike immediately before or after a storm front (Cryan and Brown 2007, Arnett et al. 2008). For surveys involving capture, wind and rain will make nets easier for bats to detect, often preventing capture even if bats are active in the area.

Short-duration surveys should typically be conducted during mild, calm, and warm nights (Fischer et al. 2009). Suitable conditions vary by region and time of year, but as a general guideline, should occur when there is no precipitation, sunset temperature is above 10°C, and wind is less than 6 m/s (Vonhof 2006, Ontario Ministry of Natural Resources 2011). These guidelines may need to be relaxed in colder climates (e.g., northern or high elevation locations), or during colder months of the year (Vonhof 2006). Long-duration acoustic surveys occur under a variety of weather conditions, and recording detailed meteorological information is needed to interpret survey results and developing effective mitigation. For example, if activity or mortality primarily occurs during certain weather conditions (e.g., low wind speeds), then mitigation for reducing fatalities may only need to be applied when those conditions are present. Collection of detailed meteorological information is recommended whenever bat surveys are completed, and may be required under existing regulatory or best-management guidelines (Lausen et al. 2010, Holroyd and Craig 2016b).

At a minimum, temperature, precipitation, wind speed, wind direction, and barometric pressure should be recorded at least every 30 minutes for wind energy projects, and for other projects where detailed meteorological information may be important (Lausen et al. 2010, Holroyd and Craig 2016*b*). Meteorological data can be collected using meteorological towers, dataloggers, or portable weather stations. Manual recording of weather conditions may also be acceptable for active surveys, unless longer-term datasets or more standardized measures are needed to support analyses.

7.0 Mitigation

Mitigation includes a combination of conservation actions intended to eliminate, reduce, or control adverse environmental effects, or restitution for damages caused by those effects through replacement, restoration, compensation or other means (Government of Canada 2014). Avoidance of adverse effects is the preferred and recommended mitigation approach, which typically requires pro-active planning and oversight early in the development process. If avoidance is not possible, then mitigation should be designed to minimize potential effects, and if possible, provide alternative habitat.

Projects may have a variety of adverse effects for which mitigation may be warranted, including:

- Habitat Loss (e.g., habitat used for migration, hibernation, swarming/mating, foraging, roosting, and for accessing drinking water).
- Habitat Degradation (e.g., altered vegetation, lighting, noise, pollution)
- Reduced connectivity between habitats (e.g., major roadways)
- Disturbance to roosting and hibernating bats
- Fatalities

The effectiveness of different mitigation options will depend on the configuration of resources in the environment, and how local bat populations are using these resources. Bat behaviour varies by species, geographic location, and time-period, so mitigation measures need to consider local conditions and species-specific biology. Post-construction monitoring programs should be designed to allow the effectiveness of mitigation measures to be assessed; where possible, appropriate controls should be established so that valid statistical procedures can be applied.

General mitigation options are shown in Table 7-1. Wind energy is shown separately (Section 7.1) because a relatively greater amount of attention has focused on this industry compared to most other industries. Environmental practitioners may wish to review Berthinussen et al. (2014) for additional mitigation options and scientific evidence supporting available mitigation approaches.

Table 7-1. General mitigation options for reducing environmental impacts on bats.

Type	Summary
Spatial Avoidance (setbacks)	Setbacks may be used to designate areas where construction is not allowed to occur, or where special mitigation, such as timing windows and noise abatement, will be applied. Appropriate setbacks for roosts and hibernacula typically range from 100 m to 1 km, depending on the type of disturbance (Lausen et al. 2010, Ontario Ministry of Natural Resources 2011, Holroyd and Craig 2016*a*, *b*). Setbacks of 2 km or more may be needed around hibernacula and roosts if high-intensity blasting will occur (Holroyd and Craig 2016*a*). For wind energy developments, a minimum setback of 1 km is recommended around hibernacula (Lausen et al. 2010, Ontario Ministry of Natural Resources 2011, Holroyd and Craig 2016*b*). Setbacks of >500 m are also recommended between areas attractive to bats (e.g., ridge tops, forest edges, wetlands and other aquatic habitats) and wind turbines (Lausen et al. 2010, Holroyd and Craig 2016*b*). For bats roosting in trees and rock fields, setbacks are most logically applied to the entire maternity roost complex (roost area), because bats using tree cavities and rock roosts frequently move among a potentially large number of roosts (Holroyd and Craig 2016*a*). In this case, a roost area should be delineated, or approximated using reported roost area sizes, and the buffer applied to the entire roost area. Likewise, setbacks for hibernacula should apply to the entire underground cave/mine network, if applicable.
Temporal Avoidance **(timing of disturbance)**	Activities that may disturb bats should be avoided during times of the year when bats are most sensitive. This includes the fall swarming (approximately August to September) and winter hibernation (approximately October 1st to April 30th) periods for activities near hibernacula, and the pregnancy and lactation period for maternity roosts (Approximately March 15th to September 1st) (Fenton and Barclay 1980, Nagorsen and Brigham 1993, Holroyd and Craig 2016*b*, *a*, Olson and Flach 2016). The timing shown here

	will not necessarily apply to all regions or all species; appropriate restricted activity periods will vary by species, region and year. Timing windows should be based on regional and local data, including surveys completed for the project. Applicable restrictions during this period will depend on the duration and intensity of disturbance, type of activity, bat species, habitat feature being disturbed, and the proximity of the disturbance (see Holroyd and Craig 2016a,b for guidelines).
Timing of roost destruction and exclusion	Destruction of bat residences should always be avoided, and their destruction may be prohibited under provincial or federal legislation (Section 4.0). However, because of the cryptic nature of bats and their frequent roost switching, it is likely that a large proportion of roosts in trees and rock-crevices will not be found during pre-clearing surveys, thereby limiting the effectiveness of roost-specific setbacks. Forest clearing and rock-blasting has considerable potential to stress, injure, and kill bats. Habitat destruction is especially harmful when dependent pups are present (e.g., June 1st to September 1st for many regions) (Holroyd and Craig 2016*b*). However, forced eviction during pregnancy may also cause lower reproductive success, such as through aborted pregnancy or delayed development, regardless of whether bats are directly killed (Brigham and Fenton 1986). Clearing of potential roosting habitat should be restricted to times of the year when bats are absent from the area being cleared. Restricted activity periods should be based on local data, including sufficient buffers to account for year-to-year variation in timing. In warmer regions (or years), bats may occupy maternity roosts by mid-March (Fenton and Barclay 1980, Nagorsen and Brigham 1993). Bats may use trees year-round in mild climates, including southern BC and coastal areas (Lausen 2015*b*). Rock-crevices may be used as both maternity roosts and hibernacula (Lausen and Barclay 2006*a*, Lausen 2015*b*). Year-round monitoring may be required to determine appropriate timing in regions where late-season/winter bat activity is suspected.
Restoration, wildlife tree reserves, and green tree recruitment/retention	Restoration of a development site following project completion is important for maintaining the long-term health of the bat population. Native tree species known to be high value roosting sites for local bats should be prioritized in restoration plans. Different bat species or sexes may have unique patterns of roost use, so a diversity of options will be needed to accommodate all species. Wildlife tree reserves should be considered to provide roosting habitat until new roosts are recruited (Holroyd and Craig 2016*a*) . Heterogenous tree age distributions are preferred for ensuring continuous availability of roost trees over time, which requires continuous

	recruitment of new trees into a forest stand (Hayes and Loeb 2007). Where appropriate, selective harvest or green tree retention practices may help ensure long-term availability of roost trees for bats (Backhouse 1993). Wildlife tree management resources should be consulted for additional options regarding the conservation and recruitment of suitable trees for wildlife (e.g., Backhouse 1993, Fenger et al. 2006).
Underpasses and wildlife bridges	Major roads have potential to be substantial barriers for some species of bats, which could degrade the quality of habitat by isolating bats from previously available resources (*reviewed in* Altringham and Kerth 2016, Fensome and Mathews 2016). Bats attempting to cross roads at vehicle height also risk collision and elevated mortality, potentially leading to the decline of local bat populations. Most current research on roadway mortality and crossing structures have been from European studies (Fensome and Mathews 2016). However, high levels of roadway morality has been documented for Little Brown Myotis in the US (Russell et al. 2009), suggesting road mortality may also be a concern for some North American bat species. Underpasses and bridges designed for wildlife have, in some situations, been demonstrated to be used by bats as crossing locations, potentially increasing connectivity and making roads safer to cross (Berthinussen and Altringham 2012). However, while use of these structures is likely to make crossing safer, it's unknown whether they are sufficient mitigation for reducing mortality to within sustainable limits (Berthinussen and Altringham 2015). Because of a lack of research in Canada regarding the effectiveness of roadway crossing structures (or the incidence of roadway mortality), properly designed monitoring studies are important for evaluating the effectiveness of this mitigation (see Berthinussen and Altringham 2015).
Manage vegetation at bridges and other commuting corridors that intersect highways	Roadway fatalities are typically highest in areas where roads intersect major bat flyways, such as watercourses or forest edges that run perpendicular to the road. Fatalities could potentially be reduced by managing the height of vegetation (or designing bat-friendly crossing structures) in areas where bat flight corridors intersect major highways (Lesiński 2007, Russell et al. 2009, Abbott et al. 2012). The objective is to reduce the occurrence of bats attempting to cross at the height of oncoming vehicles, such as by ensuring the canopy height of forest or tree-rows perpendicular to crossings is not in line with the height of oncoming traffic. Pre-construction surveys should be completed to identify potential flyways, and properly designed post-construction surveys completed to evaluate the effectiveness of attempted mitigation.

Lighting	Artificial lighting has been demonstrated to degrade the quality of habitat for roosting, commuting, foraging, and for accessing drinking water (Stone et al. 2009, Lacoeuilhe et al. 2014, Rowse et al. 2016, Russo et al. 2017). These effects are primarily because of either avoidance of illuminated areas by some bats, or disruptions to the normal activity and distribution of their insect prey. Some bats are attracted to insects at artificial lights, while others avoid illuminated areas. Avoiding or minimizing the use of artificial lighting in bat habitats is an important component of managing project effects on bats. Mitigation measures include avoiding use of artificial lighting in sensitive habitats, selecting lower intensity lights, using light fixtures that restricts/focuses illumination to target areas, selecting less reflective building materials, minimizing time periods when illumination occurs, and avoiding lights that emit blue/green/white/UV wavelengths (Lacoeuilhe et al. 2014, Stone et al. 2015). Light barriers (e.g., vegetated buffers) could be considered as a way to shade important bat habitats, such as aquatic habitats used for drinking (Stone et al. 2015, Russo et al. 2017).
Bat Friendly Structures on Bridges	Incorporating bat friendly structures into bridges could be considered as a way to mitigate potential loss of roosts from the blasting of rock crevices, or removal of riparian vegetation, during bridge and road construction (Keeley and Tuttle 1999). Several options are available, but should be tailored to the biology of the target species, and ideally would allow bats to benefit from the thermal buffering of the concrete (Johnston et al. 2004). Additional mitigation and/or monitoring may be needed to ensure bridge structures do not increase the risk of bats being killed by vehicles.
Artificial Roosts	Artificial bat roosts (e.g., bat houses) have been used to attempt to mitigate for the loss of natural roosting habitat (*reviewed in* Mering and Chambers 2014). Artificial roosts are only effective for a subset of the bat species that are likely to occur, typically favouring species that roost in buildings or trees. Although some species may readily occupy appropriately-designed bat houses, it is largely unknown how these structures affect bat community composition, social behaviours, and long-term reproductive success. Dependence on bat houses could be detrimental to bats occupying these structures if they are not maintained long-term, at least until natural roosting options (e.g., large cavity-bearing trees) re-establish. Therefore, use of artificial roosts should be accompanied with a plan for maintenance until natural roosting options are restored. If artificial roosts are being used for mitigation, there should be clear evidence that the target species will occupy the structures being installed, and the structures should be monitored to verify their effectiveness for the

	target species (guano can be collected from below the roost and used to verify species identity). Appropriately designed surveys, incorporating suitable controls (e.g., sites without bat houses), are recommended to evaluate changes in bat activity and community composition following installation of artificial roosts. The design and placement of artificial roosts should attempt to mimic those previously available in the project area (Mering and Chambers 2014). However, to reduce the risk of overheating, structures should be of a larger size, have multiple chambers, and have appropriate venting (Flaquer et al. 2014, Community Bat Programs of BC 2015). Artificial roosts should be installed well in advance of the loss of any existing roosts, so that bats have time to become familiar with their location.
Other Compensation (Offsets / Tradeoffs)	If the loss or degradation of bat habitat cannot be avoided, then compensation should be considered with the objective of "no net loss" of bat habitats (Holroyd and Craig 2016*a*, *b*). For example, if wetlands, or other aquatic habitats are removed or degraded, then features of similar or greater size and quality could be constructed outside of the affected area, but near enough to benefit bats affected by the initial loss.

7.1 Mitigation to Reduce Fatalities at Wind Energy Facilities

7.1.1 Pre-Development Mitigation / Avoidance

Incorporating appropriate mitigation early in the planning stage for wind energy facilities may be the best option to avoid bat fatalities (Table 7-2). Some mitigation decisions can be made based on known risk factors and preliminary data gathering (e.g., avoiding treed ridges), but other mitigation measures may need to be implemented only after reviewing pre-construction survey results (e.g., moving turbines from areas with higher activity levels to locations with lower activity). Potentially the best method for avoiding adverse effects involve siting turbines well away from areas expected to have an elevated risk for fatalities. Risk assessments should be based on known associations between bat activity and the risk of fatalities. Migratory bat activity that averages 1 pass / night or more may be a sufficient concern that mitigation is warranted (Government of Alberta 2013). However, pre-construction surveys will not necessarily be successful in predicting risk, because turbines themselves appear to attract bats into areas that they may not otherwise occur (Cryan 2008, Cryan and Barclay 2009, Cryan et al. 2014). This makes it difficult to predict the adequacy of avoidance strategies in advance of the turbines becoming operational, and the need for additional mitigation will need to continually be evaluated based on post-construction fatality monitoring.

Table 7-2. Pre-development mitigation options for wind energy projects.

Type	Summary
Avoid sites within or near major flight/migration corridors	Continental trends in bat fatalities indicate that wind energy facilities placed within or near major migration/movement corridors for bats are likely to have higher mortality (Baerwald and Barclay 2009). Potentially important corridors include riparian habitats (especially those orientated north-south), and along the periphery of (or passages through) major geographic barriers (for bats this may include large expanses of treeless habitat). High migratory bat activity has been observed along the forested foothills and river valleys adjacent to open prairie (Baerwald and Barclay 2009), along coastlines (Cryan and Brown 2007), and along other major waterbodies/peninsulas (McGuire et al. 2012).
Avoid bisecting travel paths between important habitat features (Government of Alberta 2013)	Bats undergo nightly movements between habitats used for roosting, foraging, and drinking. Irrespective of setbacks, turbines should be placed to avoid bisecting travel corridors between these features. For example, avoid placing turbines between forest/rock roosting habitat and sources of open water. Sources of drinking water may include relatively small features, such as dugouts and water troughs, especially in arid regions (Taylor and Tuttle 2007).
Establish appropriate setbacks from important habitat features (Government of Alberta 2013, Holroyd and Craig 2016*b*)	Turbines farther from important habitat features will typically have lower bat activity than closer sites, thereby being less likely to kill bats. Minimum setback standards have been set for some features when there is a known occurrence (e.g., hibernacula, roosts). However, adopting additional or more rigorous setbacks may help reduce the risk of unacceptably high mortality. Some features potentially associated with higher bat activity include treed habitat, cutlines, ridges, riparian habitats, coulees, cliffs, rock outcrops, caves, mines, exposed bedrock, talus, aquatic habitats, shorelines, dugouts, some types of water troughs, buildings suitable for roosting, bridges, and artificial lighting that attracts insects (Barclay 1984, Hickey and Fenton 1990, Holloway and Barclay 2000, Lausen and Barclay 2006*b*, Cryan and Veilleux 2007, Taylor and Tuttle 2007). A minimum 1 km setback is recommended around hibernacula (Lausen et al. 2010, Ontario Ministry of Natural Resources 2011, Holroyd and Craig 2016*b*). A minimum 100 m – 1 km setback is recommended around significant roosts (Holroyd and Craig 2016*b*). Larger setbacks may be needed for more disruptive or higher risk projects.

7.1.2 Operational Mitigation

Currently, the most effective operational mitigation measures to reduce bat fatalities at wind turbines involve preventing or slowing the rotation of blades during high risk periods (Table 7-3). Mitigation measures specifically designed to prevent bat fatalities can be restricted to periods when bats are active, which is only during the night, and potentially only during portions of the year (Arnett et al. 2008). The timing and duration of mitigation should be based on pre and post construction monitoring results, and consultation with bat biologists and regulators.

Some mitigation measures may not substantially decrease electricity generation (e.g., low speed idle / feathering below the cut-in wind speed), while others may result in reduced electricity output. However, when restricted to high risk periods for bat fatalities, mitigation requiring the curtailment of operations (e.g., increasing cut-in speed) may be possible with minor (e.g., <1%) loss in annual output, and typically during periods of low electricity demand (Baerwald et al. 2009, Arnett et al. 2011, 2013*b*). Operational mitigation may not be necessary during nights with high wind speeds if survey data indicates bats are not active during these conditions.

Proponents are encouraged to establish suitable controls that can be used to evaluate the effectiveness of applied mitigation. This could include nearby turbines where no mitigation is applied during the trial period. Fatalities vary annually, so comparisons among years will not be sufficient on its own to evaluate whether mitigation is effective.

Table 7-3. Potential Mitigation Strategies to Reduce Bat Fatalities at Wind Energy Facilities.

Type	Summary
Feathering Blades / Low Speed Idle (Baerwald et al. 2009, Arnett et al. 2013*b*).	Rotors that free-wheel below the cut-in wind speed may kill bats even though no electricity is being generated. Bats are most active during low wind speeds, which is when free-wheeling would be most likely to occur. Research shows that fatalities can be significantly reduced by preventing rotors from turning until the cut-in wind speed is reached, potentially with negligible loss in electricity generation. Slowing rotors until they are near motionless by feathering blades has been demonstrated to result in significantly fewer fatalities.
Increasing cut-in wind speed / rotor start-up wind speed (Baerwald et al. 2009, Arnett et al. 2011, 2013*b*)	This mitigation approach aims to reduce fatalities by preventing rotation of blades over a greater range of low-wind speed conditions, which is when bats are most active and vulnerable to being killed. Increasing the cut-in speed of turbines (i.e., the lowest wind speed at which blades will generate electricity) has been demonstrated to significantly decrease the number of fatalities at wind energy facilities. Typically, there is more than a 50% reduction in fatalities when the cut-in speed is increased by 1.5 m/s or more. Cut-in speeds of between 5.0 – 6.5 m/s have most commonly been tested as part of mitigation programs, with higher values in this range shown to be more

	effective. To be effective, blades should be feathered to prevent rotation until the cut-in speed is exceeded.
Temporary Shutdown	Temporarily ceasing turbine operation, and feathering blades to prevent rotation, could be used to prevent fatalities if other mitigation approaches are not successful (Arnett et al. 2008, Holroyd and Craig 2016*b*). This strategy could focus on weather conditions, time periods and locations that have the greatest risk (e.g., night; during the late summer to fall migration period).
Deterrents	Deterrents are intended to reduce the likelihood of bats approaching turbine blades, thereby reducing the number of bats that are killed. Acoustic deterrents (e.g., high intensity ultrasound that interferes with echolocation) and UV lighting (intended to change the visual appearance of turbines to make them less attractive) have shown promise as a deterrent (Arnett et al. 2013*a*, Gorresen et al. 2015). However, these technologies are still experimental and more testing is needed to demonstrate their effectiveness.

8.0 Existing Beneficial Management Practices and Standards

Several guidelines, best management practices (BMP), and standards have been developed by provinces, which may be applicable for projects in Canada. Information provided here is a summary of some key information found in published guidelines, best management practices, and standards in Canada. Information presented here is a summary of some of the guidelines; when applicable, the original source should be reviewed for complete information.

Existing guidelines in Canada primarily focus on activities affecting hibernacula (e.g., caves and mines)(Table 8-1) and wind energy projects (Tables 8-2 to 8-4). Wind energy projects are broken into pre-construction (Table 8-2) and post-construction (Table 8-3) guidelines. Pre-construction guidelines may also apply post-construction, because acoustic surveys are typically continued using similar methodology during post-construction surveys (Barclay and Baerwald 2015, Holroyd and Craig 2016*b*). Survey methodologies are continuing to be refined based on new information and advances in acoustic technology; older guidelines do not necessarily reflect current survey standards. Applicable BMPs and Standards may have been developed that are not shown here, and should be reviewed for additional information and project requirements.

Table 8-1. Selected Standards and Best Management Practices for Surveys at Mines and Hibernacula.

Source	Summary
Best Management Practice Guidelines for Bats in British Columbia, Chapter 2: Mine Developments and Inactive Mine Habitats	*Continuous acoustic monitoring is recommended at all potential bat habitats for at least one year prior to the initiation of mining activity, and increased to two years at high bat use sites. Two years of non-detection of bat activity is required prior to permanent closure of potential bat habitat in caves and mine tunnels.*

(Holroyd and Craig 2016*a*)	The recommended method of detecting hibernating bats is to use long-term passive detection, with continuous recording. When possible, detectors should be placed at least 10 m into the mine or cave. Detectors should be placed to ensure that bats entering or exiting the cave will travel near the microphone. Winter acoustic detection may be supplemented with fall swarming surveys, which may include both acoustic detection and visual surveys. A year of preliminary surveys may be needed to establish appropriate timing for conducting fall swarming surveys. Surveys outside the hibernation period may also be used around foraging/drinking sites to evaluate use of the area by bats.
Bats and Bat Habitats: Guidelines for Wind Power Projects (Ontario Ministry of Natural Resources 2011) (see also Ontario Ministry of Natural Resources 2000)	Potential hibernacula should be surveyed by positioning an acoustic detector within 10 m of each entrance. Acoustic surveys should last 5 hours for 10 nights from August 1 to August 31. Visual surveys should also be conducted from 10 pm to midnight during the peak swarming period (August 1 – 31). If swarming activity is not observed, then a minimum of 10 visits should occur to confirm that the site is not a hibernaculum. Acoustic and visual surveys need only continue until evidence of hibernating bats is detected.

Table 8-2. Selected Pre-Construction Standards and Best Management Practices for Surveys at Wind Energy Facilities.

Source	Summary
Survey Timing and Duration	
Wildlife Directive for Alberta Wind Energy Projects (Government of Alberta 2017) *See also Lausen et al. 2010, Government of Alberta 2013*	Pre-construction surveys must occur, at a minimum, during Spring (**May 1 – 31**) and Summer/Fall (**July 15 – October 15**) for a minimum of **one year**.
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments	The minimum pre-construction acoustic survey period for Year 1 is: - Onshore and marine nearshore developments: **March 1 to October 31**, but year-round surveys should be considered to better understand winter bat activity.

(Holroyd and Craig 2016*b*)	- Offshore developments: **March 15 to May 31, and August 1 to October 15**. **Two or more years** of pre-construction monitoring is recommended to account for annual variability in activity patterns, and to address any deficiencies in the quality or quantity of data collected. For studies after Year 1, sampling periods should be adjusted based on first year results (i.e., extended if activity is detected within 1 week of the start or end of surveys.
Bats and Wind Turbines. Pre-siting and pre-construction survey protocols. (Lausen et al. 2010)	Pre-construction monitoring in southern Alberta should include at least the **entire month of August and the first week of September**. North of the Alberta prairies, Spring and Summer Monitoring (**May – September**) should occur because of a lack of information on the risk periods in these regions - at a minimum, surveys in this region should include May and mid-July to the end of August [note: this is superseded by the Wildlife Directive for Alberta Wind Energy Projects (Government of Alberta 2017)]. Monitoring should be continuous rather than portions of the month, and **two years** of pre-construction monitoring should be completed. Additional surveys should be conducted from mid-September to mid-October if bat hibernacula are known or suspected to be present (e.g., caves, mines, badlands).
Pre-Construction Bat Survey Guidelines for Wind Farm development in NB (Government of New Brunswick 2009)	A minimum of 40 hours of surveys, distributed over at least 10 nights, is required for each of the breeding (**June 1 – June 30**) and fall migration (**August 15 – September 15**) period. In high risk areas, a minimum of 40 hours of surveys, distributed over at least 10 nights, may also be required for each of the summer (**July 1 – July 31**) and late fall (**September 15 – October 15**) period. Nights with adverse weather conditions do not satisfy minimum requirements. A minimum of 4 hours of monitoring is required for each surveyed night, starting 30 minutes after sunset. A minimum of **one year** of pre-construction surveys are required during the summer and fall season. Additional survey periods are required if the site is with 5 km of a known hibernacula, cave, or abandoned mine; within 500 m from a coastline or other major waterbody/river; or located on or near a forested ridge.

Protocole d'inventaires acoustiques de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec — 8 janvier 2008. (MRNF 2008)	Acoustic surveys for bats should coincide with the breeding (July 1 to July 31) and migration (August 15 to October 15) periods. Two sampling sessions are required for each of the breeding and migration season. Each session must be a minimum of 40 hours, over 5-nights (not necessarily consecutive). For the breeding season, one session should occur in June and another in July. For the migration season, one session should occur from mid-August to mid-September, and another from mid-September to mid-October. Only nights with suitable weather count towards minimum requirements (e.g., no precipitation; winds 20 km/h or less).
Time of Night	
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	Surveys should start at least 30 minutes before sunset, and end 30 minutes after sunrise.
Bat Mitigation Framework for Wind Power Development (Government of Alberta 2013)	A detector night is considered the period from a half-hour after sunset to a half-hour before sunrise.
Pre-Construction Bat Survey Guidelines for Wind Farm development in NB (Government of New Brunswick 2009)	Acoustic surveys should occur through-the-night from sunset to sunrise; minimum of 4-hours per night starts 30 minutes after sunset).
Protocole d'inventaires acoustiques de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec — 8 janvier 2008. (MRNF 2008)	Each night must have a minimum of 4 hours, starting 30 minutes after sunset.
Spatial Extent, Replicates, and Detector Height	
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments	The number of bat detectors used for pre-construction surveys should be sufficient to survey bat activity across the survey site, including in all four cardinal directions. Most projects should have a minimum of 5 detector stations, which are placed to represent the

(Holroyd and Craig 2016*b*)	four cardinal directions and the centre of the facility (as per Lausen et al. 2010). Additional detector stations may be required for large projects, or to monitor flyways and important habitat features. Different detector stations should have the same setup (e.g., height, equipment, enclosures) to allow comparisons between areas. Whenever possible, each bat detection stations should monitor activity at two heights: A ground-based detector should monitor activity at >1.5 m height, and another detection point should occur at least 30 m above the ground, ensuring the microphone is high enough to monitor the rotor swept area of the proposed turbines. Raised detection points should be given greater priority than ground-based ones. Meteorological towers and temporary towers are preferred for raising detectors, but trees may occasionally be used. Additional detector locations in high suitability bat habitat outside the proposed development site, but within 1 km, should also be considered to add context to data collected for the development site.
Bat Mitigation Framework for Wind Power Development (Government of Alberta 2013)	Detectors should be placed in enough locations to characterize bat movements across the proposed development area, and to capture north-south bat movements. This includes sampling the perimeter and core area, as well as any potential flyways. Monitoring should include an adequate number detectors at 30 m height, and be designed to assess differences in detection rates between ground level and 30 m (e.g., by having paired ground level and 30 m detections).
Bats and Wind Turbines. Pre-siting and pre-construction survey protocols. (Lausen et al. 2010)	Pre-construction surveys should use all existing meteorological towers for sampling, with detectors at both 1-2 m above ground and 30 m above ground. Locations can be supplemented, as needed, to ensure coverage around the perimeter in all cardinal directions, as well as near the center of the development and near any likely migratory flyways (e.g., valleys, streams, ridges). For small developments (1-5 turbines), a minimum of one bat detector station should be placed on a meteorological tower. More detectors are required for larger developments, with at least 5 needed for developments that encompass geographically, geologically or ecologically diverse terrain.

	Detectors should be spaced approximately equidistant apart to optimize geographic representation, but offset to maximize east-west and north-south coverage. For highly heterogeneous landscapes, a rotation plan may be considered as a way of increasing the number of areas monitored.
Pre-Construction Bat Survey Guidelines for Wind Farm development in NB (Government of New Brunswick 2009)	Sites with 10 or less turbines may require 2-3 survey locations, with an extra station added for each 10 additional turbines. Stations may include site corners, middle, turbine clusters and unique habitats.
Protocole d'inventaires acoustiques de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec — 8 janvier 2008. (MRNF 2008)	Acoustic surveys are completed using stationary detectors. The number of detectors will depend on the size of the facility, number of turbines, and habitat composition. For facilities with 10 or fewer turbines, a minimum of 2-3 locations should be monitored. At least one additional location should be added for each group of 10 additional turbines (e.g., at least 4-5 locations for a facility with 30 turbines).
Reported Information	
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	Acoustic activity should be summarized by species or species group to identify the total, average, and median number of bat passes/detector night. Activity should also be expressed as passes/hour to facilitate comparisons among studies. Minimally, Hoary Bats and Eastern Red Bats should be distinguished from the Big Brown Bat / Silver-haired Bat complex and the myotis complex. Other species should be classified to the species or species-group level, as appropriate. Meteorological data collected should be summarized in the reports, and bat activity should be interpreted relative to meteorological variables to identify patterns that may affect management / mitigation decisions. At a minimum, variation in bat activity in relation to moon phase, barometric pressure, wind speed and temperature should be investigated. Bat activity and the distribution of bat habitat should be interpreted within a greater regional context, incorporating information from other studies completed for the region. Differences in activity among detectors should be examined to identify potentially important or high risk bat habitats.

	Note: The original document should be reviewed for additional reporting and analyses guidelines.
Bat Mitigation Framework for Wind Power Development (Government of Alberta 2013)	Acoustic data used for the pre-construction and risk assessment of wind power developments needs to be presented as the mean number, and variance, of bat passes per detector night, as well as bat passes per megawatt of electricity generated per detector night. In addition, reporting must include passes per detector night, broken into at least two categories: migratory and non-migratory bat species.
Bats and Wind Turbines. Pre-siting and pre-construction survey protocols. (Lausen et al. 2010)	At a minimum, reporting of acoustic data should include the total bat passes and mean passes per detector-night, and be broken down by species-category (excluding nights with measurable precipitation, equipment failures, electronic or insect noise and other events that result in the inability to record bat calls). Bat passes / detector hour should also be presented, in addition to the other metrics, to allow comparison to other studies where full-night recordings are not available. Reports should also include height of detection, microphone orientation and weather-proofing details, sensitivity setting, division ratio, relative location within development area, and brief habitat description of immediate area.
Protocole d'inventaires acoustiques de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec — 8 janvier 2008. (MRNF 2008)	Reports should include a detailed summary of the results. Reports should include a table of results, broken down by sampling station, day, and species.

Table 8-3. Selected Post-Construction Survey Standards and Best Management Practices for Surveys at Wind Energy Facilities.

Source	Summary
Survey Timing and Duration	
Wildlife Directive for Alberta Wind Energy Projects (Government of Alberta 2017)	Post-construction fatality monitoring must occur from **March 1 – October 30** for **3 years**. Additional survey years may be needed if post-construction mitigation is required, or if additional wildlife data are needed.

Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	Post-construction monitoring should occur from at least **March 15 until October 15**. Longer periods should be used if pre-construction surveys indicate activity at other times of the year, or on the recommendation of an experienced bat biologist. Post-construction fatality monitoring should occur for **3 years** post-construction, and for three years post-mitigation. Once fatalities are below levels requiring additional mitigation for 3 consecutive years, surveys can occur every 5 years to ensure fatality levels remain low.
Protocole de suivi des mortalités d'oiseaux et de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec – Novembre 2013 (MDDEFP 2013)	Fatality monitoring for bats should occur from at least **May 15 to July 31** for the breeding season, **and August 1 to October 17** for fall migration. Additional periods may be needed for birds, depending on location. Fatality monitoring occurs for the first **3 years** of operation, and then every 10 years.
Bats and Bat Habitats: Guidelines for Wind Power Projects (Ontario Ministry of Natural Resources 2011)	Post-construction monitoring should occur from **May 1 to October 31**, corresponding to the timing of spring activity through fall swarming and migration. Post-construction monitoring is required for **3 years** at all industrial scale wind power projects (Ontario Class 3 and 4 wind projects). An additional 3-years of effectiveness monitoring is required following the application of new mitigation measures.
Post-Construction Bat and Bird Mortality Survey Guidelines for Wind Farm Development in New Brunswick (Government of New Brunswick 2011)	Post-construction mortality surveys occur from **March 31 – October 31**, for a minimum of **2 years**. The number of years may be extended based on survey results.
Minimum Number of Locations and Search Intervals	
Wildlife Directive for Alberta Wind Energy Projects (Government of Alberta 2017) (also see Barclay and Baerwald 2015)	A minimum of 20 turbines or 1/3 of the turbines, whichever is larger. Turbines should be selected based on stratified random sampling, but must include a mix of footprint edge and internal turbines. Searches must occur at least weekly at all turbines selected for monitoring.

Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	The number of turbines being searched should be based on pre-construction data, site conditions, and the size of the development. Proponents should clearly state how they decided on the number of turbines to search, with supporting rationale. In general, at least 33-50% of all installed turbines should be included, with a minimum of 10 turbines monitored. Turbines should be selected to facilitate statistical analysis, such as by using stratified sampling. Turbines should be searched every 3 days, or more often if the average carcass removal time is less than 3 days.
Protocole de suivi des mortalités d'oiseaux et de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec – Novembre 2013 (MDDEFP 2013)	Carcass searches occur at all turbines for facilities with 10 or fewer turbines. For larger facilities, 40% of turbines should be searched, but not less than 10. The selection of turbines should be decided based on issues identified during the environmental impact assessment, and the need to have locations representative of the periphery of the facility and in different habitats present. Turbines should be searched every 3 days during the breeding and migration period, and every 7 days otherwise.
Bats and Bat Habitats: Guidelines for Wind Power Projects (Ontario Ministry of Natural Resources 2011)	Bat mortality surveys should include all turbines when a project has 10 or less turbines. When there are more than 10 turbines, surveys should include at least 30% of the turbines (but not less than 10) Each monitored turbine should be searched twice per week (3-4 day intervals) from May 1 – October 31.
Post-Construction Bat and Bird Mortality Survey Guidelines for Wind Farm Development in New Brunswick (Government of New Brunswick 2011)	Bat mortality surveys should include all turbines when a project has 10 or less turbines. When there are more than 10 turbines, surveys should include at least 1/3 of the turbines (but not less than 10). Turbines should be searched every 3-7 days during spring migration and summer pup-rearing (March 31 – July 31), and every 3 days during fall migration (August 1 – October 31).
Survey area and transect spacing for fatality monitoring	
Wildlife Directive for Alberta Wind Energy Projects (Government of Alberta 2017); **Post-Construction Wind Energy Protocol for Bats** (Barclay and Baerwald 2015)	Search area needs to cover an area of at least half the maximum height of the turbine in all directions (i.e., measured from the top of the rotor swept area to the ground), but not less than 50 m (Barclay and Baerwald 2015, Government of Alberta 2017). Line or spiral transects may be used depending on site conditions. Transects should be spaced 5 m to 10 m apart, depending on

	visibility conditions and discussions with the applicable government agency (Barclay and Baerwald 2015). Transects should be walked at a slow and consistent pace, approximately 2.5 to 3.0 km / hr.
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	The search area should be a minimum of 50 m or half the maximum rotor height, whichever is greater. Larger search areas, or statistical correction factors, should be considered if a substantial number of bats are falling outside the search area. Circular, rectangular or square transects may be used, but should be consistent across the site. Transects should be spaced no more than 5 m apart, resulting in a search window of no more than 2.5 m on either side of an observer.
Protocole de suivi des mortalités d'oiseaux et de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec – Novembre 2013 (MDDEFP 2013)	Transects occur within an 80 m square plot, centred on the turbine. Transects should be spaced no more than 5 m apart, resulting in a search window of no more than 2.5 m on either side of an observer. Searchers should not exceed a speed of 30 to 40 m per minutes.
Bats and Bat Habitats: Guidelines for Wind Power Projects (Ontario Ministry of Natural Resources 2011)	Each turbine should have a search radius of 50 m. Search areas could be rectangular, square, or circular. Transects should be spaced 5 – 6 m apart, resulting in a search range of 2.5 – 3.0 m on either side of the observer.
Post-Construction Bat and Bird Mortality Survey Guidelines for Wind Farm Development in New Brunswick (Government of New Brunswick 2011)	Search area needs to be centered on the turbine, and cover an area of at least half the maximum height of the turbine in all directions (i.e., measured from the top of the rotor swept area to the ground). Equally spaced linear transects should be used that are less than or equal to 10 m in separation. Transects should be walked at approximately 30-40 meters / minute (1.8 – 2.4 km/h), while searching 5 m on either side (assuming 10 m transect width)
Searcher Efficiency and Carcass Removal Trials	
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	Searcher efficiency trials for all searchers should be completed at least three times a year; monthly or continuous trials during the survey season or during periods of peak bat activity are preferred. More frequent trials may be required for areas with dense or rapidly changing ground cover.

	Carcasses should be distributed among different habitats and visibility classes in proportion to what is present at the site. Each surveyor should be exposed to at least 20 bat trial carcasses over the survey year, and more if possible. The guidelines note that Strickland et al. (2011) recommend that surveyors be exposed to 50 test carcasses within each visibility class each season to reduce bias. Carcass removal trials should be conducted at least one time each season (spring, summer, fall); monthly or continuous trials are preferred to identify potential changes in scavenger activity. Carcass removal Trials should include at least 10 bat carcasses each season, and spread among different habitat types. The guidelines noted that Strickland et al. (2011) recommend that scavenger trials include 50 bat carcasses within each visibility class each season to reduce bias. Fresh, thawed, bat carcasses should be used whenever possible, and ideally of multiple species. Carcasses should be inspected daily, or monitored with a camera. Carcasses should be removed after 14 days. At any one time, there should be no more than 2 trial carcasses per turbine, and not more than 10 across the project area (for both searcher efficiency and carcass removal).
Post-Construction Wind Energy Protocol for Bats (Barclay and Baerwald 2015)	Searcher efficiency and carcass removal trials are required as part of post-construction monitoring. For searcher efficiency trials, a minimum of 20 bat carcasses, or suitable surrogates, should be used for each searcher during each season (or 100 in total). Blind trials should be spread over the season, either by using ongoing testing, or conducting three smaller trials spread throughout the season. Carcass removal trials should occur three times per season (early, mid, late). Each trial should use at least 12 carcasses, preferably different bat species. Carcasses should be left out for two weeks, unless they disappear first. To avoid attracting scavengers into search plots, scavenger trials should occur away from search plots, when possible, and not include more than 2 carcasses per turbine. Bats should be used when possible. If a suitable number of carcasses are not available, dark-coloured small mammals (mice, gerbils) are preferred. Darkly-feathered one-day old chicks may also

	be used for searcher-efficiency trials, but should be avoided for scavenger trials.
Protocole de suivi des mortalités d'oiseaux et de chiroptères dans le cadre de projets d'implantation d'éoliennes au Québec – Novembre 2013 (MDDEFP 2013)	Carcass removal trials should occur every 3 months. At least 30 carcasses should be used each 3-month period, of which 10 should be the size of bats. Carcasses should be representative of species that occur in the area, but dull-coloured small mammals (except shrews) may be used if bat carcasses are not available; bats found dead at turbines should not be used. Carcasses should be spread across different vegetation classes. No more than 2 carcasses should be deployed at a turbine at the same time. Carcasses should be monitored daily for the first 7 days, and then every 2 days thereafter, unless the carcass disappears. Searcher efficiency trials must be conducted for each searcher and every 2 months of mortality monitoring. Each trials should consist of at least 5 carcasses of each size class (bats, small and large birds). Trial turbines and carcasses used should be randomized (up to 1 or 2 carcasses per turbine), but should be representative of the various habitats where turbines are located. Surrogates for bats are recommended for trials, but must be approved by the applicable government agency. Corrected fatalities should be reported using two different estimators appropriate for the study, of which one must be Huso et al. (2012).
Post-Construction Bat and Bird Mortality Survey Guidelines for Wind Farm Development in New Brunswick (Government of New Brunswick 2011)	Searcher efficiency and carcass removal trials should be completed for each search season (spring, summer, fall) and distinct habitat type. Seperate searcher efficiency trials should be completed for each searcher, or search team. For each trial, at least 20 carcasses should be distributed across the range of different habitat types present. Carcasses should ideally be bats, but small brown birds or rodents may be acceptable.
Bats and Bat Habitats: Guidelines for Wind Power Projects (Ontario Ministry of Natural Resources 2011)	Carcass removal trials and searcher efficiency trials should be conducted at least once a season, but increased to once per month if vegetation changes occur during the season. Searcher efficiency trials should occur for each searcher or search team and for all visibility classes. A minimum of 10 carcasses is required for each searcher-efficiency trial in each visibility classes. Searcher-efficiency will be averaged per-searcher across the visibility classes.

	At least 10 carcasses should be used for each carcass removal trial, distributed across the range of habitats and visibility classes. Whenever possible, turbines that are not part of the sub-sample being surveyed should be used for carcass removal trials. For both searcher efficiency and carcass removal trials, at least a third of the carcasses should be bats, and a third should be birds (if possible). Small brown mammal or bird carcasses may be used when bat and bird carcasses are not available.

Table 8-4. Risk Assessment and Mitigation Thresholds for Wind Energy Developments in Canada.

Source	**Summary**
Best Management Practices for Bats in British Columbia, Chapter 4: Wind Power Developments (Holroyd and Craig 2016*b*)	Areas with > 10 times the median regional (or development-specific) level of bat activity are considered higher risk area for bats, as well as areas with more than 1 migratory bat pass/night. Additional mitigation should be considered when any individual turbine has >10 uncorrected bat fatalities/survey year, there is a fatality of any bat species-at-risk, there is an overall average corrected fatality rate for the development of ≥7 bats/turbine/year, the cumulative number of corrected fatalities is >350 bats/year, or if any mitigation thresholds are exceeded for three consecutive years.
Bats and Bat Habitats: Guidelines for Wind Power Projects (Ontario Ministry of Natural Resources 2011)	Bat mortality is considered significant when average mortality per turbine exceeds 10 bats / turbine / year.
Bat Mitigation Framework for Wind Power Development (Government of Alberta 2013)	**Pre-Construction:** Migratory bats (i.e., any of Silver-haired Bat, Hoary Bat, Red Bat) activity averaging 1-2 passes/detector-night represents a potentially moderate risk, while activity >2 passes/detector-night represents a potentially high risk. Pre-siting mitigation should be explored for moderate and high risk sites; operational mitigation may be necessary in high risk sites, pending results of post-construction monitoring.

	Average passes are based on migratory species, with continuous night time monitoring from August 1 to September 10. See Lausen et al. 2010 for criteria for defining a pass. [*Note that thresholds were based on pass 'files' generated using a 5 sec TBC; use of a 2 sec TBC (as is common under some survey protocols) will make it more likely that the same bat will get counted as multiple passes, potentially resulting in higher reported activity.]* **Post-Construction** A corrected post-construction mortality rate of 4 to 8 migratory bat fatalities per turbine per year requires consultation with the government wildlife branch to decide if mitigation is required. Greater that 8 migratory bat fatalities per turbine per year is considered a very high risk site requiring mitigation. Sites under this threshold may still be deemed high risk if cumulative mortality over many turbines is high. Wind energy facilities with fatalities in the range of 500 bats per development per year is concerning; lower levels may also be concerning if cumulative effects from multiple wind energy developments are already high.

8.1 Selected Additional Information Sources

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Appendix A: Checklists for Bat Components of Environmental Assessments

9.1 Project Planning

- ☐ Existing information related to landcover and the distribution of bats and bat habitat has been compiled and used to inform project requirements and survey design.
- ☐ A list of potential bat species has been compiled based on the best available information; species not currently known to occur in the project region are included when there is suitable habitat and where their range could plausibly be extended to include the project area.
- ☐ A preliminary site visit has been conducted to identify potentially important habitat features before the survey plan was finalized.
- ☐ Objectives of field surveys and related activities are clearly described, and a rationale is provided for their selection. At a minimum, objectives meet best management practices and regulatory requirements.
- ☐ Stated objectives are realistic given limitations of survey methods and project constraints (e.g., accurate and unbiased measures of diversity, density, and relative abundance are typically not possible with available methods).
- ☐ When appropriate, habitat suitability modeling requirements have been integrated into survey plans, to ensure collected data are suitable for developing and/or validating models.

9.2 Selected Survey Techniques

- ☐ Chosen approaches are consistent with applicable best management practices and standards, and provide an appropriate level of detail for meeting project objectives.
- ☐ The chosen approach(es) can provide reliable taxonomic identifications to a level needed to meet study objectives (e.g., if species-level identifications are required, then accurate identifications can be obtained using the selected survey methods).
- ☐ Inherent biases of survey methods will not prevent project goals from being met (e.g., acoustic detectors have a greater range in more open habitats; results of mist-net surveys will depend on the quality of netting locations; etc.).
- ☐ Invasive approaches, such as capture and tracking, are only used if there is a clear objective that will benefit the management and conservation of the species that less invasive approaches will not accomplish.
- ☐ Appropriate permits have been identified for survey methods used and applied for in advance of survey seasons.

9.3 Survey Design, Effort and Timing

- ☐ The study adheres to appropriate decontamination protocols for preventing the spread of White-nose Syndrome (note that bat biologists also frequently enter wetlands, so procedures for preventing the spread of Chytrid fungus and other waterborne diseases may also be applicable).
- ☐ The number and duration of survey stations is based on project objectives, and a clear rationale is provided for the chosen strategy, supported by available literature and/or power analyses.
- ☐ Study design follows a scientifically-defensible framework. When appropriate for meeting project objectives, methods allow application of valid statistical techniques for comparing results or analyzing trends.
- ☐ If collected data are being used to support statistical analyses, then there are enough replicates to detect biologically meaningful results given known sources of variability (should be supported by literature or power analysis).
- ☐ Convenience sampling (i.e., sampling only easily accessible locations) or other biased sampling methods are avoided if data will be used to support statistical inferences about the bat community across the study area.
- ☐ Pre-construction surveys are designed to complement post-construction monitoring requirements, such as by using the same methods and locations during both periods so that pre-construction monitoring results can be included as part of the monitoring dataset. For example, a BACI design could be considered for assessing project impacts (Section 5.2).
- ☐ Surveys occur during all time periods, and stages, that are relevant for the assessment, which may include:
    - ☐ Breeding
    - ☐ Migration (spring/fall)
    - ☐ Swarming
    - ☐ Hibernation
- ☐ Surveys of overwintering bats include continuous acoustic recording during both the winter hibernation period (November to February), and the swarming period (late summer and fall). Confirmations for the presence of hibernating bats are based on observations during the winter period rather than late fall or early spring. Visual surveys are also completed during the winter to look for bats or bat signs, provided access is safe, permissible, and does not risk unacceptable levels of disturbance to bats.
- ☐ There is a sufficient number and duration of surveys to detect all species of interest (rare species require much more survey effort to detect than common species).
- ☐ If seasonal changes in bat activity are important for the assessment, then continuous monitoring occurs throughout the period of concern (e.g., short-duration surveys will not provide sufficient data to characterize the timing and magnitude of migration).

- ☐ The number and timing of surveys is sufficiently robust that interannual variation in the timing of life-history events (e.g., birth, fledging, migration) will not impede interpretation of results. This may require repeated surveys (e.g., early and late surveys) and/or long-duration surveys.
- ☐ For monitoring projects, the time-period being surveyed is consistent among years to allow comparisons under similar conditions (e.g., does not compare the pre-fledging period one year to the post-fledging period another year).
- ☐ An appropriate number of control sites are included, when needed, to facilitate interpretation and support statistical analyses.

9.4 General Considerations for Acoustic Surveys

- ☐ Proposals and/or reports include sufficient details on acoustic detection methods that they could be repeated in future years. At a minimum, disclosed information should include:
  - Detector make and model
  - Microphone model used
  - Location of Detectors
  - Height of microphones
  - Orientation of microphones
  - Special housing that may affect microphone sensitivity (e.g., wind screen, cones, weatherproofing, etc.)
  - Mounting method (e.g., meteorological tower, pole, etc.)
  - Device specific settings (e.g., gain/sensitivity, TBC, etc.)
  - Recording mode (i.e., full spectrum or zero-crossing).
- ☐ The methods used to define a bat "pass" are clearly described, and are consistent with the definition used for any comparison group. A rationale is provided for the chosen method.
- ☐ If results are being compared among sites, then all sites use the same technology and setup methods (e.g., same model of detector and microphone, height, weatherproofing, device settings, etc.), or different equipment has been calibrated and has been demonstrated to have the same sensitivity, directionality, and detection probability.
- ☐ If results are compared among years, then equipment and setup protocols have remained consistent across years of the study.
- ☐ Comparisons of results to other studies clearly state whether similar methods were used (such as if other studies are used to support impact assessments). If methods differed or could not be determined, then potential limitations of using different methods are considered when interpreting results.
- ☐ Stationary acoustic detectors collect data for the whole night to allow accurate calculations of nightly activity rates (at least sunset to sunrise; 30 minutes before sunset to 30 minutes after sunrise recommended).

- ☐ Study design has sufficient redundancy, and frequency of inspections, that project goals can be met in the event of equipment failure.
- ☐ Reported results include a summary of any issues with equipment failure, and a description of procedures used to ensure equipment was operational during deployment (including ensuring microphone sensitivity remains within an acceptable range). While some equipment failure can be expected, issues should be clearly acknowledged and factored into analyses.
- ☐ If detectors are being used during the winter, then there is a description of weatherproofing, and procedures used to ensure microphones are operating normally and not impeded by ice buildup.

9.5 Acoustic Identification

- ☐ Methods used for acoustic identification are clearly described, including any validation procedures used, and criteria used for deciding on species classifications.
- ☐ Software package(s), versions, and settings used for acoustic analysis are disclosed, including any auto-identification packages and filters used for analysis.
- ☐ Acoustic analysis methods (including software, versions, and settings) are consistent throughout the study if comparisons are being made among years or locations. Or, if not consistent, then it has been demonstrated that the use of different methods will not impact reported results or conclusions.
- ☐ Results from auto-identification software are followed up to correct known limitations with these methods, which should include grouping passes that cannot be reliably identified to species, and manually correcting misidentifications.
- ☐ Species identifications are reasonable based on the current state of knowledge regarding acoustic identification (e.g., species that cannot be reliably distinguished should be grouped into broader categories).
- ☐ Report includes a statement of experience and qualifications for individual(s) that overseen acoustic identifications.

9.6 Capture and Tracking

- ☐ Biologist(s) preforming work are qualified to extract bats and birds from nets, handle bats, take accurate measurements, identify the species being examined, and extract DNA (if applicable).
- ☐ At a minimum, data collected from captured individuals includes species, sex, age (juvenile or adult), reproductive condition, mass, and forearm length, except for bats needing to be released early (e.g., because of injury, advanced pregnancy, or to maintain manageable numbers of bats).
- ☐ If the goal is to capture a diversity of bat species, then a variety of capture methods and net configurations are used (e.g., raised nets; monofilament nets; harp traps), and a diversity of different habitats are sampled (e.g., old forest, wetlands, watercourses, rock-features, etc.).

- ☐ If tracking will occur, transmitters are a reasonable weight for the size of the bat (typically <5% of the mass of a non-pregnant individual; Aldridge and Brigham 1988).
- ☐ Appropriate federal and provincial permits, and animal care approval, have been obtained, or will be obtained prior to commencement of work. A SARA permit will be required if work occurs on federal lands.

9.7 Mitigation

- ☐ The selected mitigation approach has been demonstrated to be effective, or if not, then it is consistent with available scientific information and is used within an adaptive management framework. See Berthinussen et al. (2014) for information on scientific support for available mitigation options.
- ☐ The mitigation is appropriate and effective for the target species (e.g., artificial roosts will only support a narrow range of potential bat species).
- ☐ The application of mitigation is followed with an appropriately designed monitoring study to evaluate its effectiveness. Whenever permissible and appropriate, studies designed to evaluate the effectiveness of applied mitigation follow valid scientific methods, which may require non-biased sampling and establishment of suitable control sites.
- ☐ If mitigation includes providing artificial habitats (e.g., bat houses), then structures will be maintained to ensure they are safe and remain available for bats.

9.8 Wind Energy Facilities

Pre-Construction

- ☐ Whenever possible, both ground based (i.e., >1.5 m) and raised acoustic detectors are used at each monitoring station to survey bats at onshore wind energy facilities. Raised detectors are a minimum of 30 m above the ground, and high enough to survey the rotor swept area of the proposed turbines.
- ☐ A rationale for the number of detectors is provided and consistent with recommended guidelines. In general, detectors should be situated to monitor all four cardinal directions and the centre of the facility. Additional survey stations may be needed for large facilities, or to evaluate use of potential movement corridors and other site-specific features that may be attractive to bats.
- ☐ The survey season corresponds to the times of year when bats are at risk from turbine fatalities, and comply with all regional regulations and best management practices (Section 8.0
- ☐ Monitoring occurs during the entire night (e.g., 30 minutes before sunset to 30 minutes after sunrise).
- ☐ At a minimum, acoustic surveys are reported as ‘passes / night’ for each species or species group and for each detector location.

- ☐ Predictions of potential impacts using pre-construction monitoring results are based on empirical evidence linking pre-construction monitoring results to post-construction mortality (e.g., see Table 8-4).

Post-Construction

- ☐ Carcass searches occur at all onshore wind energy facilities. Search intervals comply with applicable best management practices and standards, and are appropriate given project-specific average carcass removal time. Three-day search intervals are often required because of high scavenging (Holroyd and Craig 2016*b*).
- ☐ The number of turbines searched, and locations of turbines, is adequate to characterize fatalities across the project site, and comply with applicable best management practices and standards.
- ☐ The search area for bat fatality monitoring includes a radius of at least 50 m, or half the turbine height, whichever is greater.
- ☐ Fatality estimates are corrected for searcher efficiency and carcass removal using an appropriate adjustment technique. A rationale is provided for why the selected estimator is the most appropriate for the project.
- ☐ Separate searcher efficiency and carcass removal trials occur each season and incorporate a representative sample of different visibility classes and habitat types. Separate searcher efficiency trials are conducted for each searcher or search team. The number of bats/carcasses required for each trial are based on applicable best management practices and standards.
- ☐ Average searcher efficiency and carcass removal times are reported, along with confidence intervals and/or ranges for these estimates.
- ☐ The calculation of corrected fatalities has been checked, and is plausible given reported correction factors.
- ☐ When possible, searcher efficiency and carcass removal are estimated based on bats, rather than birds, and ideally include a variety of different bat species.
- ☐ Acoustic monitoring is conducted, at a minimum, throughout the period when fatality monitoring occurs, using the same locations, equipment, and setup as was used during pre-construction surveys (needed to help explain observed mortality patterns relative to pre-construction predictions). Extending acoustic monitoring periods to include the entire active period is recommended to help verify that the timing of carcass searches is adequate, or to develop correction factors.
- ☐ Reported results include both corrected and uncorrected fatality estimates, as well as a summary of fatalities by species and sex. Fatalities are reported as the number of fatalities per turbine per year, and the number of fatalities per megawatt of installed capacity.

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NOVA SCOTIA

Environment and Climate Change

MEMORANDUM

To: EA Branch, Policy Division

From: Surface Water Quality Specialist, Water Resources Management Unit, Sustainability and Applied Science Division

Date: April 9, 2021

Subject: Highway 316 Realignment Project, Goldboro LNG facility

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Scope of Review:

The scope of this Environmental Assessment review from the ECC Sustainability and Applied Science Division Surface Water Quality Specialist is to assess the potential environmental impacts and proposed mitigations of the proposed undertaking on surface water quality and management. While comments may also include considerations for impacts on general surface water quantity, groundwater, contaminated sites, acid rock drainage, wetlands, and freshwater fish habitat, appropriate technical specialists for these areas should be consulted for specific review and comment.

Documents Reviewed:
The following documents formed the basis for this review:

1. Realignment of Marine Drive Highway 316, Environmental Assessment Registration Document (EARD)
2. Appendices A-D, F, H, and K of the EARD.

Comments:

General:

- Although the current submission solely addresses the proposed realignment of Highway 316, that project is only one element of several that are part of the overall Goldboro LNG project site, the description and elements of which are distributed across several approvals and past, current, and potentially future EAs. This project framework and associated project information makes it challenging to assess the cumulative impacts of all LNG facility project activity, inclusive of construction, operation, and maintenance, to individual VECs and environmental features.

- The EARD provided generally satisfactory information about the area, the project, project specific VECs, and anticipated impacts of project activities on the VECs. Overall, the EARD does not provide sufficient details on proposed on-site mitigation measures, the site-specific application of NSTIR's guidance documents (Highway Construction specifications, Generic EPP, or Salt Management Plan), or the monitoring approaches that could or would be used to assess impacts on VECs.
- Pieridae indicated that the Realignment will be constructed to meet NSTIR highway construction standards, but cited the standards dated 1997. These Standards have been updated several times since 1997, and Pieridae should be required to meet the most current set of standards – December 2019.
- Weather and climate assessment provided in section 5.1.6 was supported using weather station Stillwater-Sherbrooke, discontinued in 2004. The age of this gauge was not disclosed and its appropriateness as a reference was not assessed or justified.
- Section 5.1.6, subsection "Climate Update and Predicted Future Trends" does not discuss how climate change impacts on precipitation may impact the project, and do not address comments made elsewhere in the document that storm events are frequently observed in the area in which the project will be sited.

<u>Water Resources:</u>

- In addition to CCME <u>guidance</u> on water quality, Pieridae should be required to follow <u>guidelines</u> on water quality
- The development of the proposed road will impact local drainage patterns, but the impact of this impact is not addressed in the description of Surface Water Quality VEC entry. These drainage areas were neither delineated, characterized, or further assessed within the submission.
- It is reported in the submission that "In-situ low pH values were low with only one value above 5. While all were well below the CCME FAL lower limit of 6.5 (CCME, 2007), Guysborough County is known not have depressed pH values."
    - No reference or evidence is provided to substantiate this claim, or to indicate that low pH is not due to the legacy impacts of past or present mining activities.
- Section 6.1 indicates that activities that may impact surface water quality and quantity include vegetation management practices. Section 6.1.2 indicates that herbicides will not be used for vegetation management, whereas section 6.1.3 indicates that their use will be limited or avoided if possible. Herbicides would potentially have adverse effects on surface water quality and on aquatic vegetation within wetlands.
- The submission does not assess the impacts of these changes on wetlands, or secondary impacts on the ability of wetlands to support water quality in the associated watercourses. It does not identify the number of cross-drain culverts or proposed spacing, or the general approach to ensuring effective drainage across the entire project site.
- Surface water samples were collected from eight watercourses over the course of three sampling events – June, September, and November. Only one sample was collected from each watercourse (i.e., sampling station). Water quality can

vary widely within river systems, on daily, seasonal, and broader temporal patterns. As a result, a single grab sample for one location over the course of a year does not constitute adequate water quality characterization.

- The submission notes several interactions between construction and surface waters, as well as operation and maintenance activities and surface waters, and identifies several mitigation measures to reduce impacts to these waters. No Environmental Effects Monitoring (EEM) Plan is proposed to ensure compliance with regulations, confirm the predictions made in the EARD, or to identify any conditions that warrant further attention.
- Golder identified several AMOs directly within and immediately adjacent to the PDA (Figure 5.1-4). Soil and sediment samples (SS4 and SED-1, respectively) indicated no soil contamination but did indicate sediment contamination due to petroleum hydrocarbons (Appendix C, Table C-4).
- All sediment samples were found to be contaminated with petroleum hydrocarbons
- Pieridae proposes to follow NSTIR's Salt Management Plan during winter road maintenance as a mitigation measure to reduce contamination of groundwater resources. This Plan has not been provided to ECC as part of the applicant's registration document and is not publicly available, so ECC cannot assess the suitability of this Plan to mitigate against groundwater contamination by road salt (that is, chloride, the toxic element within road salt).
- Contaminant prevention practices include avoidance of washing, fueling, and maintenance of vehicles or equipment in the vicinity of a watercourse without secondary containment.
- The applicant indicates an expectation of no sulphide bearing materials or acid rock drainage (ARD). Test results used to inform this opinion are based on samples taken outside the Project Development Area (PDA); none were collected from within the PDA. Both the project area and local area are situated within the Goldenville Formation, which is a known ARD producer. Heavily mineralized areas are particularly at risk for producing ARD. Figure 5.1-4, identifying abandoned mine openings, indicates that the area is heavily mineralized, which indicates that the risk for acid rock drainage, and associated metal leaching, is relatively high in the project area.
- No mitigation methods are proposed to address the risk of ARD, which constitutes a risk to surface water courses and aquatic habitat for both brook trout and American eel in the watercourses they inhabit within the site.
- Dust prevention and abatement measures are proposed for implementation during the construction phase. The proposed measures are not identified but typically include the use of water resources to wet ground surfaces. The source and volume of water resources required for this purpose, flow path, flow speed, and destination of wastewater from this activity are not identified. This represents a risk to surface water resources not identified within the EARD which has not been considered or mitigated by the proponent.
- Section 6.7 identifies that clearing and grubbing are required for all project components and specifies that grubbing … "is completed as a separate activity when construction of the realignment begins". This description does not address the fact that clearing is, in fact, a construction activity, and is therefore also subject to erosion and sedimentation controls.
- Several references (approximately 50) are identified within section 10.0. Although

some (approximately 20) are available for review via hyperlink to the original source, the remainder are not included within the submission for review.

Recommendations

The following recommendations could be potentially developed as conditions in support of potential approvals for the Project:

- Prior to the commencement of the Project, the proponent should develop and provide a site-specific EPP to the Nova Scotia Department of Environment and Climate Change for review and approval.
- Prior to the commencement of the Project, the proponent should develop and submit an Environmental Effects Monitoring (EEM) Program to the Nova Scotia Department of Environment and Climate Change for review and approval. This Program shall be inclusive of monitoring for all Environmental features of the site, including surface water quality and quantity, hydrogeology, wetlands, aquatic and terrestrial vegetation and wildlife, avifauna, species at risk, atmospheric environment, acoustic environment, as may be recommended by NS ECC specialists.
    - As part of the EEM Program, the proponent shall submit a surface water quality monitoring plan, which shall include but not be limited to:
        - Sampling locations, parameters, frequency, and methodology
        - Identification of methods used to determine water quality sample locations and sampling frequency
        - Analytical requirements for project identified contaminants of concern (e.g., sediment, acid rock drainage, metals (Aluminum, Arsenic, and Iron), herbicides, (petroleum, oils, and lubricants), road salt, and hydrocarbons).
        - Guidelines, protocols, interpretation of monitoring results (e.g., action criteria) and actions and mitigations measures that will be implemented if criteria are exceeded. thresholds, and
        - Pre- and post-construction monitoring plans with respect to acid rock drainage and metal leaching should be included as part of the overall surface water monitoring plan.
- Prior to the commencement of the Project, the proponent shall submit to the Department a surface water management plan for review and acceptance. This plan shall include but not be limited to:
    - Details on the specific mitigation measures for contaminants of concern listed in the EARD
    - Details on the proposed changes to local drainage, including the number, size, distribution, and spacing of cross-culverts
    - Supporting materials / rationale for the details proposed within the Plan.
- Prior to commencement of the Project, the proponent shall submit an erosion and sedimentation control plan, developed by a qualified professional engineer or geoscientist licensed to practice in the Province of Nova Scotia, to the Department for review and acceptance. The applicant shall implement the plan once the plan is accepted by the Department.
    - Site clearing activities are project activities. Consequently, clearing shall not begin until after the applicant implements an approved site-specific

Erosion and Sediment Control Plan.

- Prior to commencement of the Project, the proponent shall submit an acid rock drainage and metal leaching monitoring and mitigation plan to the Department for review and acceptance. Detailed design of site-specific mitigation measures should be developed by a qualified professional engineer licensed to practice in the Province of Nova Scotia. The Plan should include a detailed analysis of the operational feasibility and effectiveness of the proposed measures, which demonstrates the adequacy of the proposed approach.
- If herbicides are used as part of roadside vegetation control within 100 metres of any wells then groundwater samples for adjacent wells should be tested for the herbicides used, until it can be shown that these wells are not contaminated with the herbicides.
- The NSTIR Salt Management Plan should be submitted, either in its entirety or designated sections thereof, as part of the site-specific EPP for ECC approval.
  - Post-construction monitoring impact assessment should include the impacts associated with i) road salt application and ii) changes to local drainage patterns), to freshwater wetlands and watercourses.
- Erosion and sedimentation control measures should also be drawn, as appropriate, from NSTIR's Erosion and Sediment Control Course Materials (https://novascotia.ca/tran/works/enviroservices/enviroErosion.asp), and selected to best suit the site conditions at which the materials are to be applied.
- Vehicle/equipment washing, fueling, or maintenance should not be performed in the vicinity of a watercourse under any circumstance unless avoidance is impossible, in which case it must be done with secondary containment.
- Applicant should provide copies of all references, within reason, as appendices to the EARD.

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NOVA SCOTIA

Communities, Culture and Heritage

Date: April 9, 2021

To: Nova Scotia Environment

From: Coordinator Special Places, Culture and Heritage Development

Subject: Marine Drive, Highway 316 Project

Staff of the Department of Communities, Culture and Heritage has reviewed the Marine Drive, Highway 316 Project EA documents and have provided the following comments:

Archaeology

Staff reviewed the sections of the EA document pertaining to archaeology and note that further archaeological work is needed. CCH agrees with this recommendation and has received a permit application for the recommended archaeological work.

Botany

Staff reviewed the sections of the EA document pertaining to botany and provided the following comments:

SAR plants & lichens

- Several species of concern were detected within the project footprint, including:
  - 4 occurrences of Blue Felt Lichen and 1 of *Fuscopannaria sorediata* (centered around WL 22, the wetland of special significance
  - 4 occurrences of Nova Scotia *Agalinis* (scattered throughout project footprint – likely to be destroyed)
  - 1 occurrence of finger-ring lichen (*Arctoparmelia incurva*), near WL2 (near terminal – likely to be destroyed)
- Any projects that are likely to destroy or disturb species of conservation concern, such as Nova Scotia *Agalinis* and Blue Felt Lichen, present opportunities to contribute to conservation science and research. There are two main options for this that can be recommended to the proponent:
  - Assist the Nova Scotia Museum's Collections Unit to obtain new specimens that support scientific and conservation research and teaching

        - Contribute to translocation research by removing rare and vulnerable species from sites that are going to be disturbed and relocating them to nearby suitable habitat, coupled with a suitable monitoring program.

Consideration of the project's contributions to the Climate Crisis:

- The proponents gave no consideration to the loss of carbon sequestration functions on lands that are scheduled to be cleared and paved. On page 104 of the registration document, it states:
    - "The construction's effects on GHG and climate change is considered negligible in context to the impacts from the overall LNG facility construction and operation. An increase of vehicle traffic following completion of the Project is not anticipated; therefore, the operation phase will not increase any impacts to GHG and climate change compared to the present situation."
- The footprint for the proposed road realignment is 100 m x 5.6 km = 56 ha, with the majority of that being naturally-regenerating forest, treed swamps, other wetlands, and old fields, in which significant amounts of carbon are currently stored. Based on many of these being relatively young systems, carbon sequestration rates would likely have continued increasing over the coming decades if they were left undisturbed.
- The impacts of the project on GHG emissions may be negligible compared to the CO_2 emissions of the entire Goldboro LNG project, but that relative negligibility does not equal zero, or negate ethical considerations for carbon budgets. Nevertheless, having relatively small impacts means it should be relatively inexpensive to add sufficient compensation to make the impacts truly carbon neutral. For example, the proponents could reforest 56 ha of old field land elsewhere or apply silvicultural practices that enhance growth to any retained forests on-site, thereby increasing the rate of carbon sequestration to make up the difference.

Palaeontology

Staff have reviewed the sections of the EA document pertaining to palaeontology and geology. The area's bedrock geology is not of concern for potential fossil material. The abandoned mines mentioned as being present in the area may pose potential for ground subsistence (sinkholes) depending upon the extent of the historic mines.

Zoology

No CCH staff were available to review the sections relating to zoology.

Fisheries and Oceans Canada — Pêches et Océans Canada

Ecosystems Management
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April 9, 2021

Your file *Votre référence*
TE201007

Our file *Notre référence*
21-HMAR-00092

Environmental Assessment Officer
Nova Scotia Environment and Climate Change
1903 Barrington Street, Suite 2085
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Subject: Environmental Assessment Registration Document (EARD) – Realignment of Marine Drive (Highway 316) Project

The Fish and Fish Habitat Protection Program (the Program) of Fisheries and Oceans Canada (DFO) received your request to review the EARD for the proposed Realignment of Marine Drive (Highway 316) in relation to the Goldboro Liquefied Natural Gas (LNG) Project on March 4, 2021. The Realignment of Marine Drive was not part of the previously approved Environmental Assessment (EA) for the Goldboro LNG Project. Nova Scotia Environment and Climate Change (NSECC) has determined that the proposed undertaking is subject to a Class I EA based on the requirements under the *Nova Scotia Environment Act* and the Environmental Assessment Regulations. We understand that the proponent is proposing the following:

- Permanent Realignment of Highway 316 – the construction of a new 5.6 km road with two travel lanes;
- Three intersections to provide access to the existing Marine Drive west and east of the LNG Project Site, the Goldboro LNG site, temporary work camp, and laydown areas;
- The realignment will require eight watercourse crossings (i.e. Crusher Brook, Betty's Cove Brook, and six unnamed small tributaries). Each of these will be crossed by the right-of-way (ROW) with an appropriately sized culvert to maintain fish passage;

.../2

- Approximately 7.3 ha of wetlands are located within the area along the proposed ROW. A portion of these wetlands will be infilled during construction. Drainage between contiguous wetlands separated by the road will be maintained by cross-culverts.

DFO has reviewed the EARD document as well as related appendices with respect to fish and fish habitat and offers the following comments for consideration:

General

- In general, the methodologies describing how the field work and sampling was conducted often does not provide a clear picture of how the work was carried out. The methodology should be written in a manner that one could easily replicate the work and/or the reader can fully understand exactly what was conducted in the field to ensure confidence in the results presented.

- The biophysical report, located in Appendix F, only assess watercourses within the proposed planned temporary laydown area expansion and as a result, does not offer any insight into field methodologies for the watercourses found within the actual ROW Project Area.

Section 3.3 - Temporal and Spatial Boundaries

- The proponent describes the spatial boundaries of the Project Development Area (PDA), the Local Study Area (LSA), and the Regional Study Area (RSA). However, the proponent does not sufficiently describe the rationale as to how they selected these spatial boundaries. The proponent should provide rationale for the spatial boundaries they selected as well as scientific data or peer-reviewed literature to support their selected boundaries.

Section 5.1.5 - Surface Water

- The proponent makes note that all pH results found within the watercourses identified in the Study Area are below the lower CCME Freshwater Aquatic Life (FAL) guideline value of 6.5. While this may be true, the proponent should note that within Nova Scotia many species of fish, including those found within the Study Area (Brook Trout and American Eel), carryout all or some of their life processes below the CCME FAL pH threshold of 6.5. Low pH values should not be used as the sole indicator of “poor” aquatic habitat.

Section 5.2.5 – Aquatic Environment

- The proponent indicated that they collected benthic invertebrate samples in table 5.1-1, as well as Figure 5.2-5. The proponent did not present the results of benthic invertebrate sampling within the Aquatic Habitat Survey Results or in any of the appendices presented within the EARD. The proponent should clarify if, how,

.../3

when, and where they collected benthic invertebrate samples from and present the results within the document.

- The proponent indicated that they collected flow measurements in Figure 5.2-5; however, flow data is not presented in the Aquatic Habitat Survey Results Section. The proponent should clarify if, how, when, and where they collected flow samples from and present the data within the document.

- Within Section 5.2.5, the proponent states: “Where possible spot-check electrofishing for fish species presence was performed. In the event that electrofishing could not be completed within the ROW, it was completed as near as practical.” This sentence is not clear. Methodology should be presented in a manner so that the reader can replicate the sampling or understand exactly how information was collected. The proponent should expand upon their methodology and indicate where electrofishing took place. Where electrofishing was not conducted, the proponent should clearly describe why it was not to used as a sampling method for the particular watercourse or reaches.

- Table 5.2-5 contains a column labeled “Fish Observed”. It is unclear what this refers to in the case of “none observed”. The proponent should clarify the meaning of this column to either indicate that they fished and caught no fish or that they simply did not see fish visually. The proponent should use caution due to the fact that either option does not conclusively indicate that the watercourse does not contain fish or provide fish habitat.

- Table 5.2-5 makes reference to barriers to fish passage. The proponent should use caution when referring to fish barriers, particularly if the goal is to discount the presence of fish and/or fish habitat. Water levels in Nova Scotia fluctuate seasonally and DFO cautions proponents from using water levels as grounds to constitute a physical barrier. Furthermore, certain species, such as the American Eel, can navigate around many natural or anthropogenic obstructions.

Section 6.1.2 – Groundwater Resources – Potential Interactions and Effects

Sections 6.1.2 as well as 6.9 indicate that blasting activities and excavations could alter the groundwater regime and adversely impact base flow to watercourses. Furthermore, the proponent states that fish habitat quality of the watercourses near and crossing the ROW is generally poor with limited flows (Sections 5.1.5 and 5.2.5), so that any such indirect effects would be of limited consequence. Given the limited data that the proponent has submitted and the fact that some of the watercourses in the Project Area support Brook Trout and American Eel, there is evidence which would indicate that the habitat within these watercourses is not of poor quality either at the ROW crossing location or further downstream. The proponent does not explore these interactions and effects further within Sections 6.1.2 or 6.9 and simply indicates that there will be no significant adverse effects to groundwater resources or fish and fish habitat.

.../4

Mitigation measures such as monitoring are not sufficient to reach the conclusion of no significant effects. Monitoring is not a mitigation measure and DFO will not authorize impacts to fish and fish habitat after they have occurred. Therefore the proponent should assess the potential effects of excavation and/or blasting on the local groundwater regime and determine the groundwater-to-surface water interactions to properly asses these impacts on fish and fish habitat within the Project Area, Local Assessment Area, and Regional Assessment Area.

Section 6.2 – Surface Water Resources – Potential Interactions and Effects

- Section 6.2 discusses the principal interactions between Project activities and surface water, with a focus on surface water quantity. Section 6.2.1 includes the definition of significant effects for the Surface Water VEC, but fails to incorporate surface water quantity into the definition. The proponent's definition of significance only incorporates deleterious substances and exceedances related to water quality guidelines. The proponent should expand their definition of significance for Surface Water Resources to include surface water quantities. After this addition, the proponent should revise their effects assessment for the Surface Water VEC. The proponent is encouraged to use the theories within DFO's Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (https://waves-vagues.dfo-mpo.gc.ca/Library/348881.pdf) while conducting their assessment. This will be a requirement for any *Fisheries Ac*t authorization applications submitted by the proponent.

- The proponent states "The effects on surface water quality and quantity in watercourses crossed by the Realignment that may be caused by the construction, operation and maintenance of the Realignment are not expected to be significant.". The proponent should give a rationale as to how they came to this conclusion without assessing impacts to surface water quantity. Please note that professional judgement without the use of scientific data, modeling, or references should not count as rationale.

- Table 6.2-1 indicates that similar habitat exists in the region and that there is generally poor quality habitat on site. The proponent does not give context or rationale to support these statements. The proponent should use caution when using a "poor quality" label for habitat. Many of the watercourses located within the Project Area contain Brook Trout and American Eel, species that are indicative of good quality habitat. The proponent should remove these labels and give alternate rationale in Table 6.2-1.

Section 6.8 – Wetlands – Potential Interactions and Effects

- Wetlands have the potential create direct and indirect habitat for fish. The proponent has not indicated whether or not the alteration of 7.3 ha of wetland habitat within the Project Area has potential for effects to fish and fish habitat in

.../5

either Section 6.8 (Wetlands) or Section 6.9 (Aquatic Environment) of the EARD. Many of the wetlands that are proposed to be altered are situated within the headwaters of some of the small streams and waterbodies within the Project Area (Betty's Cove Brook, Crusher Brook, Crane Lake, and unnamed tributaries). The alteration of these wetlands may result in hydrological effects on many of these watercourses and thus have the potential to cause impacts to fish and fish habitat through reduced flows. The EARD does not contain sufficient information to make any determination on water quantity impacts on fish and fish habitat. The proponent must conduct a hydrological assessment on the effects of wetland alterations on ecological maintenance flows in each of the potentially effected waterbodies and include the results of this assessment in the EARD. The proponent is encouraged to use the theories within DFO's Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (https://waves-vagues.dfo-mpo.gc.ca/Library/348881.pdf) while conducting their assessment. The proponent should note that this will be a requirement for the *Fisheries Act* authorization process.

Section 6.9 - Aquatic Environment – Potential Interactions and Effects

- The proponent defines a significant adverse residual environmental effect on the aquatic environment as a Project-related environmental effect that, after mitigation measures are applied:

  > -" results in the harmful alteration, disruption or destruction of fish habitat (as defined by the *Fisheries Act*), that occurs as a result of Project activities without federal approval and/or without required implementation of approval conditions (e.g. offsetting plan)"

  The proponent has not appended a draft conceptual offsetting plan to the EARD for review, nor have they applied for a *Fisheries Act* authorization. Due to the fact that DFO has not issued an authorization for the Project or reviewed an offsetting plan, impacts from the proposed project would be occurring without federal approval and without the required implementation of approval conditions. The proponent should note that federal approvals are not guaranteed and they should not assume approval will be granted. As a result, currently any residual project-related environmental effects would cause Significant Adverse effects to the Aquatic Environment, according to the proponent's definition. The proponent should consider an alternate definition of significant adverse residual environmental effects for the Aquatic Environment VEC, which is not linked to a regulatory approval, and revise their effects assessment accordingly.

If you have any questions with the content of this letter, please contact at our Dartmouth office at or by email at @dfo-mpo.gc.ca. Please refer to the file number referenced above when corresponding with the Program.

Yours sincerely,

Regulatory Reviews Biologist
Ecosystems Management
Maritimes Region

NOVA SCOTIA
Environment and
Climate Change

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Date: April 9, 2021

To: Environmental Assessment Officer
Cc: Manager, Water Resources Management Unit, Sustainability and Applied Science Division

From: Senior Hydrogeologist, Sustainability and Applied Science Division

Subject: Environmental Assessment Review of Realignment of Marine Drive (Hwy 316) Goldboro LNG Project

Reviews for EA's from the Nova Scotia Environment and Climate Change (NSECC) Sustainability and Applied Science Division Senior Hydrogeologist focus on the potential for the proposed undertaking/project to adversely affect groundwater resources, including general groundwater quality, local water wells/water supply and groundwater discharge to surface water.

The purpose of the proposed undertaking is to permanently realign approximately 3.5 km of the existing Marine Drive (Hwy 316) around the proposed Goldboro LNG Project site, located in Goldboro Industrial Park, Guysborough County, Nova Scotia. The realigned new Marine Drive will be a 6 km, two-lane public road.

Comments:

1. The nearest Protected Water Area (PWA) to the site is the Antigonish, James River Watershed. This is located >60 km to the northwest and is in a different watershed.

2. The nearest Municipal drinking water supply and watershed is located at Sherbrooke, NS approximately 20 km to the west. This is in a different watershed than the site.

3. The proponent has identified 13 homes on drilled wells in the area, but also mention up to 40 wells (mostly dug) in the "community of Goldboro", on page 30 of the Registration document. These were identified primarily during previous investigations (2013, 2018) for prior EA registrations.

4. There are no Registered Public Drinking Water Supplies located in the Goldboro/Isaac's Harbour area (according to NSECC records).

5. Using the Department of Energy and Mines online Groundwater Atlas, the reviewer found approximately 10 water supply wells located for residences within 800 metres

buffer distance of the currently proposed project realignment. This is roughly equivalent to the number of wells identified by the proponent (13, on page 30). However, the number of water supply wells need to be re-assessed by the proponent based on the new project highway re-alignment boundaries. It should also be noted that all water well locations must be verified and identified by field visits.

It has been noted previously that the Well Logs Database Records and any mapping based on these records need to be considered in terms of locational errors/accuracy of the original data. In addition, the Well Logs Database does not contain a complete listing of every water supply well in the province and some areas may contain water supply wells not reported. Field truthing and field surveys for water supply well locations is necessary. This is particularly important given the potential changes to project area in the current EA registration document (i.e. LNG site project area versus highway realignment project area).

6. The proponent briefly discusses the potential for the site to be affected by Acidic Rock Drainage (ARD) and Metal Leaching due to exposure of potential acidic rock during construction. On page 27, they state "*Certain rocks of the Goldenville Formation may also be a source of acid rock drainage (ARD), particularly (in small areas) where highly mineralized zones are present*." This is relevant because the proposed realignment site area crosses areas containing numerous historic mine openings and potentially tailings from the historic mine operations (this is evident as shown in the north-western areas of Figure 5.1-4 (Abandoned Mine Openings). Mines in the area are essentially designed to intersect "highly mineralized zones" of the Goldenville Formation rocks to obtain gold. It is known that at one point, in addition to gold, arsenic was historically shipped from this area. The site has the potential to encounter ARD materials through excavation and blasting of both bedrock and native soil (glacial till) materials, as well as through encountering historic mine tailings. ARD conditions would enhance mineral solubilities for contaminants such as Arsenic that could affect surface water and groundwater.

   Of related note is pH sampling for 8 surface water samples in the area which indicate relatively low pH's of between 4.06 and 5.92 pH units.

   The proponent references 2008 sample analysis for soil sulphur concentrations, noting these meet NSECC requirements at the time, but also noting the samples were conducted from test pits not within the current Project Development Area.

7. Soil and sediment sampling has identified exceedances for Arsenic in several samples. Also, modified TPH was found in some sediment samples, although potentially biogenic. Soils and sediment metals may cause leaching to groundwater and thus are a concern if not properly identified and mitigated during construction (with proper disposal or management)

8. It is noted that the proponent identifies Groundwater Resources as a Valued Environmental Component (VEC) on p. 73 of the Registration Document - "*Groundwater resources were identified as a VEC based on the potential for* *adverse effects on water supply wells as a result of blasting and excavation during road construction."*

9. The proponent identifies potential residual groundwater effects due to the project, but determines that these are of minor/minimal nature and not significant. (p. 73-75)

<u>Discussion</u>

From a groundwater perspective some of the greatest concerns for the proposed project are related to the maintenance of groundwater conditions for local water supply wells.

This includes protection of well yield/aquifer recharge, structural damage due to construction and protection of water quality due to potential mobilization of new (ARD and metals leaching from bedrock blasting/soil disturbance), but also from potential pre-existing contaminants (historic mine tailings/soil/sediment ARD and metals or previous industrial activities (petroleum hydrocarbon or other) .

In addition, changes to the shallow groundwater regime have the potential to negatively affect both water quantity and water quality in stream flow and related wetland function.

Several areas have been identified in this review for which information is lacking or currently not adequate for evaluation:

1) The water well survey for (10) wells within 800 metres of the project boundaries was conducted for a prior project (2020) although sampling was apparently conducted in 2018 (page 30). The Registration Document states that results were compared to the "*the most current version of the Guidelines for Canadian Drinking Water Quality (GCDWQ) at that time (Health Canada, 2017)*" (page 30).

   As a result, the survey needs to be updated to include comparison to current relevant criteria (Health Canada has updated several drinking water parameter criteria in the past 3 years since the study was conducted). In addition, it is not clear that all water supply wells within the current project boundaries (for the realignment project) have been included. The location and baseline sampling of any dug wells is of primary concern. The water well survey report described by the proponent was not provided in the Registration Document submission.

2) ARD sampling results provided in the report clearly state they are from outside the project area. ARD sampling and evaluation needs to be conducted for areas within the project realignment construction area where either bedrock blasting, or soil disturbance is anticipated. ARD sample analysis should be conducted and reported for current requirements (Nova Scotia *Sulphide Bearing Material Disposal Regulations*).

   The surface water pH reported at the site raises concerns for whether this is depressed because of existing ARD, or as a result of background conditions (which are not presented).

3) Much of the proposed mitigation for groundwater resources refers to and relies on documentation by others:

- Standard Specification; Highway Construction and Maintenance (NSTIR, 1997 and revisions);
- Generic EPP for the Construction of 100 Series Highways (NSTIR 2007);
- NSTIR's Integrated Roadside Vegetation Maintenance (IRVM) program; and
- NSTIR's Salt Management Plan.

These documents were not included and have not been reviewed in the context of this project to determine if they represent adequate environmental and human health protection related to groundwater resources.

4) Property ownership agreements and zoning were not evaluated in this review. However, actual land ownership and zoning is relevant to assumed chemical criteria for any contaminant clean-up. The project area seems to incorporate several municipal land zone designations (Figure 5.3-2). Note that due to the lack of municipal water supply, this area (included the entire project area) defaults to potable groundwater (drinking water), regardless of zoning.

<u>Recommendations</u>

The following recommendations are made for the proposed Realignment of Marine Drive (Hwy 316) for the Goldboro LNG site.

Planning/Design Issues

- No planning/design issues are specifically noted from a groundwater resources management point of view.

Operational Issues/Other Permitting Processes

- From and operational and permitting point of view, more detailed description is needed of long-term water quality protection and mitigation measures concerning groundwater conditions both during road construction and operations. This includes conditions resulting from winter road maintenance road salting, potential acid rock drainage effects and herbicide use in close proximity to wells (or otherwise affecting drainage that may also impact water wells). Management plans (TIR's EPP and Salt Management Plan were not provided.
    - The TIR management/maintenance plans intended for the project should be provided to Nova Scotia Environment and Climate Change for review with respect to evaluation of appropriate environmental protection measures.

- Better operational information is needed regarding ARD and soil contaminant conditions, both for planning purposes and during road construction at potential locations where blasting and soil disturbances may occur. An ARD/soil/sediment sampling plan should be prepared that specifically includes testing for conditions found along the highway re-alignment route, and them properly mitigating any conditions that may require it.

- Baseline information for water wells within 800 metres of any potential blasting sites as well as all water wells within 500 metres of the proposed project boundaries should be updated and augmented if necessary. Baseline information should include water well construction details, water quality assessment compared to current guidance (2021) and water quantity assessment.

- A water well supply contingency and mitigation plan should be prepared to address the long-term needs of individual residences in the community for water supply, that could be negatively affected as a result of the project.

Other Observations

- None

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NOVA SCOTIA
Environment & Climate Change

Date: April 9, 2021

To: Nova Scotia Environment & Climate Change - EA Branch

From: Wetland & Water Resources Specialist, Water Resources Management Unit

Subject: Pieridae Highway 316 Realignment EA - Wetlands

Scope of Review:
The following review of the Pieridae's Highway 316 Realignment Project Environmental Assessment Registration Document (EARD) (Pieridae, March 2021) is specific to the mandate of the NS ECC Wetlands Program within the Sustainability and Applied Sciences (SAS) Division. The review considers whether the environmental concerns associated with wetlands and the proposed mitigation measures to be applied have been adequately addressed within the EARD. The recommendations provided below are meant to supplement the actions outlined in the EARD.

Reviewed Documents:
- Wood. 2021. *Goldboro LNG. Environmental Assessment Realignment of Marine Drive (Highway 316) Environmental Assessment Registration*. Pieridae Energy (Canada) Limited.

General Comments:

Summary of Wetland Findings:
- Field studies identified 32 wetlands within or adjacent to the Project ROW, the majority of which are classified as swamps.

Wetlands of Special Significance:
- One *Wetland of Special Significance* (WSS) was identified (WL22), based on the presence of Blue Felt Lichen (*Pectenia plumbea*) within its boundaries.
- Any mitigation or permitting related matters for addressing occurrences of blue felt lichen within the WSS will require coordination with the appropriate staff at NSDLF Wildlife Division.
- Within the EARD, rationale for subdividing the WSS designation of WL22 is provided on the sole basis of differing vegetation communities within the wetland complex – which in turn relate to habitats/substrates which are ranked as either suitable or not-suitable for blue felt lichen. When dealing with a wetland complex, any proposed parsing of

areas out of a WSS must be better rationalized in order to be considered a valid approach. Detailed ecological mapping and study of the wetland site, and demonstration that there is sufficient differentiation between the areas proposed to be seperated (in terms of vegetation, surface hydrology, hydrogeological influence, geomorphology, pedology, etc.) is key information, which the EARD and appendices do not provide. This comment is made in consideration of the statement below (Section 5.2.4):

"One WSS was identified (WL22) based on the presence of several locations of blue felt lichen within the wetland habitat (Figure 5.2-4). Only portions of the wetlands that had vegetation types belonging to the Wet Deciduous and Wet Coniferous Forest Group provided suitable habitat for this species. Remaining portions (the southern sections of this wetland) were determined to not be suitable habitat for blue felt lichen and therefore is not designated as WSS. These vegetation communities which have not been designation as WSS comprise of the PG1 – Huckleberry – Crowberry Bog; PG3 – Coastal Sedge Fen and the SS1 – Mountain Holly – Alder vegetation type. These vegetation types are either absent of tree cover (i.e., PG3 vegetation type) or support stunted conifer trees which are not suitable substrate for blue felt lichen."

Wetland Impacts:

- *Avoidance:* Avoidance of impacts to the northern tip of the WSS at WL22 has not been well demonstrated in the EARD. Avoiding unnecessary impacts to any WSS should be considered a top priority in Project design, as permit approvals may not necessarily be granted without full consideration of avoidance.
- *Direct Impacts:* It is indicated in Section 6.8.2 of the EARD that WL15 and 24 will be removed in their entirety, and that numerous others will be partially altered during the Project development, for a total infilled area of approximately 3.75 ha.
- *Indirect Impacts:* It is anticipated that numerous wetlands will be bisected, and will also experience indirect hydrological impacts as a result of the Project development. It is indicated in the EARD that "Drainage between contiguous wetlands separated by the road will be maintained by cross-culverts"; however the number, locations, and specifications of such culverts are not indicated.

Wetland Evaluation:

- *Plant Communities:* General wetland plant communities are well documented in text form, and cross-referenced to appropriate existing vegetation classification schemes, where these exist. Wetland plant communities are not mapped in any way in the EARD or appendices, whereas they are for the upland plant communities. Details of specific vegetation composition at the wetland evaluation plots was not provided in the EARD or appendices.
- *Hydric Soil Indicators:* Documentation of hydric soils was not provided in the EARD or appendices.
- *Functional Assessment:* WESP-AC functional assessments appear to have been completed for the wetlands identified on the Project site. The WESP-AC results provided in Appendix G are considered incomplete (i.e., only Group functions are presented), and are provided in a non-standard format.

Mitigation and Monitoring:

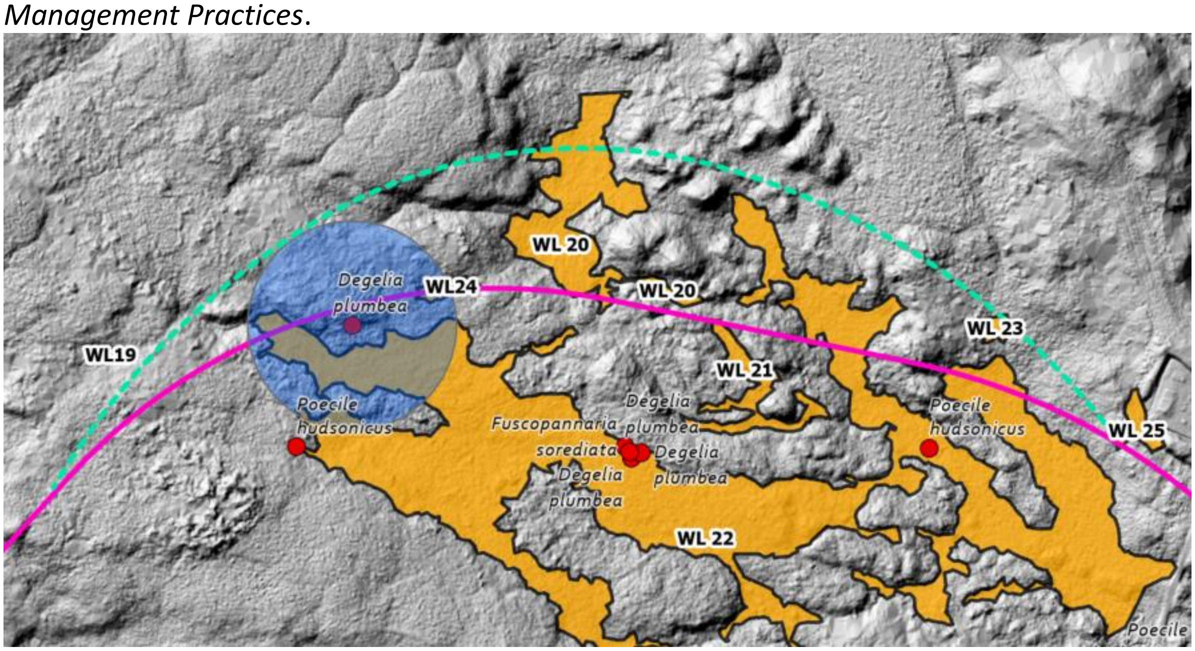
- *Mitigation:* The EARD (Section 6.8, Table 8.0-1) does not provide sufficient details on proposed on-site mitigation measures and design elements that are specific to the protection of remaining portions of partially altered wetlands. The EARD references the application of NSTIR's *Standard Specification: Highway Construction and Maintenance* (1997 & revisions), and NSTIRS's *Generic EPP for the Construction of 100 Series Highways* (2007) – however, provides no indication of the site-specific applications of these standards/plans to the Project area wetlands.
- *Monitoring:* The EARD does not provide details on the proposed monitoring approaches that could be used in order to determine the magnitude of both direct and indirect impacts (both area and function) within remaining portions of wetlands that will be altered during Project development.

Conclusions & Recommendations:

Beyond the estimates of wetland area removal, there is insufficient information provided in the EARD to predict whether adverse environmental effects on wetland function will occur. A series of recommendations are provided below.

Planning/Design Issues:

- The proponent, in their Project design, shall make every effort to avoid impacting the WSS at WL22. It appears that this avoidance may be achievable through a slight alignment shift to the north (dashed green line in sketch below). This may simultaneously achieve the presumed requirement for a 100 m buffer (blue circle in sketch below) from the nearest occurrence of blue felt lichen, located near the northern boundary of WL22. The indicated 100 m buffer is per NSDLF *At-Risk Lichens Special Management Practices*.



- The proponent shall prepare and submit a *Wetland Management and Monitoring Plan* for NS ECC review and acceptance. This plan should be developed in consultation with the NS ECC Wetland Specialist. This document should include:
    - Details and designs for proposed on-site mitigation measures specific to the protection of remaining wetlands or portions of wetlands, including measures for sediment and erosion control, maintenance of groundwater hydrology, vegetation management, stormwater management, and water quality management.
    - A detailed ecological and hydrological monitoring plan for:
        - The remaining portion of all partially altered wetlands.
        - The wetlands immediately adjacent of the Project development, in order to ascertain whether indirect impacts are occurring.
    - An Adaptive Management framework related to wetlands.
    - An outline of the measures to be implemented for rare species protection within remaining wetlands, consistent with any NSDLF management plan requirements that may be requested.
    - Inclusion of any monitoring considerations raised by NS ECC specialists in terms of Hydrogeology, Surface Water Quality, or Surface Water Quantity.

Operational Issues/Other Permitting Processes:

- Should the Project receive approval, the proposed activities will be subject to the NSE Wetland Alteration Approvals process prior to any wetland impacts. The NSE-approved *Wetland Management and Monitoring Plan* shall be a key piece of supporting information for this approval application.
- Should the Project receive approval, the results of WESP-AC functional assessments for any wetlands to be altered shall be submitted as a component of the ensuing NSE Wetland Alteration Approvals process. These data shall be submitted in standard format (per WESP-AC calculator 'Scores' tab), rather than the modified format provided in the EARD and appendices.
- Should the Project receive approval, design drawings showing details of road bed design shall be provided as a component of Wetland Alteration Permit applications. These drawing shall include explicit reference to the implementation of wetland hydrology maintenance, which may include (but not necessarily be limited to) cross-drain culvert configurations, and/or porous road bases allowing conveyance of groundwater between bisected portions of wetlands.

NOVA SCOTIA

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MEMORANDUM

To: **EA Branch**

From: **Water Resources Engineer, Industrial Management Unit, Sustainability and Applied Science Division**

Date: **April 9, 2021**

Subject: **Goldboro Highway Realignment EA Review Comments**

Scope of review:

The scope of this Environmental Assessment review from the NSE Sustainability and Applied Science Division Hydrologist is to assess the potential environmental impacts and proposed mitigations of the proposed undertaking on surface water quantity and management. While comments may also include considerations for impacts on general surface water quality, groundwater, freshwater fish habitat, and wetlands, appropriate technical specialists for these areas should be consulted for specific review and comment.

Documents reviewed:

The documents outlined below formed the basis for this EA review, and is referred to as the 'the submission' through the rest of this memorandum:

- Environmental Assessment – Realignment of Marine Drive Highway 316 - Environmental Assessment Registration. Report Prepared by wood.. Dated March 2021, and accessed from https://novascotia.ca/nse/ea/Realignment-of-Marine-Drive-Project/

Comments and recommendations re: the submission:

General:

- The proposed activity will realign approximately 3.5 km of the existing Highway 316 through 5.6 km of new road segment around the planned Goldboro LNG facility

- A weather gauge that was discontinued in 2004 was used to support assessment of Section 5.1.6 Climate and Weather
- The 'Climate Update and Predicted Future Trends' section outlines changes to sea level and temperature, but does not discuss how climate change impacts on precipitation may impact the project
    - It is also noted that this area is particularly hard-hit by storm events – how will this be considered in final highway designs?

Water Resources

- It is noted that "Culverts designed to address potential climate change impacts on stream flow" (pg 12)
- It is reported in the submission that "A total of 39 wetlands (WLs) were identified, delineated and characterized (Figure 5.2-4; Table G-1; Appendix G) during the field program; however, seven of those (WLs 1 -7) were within the LSA, but outside the PDA." (pg. 57)
    - The submission also states "A draft Wetland Management Plan (Wood, 2021) has determined that 23 wetlands representing 3.75 ha are located within the Realignment footprint (Table 6.8-1). The largest area of wetland to be impacted is 1.8 ha, and none of the remaining 22 wetlands are larger than 0.52 ha. Two wetlands (20-WL-15 and 24) will be lost entirely; however, portions of numerous wetlands will be infilled, with a total maximum infilled area of approximately 3.75 ha (Table 6.8-1)." (pg 106)
- It is reported that "One WSS was identified (WL22) based on the presence of several locations of blue felt lichen within the wetland habitat (Figure 5.2-4). Only portions of the wetlands that had vegetation types belonging to the Wet Deciduous and Wet Coniferous Forest Group provided suitable habitat for this species. Remaining portions (the southern sections of this wetland) were determined to not be suitable habitat for blue felt lichen and therefore is not designated as WSS." (pg 57)
    - To note – I would question this approach for delineating a WSS. Without more information to support why it was felt the habitat was unsuitable, it is unclear how/if the hydrologic connectivity of this wetland was considered in this delineation.
- It is stated in the submission that 'In addition to the direct impacts due to localized infilling, wetlands surrounding the Project footprint could potentially be adversely affected by changes to the hydrology due to impeded drainage caused by the construction of the Realignment. Wetlands located upgradient of the construction may be flooded if drainage is impeded, and wetlands located down-gradient could be adversely affected if surface water flow decreases. If stormwater from the roads, which is collected in roadside ditches, is allowed to enter wetlands in quantities exceeding natural pre-construction flow, similar adverse effects are possible." (pg 109)
    - The mitigations provided, "Maintain surface water paths through culvert placement and appropriate structure sizing", is very high-level and does not provide an adequate level of information to support having confidence that this potential impact will be effectively mitigated. What is the planned approach to locating culverts, understanding the potential impacts stated in the submission and recognizing that there are sections of the planned alignment that cut directly through large wetlands (e.g., 20-WL-31, 20-WL-34, etc.)? In wetland areas where less clear drainage channels exist and where the proposed

alignment splits through the wetland, how will drainage be maintained? At current, the level of information provided is such that it is not possible to have a clear understanding of the level of impact that may exist due to the proposed activity, as well as what will be done to mitigate and whether it will be effective.

- It is reported in the submission that "Two named watercourses (Crusher Brook and Betty's Cove Brook) and 6 other unnamed watercourses were identified to be crossed by the Realignment (Figure 5.2-5)." (pg 58)
  - The development of the proposed road will alter local drainage patterns. Alteration of surface water flow patterns is not highlighted in the description of potential environmental effects in the Surface Water Quality VEC entry throughout the submission, and there is no assessment or consideration of this within submission text, including no delineation or consideration of drainage areas, etc.
  - What are the potential impacts associated with these changes, and how will they be mitigated? Will there be cross-drain culverts every so many metres between the watercourse crossings, as is typical with many roadworks? As discussed previously, what will be the approach to ensuring effective drainage through the large wetland areas that are split by the proposed realignment (e.g., 20-WL-31)?
  - It is not clear exactly what was completed from the perspective of field work related to watercourses – while it is reported that 8 watercourses were identified, 7 are listed within Table 5.2-5. In addition, WC4 and WC7, which are not listed as electrofishing sites on Figure 5.2-5, are outlined as having no fish observed in Table 5.2-5.
- The potential exposure of acid generating rock is highlighted in Section 6.2.2 Potential Interactions and Effects, but is not elaborated on or adequately discussed further. As example, it is not included within Table 6.2-1, and no rationale is provided for its exclusion from this table
  - This is also reported in Section 6.8 Wetlands, where it is stated that '…contaminated runoff from acid-generating material potentially exposed during blasting may have an adverse effect on wetlands' (pg 106).
  - On Figure 5.2-3, two segments of watercourses are outlined as 'Field Verified Streams', but these do not include all the segments of watercourse that is crossed by the highway that is also reported in the submission as being sampled and assessed?
- It is not clear in the document how much permanent loss to fish and fish habitat will occur as a result of the proposed works
  - In particular, it is unclear what the approach will be at WC-6, where the alignment appears to run parallel with the watercourse
  - The level of information provided for each watercourse is minimal and from a review of the datasheets provided in Appendix H has been based off a single field visit
  - According to figure 5.2-4 and elsewhere in the submission, there are several wetlands interspersed with the watercourses that cross the Proposed R.O.W. of the Highway. Partial infilling of several of these wetlands is highlighted, with mitigations to alterations to drainage resulting from this activity outlined as "Maintain surface water paths through culvert placement and appropriate structure sizing" (pg. 110).
- The document refers to many references that are not publicly available and have not been provided for review

Conclusions & Recommendations:

In general, the potential impacts resulting from the proposed activity are currently unclear with the level of information provided in this submission. There is a need to continue to assess the proposed activity at several touch points as it proceeds so that potential impacts can be effectively identified, mitigated, or avoided.

Planning/Design Issues:

-

Operational Issues/Other Permitting Processes

- With the level of detail provided in the submission, it is currently not possible to have a clear understanding of the potential impacts on local drainage, and as a result wetlands and associated watercourses resulting from the proposed activity. Prior to commencement of the project, the applicant must provide the following for review and acceptance by NSE, with a sufficient level of detail that is informed by final designs of the road:
    - The approach and considerations to mitigate potential impacts to local drainage patterns resulting from the proposed works;
    - The approach to mitigate impacts to wetlands as a result of disruption of hydrologic connectivity due to the construction of the highway, including what will be done to maintain effective drainage in wetland areas where no clear channel exists, as outlined in the submission comments above.
- A detailed sediment and erosion control plan for the overall project is to be developed by a qualified professional and is required to be submitted as part of any industrial approval application for NSE review and approval prior to construction activities, including clearing, grubbing, and stripping, take place. The plan is required to adequately consider the various phases of the project, including clearing, grubbing, and stripping.
- Any necessary approvals for the watercourse alterations associated with the proposed works must be obtained prior to project commencement, and applications must include:
    - Details associated with the loss of fish and fish habitat associated with the proposed works, including consideration for any partial infilling of associated wetlands for review by NSE and DFO;
    - Details surrounding plans to address potential climate change impacts on flow and the propensity of this area to experience significant storm events, as outlined in the submission
- It is recommended that as part of wetland monitoring after construction, assessment of impacts related to salt application be completed. In addition, details related to how wetlands will be monitored to 'identify any signs of changed hydrologic regime', as outlined in page 113, are to be submitted for review and acceptance by the Department prior to implementing the monitoring plan.
- The applicant should assess and justify the use of a discontinued gauge to support future project activities, and consider installation of an appropriately sited gauge or reactivation of reference Stillwater Sherbrooke gauge

- The Goldboro LNG facility is currently an activity that is split across several approvals and potential EAs. This approach makes it very challenging to have a comprehensive and clear understanding of the cumulative impacts associated with other previously approved or upcoming project activities. An example of this would be Betty's Cove Brook, which is understood to have a reduction of contributing drainage area from the LNG Facility itself, as well as potential impacts associated with the highway realignment and disruption of flow patterns, and potentially additional impacts due to proposed laydown areas and temporary work camps that have yet to be assessed. Future EAs that result from this activity need to clearly and effectively consider the entirety of the activity that is being proposed, including the LNG facility and the realignment of the Highway.

NOVA SCOTIA

Environment

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Date: April 12, 2021

To: Environmental Assessment, Nova Scotia Environment

From: Climate Change Unit

Subject: Realignment of Marine Drive Project

The proposed LNG facility is expected to be a major source of greenhouse gas emissions in Nova Scotia. Part of the original Environmental Assessment approval of the Goldboro LNG facility included the condition to prepare and receive approval for a Greenhouse Gas Management Plan. That plan is still outstanding. The current proposal to re-align the highway is not expected to significantly change the overall greenhouse gas emissions profile associated with the project.

While the proponent noted that the project will not have a major or significant adverse effect on Climate Change and outlined several mitigation measures, they could also consider the following comments in relationship to the Guide to Considering Climate Change in Project Development in Nova Scotia (Microsoft Word - Development CC Guide[1].doc (novascotia.ca)).

Climate Change Data: (*EA section 5.1.6 Climate and Weather; pp. 31*)
While proponents provided climate change information, it is recommended that the assessment consider more recent climate change projections for Nova Scotia with particular attention to monthly or seasonal trends for precipitation. Further, the trend data and projections should be considered with relationship to relevant valued components with sensitivities to climate change. Projections for climate data can be found at climatedata.ca. For advice on which climate projections to use for this context, please contact the Canadian Centre for Climate Services at Environment and Climate Change Canada. https://www.canada.ca/en/environment-climate-change/services/climate-change/canadian-centre-climate-services.html

Indirect GHGs: (*EA section 6.3: Atmospheric Environment*, pp. 83-84)

- The proponent should consider clarifying the relationship between this assessment and the larger LNG project, specifying where the monitoring overlaps and how the effects are being assigned and mitigated.

- The proponent should consider including indirect and accumulative GHGs emissions in the assessment. For example, the realignment will extend Highway 316 by approximately 2 kms causing a minor accumulative effect with regular local traffic.

Carbon Sinks: (EA *section 6.3: Atmospheric Environment*, pp. 83-84)
- Consider calculating the area of lost natural habitats associated with the development as an important part of reporting on GHG impacts, because forests and wetlands are typically GHG sinks, whereas road corridors are not.

Adaptation to Climate Change: *(EA sections 6.15.3: Severe Weather and 6.15.4 Climate Change, pp.126)*
- While the proponent noted that they will accommodate severe weather events, particularly with regards to surface water and drainage around wetlands, there is not enough details on the specific actions to comment at this time.

NOVA SCOTIA
Department of Municipal Affairs

Maritime Centre, Floor 8 North
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Halifax, NS B3J 2M4

Date: April 14, 2021

To: NS Environment and Climate Change

From: Department of Municipal Affairs

Subject: **ENVIRONMENTAL REVIEW:
MARINE DRIVE (HIGHWAY 316) PROJECT**

As requested, the Department of Municipal Affairs has reviewed the Environmental Assessment Registration Documents for the proposed Marine Drive (Highway 316) Project. From the perspective of our Departmental mandates, we have no comments to submit relative to this EA review.

Thank you for the opportunity to review the Registration Documents for the above-noted project.

Senior Planner, DMA

Higgins, Jeremy W

From: @mikmaqrights.com>
Sent: April 21, 2021 10:12 AM
To: Higgins, Jeremy W
Cc:
Subject: RE: EA Registration - Pieridae Energy Ltd - Realignment of Marine Drive, Highway 316, Goldboro, Guysborough Co., NS

Hi Jeremy,

Please see below comments on Pieridae's EA Registration for the Realignment of Marine Drive in Guysborough, NS..

- Based our internal data, it appears that several of the proposed highway realignments will be crossing several known areas that are known to be inhabited by deer. We are requesting further elaboration on how the proponent plans on offsetting any area habituated by deer.
- Based on the supported documents, it appears that the proposed project will cross 32 wetlands and 8 water courses. Please advise KMKNO when a Fisheries Authorization and/or Letter of Advice from Department of Fisheries and Oceans.
- We would also like to know whether a Species at Risk assessment was completed for the proposed project area. If so, please forward the assessment to our office for further review.
- Based on the information currently available in the Archaeological Resource Impact Assessment (ARIA) desktop review for the HWY 316 re-alignment, KMKNO's Archaeological Resource Department has not identified any concerns at this time and is supportive of the recommendations. Additionally, should the project deviate from the proposed impact or study area(s) presented in the ARIA, including laydown and logistical areas, an additional assessment will be required as per the recommendations in the report. We expect that, as per the recommendations included in the ARIA, that the archaeological team will be in contact regarding the next phase prior to the beginning of any construction activities, including clearing and grubbing.

That is all the comments we have for the time being. We look forward to receiving updates on this project and will continue working directly with Pieridae to ensure meaningful engagement and consultation.

Wela'lin,

Mi'kmaq Energy and Mines Advisor

Kwilmu'kw Maw-klusuaqn
Mi'kmaq Rights Initiative

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C: 902-304-6972

www.mikmaqrights.com

From: Higgins, Jeremy W <Jeremy.Higgins@novascotia.ca>
Sent: April 9, 2021 10:14 AM
@mikmaqrights.com>

Subject: RE: EA Registration - Pieridae Energy Ltd - Realignment of Marine Drive, Highway 316, Goldboro, Guysborough Co., NS

Further to my voicemail, I wanted to touch base with you regarding KMKNO's request for an extension to provide comment on the Environmental Registration Document for the Realignment of Marine Drive (Highway 316) Project. I want to reiterate that given the legislated timelines associated with the provincial Environmental Assessment (EA) process, the Minister of Environment and Climate Change is required to make a determination on the proposed project on April 29, 2021. The Regulation does not provide a mechanism to extend these timelines. The Minister will be briefed by the EA Branch on April 22, 2021. As such, we request that if there are any potential adverse impacts to Aboriginal and Treaty rights that these are brought forward by **April 21, 2021 at 12 pm**, so that this information can be considered in the briefing to the Minister of Environment.

Please be advised that to accommodate any potential adverse impacts to Aboriginal and Treaty rights, the Crown must be advised of this information in advance of a project being approved. Once an approval has been issued, the Department does not have an additional mechanism to accommodate any potential adverse impacts to Aboriginal and Treaty Rights.

Please don't hesitate to reach out to me if you have any questions or would like to further discuss.

Regards,
Jeremy

Environment and Climate Change

1903 Barrington St.
Suite 2085
Halifax, NS, B3J 2P8

Jeremy W. Higgins
Environmental Assessment Officer

Policy, Planning and Environmental Assessment

902-233-4477

Jeremy.Higgins@novascotia.ca

From: @mikmaqrights.com>
Sent: April 8, 2021 2:16 PM
To: Higgins, Jeremy W <Jeremy.Higgins@novascotia.ca>

Subject: RE: EA Registration - Pieridae Energy Ltd - Realignment of Marine Drive, Highway 316, Goldboro, Guysborough Co., NS

** 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

Hi Jeremy,

I am writing in response to your March 10, 2021 e-mail re: The Realignment of Marine Drive, Highway 316.

Due to the vast amount of supporting documents associated with the project, KMKNO is asking for an extension to April 23, 2021 to provide comments on the decision if the Realignment of Marine Drive (Highway 316) Project will be granted a conditional environmental assessment approval. This two-week extension will give our Archeology Department thorough time to review the supporting documents and provide meaningful comments on this highway realignment.

We also hope to schedule a project overview meeting with during this 2 week period as well. previously offered a session to get more familiar with the project and KMKNO has kindly accepted. We are currently waiting for to suggest meeting dates and times for this project overview.

KMKNO is able to follow up with this e-mail with a formal letter if preferred. Please feel free to e-mail or call if you have any further questions on this extension request.

Wela'lin,

Mi'kmaq Energy and Mines Advisor

Kwilmu'kw Maw-klusuaqn
Mi'kmaq Rights Initiative

Kwilmu'kw Maw-Klusuaqn Negotiation Office
Mi'kmaq Rights Initiative
75 Treaty Trail
Truro, Nova Scotia
B6L 1W3

P: 902-379-2209

F: 902-379-2186
C: 902-304-6972

www.mikmaqrights.com

From: Higgins, Jeremy W <Jeremy.Higgins@novascotia.ca>
Sent: March 10, 2021 3:40 PM

Subject: EA Registration - Pieridae Energy Ltd - Realignment of Marine Drive, Highway 316, Goldboro, Guysborough Co., NS

Please find attached a letter regarding the proposed **Realignment of Marine Drive (Highway 316)**, associated with the Goldboro LNG Project located in Goldboro, Guysborough County, Nova Scotia. A hardcopy of this letter will follow in the mail.

This Project has registered for environmental assessment on March 10, 2021. Please provide comments you may have by **April 9, 2021**. Please be advised that on or before April 27, 2021, the Minister of Environment and Climate Change will be required to decide if the Realignment of Marine Drive (Highway 316) Project will be granted a conditional environmental assessment approval.

Kind regards,
Jeremy

NOVA SCOTIA
Environment and Climate Change

1903 Barrington St.
Suite 2085
Halifax, NS, B3J 2P8

Jeremy W. Higgins
Environmental Assessment Officer

Policy, Planning and Environmental Assessment

902-233-4477

Jeremy.Higgins@novascotia.ca

From:	@eastlink.ca
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 12, 2021 9:02:11 AM

Project: realignment-of-marine-drive-project Comments: this project was pushed down the throats of the people in the area. Not all landowners were told of the meetings and what was going on. Those that were there did try to complain but were told that the meeting was not for that. It was an information meeting only. How can you approve something that is going to destroy the environment? Please do not approve the realignment of the highway as you will have to go over old gold mine areas. Old chemicals that are in the land from old goldmining will be able to leach out of the ground and move towards the ocean. More study is needed to make sure these chemicals including lead are not able to move. The communities were built on gold mining years ago so there was never a clean up from that. Name: Email: @eastlink.ca Address: Municipality: Dartmouth email_message: Privacy-Statement: agree x: 50 y: 25

From:
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 12, 2021 9:19:26 AM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: I fully support the realignment of highway 316 around the Goldboro LNG site. Both motorists and Goldboro LNG will benefit from the upgrades to this new portion of highway. Name: Email: @shaw.ca Address: Municipality: Goldboro email_message: Privacy-Statement: agree x: 54 y: 22

From:
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 12, 2021 9:35:29 AM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: This project is a swindle. This is a few people who are swindling money out of some investors and making this appear to be a legit project with adequate financial backing and access to product. THEY HAVE NEITHER. Theyve dragged the public purse along with the time of provincial employees for over a decade to help legitimize the appearance of the swindle...but...its a scam folks. Its all there in the details and its been reported on in the examiner. If you cant see it you have rocks in your head. Theres no way this thing will ever make money. Now theyve got you talking about re-aligning a provincial highway which in the VERY off chance that this swindle actually goes ahead, THIS COMPANY HAD BETTER PAY FOR THE COST OF THE ROAD 100 UP FRONT and not a red cent from NS. If this company isnt willing to pay for the road cost 100 UP FRONT then tell them to KICK ROCKS or build an overpass. This is a project that by its own numbers and the numbers of NS will increase our Greenhouse Gas Emissions by 18....why is this even through the first steps...Thats a non-starter. 18 frickin percent increase when were in a global climate crisis...Thats certifiably crazy. Not only should the highway NOT be re aligned, the whole thing should be scrapped on the basis of us being IN A GLOBAL CLIMATE CRISIS!!!!! If you want to increase our GG emissions by 18 with virtually NO BENEFIT to the people of NS then just go light an adequately sized pile of coal on fire and let it burn each year. It makes about as much sense as doing this. Im not leaving my name because the last thing I need is after me. I dont have the 9 billion youre looking for bud...hope you can at least build a nice house somewhere with what you bilk from investors. Name: NO Email: Address: Guysborough Municipality: Guysborough email_message: Privacy-Statement: agree x: 56 y: 23

From: @hotmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 12, 2021 2:26:20 PM

Project: realignment-of-marine-drive-project Comments: Having lived in the Goldboro area for a goodly portion of my life. I know the area well and I do not see any problem in moving the Highway 316 so it goes around the LNG site. Please do not let this project die. Nova Scotia needs good paying jobs. Enough people have departed NS. Name: Email: @hotmail.com Address: Municipality: Saint-Sylvestre,QC email_message: Privacy-Statement: agree x: 65 y: 16

From: @gmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 12, 2021 2:39:14 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: Dear Sir, We are supposed to be moving away from fossil fuels Please stop destroying the environment for a Highway Name: Email: @gmail.com Address: Municipality: email_message: Privacy-Statement: agree x: 60 y: 18

From:	@HOTMAIL.COM
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 12, 2021 2:57:46 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: If the gas company will pay for it let them do so but dont close the old road till boats are in the harbour and gas is flowing. Maybe they could put a rest stop along the route as well. Name: Email: @HOTMAIL.COM Address: Municipality: dartmouth email_message: Privacy-Statement: agree x: 33 y: 35

From: @gmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 12, 2021 7:33:13 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: I approve of the realignment of Marine Drive, and am looking forward to the employment opportunities it will bring to many people in our province. Name: Email: @gmail.com Address: Municipality: Plympton email_message: Privacy-Statement: agree x: 44 y: 26

From:	@yahoo.ca
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 12, 2021 11:21:41 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: Liquid natural gas aggravates the climate crisis, and such projects must be replaced by green energy projects. Name: Email: @yahoo.ca Address: Municipality: Halifax email_message: Privacy-Statement: agree x: 59 y: 29

From:	@dal.ca
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 13, 2021 1:32:10 AM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: â?oReceived environmental approval in 2014â? ??????????? HOW is this even possible, let alone still up for discussion now as if it isnâ?Tt a crime to even consider it. Iâ?Tm disgusted, cancel this immediately, for the many reasons not least of which is the reality of climate change that this still even needs to be spelled out is literally heartbreaking. Open up your eyes and stop pretending we live in 2 different realities whenever it is temporarily and short-sightedly convenient. Iâ?Tm honestly stupefied that this is even being considered. Represent the interests of the PEOPLE in this province for ONCE. Name: Email: @dal.ca Address: Municipality: Halifax email_message: Privacy-Statement: agree x: 72 y: 15

From:	@hotmail.com
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 14, 2021 11:32:36 AM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: The proposed realignment will put my Home and property at a dead end leaving me isolated from the main route. Name: Email: @hotmail.com Address: Municipality: Goldboro email_message: Privacy-Statement: agree x: 82 y: 30

From:	@hotmail.com
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 14, 2021 3:30:05 PM

Project: realignment-of-marine-drive-project Comments: This needs to happen. We need the industry work in Nova Scotia. So many positive spin offs and get people to work Name: Email: @hotmail.com Address: Municipality: Antigonish email_message: Privacy-Statement: agree x: 77 y: 26

From: @hotmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 15, 2021 11:06:50 AM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: This will allow much needed industrial development in Nova Scotia. Name: Email: @hotmail.com Address: River, NS. Municipality: Sutherlands River email_message: Privacy-Statement: agree x: 67 y: 16

From:	environment@novascotia.ca
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 15, 2021 11:20:02 PM

Project: realignment-of-marine-drive-project Comments: I welcome the LNG project to Nova Scotia and the Goldboro and surrounding areas. Plant a lot of trees to offset if we must. To have jobs to bring our communities, friends and family back home would make our province better. Nova Scotians will have more friends and family to call on for support, rather than falling through the cracks and require state money. It will surround us with more love. Money doesnâ?Tt buy happiness but poverty takes it away. Name: Email: Address: Municipality: email_message: Privacy-Statement: agree x: 45 y: 19

From: @icloud.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 16, 2021 9:03:45 PM

Project: realignment-of-marine-drive-project Comments: Get it done Name: Email: @icloud.com Address: Municipality: Salmon river email_message: Privacy-Statement: agree x: 50 y: 26

From:	@hotmail.com
To:	Environment Assessment Web Account
Subject:	Proposed Project Comments
Date:	March 17, 2021 4:49:22 PM

** EXTERNAL EMAIL / COURRIEL EXTERNE **
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Project: realignment-of-marine-drive-project Comments: I support the realignment because this section of road is incredibly damaging to cars in the area now as it is. The new road will be welcome. With respect to using parts of the Sable Road, changes need to be made. Sable Road was not built to normal road standards, and road slopes are not correct. It was built for slow speed traffic only, not 80 km/h traffic. Name: Email: hotmail.com Address: Municipality: Fall River email_message: Privacy-Statement: agree x: 51 y: 27

March 19, 2021

Re: EA Registration - Pieridae Energy Ltd, Realignment of Marine Drive (Highway 316), Goldboro, Guysborough Co. NS

The Maritimes Energy Association (MEA) is pleased to have the opportunity to comment on Pieridae Energy Limited's Environmental Assessment Registration to realign Marine Drive in Goldboro, Guysborough County.

The MEA is a not-for-profit trade association that represents the full spectrum of the energy sector in Nova Scotia, New Brunswick and Prince Edward Island. With approximately 165 members, the Association works to advance the Maritimes and its energy economy by working with our valued stakeholders, including members, governments, policy makers and local communities.

The Maritimes Energy Association (MEA) is supportive of the proposed Goldboro LNG Project put forward by Pieridae Energy. The project will create approximately 3500 jobs during construction and up to 200 permanent positions once it is up and running. This project will bring significant investment to Nova Scotia and aid the province in its economic recovery from the COVID-19 pandemic. It will also serve to diversity the local economy and increase tax revenues to the municipality, all of which will bring benefits to the local community.

The Association is also supportive of the environmental assessment of the realignment of Marine Drive to increase public safety and provide Pieridae with access to planned infrastructure required for the project.

The Goldboro LNG Project has the MEA's full support, and we look forward to all the opportunities it will create for our members and the Nova Scotia economy.

Sincerely,

CEO
Maritimes Energy Association

From: @hotmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 19, 2021 10:48:47 AM

Project: - Choose - Comments: All for it! Nova Scotia needs job opportunities and these will be great paying ones at that! More industry in the province is a good thing one hundred percent. Name: Email: @hotmail.com Address: Municipality: New Glasgow email_message: Privacy-Statement: agree x: 76 y: 18

From:	@hotmail.com
To:	Environment Assessment Web Account
Subject:	Environmental Assessment Feedback
Date:	March 21, 2021 10:47:16 PM

email: @hotmail.com comments: Re: Water Pipeline from Meadow Lake to Pieridae LNG Plant Goldboro Two Questions 1 Has Pieridae or one of its affiliated companies filed the paperwork for an Environmental Assessment of this project? 2 When an Environmental Assessment application for a water pipeline is submitted for consideration assuming that the proposed route and engineering details for the installation are included is it a requirement to have all the easements associated with that project signed and included with the submission? Thanks Page Last Viewed: www.novascotia.ca/nse/ea/Default.asp

From: @hotmail.com
To: Environment Assessment Web Account
Subject: Environmental Assessment Feedback
Date: March 21, 2021 10:47:16 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

email: hotmail.com comments: Re: Water Pipeline from Meadow Lake to Pieridae LNG Plant Goldboro Two Questions 1 Has Pieridae or one of its affiliated companies filed the paperwork for an Environmental Assessment of this project? 2 When an Environmental Assessment application for a water pipeline is submitted for consideration assuming that the proposed route and engineering details for the installation are included is it a requirement to have all the easements associated with that project signed and included with the submission? Thanks Page Last Viewed: www.novascotia.ca/nse/ea/Default.asp

From: @hotmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: March 30, 2021 11:06:10 PM

Project: realignment-of-marine-drive-project Comments: Re: Abandoned mine shaft that may or may not be under or near the Marine Drive realignment. It is difficult for me to determine exactly but the proposed route of the new highway may be located over or very near an abandoned mining shaft. I believe a mine was opened up on that location sometime in the 30s but closed down a short time later. The shaft had been used a community dumping area until the 80s with everything under the sun being tossed into the hole. Sometime during the early 80s the wooden shaft structure between the surface and the underlying bedrock collapsed. I believe is was the NS DOE or DNR that contacted me at the time with a recommendation that it be filled in. I understand that the vertical shaft is approximately 95 feet deep but not sure to the extent of horizontal shafts and drifts that may exist underground. I had the shaft filled in mid 80s if my memory is correct and at that time the finish grade was level with the surrounding landscape. The contractor used a large piece or pieces of concrete from the site to plug the shaft but I was not present while the work was being done and do not know any details such as if the concrete was reinforced or in a state of deterioration, if it plugged the hole completely, etc. While I have not visited the site for many years, I understand that there has been some further subsidence in the area. Any initiative for highway construction should take into consideration all potential hazards that exist and carry out what remedial action that may be required. My memory is not the best but as I recall there was from 10 to 15 feet of overburden above the bedrock that existed at the vertical shaft site. The shaft itself was not very large, probably 9 by 14 feet, again that is only a guess. At the time I had the shaft filled a concrete cap was one of the options under consideration. The contractor suggested that it would be overkill. In reference to the proposed plan for the realignment contained in the submission Appendix B Road Detailed Design Drawings Page 9,GOFE-HAT-000-CV-DWG-CSK-000001 REV A my best estimate of the shaft location, without going to the site, is somewhere in the vicinity of the 300 and 400 meter distances as shown on the plan. It should be easy to locate once you are in the area. There is old access road and culvert at the site very close to the shaft. Just walk on this road perpendicular to the main highway and the shaft is about 50 feet or less from the edge of the highway. The actual mine shaft site may be overgrown with trees. If you would like a bit more info on this do not hesitate to get in contact. I would appreciate any feedback on your findings, particularly with respect to the actual location of the shaft relative to the proposed roadway and any decisions that may be taken with respect to potential issues this may present to the proposed realignment project. Name: Email: @hotmail.com Address: Municipality: Dartmouth email_message: Privacy-Statement: agree x: 65 y: 19

From: @gmail.com
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: April 2, 2021 1:27:11 PM

Project: realignment-of-marine-drive-project Comments: A I have the following questions: 1 will the cut off portion of the road still be maintained with snow removal. 2 will this cut off portion of the road be renamed? If so, do I have the opportunity to name it? 3 will the old portion of the 316 be repaved when the new road is made as it is dire state at present? Name: Email: @gmail.com Address: Municipality: Drum Head email_message: Privacy-Statement: agree x: 63 y: 15

From: @smu.ca
To: Environment Assessment Web Account
Subject: Proposed Project Comments
Date: April 6, 2021 12:23:13 PM

Project: realignment-of-marine-drive-project Comments: Its hard to believe that anyone still thinks investing in fossil fuels for energy is still viable in the face of Climate Change and the impending ecological collapse. Continuing to invest in and promote the use of fossil fuels for energy, including the provision of infrastructure to allow them to expand, is not compatible with Canadas Climate Change mitigation goals. This facility, and all infrastructure to support it, should be cancelled immediately, in favour of enhanced investment in green power and sustainable resource development. Name: Email: @smu.ca Address: Canada Municipality: Halifax email_message: Privacy-Statement: agree x: 68 y: 23

Tourism Guysborough County Association
159 Wharf Rd., Charlos Cove
R.R.2, Larry's River, NS
B0H 1T0
tourismguysboroughcounty@gmail.com

April 6, 2021

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

Re: Pieridae Energy Ltd.'s Realignment of Marine Drive (Highway 316) Project

I am writing on behalf of Tourism Guysborough County Association with respect to the proposed realignment of Marine Drive related to the construction of the Pieridae Energy Ltd.'s LNG plant. We believe that economic development needs to be undertaken in cooperation with and consideration of other existing industries in the area, such as Tourism, to ensure no harm is done.

The Marine Drive is the major tourism travel route along the Eastern Shore. Visitors to our shore enjoy its quiet natural beauty and ocean vistas. In order to minimize the potential damage to our reputation and consequential loss of travellers, we would recommend that the following actions be incorporated into the realignment project:

- The rerouting must ensure that the view-plain from the road does not show a massive industrial site. One potential solution is the creation of a tree buffer zone to obstruct the view of the site that is sufficiently wide to allow blowdowns; we would recommend consideration of at least a 300m wide tree zone between the road and the LNG facility.
- As the realignment will be taking people away from the shore, proper signage to reassure travellers they are still on the Marine Drive is needed.
- During the construction phase, planning and execution must be done to ensure that the way through remains open without significant delays or disruptions.

We are encouraged that Pieridae committed to the construction of a visitor information center in their application and would be happy to work with them on its design. It would be of significant benefit to travellers to our area if this center could house washroom facilities accessible and open 24 hours and be placed in such a way that the view was tourist friendly.

Thank you for your consideration. Please contact me if I can be of further assistance.

Yours truly,

Chair

Maritime Aboriginal Peoples Council

The Maritime Regional Aboriginal Leaders
Intergovernmental Council of Aboriginal Peoples
Continuing to Reside on Traditional Ancestral Homelands

Forums

- ☐ Leaders Congress
- ☐ MAPC Commissions/Projects
- ☐ MAARS Secretariate
- ☐ IKANAWTIKET SARA
- ☑ MAPC Administration

MAPC Regional
Administrative Office
172 Truro Heights Road
Truro Heights, Nova Scotia
B6L 1X1

Tel: 902-895-2982
Fax: 902-895-3844
Toll Free: 1-855-858-7240
Email: frontdesk@mapcorg.ca

Governmental
APRO Councils

Native Council of
Nova Scotia
P.O. Box 1320
Truro, Nova Scotia
B2N 5N2

Tel: 902-895-1523
Fax: 902-895-0024
Email: chieflaugustine@ncns.ca

New Brunswick Aboriginal
Peoples Council
320 St. Mary's Street
Fredericton, New Brunswick
E3A 2S4

Tel: 506-458-8422
Fax: 506-451-6130
Email: chief@nbapc.org

Native Council of
Prince Edward Island
6 F.J. McAuley Court
Charlottetown
Prince Edward Island
C1A 9M7

Tel: 902-892-5314
Fax: 902-368-7464
Email: chief@ncpei.com

April 8, 2021

Pieridae Energy (Canada) Limited
1718 Argyle Street
Halifax, Nova Scotia
B3J 3N6

Comments on Environmental Assessment Registration of the Realignment of Marine Drive Highway 316

The Maritime Aboriginal Peoples Council (MAPC) was established in the late 70s as the intergovernmental leader's forum of the Native Council of Nova Scotia (NCNS), New Brunswick Aboriginal Peoples Council (NBAPC), and Native Council of Prince Edward Island (NCPEI) to share regionally-based information, as well as to conduct research on regional matters. The first research activity produced the seminal work "Our Land: The Maritimes" which traced the history of relationships between the Mi'kmaq and the Crown and established the evidence for the assertion that the three Maritime provinces are no more than tenant governments on lands that were inappropriately expropriated. Each of the three Council's elected Chief and President is automatically confirmed as one of three Board of Directors (Board Members) for MAPC for a term determined by the election process of Chief and President for each Council. The Board provides direction to the MAPC Director(s) on initiatives that it would want to pursue or produce reports to be distributed to the community at large, as well as to decision-makers at the federal and provincial levels of government. MAPC, in keeping its independence from government interference, is not funded by any government department or agency, rather it accrues its funding from a variety of sources which does not compromise the positions taken by the three Native Councils.

MAPC also involves key persons with expertise in certain areas with the United Nations and other international bodies responsible for biodiversity, oceans management, pollution, climate change, and other environmentally-related subject matters, such as the Convention on

Biological Diversity. MAPC administers and maintains the DFO-funded Aboriginal Aquatic Resources and Oceans Management (AAROM) body, the Maritime Aboriginal Aquatic Resources Secretariate (MAARS). MAPC, in the mid-2000s established an environmental charity, incorporated as IKANAWTIKET, to promote an ecocentric world view, particularly through the preservation of the natural environment by educating and informing the public about environmental issues and biodiversity in the Maritime Provinces, and Aboriginal culture, worldviews, and knowledge in relation to the environment.

On March 10th, 2021, one of the MAPC partners, the NCNS, was apprised of the intent by Pieridae Energy to realign Highway 316, Goldboro, Nova Scotia. On March 22nd, 2021, we responded by email to Pieridae Energy's Environmental Manager, This email briefly provided a general overview about the role of MAPC, and the advocacy role of the NCNS on behalf of s. 91(24) Status and Non-Status Indians/Mi'kmaq/Aboriginal/Indigenous peoples continuing on their traditional ancestral homeland in what is now known as Goldboro, the site of the proposed highway realignment.

On March 22nd, 2021, we were advised that Pieridae Energy has aligned its engagement practices with the "principles outlined by The Government of Nova Scotia and the practical guidance for proponents regarding supporting crown consultation through engagement." This engagement in fact, did not occur with the representatives with the NCNS. We write this letter to draw your attention to the failure of Pieridae Energy to engage with the NCNS and Pieridae Energy failure to share information directly with us regarding the project.

Advancing, Promoting and Advocating the Reality of the
Maritime Off-Reserve Community of Aboriginal Peoples

Director of Intergovernmental Affairs   Habitat Impact Assessment Manger

Cc: Chief and President, NCNS
Commissioner, Netukulimkewe'l Commission
Iain Rankin, Premier of Nova Scotia
Keith Irving, Minister of Environment, Nova Scotia

Native Council of Nova Scotia

The Self-Governing Authority for Mi'kmaq/Aboriginal Peoples residing Off-Reserve in Nova Scotia throughout traditional Mi'kmaq Territory

"Going Forward to a Better Future"

P.O. Box 1320
Truro, Nova Scotia
B2N 5N2

Tel: 902-895-1523
Fax: 1-902-895-0024
Toll Free: 1-800-565-4372
chieflaugustine@ncns.ca
www.ncns.ca

Aboriginal/Treaty Rights Negotiations Facilitating Directorate

NCNS Citizenship Information Office

Education & Student Services

Rural & Native Housing Group

Aboriginal Peoples Training & Employment Commission (APTEC)

Netukulimkewe'l Commission

Wenjikwom Housing Commission

Social Assistance Recipient Support for Employment & Training (SARSET)

Micmac Language Program

Native Social Counselling Agency

Child Help Initiative Program (CHIP)

E'pit Nuji Ilmuet Program (Prenatal)

Reaching Home Indigenous Program

Parenting Journey Program

Youth Outreach Program

Mi'Kma'ki Environments Resource Developments Secretariat (MERDS)

Aboriginal Connections in Trades & Apprenticeship (ACITA)

April 8, 2021

Pieridae Energy (Canada) Limited
1718 Argyle Street
Halifax, Nova Scotia
B3J 3N6

Comments on Environmental Assessment Registration of the Realignment of Marine Drive Highway 316

The Native Council of Nova Scotia was organized in 1974 and represents the interests, needs, and rights of Off-Reserve Status and Non-Status Section 91(24) Indians/Mi'kmaq/Aboriginal Peoples continuing on our Traditional Ancestral Homelands throughout Nova Scotia as Heirs to Treaty Rights, Beneficiaries of Aboriginal Rights, with Interests to Other Rights, including Land Claim Rights.

The Native Council of Nova Scotia Community of Off-Reserve Status and Non-Status Indians/Mi'kmaq/Aboriginal Peoples supports projects, works, activities and undertakings which do not significantly alter, destroy, impact, or affect the sustainable natural life ecosystems or natural eco-scapes formed as hills, mountains, wetlands, meadows, woodlands, shores, beaches, coasts, brooks, streams, rivers, lakes, bays, inland waters, and the near-shore, mid-shore and off-shore waters, to list a few, with their multitude of in-situ biodiversity.

Our NCNS Community has continued to access and use natural life within those ecosystems and eco-scapes where the equitable sharing of benefits arising from projects and undertakings serve a beneficial purpose towards progress in general and demonstrate the sustainable use of the natural wealth of Mother Earth, with respect for the Constitutional Treaty Rights, Aboriginal Rights, and Other Rights of the Native Council of Nova Scotia Community continuing throughout our Traditional Ancestral Homeland in the part of the Mi'kma'ki now known as Nova Scotia

On reviewing the government of Nova Scotia Environmental Assessment webpage, we learned about Pieridae Energy's intent to file for the Realignment of Highway 316, through Nova Scotia Environmental Assessment process. We had advised our Habitat Impact Assessment Manager to introduce ourselves to the proponent and to seek a virtual meeting with a representative of Pieridae Energy to discuss the project description for the Realignment of Highway 316.

On March 22nd, 2021, , Environmental Manager for Pieridae Energy emailed us advising that would be contacting shortly. On March 23rd, 2021, advised us that Pieridae Energy has been engaging on all aspects of the Goldboro Project, including the highway realignment, with local indigenous, first nations, and aboriginal communities through the Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO), a fisheries advisory comity, and a local liaison committee. also informed us that on March 21, 2014, the minister of the environment approved the Goldboro LNG facility of "section 40 of the Environment Act (Nova Scotia) and subsection 26(1) of the Environmental Assessment Regulations." Which approval was subject of approximately 40 conditions which are described in detail in the government of Nova Scotia website.

tersely advised us that,

> in case you ( ) have any additional questions for them (KMKNO), please feel free to reach out. With regret, I will not be able to meet between March 30-31 with yourself, and the Chief and President of the Native Council of Nova Scotia , due to scheduling conflicts. If you could please submit any questions or concerns for the realignment of Highway 316 in a Class I EA submission, we would be happy to provide a response in the meantime.

Trite, but worthy of note, the process of consultation requires both parties to honor the intent of consultation which would lead to a form of understanding, or reconciling the views and issues posed by the parties, while upholding the honor of the Crown. The proponent does not escape the legal requirement to make an effort when they are apprised of the fact that there are Aboriginal People's issues, concerns, views, or comments which must be considered before a decision can be made.

I will not go into the issue regarding the KMKNO, or whom they speak for, rather than to inform you that the KMKNO does not represent or speak for the interests and rights holders who live on their Traditional Ancestral Homeland off an Indian Act Reserve. The situation is most disturbing when our efforts to Engauge in a virtual meeting are brusquely denied, and we are cavalierly told to seek out information regarding the project from a 3rd party.

Aside from a host of pertinent questions regarding the proposed realignment arching over the Goldboro LNG project, is it a fact that "the future of Pieridae Energy's Goldboro LNG project will become much clearer June 30?" That on that date, Pieridae Energy "will make a final decision on the project that would bring natural gas from its western Canadian operations to Goldboro, Guysborough County, on the North American pipeline network, the final leg of which will be the Maritimes and Northeast Pipeline?" And that "the natural gas would then be stored and shipped to Europe?"

Is it also true that the company is "hoping to get assistance from Canadas Federal government" to get "over the finish line," through a "loan guarantee, grant or repayable loan?"

Other than the 56-month projected construction period, what is Goldboro's road map to making the project net zero in terms of carbon emission? We understand this project includes a carbon capturing and sequestering project in Alberta. How does this benefit Nova Scotians? With just a sampling of those statements by Pieridae Energy officials, with a series of hopes and projected future timelines, how does the Realignment of Highway 316 fit into the road map or any meaningful aspect of the project approval.

And too those questions, and in no way is this an exhaustive list, we would like to voice a series of questions and statements regarding the Environmental Assessment registration document:

In section 2.4, page 7, it is stated that "approximately 7.3 hectares (ha) of wetland are located within the area inventoried along the proposed ROW. A portion of these wetlands will be filled in during construction. Drainage between contiguous wetlands separated by the road will be maintained by cross-culverts."

Q. Regarding the watercourse and wetland crossing/drainage, where will these "cross-culverts" be located, as the are not shown on any given map?

Q. Significant portions of wetlands will be divided close to Crane Lake, will this portion be looked at specifically for "cross-culverts?"

Q. What is the effectiveness of these "cross-culverts" to maintain drainage between effected wetlands? What is the desired effect meant to be achieved through their implementation?

In section 6.7.2, pages 101-102, it is noted that "several alien plant species have already been detected in the footprint of the Project, which may be the result of previous disturbance from forest harvesting or other human use."

Q. Are there any intention to remove these "alien plant species" from the project footprint prior to construction?

S. With the confirmed presence of multiple invasive alien species, it is crucial to implement mitigation measures which will reduce the transportation vectors for said invasive alien species.

Similarly, in section 6.7.2, pages 101, it is acknowledged that "Seeds, roots or 'rootable' fragments of invasive species may stick to construction equipment, transportation vehicles or shoes of workers."

S. While it is acknowledged by the proponent that there is a potential for invasive species to use worker's shoes as a transportation vector, there is no mention of any mitigation methods that target worker shoes specifically. We highly recommend the installation of boot brushes at the project site, as advocated by PlayCleanGo, to reduce the likelihood of the further displacement and introduction of invasive species.

Throughout the environmental registration document, notably in section 5.2.3, it is stated that Blue Felt Lichen (Pectenia plumbea) was observed within the project footprint.

Q. has there been any development regarding the management plan for the Blue Felt Lichen found in the area?

In section 5.2.6, page 61, it was noted that Atlantic Salmon was identified in the LSA, though no suitable habitat may have been located.

Q. Has any eDNA or comprehensive survey been done to identify if these streams are used as migration paths?

Throughout the document, the proponent mentions that the project will be following the NSTIR Generic Environmental Projection Plan (EPP).

Q. Who is the person appointed by the contractor who will be responsible for environmental protection, as required by the Generic EPP?

Q. As per section 2.1.1 of the EPP, what is the status of receiving an NSEL Wetland Alteration Approval? Has there been a "comprehensive environmental screenings and review by the Nova Scotia Environmental Department, the Nova Scotia Department of Lands and Forestry, and Department of Fisheries and Oceans."

Will the proponent follow the *Proponents' Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia* (Province of Nova Scotia 2012) and engage with the NCNS regarding this project?

Going Forward To
A Better Future

Director of Intergovernmental Affairs Habitat Impact Assessment Manger

Cc: Chief and President, NCNS
Commissioner, Netukulimkewe'l Commission
Iain Rankin, Premier of Nova Scotia
Keith Irving, Minister of Environment, Nova Scotia

Submission on Environmental Assessment of Realignment of Marine Drive (Highway 316)

Submitted to:
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Submitted by:
Ecology Action Centre
The New Brunswick Anti-Shale Gas Alliance
Sierra Club Canada Foundation

Prepared by:

April 9, 2021

1.0 Overview

This is joint submission by the New Brunswick Anti-Shale Gas Alliance, the Sierra Club Canada Foundation and the Ecology Action Centre.

The New Brunswick Anti-Shale Gas Alliance (NBASGA), is an umbrella organization representing both Anglophone and francophone groups, of all types, across the province. Its mandates are to keep unconventional fossil fuels out of the province, and to promote the move to a clean energy economy in light of the climate emergency. In the past, the group has filed suit against the province leading to a moratorium on fracking, and recently it has successfully intervened in two provincial appeals courts cases supporting federal carbon pricing, and intervened on the same issue at the Supreme Court. NBASGA and its member groups work closely with First Nations on the shale gas and climate issues.

Sierra Club Canada Foundation empowers people to be leaders in protecting, restoring and enjoying healthy and safe ecosystems. We are a grassroots organization with a “think globally, act locally” philosophy. Members are encouraged to actively contribute to environmental causes that engage or inspire them, in a capacity that best suits their capabilities. We have four regional Chapters and a youth-led Chapter, Sierra Youth. We engage in projects designed to connect children to nature, protect wildlife and wild spaces, and to offer solutions to climate change.

Sierra Club Canada Foundation has worked for decades to protect the environment in Canada and has participated in many kinds of environmental assessments across the country and in Atlantic Canada. We oppose the Goldboro LNG project, of which this road realignment is a necessary part, in its entirety, for reasons described in this submission, as well as many others.

The proposed Goldboro LNG project is of great concern to our organization and its members because of its serious and adverse impacts on GHG emissions, wildlife (including marine mammals and seabirds), coastal habitats, and its societal and justice implications, particularly on Indigenous women, of constructing large "man camps". Government subsidies requested by the proponent for this project run contrary to Canada's commitment to end subsidies to the fossil fuel industry. If implemented, this project alone will prevent Nova Scotia from achieving the emissions reductions that are vital to provincial, national and world-wide efforts to halt human-made climate change.

The Ecology Action Centre is a Nova Scotia-based environmental organization established in 1971 with over 5000 members across the province. The Centre aims to create a society in Nova Scotia that respects and protects nature and provides environmentally and economically sustainable and just solutions for its citizens. The Centre works with its partners to provide current environmental information, promote researched solutions, and act as a watch-dog for the environment.

The Centre has participated in numerous provincial and federal environmental assessments including many reviews of onshore and offshore fossil fuel projects. The EAC was an active intervenor and participant in the 1997 review of the Sable Offshore Energy Project, the 2006 review of the Keltic Petrochemicals Inc. LNG and Petrochemical Facility proposed for Goldboro, NS and the 2014 review of the Goldboro Liquefied Natural Gas Project. In reviewing these projects the Centre focused on the impacts of these projects on the climate, plants and wildlife, aquatic systems, marine and fresh, and on local communities and Indigenous Peoples' rights.

As well, during reviews of these various proposed petrochemical projects, whether for import or export, the Ecology Action Centre, Sierra Club Canada Foundation and other groups have consistently and increasingly raised concerns over the impact of a project like this on the climate targets of the Province of Nova Scotia. As noted in this submission the Nova Scotia Government has committed in legislation to reducing its emissions to 11.5 Mt by 2030. Currents emissions are estimated to be approximately 18Mt. If the same Nova Scotian Government approves this project, the province's emissions will increase to nearly 21Mt. Thus Nova Scotia would have to cut its emissions in half in under 10 years to meet its target. Few if any jurisdictions in the world have yet to make such reductions.

Nova Scotia's commitment to reduce its GHG emissions is praiseworthy. However, it is only worthy of praise if the Government intends to meet this commitment. If the Government is serious about keeping its commitments then it needs to start taking steps right now to reduce its emissions. Approving this project would do the opposite.

In Section 3 we detail our concerns that the proponent has inadequately assessed the impacts of gold mining on the project. The proponent makes no reference to some key documents and information on abandoned gold mines in the area. In addition, it appears that the proponent has not conducted some essential fieldwork to ensure that the integrity of the road will not be compromised by old mining shafts and that construction will not disturb toxic mine tailings putting the environment and water quality at risk. Another possibility is that the proponent has done the work but has omitted to include this information in the EA document. Either way, a focus report is required before the Minister is in a position to determine whether approval is appropriate.

In the conclusion on p. iii of the EA Registration Document the proponent states that the Realignment 'will facilitate the implementation of the Goldboro LNG development proposal, providing significant short- and long-term economic stimulus and job opportunities to Guysborough County.' Short-term and limited economic benefits must not outweigh climate imperatives. If the alleged benefits of this highway realignment project include benefits relating to the overall project, then the adverse effects of that same overall project must likewise be considered.

Our groups have consistently reminded the Province of Nova Scotia and the Government of Canada and all agencies involved in the regulation of the proposed Goldboro LNG project, and related pipelines, that the approval of this project severely jeopardizes the credibility of Nova Scotia's and Canada's climate goals and makes it impossible to meet such goals. This will impose further climate disaster on our world and on future generations. Nova Scotia and Canada must not approve this project.

2.0 Climate Impacts

Nova Scotia has committed to follow a pathway to net-zero by 2050, which includes interlinking economics and environmental policies. And as international parties are aligning with a 1.5-degree world, it is important for our province to play our part as well. Short-term economic gains must not be prioritized over long-term environmental impacts. New fossil fuel-based projects will be stranded assets in a decade or two, as governments accelerate efforts to reduce emissions and reach net zero. In addition to the significant financial risk, these projects would leave lasting impacts on human and environmental health.

The Environmental Assessment conducted for the Pieridae Goldboro project in 2013 estimated that the overall project would increase Nova Scotia's emissions of CO2 by 15% and increase Canada's emissions by 0.5%, based on 2010 emission estimates.[1] The Ecology Action Centre did its own calculations and estimated that the project would increase Nova Scotia's emissions by 18% based on 2010 emission estimates.[2] This is considered a significant adverse effect which cannot be mitigated effectively, and will cancel emission reductions achieved thus far by the Province of Nova Scotia. Moreover, fugitive methane emissions and their significant additional climate impacts have not been accounted for, and need to be studied comprehensively not only over the life cycle of the highway realignment project, but through the entire the life cycle of the Goldboro LNG facility, related infrastructure, and operations.

Nova Scotia's emissions in 2010 were around 20 Mt of CO2eq. In 2015 emissions dropped to 17 Mt[3] but then, because of increases from electricity, buildings and transport, increased to 18 Mt in 2018.[4] If this project is approved our emissions would increase to approximately 20.5 Mt. To put matters into context, the province must achieve a 2030 emissions level of 11.5 Mt; an

[1] https://novascotia.ca/nse/ea/goldboro-lng/10-Environmental-Effects-Assessment.pdf
[2] https://ecologyaction.ca/press-release/goldboro-lng-was-approved-prematurely
[3] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-nova-scotia.html
[4] http://publications.gc.ca/collections/collection_2020/eccc/En81-4-2018-1-eng.pdf - Page 29

almost 50% reduction in current emissions in less than 10 years. Proceeding with the LNG project without adequate information on the latest (2021) emission inventory estimates and trends will further impact key policy decisions to align with 53% below 2005 by 2030 target of 11.5 Mt outlined in the province's Sustainable Development Goals Act.[5]

The provincial Environmental Assessment conducted in 2014 left virtually all analysis of climate impacts and associated adverse environmental effects up to the proponent within the requirement to produce a Greenhouse Gas (GHG) Management Plan.[6] Neither the public, nor the Minister, has seen or approved this plan, creating an unacceptable and grossly inadequate response to the climate crisis. Without a concrete and realistic plan, or any determination as to how the plan will enable full compliance with GHG emission caps, this project simply cannot be permitted to move forward.

Understandably, the larger Goldboro LNG project is not directly within the scope of the current Environmental Assessment regarding highway realignment. However, approval of this related highway project is essential to enable the larger project as currently designed. Each successive component furthers the pathway for the larger project, which combined with incomplete information on the latest trends of GHG emissions would effectively set emission achievements in Nova Scotia back by half a decade and deepen the climate crisis.

3.0 Abandoned Gold Mines and Risk to Project, Community and Environment

As noted by the Proponent the Goldboro area is the site of extensive gold mining activity. See Figure 5.1-4. Disruption of these abandoned gold mines, because of old mine openings and toxic mine wastes, poses significant risks to the project, project personnel, adjacent residences and the environment, and is likely to create significant adverse impacts for which no effective mitigation is proposed.

The proponent has provided a map of gold mining activity, collected and analyzed water and soil samples, and stated that they will follow Nova Scotia guidelines. However, they appear not to have consulted the most authoritative sources on abandoned gold mines in Nova Scotia, nor do they appear to have assessed the impact of abandoned mine openings and shafts on road construction or vice versa.

3.1 Inadequate Consideration of Literature and Expertise on Gold Mining in Nova Scotia
University and government experts have compiled an extensive body of work identifying abandoned gold mine shafts and historical gold mining wastes in Nova Scotia, as well as researching the effects of both.

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[5] https://nslegislature.ca/sites/default/files/legc/PDFs/annual%20statutes/2019%20Fall/c026.pdf
[6] Environmental Assessment Approval Conditions, March 21, 2014, Goldboro LNG, section 2.2: https://www.novascotia.ca/nse/ea/goldboro-lng/conditions.pdf

As a result of this research, we have the benefit of knowing the care that needs to be taken when contemplating the disturbance of this historical industrial legacy, and the risk of harm that could ensue if proper care is not taken.[7] [8]

This knowledge base has been utilized since 2006 for the purpose of examining potential industrial development in Goldboro; a major centre of this historical gold mining. The expertise of federal and provincial government civil servants played a crucial role in the environmental assessment of the proposed Keltic Petrochemical complex, and then for Goldboro LNG, proposed for the same industrial site.

Nowhere in the current documents for the Road Re-Alignment Environmental Assessment Registration is there any evidence that the same government experts were consulted about how road construction would be impacted by these previously well identified concerns. This lack of consultation is confirmed by the fact that none of our references for this submission is to be found in the five full pages of references for the Registration Document.

In both the documents and the associated review processes of the earlier Keltic Petrochemical (2007) and Goldboro LNG (2014) Environmental Assessments, safety and contamination transmission risks posed by heavy construction through areas with abandoned gold mining shafts were noted at many points in the processes. Equal attention was paid to assessing the risks of disturbing prolific and dispersed deposits of mining wastes, both known and unknown. During the course of the Keltic Petrochemical reviews, work was begun identifying the locations and nature of gold mine tailings with their typically high concentrations of arsenic and mercury. Researchers noted when they discovered tailing deposits for which there was no previous record.

It is essential that a proponent contemplating the building of a Nova Scotia Department of Transportation and Infrastructure Renewal approved road through an area of historical gold mining wastes and abandoned shafts should base their assessments on the province's digital database, *Nova Scotia Mine Tailings Data Base.*[9] The staff who manage the database are mandated to collect all available information, and to initiate their own investigations of previously identified or not fully characterized locations.

If the proponent has not demonstrated in detail how they have used the database to scope out their own investigation of potential hazards, the Minister can have no assurance that the

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[7] See especially Parsons, who was consulted extensively for the Keltic Petrochemicals Provincial Environmental Assessment.

[8] *Appendix A contains excerpts, including a detailed summary and timeline of all Nova Scotia research to date; from* Parsons, M. B., LeBlanc, K. W. G., Hall, G. E. M., Sangster, A. L., Vaive, J. E. and Pelchat, P. 2012: Environmental geochemistry of tailings, sediments and surface waters collected from 14 historical gold mining districts in Nova Scotia; Geological Survey of Canada, Open File 7150, 2012; 326 pages

[9] Henrick and Poole, 2020. *Nova Scotia Mine Tailings Data Base*

impacts of the project approval have been properly and comprehensively assessed, and is unable to approve the project. And the public has a right and a need to see this information to enable meaningful, informed comment on the proposal.

3.2 Inadequate Consideration of Safety and Contamination Risks Posed by Mine Shafts and Mine Wastes

The Environmental Assessment Registration materials contain many instances where information is omitted, and is not fully assessed.

There are highly elevated arsenic levels in sediment shown for SED 5 and SED 7 (right of way locations shown on Figure 5.1-8), especially SED 7 near Sable Road. These readings suggest the possibility of historical mine workings in the immediate vicinity. As well consideration of whether there are mine tailings in this area of the ROW, the nearby soil samples, SS 12 and SS 18, did not show significant levels of arsenic or mercury. [Environmental Assessment of Realignment of Marine Drive Registration, Appendix C][10] But since there is no evidence that experts in the field were consulted, it is impossible to assess the adequacy and comprehensiveness of the soil sampling and whether any reliable conclusions can be drawn from the data that was gathered.

For a comparison of a minimum baseline of assessment required in these conditions, we refer to the consulting field work of Dr. Mike Parsons, Natural Resources Canada, and others for the Keltic Petrochemical Environmental Assessment. They identify and list areas of mine waste tailings, with a table of tailings sample results for arsenic and mercury contamination.[11] Four of the tailings deposit contamination sites they refer to are within 750 metres of the SED 5 and SED 7 road right of way sampling locations we referenced above. We further note that this 2006 work was itself seen as preliminary, and further work was recommended in the Keltic Petrochemicals Environmental Assessment Board Report. [Report of the Nova Scotia Environmental Assessment Board on Keltic Petrochemicals p. 135-136][12]

While the proponent does not assess the risks in road construction over abandoned mine shafts, nor and does not address contamination risks posed by construction through historical mine waste, it does include Figure 5.1-4 *Abandoned Mine Openings*. However, the information from that figure is not analyzed or incorporated into any assessment of the problems posed by these historical features and hazards.

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[10]Keltic Petrochemical Provincial Environmental Assessment, Appendix C
https://www.novascotia.ca/nse/ea/Realignment-of-Marine-Drive-Project/AppendicesVol1.pdf

[11] Keltic Petrochemical Provincial Environmental Assessment, Section 8
https://novascotia.ca/nse/ea/kelticpetro/eareport/KelticPetro_Section08.pdf, p 143-145

[12]Keltic Petrochemical Provincial Environmental Assessment, Section 8, p 135-135
https://novascotia.ca/nse/ea/kelticpetro/eareport/KelticPetro_Section08.pdf

The only apparent textual reference to this important map is the isolated statement that "Previous site investigations between 2005 and 2013 have revealed multiple "unmapped" abandoned mine openings (AMOs)". [p. 27][13]

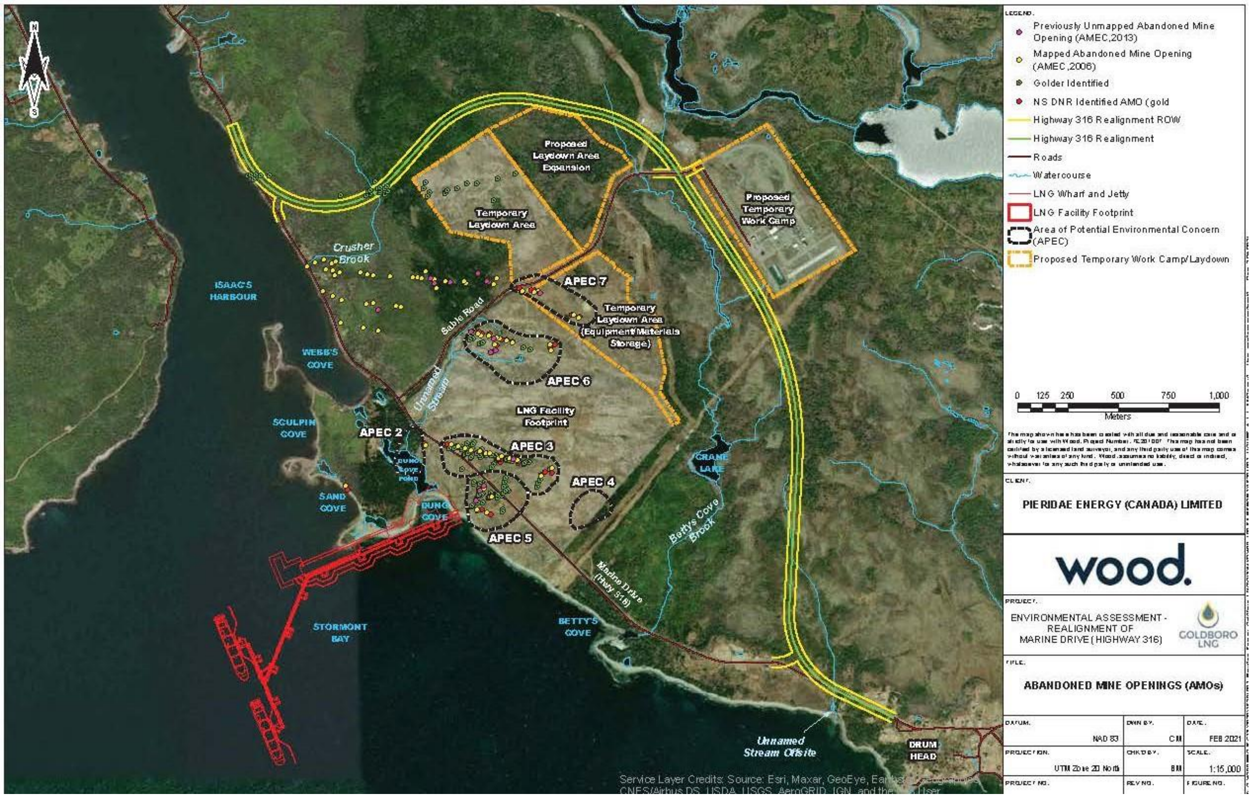
The map itself appears to have been developed to meet, in part, the 2014 Goldboro LNG Environmental Assessment Approval Condition 2.13, requiring: "*A survey to identify and delineate tailings deposits and mine openings within the Project area."*

That Ministerial condition of approval built on the Project Description in the Registration Document:

> *3.2.2* ***Geotechnical Investigations.*** *Due to the uncertainty of the locations of abandoned mines, a site investigation will be conducted prior to any earthworks to assess the pertinent geotechnical properties of the foundation soils and rocks.* [Including that] c*avities (e.g., mine workings) will be investigated using methods such as ground penetrating radar and the more sensitive micro-gravity technique, combined with focused site specific drilling.* [Goldboro LNG Environmental Assessment Report 3- 18][14]

The proponent in the current environmental assessment provided a map of Abandoned Mine Openings (Figure 5.1-4). This map includes AMOs identified on the two earlier plant site environmental assessments, with the addition of "Golder Identified" locations. We conclude this to be Golder Associates, and we further conclude that the proponent secured the services of this company to perform geotechnical analysis on both the LNG plant site (as per Approval conditions there), and on the road right of way to map abandoned mine shafts that are slated to have heavy equipment operating over them with the obvious safety hazards that poses.

[13] Marine Drive Realignment Environmental Assessment Registration Document, page 27 (page 47 of 172 of the PDF version).
[14] Goldboro LNG Environmental Assessment Report, Project Description, p. 3-18, section 3.2.2



Map 1: Abandoned Mine Openings (AMOs). From p. 61 of Environmental Assessment Registration Document.[15]

As the Golder analysis is not provided, the Minister and the public were not provided with crucial information that would permit an informed determination as to the environmental effects and risks associated with abandoned mine openings on site. The geotechnical analysis may have included ground penetrating radar. These would be a crucial part of assessing risk, but have not been made available such that a decision can be made in respect of this environmental assessment registration. If the work was performed and conclusions drawn, it must be included. The Minister must therefore require the proponent to provide all such information and relevant studies and assessments to enable a decision to be made on a full record. As well, once a complete set of such material has been submitted, a further public comment period is required to permit the public to comment fully on all aspects of this project. Without a complete set of information, the Minister cannot make a decision regarding whether to approve this project.

The clusters of "Golder Identified" locations on Figure 5.1-4 correspond with mine shaft locations shown on the map sheet, *Historical Gold Mining Isaac's Harbour Area*. The

[15] Marine Drive Realignment Environmental Assessment Registration Document, Figure 5.1-4 (page 61 of 172 of the PDF version).

proponent's Environmental Registration document does not include this map, and it is therefore attached as Appendix B.

We also include pictures of the extensive mine waste rock field where the road right of way crosses Crusher Brook, and which correspond with one of the "Golder Identified" clusters of AMOs. The breadth of this waste rock field extending from the wetland into reforested areas indicates abandoned mine shafts more extensive than what is shown on the NSDNR map sheet, or what Golder Associates has identified. The extent of mine shafts is often not fully represented on those departmental maps.

As was noted in the Keltic Petrochemical EA, close on the ground survey by researchers in this vicinity turned up "two to four shafts or trenches identified in the field for everyone shown in the database in the southwestern most parts of the site along Route 316."[16]

Below are pictures of the waste rock field where the road right of way crosses Crusher Brook showing the brook passing through the length of the field, and the field extending into wetlands and surrounding reforested area. The pictures were taken by , EAC volunteer and one of the authors of this report, on March 21, 2021.

[16] Keltic Petrochemical Provincial Environmental Assessment Section 8 p. 139

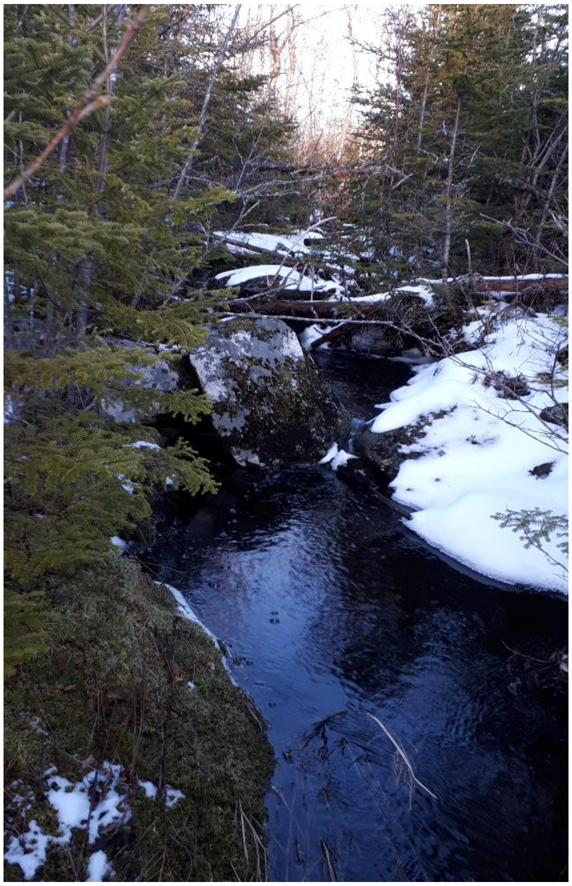


Figure 1: Mine waste rock field showing Crusher Brook flowing through it, within the road right of way.

Figure 2: Crusher Brook waste rock field extending into reforested area.


Figure 3: Crusher Brook waste rock field includes an extensive wetland.

At this Crusher Brook ROW crossing there are extensive underground abandoned mine shafts. The mine shafts are flooded and are connected with the watercourse and extensive wetland above. So as well as the already noted construction safety hazard of collapsing tunnels, there is the risk of contaminant transmission through the flooded mine shafts. A risk from both contaminants introduced during construction, and the construction mobilizing mine waste contaminants that presumably have not yet been mapped for this area. The proponent has not noted assessments of these risks or of searches for evidence of significant deposits of mine wastes.

Both previous environmental assessments for the plant site in 2006 and 2014 noted significant communication between monitoring wells; presumed to be a consequence of both the abandoned mine shafts and the faulted rock structures. Groundwater moves downslope to Isaac's Harbour.

The cluster on Figure 5.1-4 of Golder identified AMO locations in the road right of way, and under the existing Highway 316, corresponds with another set of mine shaft locations shown on the Appendix B map sheet, *Historical Gold Mining Isaac's Harbour Area.*[17]

[17] This map (*Historical Gold Mining Isaacs Harbour Area)* is also available on line at https://novascotia.ca/natr/meb/data/mg/ofm/pdf/ofm_2009-001_s61_dp.pdf

North of that cluster location, encompassing a road right of way length of about 200 metres, three footprints of historical mine buildings are shown on the same map sheet. Tailings deposits with high concentrations of arsenic and mercury are typically found in the immediate vicinity of these buildings.

As noted in the Keltic Petrochemical EA:

> *"Recent investigations by Parsons et al. (2005) just outside the proposed Keltic Site boundaries and at other sites in Nova Scotia have documented high concentrations of mercury (up to 350 mg/kg) and arsenic (up to 31% by weight) in mine wastes."* [Keltic Petrochemical Provincial Environmental Assessment p *8-143, with the finding of the tailings by field researchers described pp 8 143-145]*[18]

The north tail of the road right of way we refer to immediately above had the same historical gold mining use as the area just off of the Goldboro LNG / Keltic site identified by Parsons et al.

The proponent did not note the presence of the old mine structures. Their presence would indicate that soil samples should have been taken for these locations due to the high likelihood of contaminants associated with the workings. Water samples tested for drilled wells included one well in this section of the road right of way. The location is shown as #1 in Figure 5.1-9. The proponent reported as follows about these test results:

> *"Concentrations of aluminum, arsenic, iron, lead, and manganese exceeded the GCDWQ AO, OG, and/or Maximum Allowable Concentrations (MAC) at one or more locations."* [p.30][19]

Readings like that could indicate the presence of mine tailings. But the proponent did not present the data, and we do not know which of "one or more locations" had the elevated metals levels.

Given these gaps and lack of analysis, there may well be other locations in the road right of way that also need further investigation. Having no proponent references, we have no way of knowing what protocol, if any, the proponent used to scope out locations in the right of way that might require investigation for AMO and/or mine wastes. The field notes and logs for these investigations are not summarized or included, such that the sufficiency of the work can be verified and that the Minister can be confident that all information has been taken into account in formulating the conclusions contained in the Environmental Assessment Registration materials.

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[18] Keltic Petrochemical Provincial Environmental Assessment, Section 8 https://novascotia.ca/nse/ea/kelticpetro/eareport/KelticPetro_Section08.pdf, p 143-145

[19] Marine Drive Realignment Environmental Assessment Registration Document, page 30 (page 50 of 172 of the PDF version).

The proponent has not shown that there is a formal assessment of soil and rock structure stability in the road right of way. This would appear to be an essential safety issue, both during construction and during years of road use, given the known extensive lacing of mine shaft cavities, and the uncertainty of where they are located. These omissions increase the risks of heavy equipment and their operators suddenly dropping into collapsed depressions. Further, it could present a long-term risk to years of road traffic by building roadways in areas with insufficiently identified or characterised underground cavities.

Such risks must be fully addressed and assessed, and the assessment must be subjected to public scrutiny.

Finally, we see no protocol for identifying locations in the road right of way that might contain toxic gold mining tailing deposits. Nor do we see a protocol for when tailing deposits are found, how to contain them and prevent them from mobilizing into the environment; and/or determining if re-locating them is the best course of action.

Given the many unassessed risks and information gaps, the Minister is not in a position to make a decision based on the proponent's materials. Likewise, the public is prevented from making informed comments on what amounts to a partial environmental assessment. The missing and crucial information presents serious environmental risks and other hazards and makes it impossible to assess the adverse impacts of this project.

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APPENDIX - "A"

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7150

Environmental geochemistry of tailings, sediments and surface waters collected from 14 historical gold mining districts in Nova Scotia

M.B. Parsons, K.W.G. LeBlanc, G.E.M Hall,
A.L. Sangster, J.E. Vaive and P. Pelchat

2012

Natural Resources Canada   Ressources naturelles Canada

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GEOLOGICAL SURVEY OF CANADA
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Environmental geochemistry of tailings, sediments and surface waters collected from 14 historical gold mining districts in Nova Scotia

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ABSTRACT

From 1861 to the mid-1940s, stamp milling at orogenic lode gold mines in Nova Scotia generated more than 3,000,000 tonnes of tailings. Most of the mined gold was recovered using mercury (Hg) amalgamation, and an estimated 10–25% of the Hg used was lost to the tailings and to the atmosphere. Arsenic (As) also occurs naturally in the ore, and is present at high concentrations in the mine wastes. Tailings from these operations were generally slurried into local rivers, swamps, lakes and the ocean. Recent land-use changes (e.g. residential development, recreational activities, shellfish harvesting) in some historical mining districts are increasing the likelihood of human exposure to these tailings. This Open File Report presents the results of a multi-disciplinary investigation of the dispersion, speciation and fate of metal(loid)s in terrestrial and shallow marine environments surrounding 14 abandoned gold mines in Nova Scotia. From 2003 to 2006, samples of tailings, sediment, and water were collected at 14 former gold mines. Field studies reveal that most mine sites contain large volumes of unconfined tailings, and in several districts these have been transported significant distances (>2 km) offsite by streams and rivers. Chemical analyses of 482 tailings and sediment samples show high concentrations of As (10 mg/kg to 31 wt.%; median 2550 mg/kg) and Hg (<5 µg/kg to 350 mg/kg; median 1640 µg/kg). Arsenic is hosted in arsenopyrite and a variety of secondary phases including scorodite ($FeAsO_4 \cdot 2H_2O$), amorphous Fe arsenate, and As bound to Fe oxyhydroxides. Mercury is present in elemental form, amalgam (Au_xHg_x), and in secondary phases. Results from this study led to the formation of a Provincial-Federal Historic Gold Mines Advisory Committee in 2005, which has evaluated the ecological and human health risks associated with gold mines throughout Nova Scotia and developed recommendations for management of these tailings sites. This Open File Report provides the most comprehensive summary available of the history, distribution, and geochemistry of tailings at gold mines throughout Nova Scotia. The geographic coordinates provided for each district can be used to quickly explore the tailings deposits via most web-based mapping services. The results can be used to help minimize the environmental impacts associated with past, present, and future gold extraction and to inform land-use decisions.

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INTRODUCTION

Purpose of Study

From 2003–2006, Natural Resources Canada carried out a project entitled "*Metals in the Canadian Surface Environment: Sources, Fate, and Risks*" as part of the Metals in the Environment Program of the Earth Sciences Sector (ESS). The main objective of this project was to characterize the distribution, chemical form, and potential risks associated with metals released into the Canadian surface environment from natural sources and activities related to their exploitation. Multi-disciplinary studies defined areas that pose risks to both ecosystem and human health and led to a better understanding of processes that affect the distribution and fate of metals. This geoscience knowledge has contributed to the assessment and mitigation of risks, and has been used directly by various stakeholders to help develop environmental quality guidelines and risk-management strategies.

As part of this project, ESS staff carried out a multi-disciplinary, multi-partner investigation of the dispersion, transformation, and fate of metals and metalloids in freshwater and marine environments surrounding abandoned gold mines in Nova Scotia. From 1861 to the mid-1940s, gold was produced from 64 mining districts in the southern part of the province (Bates 1987). Most of the gold was recovered using mercury (Hg) amalgamation, and an estimated 10–25% of the Hg used was lost to the tailings and to the atmosphere (EPS 1978; Nriagu and Wong 1997). Arsenopyrite (FeAsS) occurs naturally in the ore and surrounding bedrock in these gold deposits, and was concentrated in the tailings during milling operations. Approximately 3,000,000 tonnes of tailings from these early mines were slurried directly into local rivers, swamps, lakes, and the ocean with little or no consideration of their environmental impact (Wong *et al.* 1999, 2002). Over the last several decades, expanding residential developments and recreational activities have increased the likelihood of human exposure to these mine wastes.

The primary objectives of this study were: (1) to determine the concentrations, distribution, and speciation of metal(loid)s in tailings, soils, till, rocks, sediment, and water near these mine sites; (2) to identify and characterize the chemical and physical processes that control the release of elements from the tailings; and (3) to assess the bioavailability and biological impacts of metal(loid)s, and potential routes for human exposure (Parsons *et al.* 2004). Project partners included ESS, the Nova Scotia Department of Natural Resources, Environment Canada, Fisheries and Oceans Canada, and four universities (Queen's University, University of Ottawa, Dalhousie University, and the Royal Military College). Results from this study have been used by the Province of Nova Scotia and several federal government departments to assess environmental and human health risks associated with the mine wastes and to support better informed land-management decisions for these abandoned mines.

Scope of Report

This report contains geochemical data for samples of mine tailings, stream and lake sediments, and surface waters collected by the authors from 2003–2007 during field studies at 14 historical gold mining districts throughout southern Nova Scotia (Fig. 1). The concentrations of As and Hg are presented in a series of maps and tables for each district (arranged in alphabetical order) and

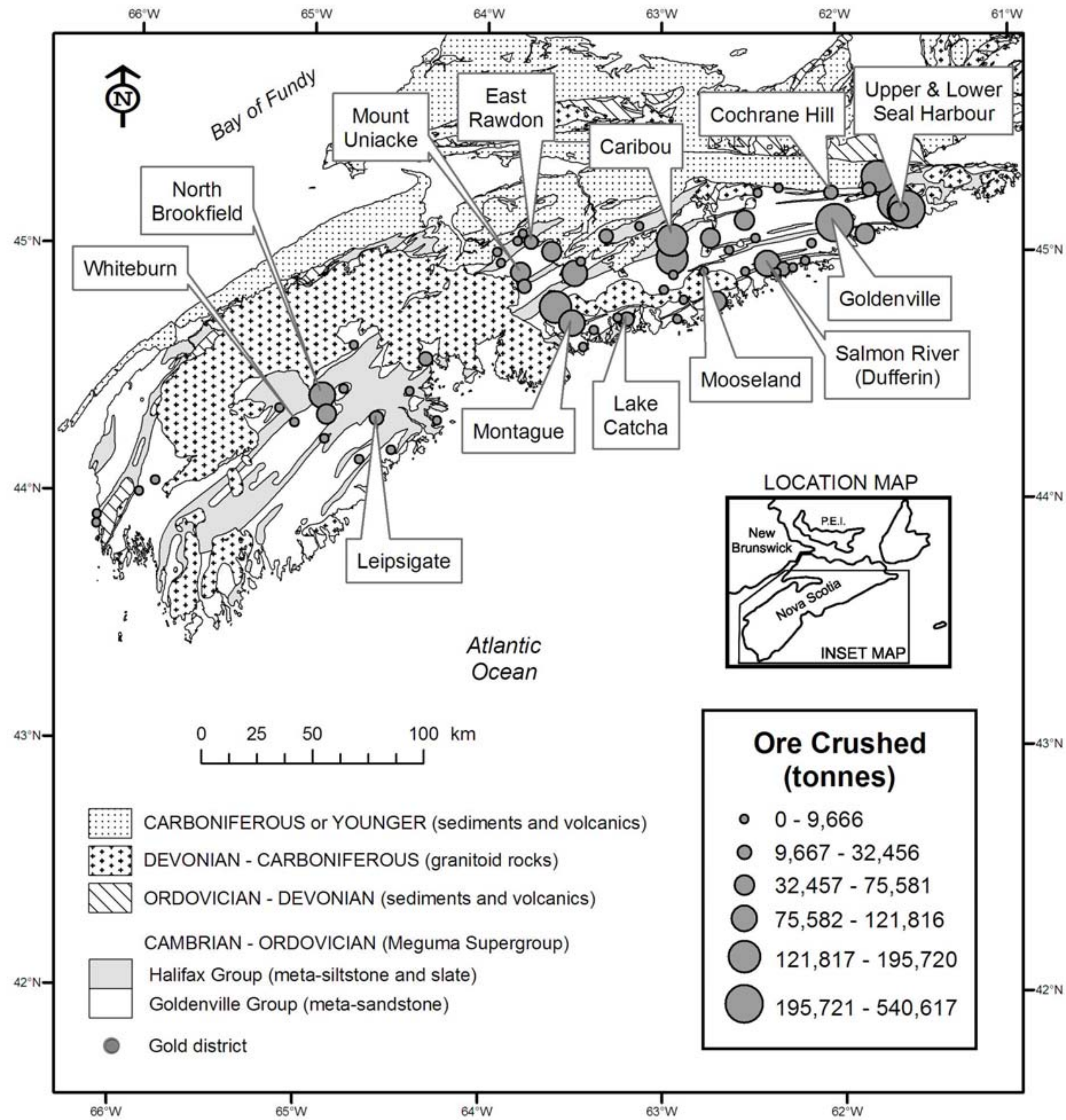

Fig. 1. Generalized geological map of southern Nova Scotia, showing the location of historical gold districts within rocks of the Meguma Supergroup, after Ryan and Smith (1998), with bedrock geology simplified from Keppie (2000). Graduated symbols show the total tonnes of ore crushed in each district from 1862 to 2011 (Nova Scotia Department of Mines (1961), and pers. comm. P.K. Smith (2011)), which is roughly equivalent to the total volume of tailings at each site.

the appendices contain brief descriptions of each sample site and tables of the full geochemical dataset for each sample. The Discussion section provides details on a background survey of sediments and waters carried out in the Seal Harbour Gold Districts in 2003 and 2004, data on the seasonal variability of As and Hg concentrations in waters, as well as sequential extraction data for these elements in tailings and sediments. Detailed investigations of the mineralogy and bioaccessibility of As in tailings from the Montague and Goldenville sites have been carried out in recent years (Laird *et al.* 2007; Walker *et al.* 2009; Meunier *et al.* 2010a, 2010b, 2011; Corriveau *et al.* 2011a, 2011b; DeSisto *et al.* 2011) but are not discussed in this Open File report.

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GOLD MINING IN NOVA SCOTIA

Location and Geological Setting

There are over 300 documented gold occurrences throughout mainland Nova Scotia from Yarmouth to Guysborough County. Most of these occurrences are located within 64 formal gold districts that were defined by the provincial government in the late 1800s and early 1900s for claiming purposes (Fig. 1; Malcolm 1929; Smith and Goodwin 2009). The gold deposits can be divided into three main types: (1) high-grade (~15 g/t Au), narrow gold-bearing quartz veins; (2) low-grade (0.5–4 g/t Au) slate-argillite hosted; and (3) low-grade (0.5–5.5 g/t Au) meta-sandstone hosted. Almost all historical production has come from high-grade quartz veins located within 200 m of the surface (Ryan and Smith, 1998). These veins are primarily hosted by meta-sandstones and slate of the Cambro-Ordovician Meguma Supergroup, which makes up most of the southern mainland of Nova Scotia (Fig. 1). The Meguma Supergroup consists of the meta-sandstone-dominated Goldenville Group and the overlying slate-dominated Halifax Group, with a combined vertical thickness of at least 11 km (White 2010).

Most of the auriferous quartz veins are located within the Goldenville Group, are structurally controlled, and generally occur in proximity to anticlinal fold hinges (Sangster 1990). The most abundant accessory minerals in the quartz veins include: chlorite, biotite, muscovite, and plagioclase. Carbonates (ferroan dolomite to ankerite and calcite) and sulfides are associated with all types of auriferous veins. Arsenopyrite is the predominant sulfide, with variable amounts of pyrrhotite, pyrite, chalcopyrite, galena and rare sphalerite and molybdenite (Kontak and Jackson 1999, Morelli *et al.* 2005). Although there has been much debate regarding the genesis of these auriferous veins (e.g. Graves and Zentilli 1982; Henderson and Henderson 1987; Haynes 1983, 1987; Smith and Kontak 1987; Kontak *et al.* 1990; Sangster 1990; Morelli *et al.* 2005), high-grade, plunging gold ore shoots within bedding-parallel veins generally provide the best economic potential for mining. Further details on the metallogeny of gold deposits in the Meguma Supergroup can be found in Malcolm (1929), Graves and Zentilli (1982), Sangster (1990), Ryan and Smith (1998), and Sangster and Smith (2007).

Mining, Milling, and Metallurgical History

Bedrock gold mineralization in Nova Scotia was first discovered in 1858 in quartz outcrops near Mooseland along the Tangier River (Heatherington 1868). Mining has since been carried out at 64 formal gold districts, resulting in a total production of approximately 1.2 million troy ounces of gold (Table 1). The majority of this production took place between 1862 and the mid-1940s, and there has been only limited mining of gold deposits since that time (Fig. 2; Bates 1987). A resurgence in the price of gold over the last decade [from US$260/oz. (2001) to >US$1900/oz. (2011)] has led to renewed interest in Nova Scotian deposits, and there are now numerous exploration programs underway, and several new gold mines in development.

Since the first Nova Scotian gold rush in the early 1860s, gold mining and milling processes have generated tailings deposits containing As, Hg, cyanide, and other potentially toxic elements (e.g. antimony (Sb), lead (Pb)). At all mines, stamp milling and Hg amalgamation were the primary methods used for gold extraction. This process involved crushing the ore to sand- or silt-sized material, then washing the pulp over Hg-coated copper plates (Fig. 3a). At most stamp mills in the province, amalgamation plates were located both inside and outside the stamp battery itself, and Hg was also added directly below the stamps in the mortar boxes. Some of the free gold would combine with the Hg to form an amalgam, which was periodically scraped off the plates and heated in a retort to recover the gold. As a general "rule of thumb," one ounce of Hg was used for each ounce of gold in the ore to obtain satisfactory recovery rates (Phillips 1867; Richards and Locke 1940). Hind (1872) recommended adding 1 1/5 oz. of Hg per ounce of gold in the ore, and also noted an abundance of Hg globules in the tailings at some early milling operations in Nova Scotia. The historical literature suggests that up to three times this amount of Hg was added to the mortar boxes at some mines (Moggridge Kuusisto 1978).

At most stamp mills, 10–25% of the Hg used in the process was lost to the environment through flouring (i.e. subdivision of the amalgam into fine particles), sickening of the Hg (i.e. formation of Hg-sulphides), evaporative losses during retorting, and careless handling of Hg by mill personnel (Henderson 1935; EPS 1978). Considering the total reported gold production of approximately 1.2 million ounces (Table 1), 3700 to 9100 kg of Hg may have been lost to the tailings and/or atmosphere as a direct result of gold milling in Nova Scotia (assuming that 1 oz. of Hg was used for each ounce of gold produced). This estimate of Hg loss is likely a minimum, as it is well-known that the gold production at most mines was routinely under-reported to avoid paying royalties to the Province. Records of Hg loss are relatively scarce in the historical literature; however, MacKenzie (1907) reports a loss of 0.07–0.10 oz. of Hg per ton of

Table 1. Production data for Meguma lode gold deposits, 1862-2011 (sorted by tonnes of ore crushed)

Rank	Mining District	Dates of Operation	Amal.[a]	Chlor.[a]	Cyn.[a]	Ore Crushed (tonnes)	Gold Produced (troy ounces)
1	Goldenville	1862-1941	●		●	540,617	210,153
2	Upper Seal Harbour	1893-1958	●		●	400,516	57,846
3	Lower Seal Harbour	1904-1949	●		●	394,905	34,295
4	Moose River	1888-1989 [b]	●			195,720	28,551
5	Caribou	1869-1968	●		●	168,411	91,359
6	Forest Hill	1895-1989 [b]	●			156,502	46,718
7	Waverley	1862-1940	●	●	●	152,496	73,105
8	Montague	1863-1940	●		●	121,816	68,139
9	Salmon River (Dufferin)	1881-2001	●		●	107,084	49,216
10	Oldham	1862-1946	●			107,080	85,295
11	Brookfield	1887-1936	●	●	●	96,756	43,041
12	Wine Harbour	1862-1939	●		●	75,581	42,727
13	Molega	1888-1950	●			63,926	34,876
14	Renfrew	1862-1958	●			60,389	51,986
15	Mount Uniacke	1867-1941	●			54,256	27,740
16	Fifteen Mile Stream	1878-1988 [b]	●			51,052	19,741
17	Isaacs Harbour	1862-1958	●			48,566	39,654
18	Tangier	1862-1999	●			45,584	26,135
19	Beaver Dam	1889-1989 [b]	●			44,345	2,908
20	Leipsigate	1884-1949	●		●	32,456	12,084
21	Lake Catcha	1882-1961	●			29,462	26,118
22	Country Harbour	1871-1951	●			26,301	9,960
23	Gold River	1889-1940	●			26,223	7,751
24	Cochrane Hill	1868-1990	●		●	24,166	2,081
25	Gays River	1870-1968	●			13,729	2,268
26	East Rawdon	1884-1932	●			13,415	13,494
27	Harrigan Cove	1874-1961	●			12,499	8,071
28	South Uniacke	1888-1948	●			11,070	20,762
29	Whiteburn	1887-1955	●			9,666	11,890
30	Mooseland	1861-1934	●			8,217	3,865
31	Blockhouse	1896-1938	●			5,634	3,588
32	Central Rawdon	1888-1939	●			4,840	6,745
33	West Gore	1905-1939	●			4,713	7,149

Table 1. Production data for Meguma lode gold deposits, 1862-2011 (sorted by tonnes of ore crushed) (cont'd)

Rank	Mining District	Dates of Operation	Amal.[a]	Chlor.[a]	Cyn.[a]	Ore Crushed (tonnes)	Gold Produced (troy ounces)
34	Killag	1889-1951	●			3,415	3,585
35	Kemptville	1885-1939	●			3,110	1,852
36	Ecum Secum	1893-1935	●			2,707	1,276
37	Moosehead	1899-1935	●			2,576	471
38	Fifteen Mile Brook	1902-1934	●			2,518	881
39	Mill Village	1901-1951	●			2,071	910
40	Lawrencetown	1862-1912	●			1,534	867
41	Cow Bay	1896-1937	●			1,326	1,243
42	Miller Lake	1902-1951	●			1,164	539
43	Pleasant River Barrens	1890-1913	●			464	112
44	Carleton	1879-1940	●			431	190
45	Ovens	1862-1958	●			320	544
46	Vogler's Cove	1905	●			181	43
47	Cranberry Head	1870-1900	●			175	119
48	Upper Stewiacke	1906-1907	●			164	44
49	Gold Lake	1890-1899	●			91	39
50	Little Liscomb Lake	1893-1935	●			86	52
51	Stanburn	1933-1936	●			78	13
52	Chezzetcook	1883-1944	●			73	11
53	McKay Settlement	1904-1910	●			68	14
54	Ardoise	1890-1904	●			58	6.8
55	Clam Harbour	1904	●			52	54
56	Lake Charlotte	1938-1964	●			42	78
57	Elmsdale	1890	●			9	1.4
58	Lochaber Mines	1883	●			4.5	2.3
59	Lower Caledonia	1934-1956	●			1.0	3.6
60	Quoddy	1906	●			0.9	1.0
61	West Caledonia	1925	●			0.9	1.7
62	Sheet Harbour	1898-1935	●			NA	431.1
63	Ship Harbour	1935-1937	●			NA	7.4
64	Chegoggin	*c.* 1833	●			NA	NA
					Totals:	3,130,714	1,182,702

[a] Amal. = Amalgamation; Chlor. = Chlorination; Cyn. = Cyanidation.

[b] Ore from 1980s mining was milled in Gays River, NS

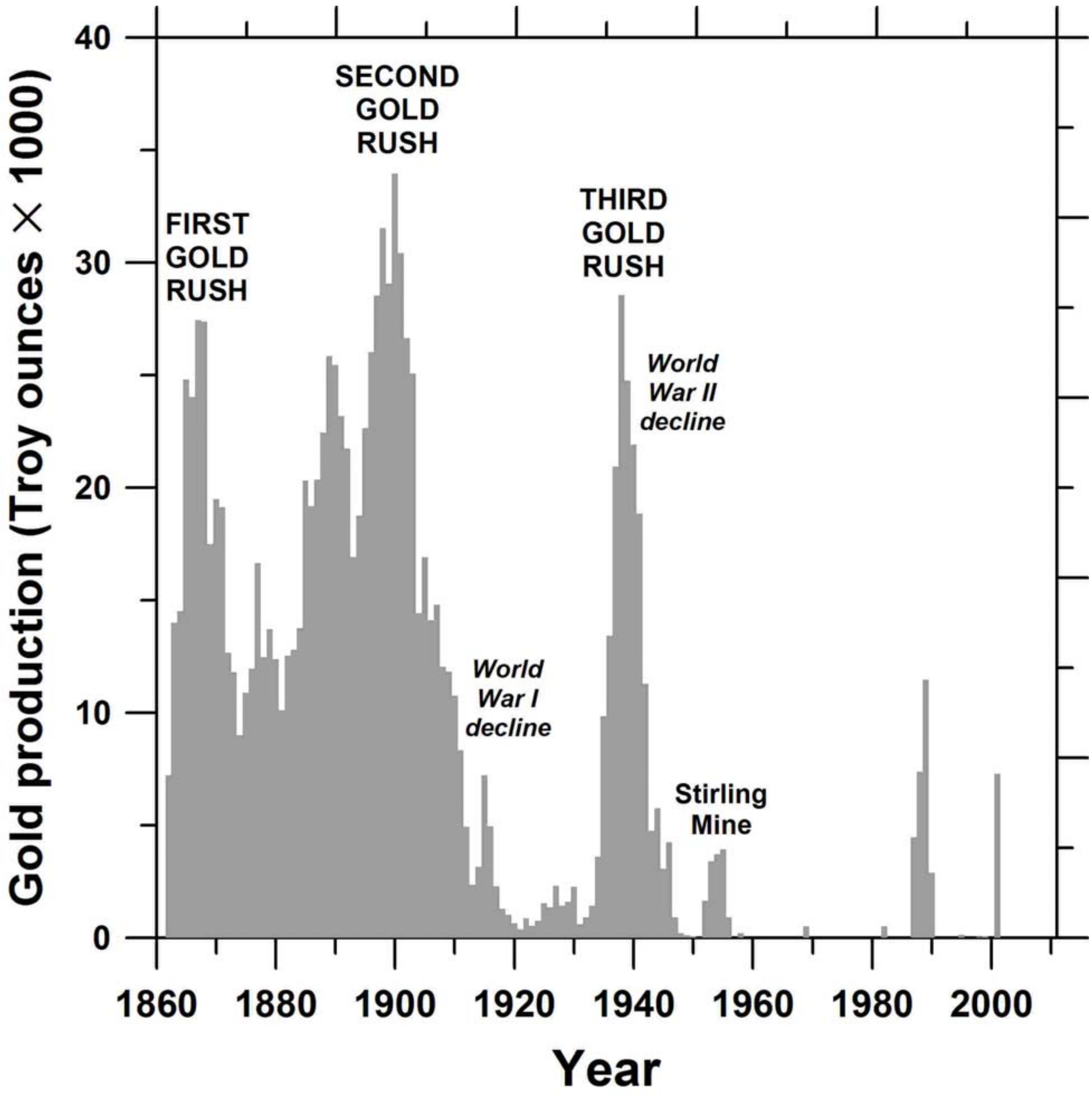
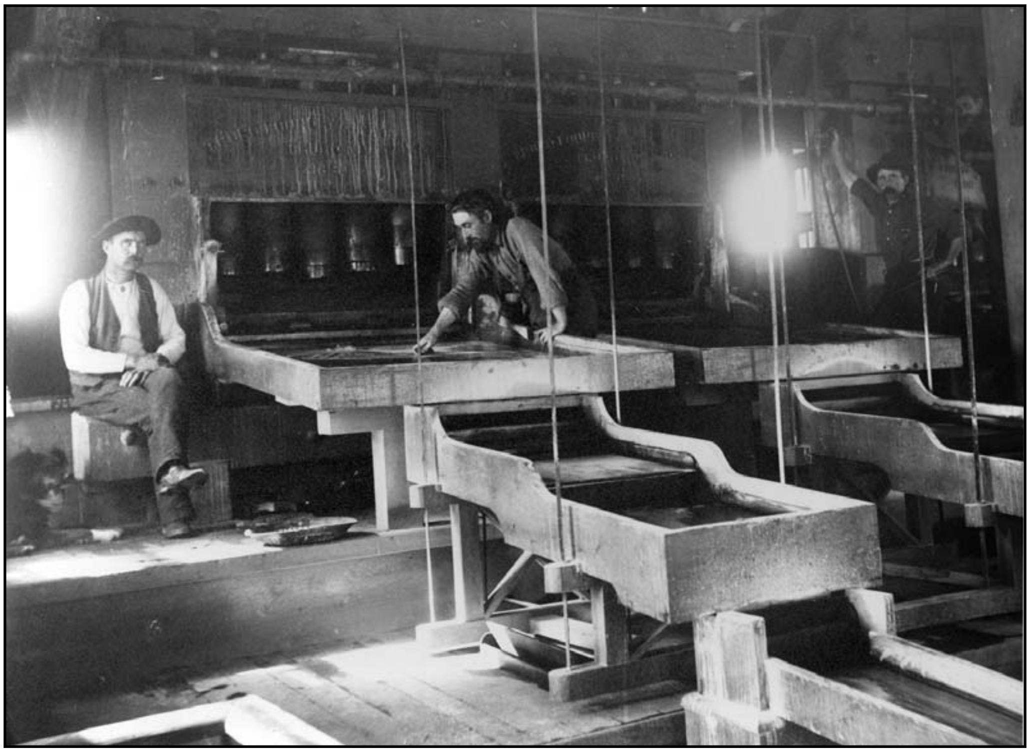


Fig. 2. Production of gold in Nova Scotia from 1862 to 2011 (after Bates (1987), Nova Scotia Department of Mines (1961), and pers. comm. P.K. Smith (2011)).

a)



b)

Fig. 3. (a) Recovery of Hg amalgam from copper-plated amalgam tables in the 20-stamp mill, Dufferin Gold Mine, Salmon River, Nova Scotia, 1893. The suspended shaking tables below the amalgam plates were used to recover sulfide concentrates (predominantly arsenopyrite). Tailings from each table were discharged from the mill via a wooden trough. **(b)** Unconfined tailings disposal into the Tangier River from 10-stamp mill at the Mooseland gold mining district in 1897. Photos taken by E.R. Faribault, Geological Survey of Canada. Reproduced with permission from the Natural Resources Canada Library, Ottawa**.**

ore crushed in the stamp mill at Lower Seal Harbour, and Henderson (1935) reports an average loss of 0.075–0.177 oz. of Hg per ton of ore crushed at Goldenville. From 1882–1949, a total of approximately 3,130,714 tonnes (3,220,529 short tons) of ore were milled at various gold districts in Nova Scotia (Table 1; Blakeman 1978); therefore, an average Hg loss of 0.1 oz. per ton of ore crushed represents a total loss of about 9100 kg of Hg.

Beginning in the 1890s, gravity separation, roasting, chlorination, and cyanidation were also added to the milling circuit at some mines to recover gold from sulphide minerals and/or amalgamation tailings (Table 1; Forbes, 1904; Malcolm 1912, 1929). Most of the gold in Nova Scotia is "free-milling" (i.e. individual particles can be liberated by crushing), but some also occurs in sulphide minerals such as arsenopyrite and cannot be recovered by amalgamation. A variety of gravity concentration devices (e.g. shaking tables, Frue vanners, Wilfley tables) were used to treat the tailings from the amalgamation plates and separate out the sulphide minerals on the basis of their relatively high specific gravities (Fig. 3a). These concentrates were then leached with sulphuric acid, sodium hypochlorite or sodium cyanide solutions to recover the gold. During cyanidation, other chemicals were also added during the extraction process, including lead nitrate (used to limit the alteration of cyanide to ferrocyanides, sulphocyanates, etc.) and zinc dust (used to precipitate gold from the pregnant cyanide solutions). In general, these leaching procedures met with relatively little success (Parsons 1922) until the construction of a 200-ton-per-day cyanide plant at Lower Seal Harbour in 1936 (Roach 1937, 1940). Prior to the enactment of modern environmental regulations in the 1970s, tailings and process chemicals from all of these gold mills were released directly to the environment (Fig. 3b).

In the early 1920s, there was a sudden increase in the demand for arsenical insecticides in the United States following an announcement in 1919 from the U.S. Bureau of Entomology, stating that calcium arsenate [$Ca(AsO_4)_2$] was the most economical and efficient insecticide yet discovered for fighting the boll weevil infestation in the cotton fields of the southern states (Hurst 1927). This situation prompted the operators of many gold mines in Nova Scotia to improve their recovery of arsenopyrite, and a 1924 survey of As resources in the province revealed approximately 1000 tons of arsenical concentrates (assaying from 15–25% As) stockpiled at various mines (Hurst 1924). The remains of these high-As concentrates, or their weathered equivalents, are exposed near several old mill structures around the province (Fig. 4). At some sites (e.g. Montague) the sulfide concentrates appear to have been disposed on top of the tailings following leaching with cyanide near the end of milling operations (Roach 1940).

Throughout the history of gold mining in Nova Scotia, many companies have investigated the feasibility of extracting gold from the tailings at past-producing mines using improved technology. Reprocessing of historical amalgamation tailings using cyanide was routinely practiced in many districts (Parsons 1922), but amalgamation continued to form part of most mill circuits up until the 1940s (Roach 1940). An increase in the price of gold in the 1970s and 1980s lead to widespread metallurgical testing of tailings deposits around the province, but no large-scale gold-recovery operations from tailings have been carried out since the 1940s for a variety of economic, environmental, and technical reasons (e.g. Glover *et al.* 1983; Jacques Whitford and Associates Ltd. 1984, 1985; Graves 1992; Mills 1997). The recent surge in the price of gold over the last decade has recently led to renewed interest in reprocessing historical mine tailings.

a)

b)

Fig. 4. (a) Cemented remains of sulphide concentrate near the former Dufferin 60-stamp mill in the Salmon River Gold District. **(b)** Fine-grained, As-rich residue formed through weathering of sulphide concentrate near a stamp mill foundation at Goldenville. The green colour of the residue at both sites is mainly associated with secondary scorodite ($FeAsO_4 \cdot 2H_2O$).

Previous Environmental Studies

Mine tailings from these early milling operations were generally slurried directly into local rivers, swamps, lakes and the ocean with little or no consideration of their impacts on receiving environments (Fig. 3b). In addition to the Hg added during amalgamation, potentially toxic elements (e.g. As, Cu, Pb, Sb) also occur naturally in the ore, and may be present at relatively high concentrations in the mine wastes. Before the beginning of our research in 2003, there had been only a limited number of environmental studies at gold districts throughout the province (Table 2). The first investigation of human health risks associated with these wastes took place in 1976, when a resident living near a past-producing gold district (Waverley) was diagnosed with chronic arsenic intoxication (Hindmarsh *et al.* 1977). Examination of the patient's dug well established that it was receiving groundwater from both tailings and waste rock deposits, and their tap water contained 5000 µg/L arsenic – 500 times the present-day drinking water guideline of 10 µg/L. A subsequent study of 642 wells in gold districts throughout Nova Scotia revealed that 13% exceeded the 50 µg/L drinking water guideline for As (Grantham and Jones 1977).

The results of these previous studies show that tailings from historical gold mines have high concentrations of both As and Hg, and at some sites (e.g. Caribou, Goldenville, Montague, Oldham), the mine wastes have contaminated downstream environments. Investigations by the Provincial Arsenic Task Force in the late 1970s resulted in a list of recommendations to help protect Nova Scotians from high levels of As in groundwater, and eventually led to the provision of a new public drinking water supply based on treated surface water for residents in the Waverley area. However, as of 2003, the human health and environmental risks associated with tailings in other gold districts remained obscure. Over the last 30 years, ongoing residential development, industrial construction, and recreational activities (e.g. ATV, dirtbike and 4X4 racing) have increased the potential for human exposure to these mine wastes.

In March 2005, NRCan presented a summary of the preliminary results from this project to the Province of Nova Scotia, along with a list of recommendations focusing on reducing potential hazards to human health. Several key issues were highlighted, including the ongoing exposure of recreational users to tailings at several sites, the construction of a cottage in 2004 on mine tailings, and recent results from Environment Canada showing high levels of As in soft shelled clams collected from an intertidal tailings flat in Seal Harbour, NS (Koch *et al.* 2007). The Province quickly established the Historic Gold Mines Advisory Committee (HGMAC) in April 2005, which includes representatives from five provincial and five federal departments. The mandate of the HGMAC is to evaluate the potential ecological and human health risks associated with gold mines throughout Nova Scotia, and to develop recommendations for future management of the tailings sites (http://www.gov.ns.ca/nse/contaminatedsites/goldmines.asp). To date (April 2012), the committee has issued two press releases warning Nova Scotians of potential health hazards at these mines, and advising residents to limit their exposure to tailings. Health warning signs have been posted at the Montague and Goldenville districts, and environmental assessments of both sites were carried out from 2007 to 2008. In May 2005, Fisheries and Oceans Canada issued a precautionary bivalve shellfish closure for Seal and Isaacs harbours, and members of the HGMAC have completed additional studies near other gold mines to determine the extent of As and Hg pollution in the coastal zone. Detailed multi-disciplinary studies from 2004 to 2011 have also helped to clarify the chemistry and mineralogy of the mine

Table 2. Timeline of previous environmental research at Nova Scotia gold mine sites

Date	Event
1976	- Waverley resident diagnosed with chronic As intoxication from drinking well water - Provincial Arsenic Task Force appointed to study As problem in Waverley area, and in other historical gold districts throughout southern Nova Scotia
1977	- Clinical study of As exposure in 92 Waverley residents (Hindmarsh *et al*. 1977) - Grantham and Jones (1977) identify gold mine tailings as main As source - Environment Canada commissions study of Hg at abandoned amalgamation sites
1978	- Mudroch and Sandilands (1978) document elevated As and Hg levels in Waverley area lake sediments—the Hg is attributed to both gold amalgamation and historical production of Hg-fulminate explosives in the Powder Mill Lake area
1981–1982	- Published studies of As in tailings, sediment, water, and biota at Montague Gold Mines (Brooks *et al*. 1981, 1982; Dale and Freedman 1982) - Formation of Federal-Provincial study group to investigate the impact of past gold mining activities on the Shubenacadie Headwater Lakes
1984	- Published studies of As in Nova Scotian groundwater (Meranger *et al*. 1984; Bottomley 1984) document additional contamination near various gold districts
1985–1986	- Environment Canada / N.S. Dept. of the Environment report (Mudroch and Clair 1985, 1986) demonstrates significant contamination of sediment, water, and fish with As and/or Hg in the Waverley and Montague areas - Seabright Resources submits an environmental assessment of their proposed gold tailings recovery project at Oldham, which does not proceed for economic reasons
1988–1989	- Investigation of As and Hg concentrations in tailings, waters, and plants at the Oldham Gold District (Lane *et al*. 1988; 1989)
1998	- Beauchamp *et al*. (2002) report high gaseous Hg fluxes and total gaseous Hg concentrations in air over gold mine tailings at Caribou and Goldenville
1999	- Wong *et al*. (1999) publish results from an Environment Canada study of the dispersion and toxicity of metals derived from mine tailings at Goldenville - Tetford (1999) reports high levels of Hg in white perch near the Caribou gold mine
2002	- Wong *et al*. (2002) publish results from an Environment Canada study of the Caribou Gold District, showing high metal burdens in tailings and lake sediments, high gaseous Hg fluxes, and stream water / sediment toxicity to benthic biota
2003–2012	- Ongoing multi-disciplinary studies by ESS and partners of metal(loid) distribution, transport, speciation, and fate at 14 gold mining districts (Parsons 2007)

tailings (Walker *et al.* 2009; Corriveau *et al.* 2011a, 2011b; DeSisto *et al.* 2011; Jamieson *et al.* (2011); Percival *et al.* (in press)), the bioaccessibility of As (Laird *et al.* 2007; Meunier *et al.* 2010a, 2010b, 2011) and Hg (Welfringer and Zagury 2009), the methylation of Hg in the tailings (Winch *et al.* 2008, 2009), and the biological impacts of As and Hg on terrestrial and marine biota (Koch *et al.* 2007; Moriarty *et al.* 2009; Saunders *et al.* 2009, 2010).

The present report outlines the distribution of tailings at 14 past-producing gold mines (Fig. 1) and the chemical characteristics of mine wastes, stream and lake sediments, and surface waters near these sites. This information can be used to assess the extent of tailings in each gold district and their impact on downstream environments. Data from this study should be useful for assessing ecosystem and human health risks at these sites and for guiding land-use decisions.

STUDY DESIGN

Site selection and field sampling

The first year of this project (2003) focused on identifying gold mines with relatively large volumes of tailings that were likely to contain significant quantities of Hg in the mine wastes based on their processing history (Table 1). Fieldwork included reconnaissance-level sampling of tailings, sediment, and surface water at 13 gold mining districts (Fig. 1): Whiteburn (WB), North Brookfield (NB), Leipsigate (LEI), Mount Uniacke (UNI), East Rawdon (RAW), Montague (MG), Lake Catcha (LC), Mooseland (MSL), Salmon River (renamed Dufferin in 1899) (SR), Goldenville (GD), Cochrane Hill (CH), Upper Seal Harbour (USH), and Lower Seal Harbour (LSH). Samples were collected from areas directly impacted by mining and milling activities, and from background sites to assess regional variations in metal(loid) concentrations.

At most mines, the tailings are overgrown and often difficult to recognize. Therefore, detailed Geological Survey of Canada maps of the Nova Scotia gold districts produced by E.R. Faribault and Hugh Fletcher from 1885 to 1920 proved to be invaluable for locating the mine wastes. These maps are available in digital format from the ESS GEOSCAN bibliographic database (http://geoscan.ess.nrcan.gc.ca/geoscan-index.html) and have also been digitized by the Nova Scotia Department of Natural Resources (http://www.gov.ns.ca/natr/meb/pubs/pubs3gd.asp; Smith and Goodwin 2009). The historical maps were used to help locate the unconfined tailings deposits, which are generally situated in low-lying areas downslope of former stamp mill sites. In the early 1980s, Seabright Resources Inc. mapped and evaluated 28 tailings sites in Nova Scotia for possible recovery of their gold content—these maps were also used to locate sampling sites for the present study (Glover *et al.* 1983; Jacques Whitford and Associates Ltd. 1984, 1985).

In 2004 and 2005, additional tailings and water samples were collected during detailed multi-disciplinary investigations of the Upper and Lower Seal Harbour gold districts. These sites were chosen based on the results of reconnaissance fieldwork in 2003, as they contain large volumes of tailings, are located away from residential areas, and provide an excellent opportunity to study the seasonal variations in surface water chemistry and the biological impacts of elevated As and Hg concentrations on both terrestrial and marine biota.

From 2005 to 2007, field sampling focused on sites where the tailings are being actively reworked by human activities (e.g. off-road vehicle usage) and tailings were collected primarily for research on the mineralogy and bioaccessibility of As. Near-surface tailings samples were collected from the North Brookfield, Montague, Caribou (CAR) and Goldenville districts. Results of mineralogical and bioaccessibility studies have been published elsewhere (Walker *et al.* 2009; Meunier *et al.* 2010a, 2010b, 2011) and are not discussed in the present report.

Field Methods

Sediments and mine waste

In 2003 and 2004, a total of 429 individual tailings samples were collected from 13 gold districts, from Whiteburn in the west to Lower Seal Harbour in the east (Fig. 1). In general, a shovel was used to dig holes for sampling, with typical dimensions of 30-150 cm deep by 40-50 cm wide (Fig. 5a). Sampling locations were chosen based on down-hole variations in the colour and/or texture of the tailings. At most sites, the vertical stratigraphy consisted of a top layer of organic-rich soil, overlying rusty-brown oxidized tailings, transitioning into grey, unoxidized tailings at greater depths. In areas that are relatively unvegetated, weathered tailings are present at surface and the oxic layer extends to depths of 10s of centimetres to >1 m depending on the grain size of the tailings and the degree of weathering (Fig. 5a). Those sites located within wetlands and other water-logged areas consist of dark grey, unoxidized tailings without any oxidized layers. In drier areas, samples were taken from both the oxidized and unoxidized layers to evaluate differences in chemistry and mineralogy. At water-logged sites, one sample from the unoxidized tailings was generally considered sufficient.

On October 31, 2003, nine samples of the top 5-10 cm of surface sediments from Lake Catcha (Fig. 1) were collected using a Ponar grab sampler deployed from a Zodiac inflatable boat. These sediments contained large amounts of organic material and were variably mixed with gold mine tailings from historical milling operations.

In 2005 and 2006, an additional 52 near-surface tailings samples were collected from the Whiteburn, North Brookfield, Montague, Caribou (CAR), and Goldenville gold districts (Fig. 1) for analyses of As mineralogy and bioaccessibility (Walker *et al.* 2009; Meunier *et al.* 2010a, 2010b, 2011). Samples from Caribou were collected along a community walking trail on the tailings and in areas disturbed by all-terrain vehicles, whereas all samples from North Brookfield, Montague and Goldenville were collected in areas frequented by off-road vehicles. All tailings samples except two were visibly oxidized and were selected based on distinct visual characteristics thought to be indicative of different mineralogy. Of the two unoxidized samples, one from Caribou was distinctly arsenopyrite-rich (CAR05-T02) and another from Montague was from saturated tailings immediately beneath a thin layer of wetland vegetation (MG05-T04). At each sampling site, a test pit was excavated to examine the stratigraphy of the tailings, and then 1-2 kg samples were collected at specified depth intervals using a stainless steel hand trowel and plastic sampling containers. In 2007, one additional tailings sample (MG07-S28) was collected from a previously unrecognized and overgrown tailings deposit during background soil sampling at Montague Gold Mines.

a)

b)

Fig. 5. (a) Example of a hand-dug pit in tailings showing oxidized and reduced materials. Base of pit is 75 cm (light brown sandy tailings from 0-45 cm; olive-grey tailings with rusty lenses from 45-58 cm; light grey sandy tailings from 58-75 cm). **(b)** Field filtration of water samples at the Lower Seal Harbour Gold District, August 2004.

All tailings and sediment samples were stored in air-tight, 125 mL high-density polyethylene (HDPE) vials in the field and placed in a cooler at 4°C during transport to the laboratory. Larger samples for bioaccessibility work in 2005 and 2006 were stored in Ziploc® bags before laboratory processing. Appendix A contains brief descriptions and coordinates for all sediment and tailings sample sites, as well the full geochemical dataset for each sample.

Surface water

All waters were collected using field and analytical protocols suitable for low-level (i.e. µg/L, or part-per-billion and ng/L, or part-per-trillion) trace element determinations (Hall 1998; Hall *et al.* 2002). Prior to fieldwork, bottle sets were prepared in the lab by triple-rinsing 60 mL HDPE bottles (Nalgene® 2114-0002) with Milli-Q® water for collection of cation and anion samples, and by triple-rinsing 60 mL polypropylene (PP) bottles (Nalgene® 2110-0002) with Milli-Q® water for collection of Hg samples. Each sampling kit was pre-loaded with five 60 mL bottles: two HDPE bottles for collection of filtered and unfiltered cation samples, one HDPE bottle for collection of samples for anion, dissolved organic carbon (DOC), and alkalinity analyses, and two PP bottles for collection of filtered and unfiltered Hg samples. The sampling kits were also pre-loaded with an all-plastic 50 mL syringe (Norm-Ject® Sterile Luer-Lock Syringe), and several Sterivex™ capsule filters with a 0.45 µm Durapore membrane.

Field sampling was carried out by a two-person team using a "clean-hands / dirty-hands" approach, whereby the "dirty-hands" person collected the surface water sample using a 1 L bottle and made all on-site water quality measurements (e.g. pH, specific conductance, temperature), and the "clean-hands" person carried out the water filtration on-site using non-powdered nitrile gloves and careful handling to prevent contamination of the water samples (Fig. 5b). To condition each bottle, the containers were rinsed on-site with the water that was to be sampled. Duplicate water samples were collected at every tenth sample site (or at least once per day), and travel blanks, acid blanks, and sample blanks were collected each day. Once all samples were processed, they were stored at 4°C in a cooler for transport to the field laboratory.

Within 12 hours of sample collection, 60 mL samples for cation analyses were preserved with 0.5 mL of 8 N ultrapure nitric acid (J.T. Baker® ULTREX II grade), and 60 mL samples for Hg analyses were preserved with 0.5 mL of ultrapure BrCl. Once removed from the field, the samples were stored in the dark at 4°C, and then shipped to the Analytical Method Development Laboratory at GSC Ottawa for analysis within 90 days.

In 2005 and 2006, seasonal water samples were also collected for analysis of inorganic arsenite [As(III)] and arsenate [As(V)] concentrations. Samples were filtered in the field to <0.45 µm and collected in opaque 60 mL HDPE bottles (Nalgene® 2106-0002) to prevent photocatalyzed As(III) oxidation by Fe(III) (Hall *et al.* 1999; McCleskey *et al.* 2004). Within 12 hours of sample collection, the As species in each 60 mL sample were stabilized by adding 3 mL of 0.25 M EDTA, then storing the sample in the dark at 4°C until analysis at GSC Ottawa.

Laboratory Methods

Bulk chemistry of sediments and mine waste

All tailings and sediment samples were homogenized, sub-sampled, and freeze-dried at GSC Atlantic prior to bulk chemical analysis. Analyses of major and trace elements were performed at Acme Analytical Laboratories in North Vancouver, BC. Samples were digested using modified *aqua regia* (0.50 g of sample digested in a solution containing 2.0 ml HCl, 2.0 ml HNO_3 and 2.0 ml H_2O at 95ºC for one hour) and analyzed for 37 to 53 elements following the Acme 1F-MS Ultratrace Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) protocol. Samples with concentrations of As and/or Hg greater than the upper limit of the 1F-MS package were re-analyzed using Acme's 7AR Multi-Element Assay by Inductively Coupled Plasma – Emission Spectrometry (ICP-ES) protocol following *aqua regia* digestion (Appendix A). Certified reference materials STSDs 1-4 (Lynch 1990, 1999) and duplicate samples were used to monitor analytical accuracy and precision, which were generally within ± 5 to 10% of the expected values for most elements (Appendix F). Total carbon content of the tailings and soils was measured in 0.5 g sub-samples at GSC Atlantic using a LECO WR-112 carbon analyser. Organic carbon concentrations were analysed following removal of the inorganic carbon using 1 M HCl. Inorganic carbon concentrations were calculated by difference. Precision and accuracy were approximately ± 0.05 wt.% based on replicate analyses of calibration standards.

Sequential extraction analysis of sediments and mine waste

Sequential extraction analysis (SEA) was used to investigate the mineral hosts for both As and Hg in selected tailings and sediment samples collected from the Upper and Lower Seal harbour districts from 2003-2005. Samples for SEA were placed in air-tight, 125 mL HDPE vials in the field and frozen until analysis. For As, an optimized 7-step sequential extraction procedure was employed (Table 3) and pure samples of arsenopyrite, scorodite and yukonite were used to test the selectivity of the various extraction steps. For Hg, an optimized 7-step sequential extraction procedure was also used (Table 3) and pure samples of cinnabar (HgS) and cinnabar mixed with granite were used to test the reagent selectivity. Further details on the experimental conditions and analytical procedures can be found in Hall *et al.* (2005) and Hall and Pelchat (2005). Results from the SEA on all tailings and sediment samples are tabulated in appendices D and E.

Water analysis

All surface water samples were sent to the Analytical Method Development labs at GSC Ottawa for analyses, which included measurements of cations, anions, Hg and DOC concentrations. Major element concentrations were measured using a PerkinElmer model 3000 DV ICP-ES, and minor and trace elements were measured using a Thermo X7 Series II ICP-MS. Detection of Hg concentrations with values less than 10 ng/L was carried out using a Tekran 2600 Hg analyzer, with a detection limit of 0.5 ng/L. Determinations of anion concentrations were made with a Dionex DX-600 ion chromatograph using an AS-18 column and gradient elution. Dissolved organic carbon was measured on a Shimadzu TOC-5000 analyzer following removal of inorganic carbon using phosphoric acid. Alkalinity measurements of the waters were completed using a PC-Titrate system. Samples for As speciation were analyzed by liquid chromatography-

ICP-MS in a similar manner to that described by Hall *et al.* (1999), but using a Dionex AS7 anion exchange column and gradient elution with 2.5 – 50 mM HNO_3 in 2% methanol as the mobile phase to separate As(III) and As(V). For each type of water analysis, measurements were routinely performed on one or more certified standards of known concentrations. Analytical results for field blanks from each trip were at or below detection limits for all analytes, except for Zn, which ranged from <0.5 – 3.7 µg/L in the laboratory water used to prepare acid and sample blanks in 2003 (this water source was replaced from 2004 onwards). The full geochemical dataset for all waters analyzed during this study is compiled in Appendix B. Results from As speciation analyses on surface waters are tabulated in Appendix C.

Table 3. Sequential extraction schemes used to examine As and Hg partitioning.

As Sequential Extraction Scheme	
Targeted phase	**Reagent**
Adsorbed/exchangeable elements	1.0 M NH_4OAc (2 hr @ pH 7.0) [a]
Carbonates	1.0 M NH_4OAc (2 hr @ pH 5.0)
Amorphous Fe/Al oxides	0.25 M $NH_2OH{\cdot}HCl$ in 0.25 M HCl
Crystalline Fe/Al oxides	1.0 M NH_2OH in 25% HOAc
Scorodite-like	4 M HCl (2 hr)
Arsenopyrite-like	*Aqua regia* (3HCl: $1HNO_3$)
Silicates and residuals	$HF\text{-}HClO_4\text{-}HNO_3\text{-}HCl$
Hg Sequential Extraction Scheme	
Targeted phase	**Reagent**
Adsorbed/exchangeable elements	1.0 M NH_4OAc (2 hr @ pH 7.0) [a]
Carbonates	1.0 M NH_4OAc (2 hr @ pH 5.0)
Amorphous Fe/Al oxides	0.25 M $NH_2OH{\cdot}HCl$ in 0.25 M HCl
Crystalline Fe/Al oxides	1.0 M NH_2OH in 25% HOAc
Non-labile organics, elemental Hg	40% (6.4 M) HNO_3
Cinnabar-like	*Aqua regia* (3HCl: $1HNO_3$)

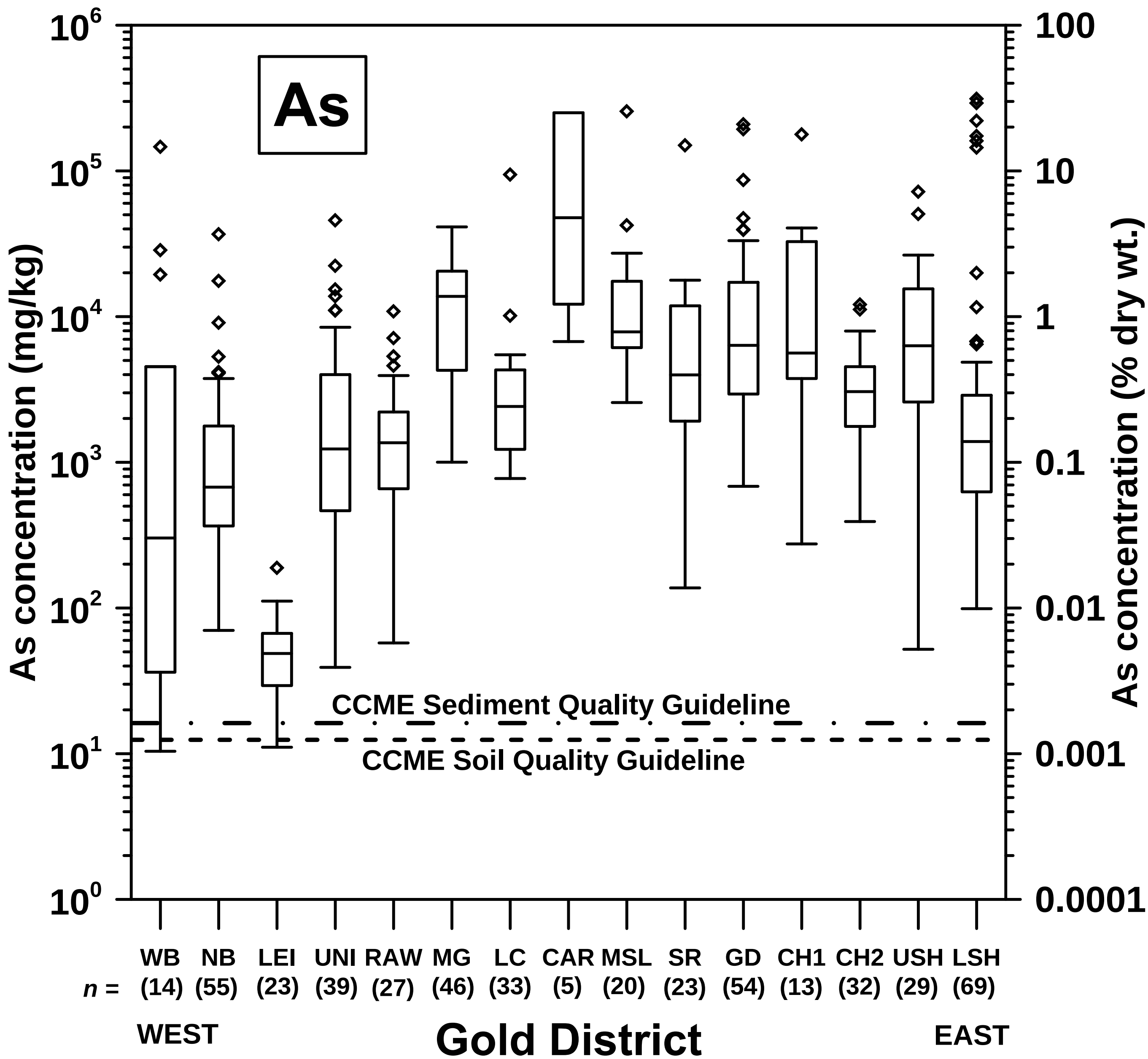
[a] OAc = acetate (CH_3COO^-)

DISCUSSION

Summary plots of As, Au, Cu, Hg, Ni, Pb, Sb, and Zn concentrations in tailings and waters

The bulk concentrations of As, Au, Cu, Hg, Ni, Pb, Sb, and Zn in tailings from 14 historical gold districts in Nova Scotia are shown in a series of box-and-whisker plots in figures 105-112, respectively. In these plots, maximum and minimum values are shown by the whisker extents, upper and lower quartiles define the boxes, median values are given by the horizontal line within each box, and outliers are shown as diamonds. The districts are arranged from west to east on these plots as follows: Whiteburn (WB), North Brookfield (NB), Leipsigate (LEI), Mount Uniacke (UNI), East Rawdon (RAW), Montague (MG), Lake Catcha (LC), Caribou (CAR), Mooseland (MSL), Salmon River (SR), Goldenville (GD), Cochrane Hill (CH), Upper Seal Harbour (USH), and Lower Seal Harbour (LSH). The tailings at Cochrane Hill are subdivided into two groups: amalgamation tailings from historical stamp milling between 1868 and 1921 (CH1) and cyanidation tailings from more recent (1981-1990) gold mining operations (CH2) (Figs. 10-11). Where applicable, Canadian environmental guidelines are also shown on these plots for both soils and sediments to help place the data in context. The soil quality guidelines are the upper limits recommended for the protection of environmental and human health during residential and/or parkland use. These apply to mine sites where the tailings are located close to residential properties, or where the tailings are used for recreational purposes (e.g. Montague, Goldenville). The sediment quality guidelines shown on these plots are Probable Effects Levels (PELs), above which adverse biological effects on freshwater aquatic biota are expected to occur frequently. These apply to sites where the tailings are present in wetlands, streams, and/or lakes that contain organisms living in or having direct contact with sediments (CCME 2012).

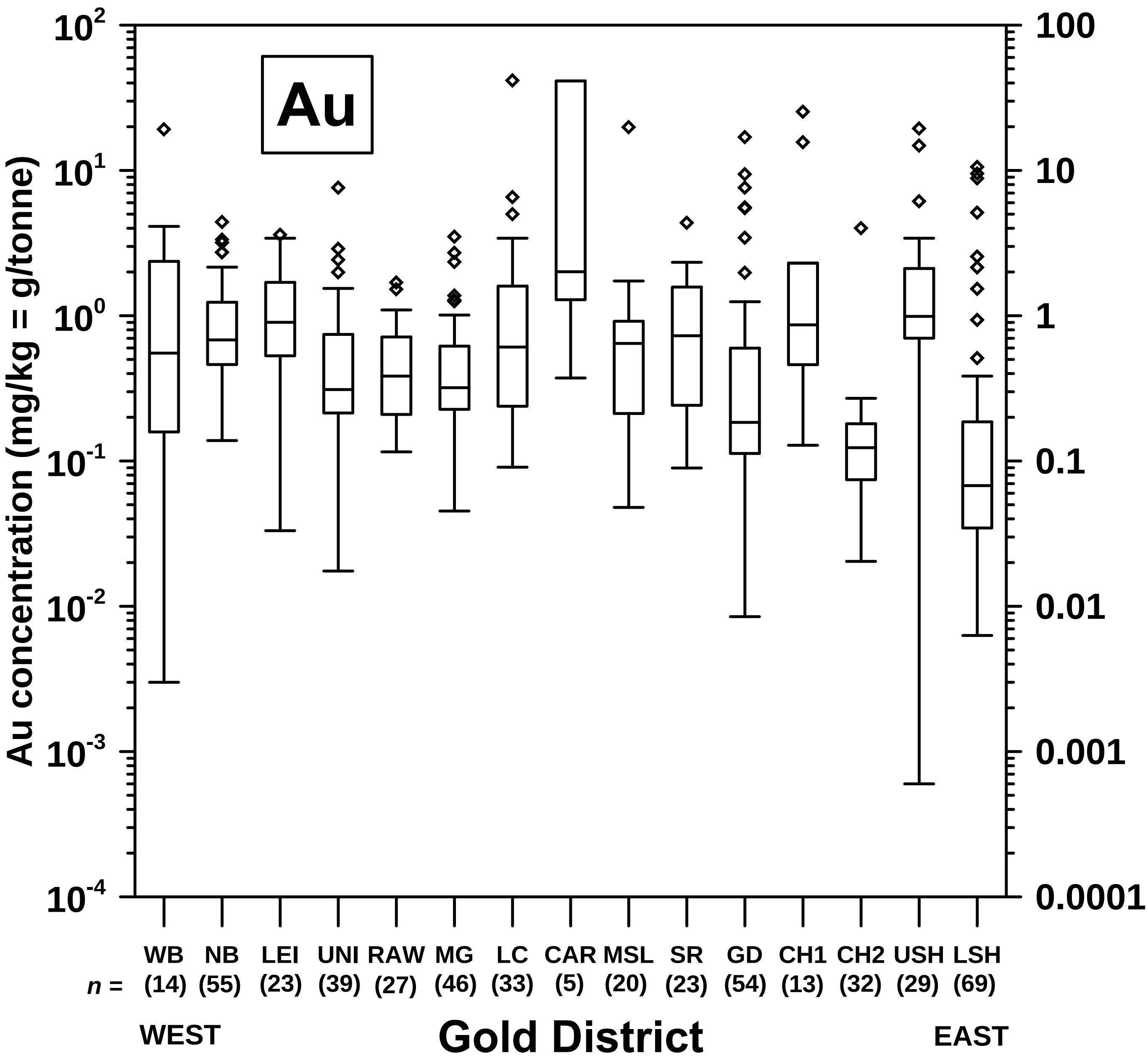
The median As concentrations in most districts range from about 0.1 to 1.0 wt.% (Fig. 105). The relatively low As concentrations at Leipsigate reflect the extensive re-processing of tailings in a cyanide plant from 1903-1905, whereas the abnormally high range for the Caribou tailings is skewed by a single sample of sulphide concentrate containing 25 wt.% As. More than 99% of all samples exceed both the soil and sediment quality guidelines for As. The median Au grade in the tailings is 0.37 g/t, with the lowest concentrations occurring at the two sites where cyanide plants operated most recently (CH and LSH; Fig. 106). Copper concentrations in the tailings show a distinct geographic trend, with higher concentrations west of the Mooseland Gold District and lower concentrations in the more easterly regions of the Meguma Supergroup (Fig. 107). Mercury concentrations in the tailings are shown in Fig. 108. The low Hg levels in the recent cyanidation tailings from Cochrane Hill (<5 to 25 μg/kg; median 6 μg/kg) are representative of natural Hg levels in various bedrock lithologies of the Meguma Terrane. The comparatively lower median Hg concentrations at NB, LEI, MG, GD, and LSH most likely reflect the reprocessing of amalgamation tailings using cyanide in the latter stages of mining at these sites. Approximately 20% of the tailings samples exceed the soil quality guideline for Hg and 71% exceed the sediment guideline. The concentrations of Ni in the tailings show a similar geographic pattern to Cu (Fig. 109). Lead, Sb, and Zn are comparatively low in the tailings relative to environmental quality guidelines and do not show the same regional patterns observed for Cu and Ni (Figs. 110-112). The relatively high Zn concentrations in the tailings at Cochrane Hill may reflect both the presence of sphalerite in this deposit (Smith 1983) as well as the use of Zn plates to precipitate gold in the cyanide plant during the 1980s (Mosher 2004).



STATISTICS

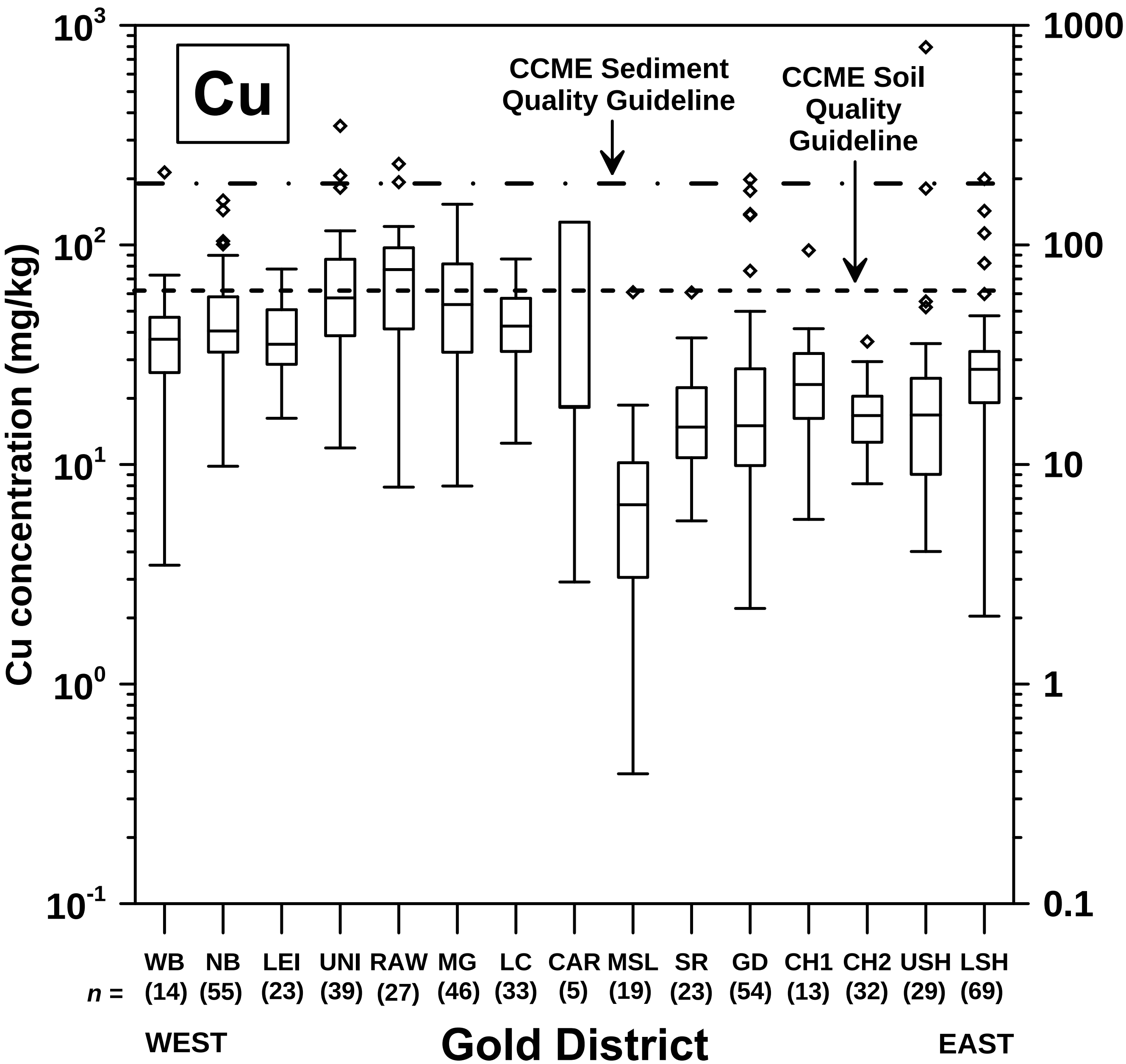
Minimum:	10 mg/kg	# samples:	482
Maximum:	312,000 mg/kg	As > Soil guideline: 99%	
Mean:	11,900 mg/kg	As > Sed. guideline: 99%	
Median:	2,550 mg/kg		

Fig. 105. Box-and-whisker plot showing the concentration of As (mg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS			
Minimum:	0.001 g/t	Median:	0.37 g/t
Maximum:	41 g/t	# samples:	482
Mean:	1.26 g/t		

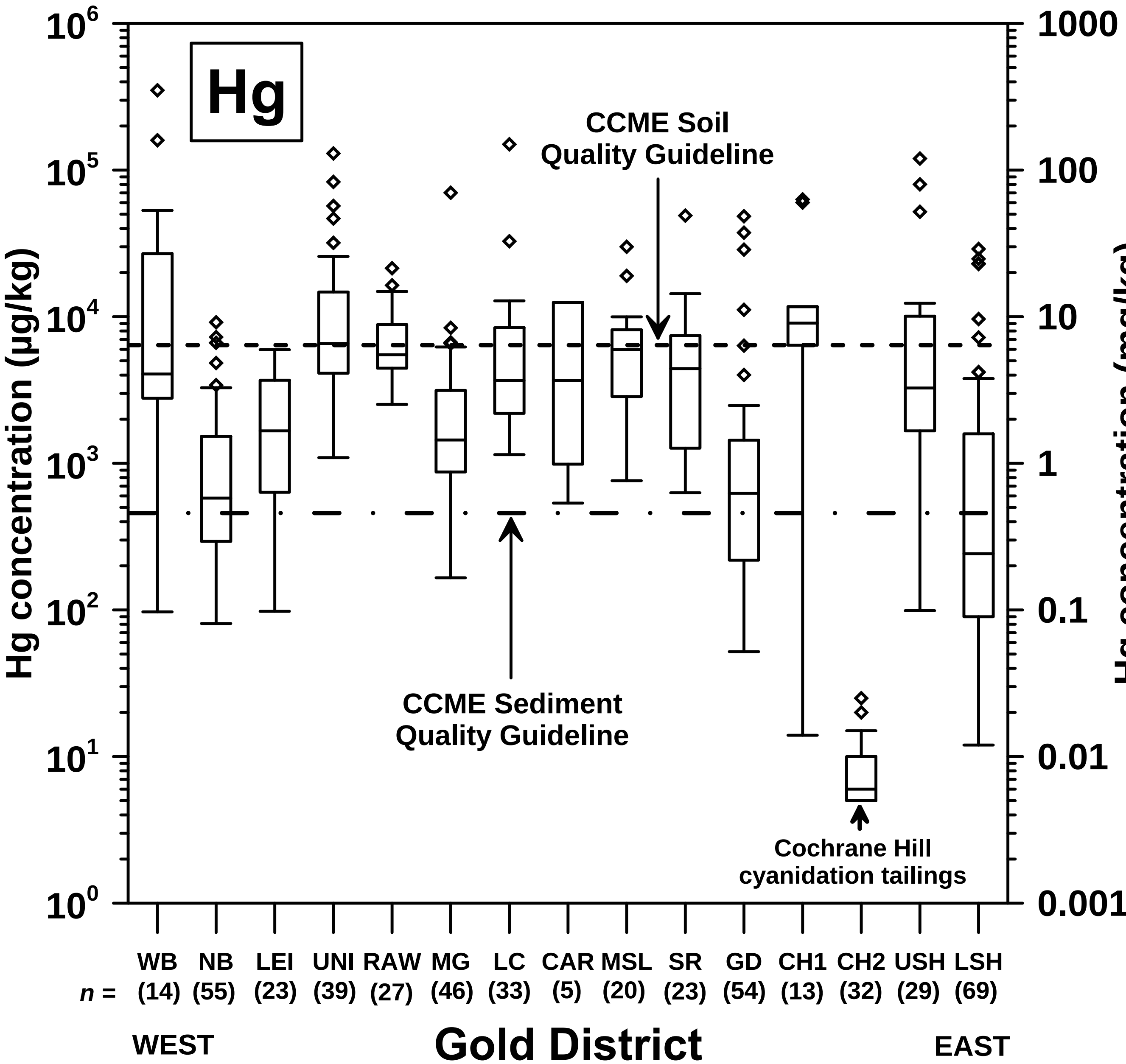
Fig. 106. Box-and-whisker plot showing the concentration of Au (g/tonne) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS

Minimum:	0.4 mg/kg	# samples:	481
Maximum:	796 mg/kg	Cu > Soil guideline:	18%
Mean:	42 mg/kg	Cu > Sed. guideline:	1%
Median:	31 mg/kg		

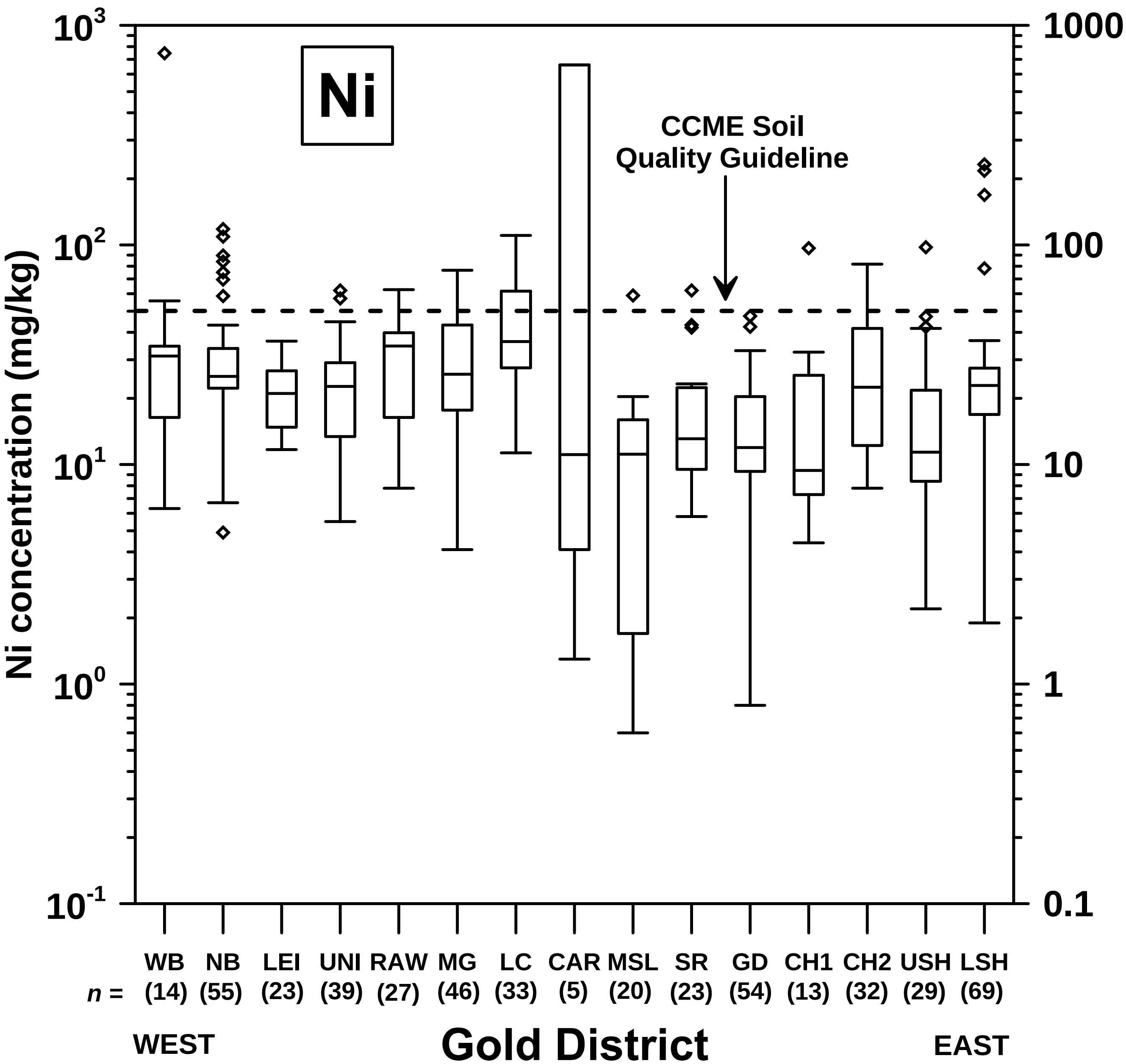
Fig. 107. Box-and-whisker plot showing the concentration of Cu (mg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS

Minimum:	5 µg/kg	# samples:	482
Maximum:	350,000 µg/kg	Hg > Soil guideline:	20%
Mean:	6770 µg/kg	Hg > Sed. guideline:	71%
Median:	1640 µg/kg		

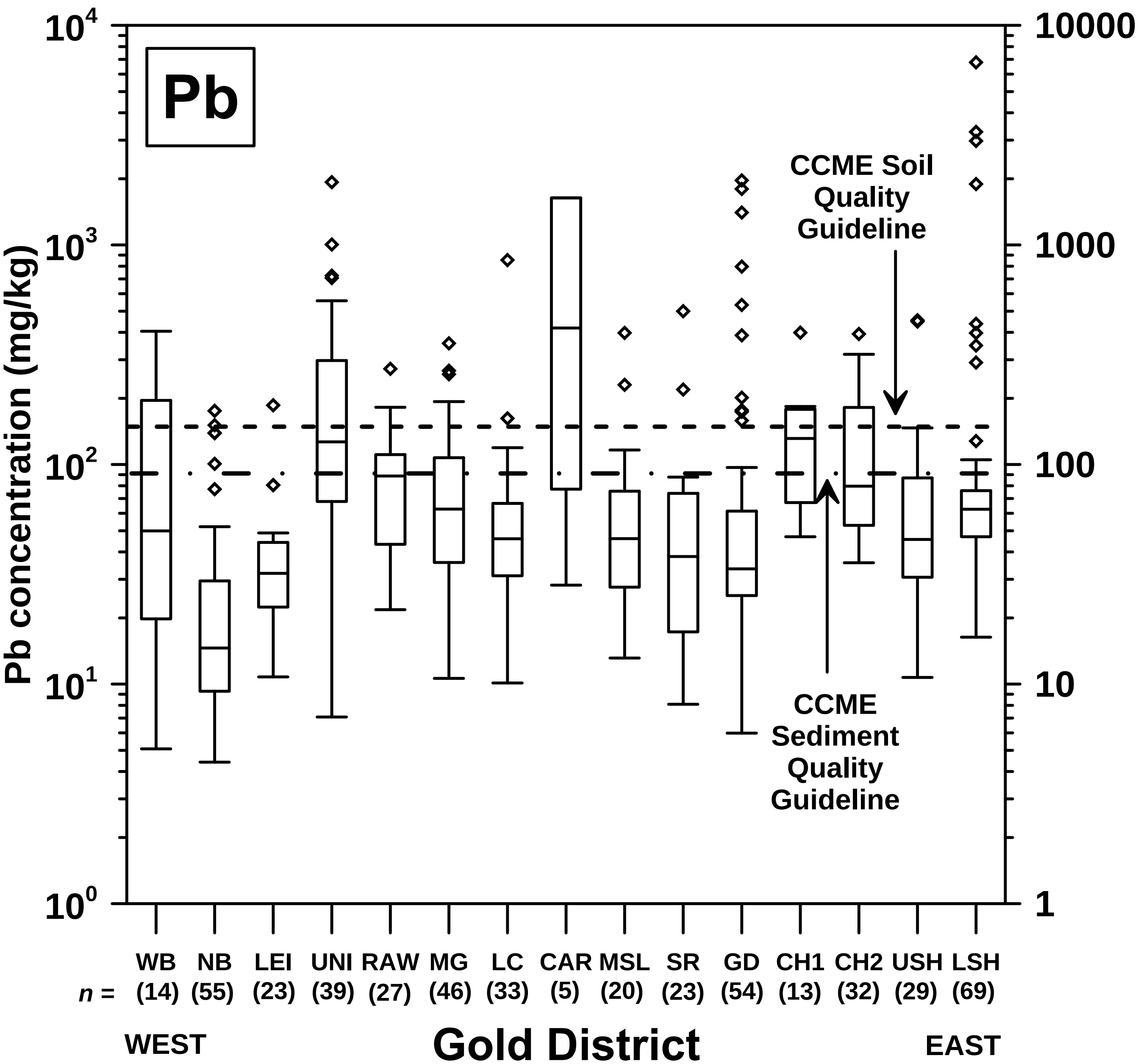
Fig. 108. Box-and-whisker plot showing the concentration of Hg (µg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS

Minimum:	0.6 mg/kg	Median:	22 mg/kg
Maximum:	746 mg/kg	# samples:	482
Mean:	29 mg/kg	Ni > Soil guideline: 10%	

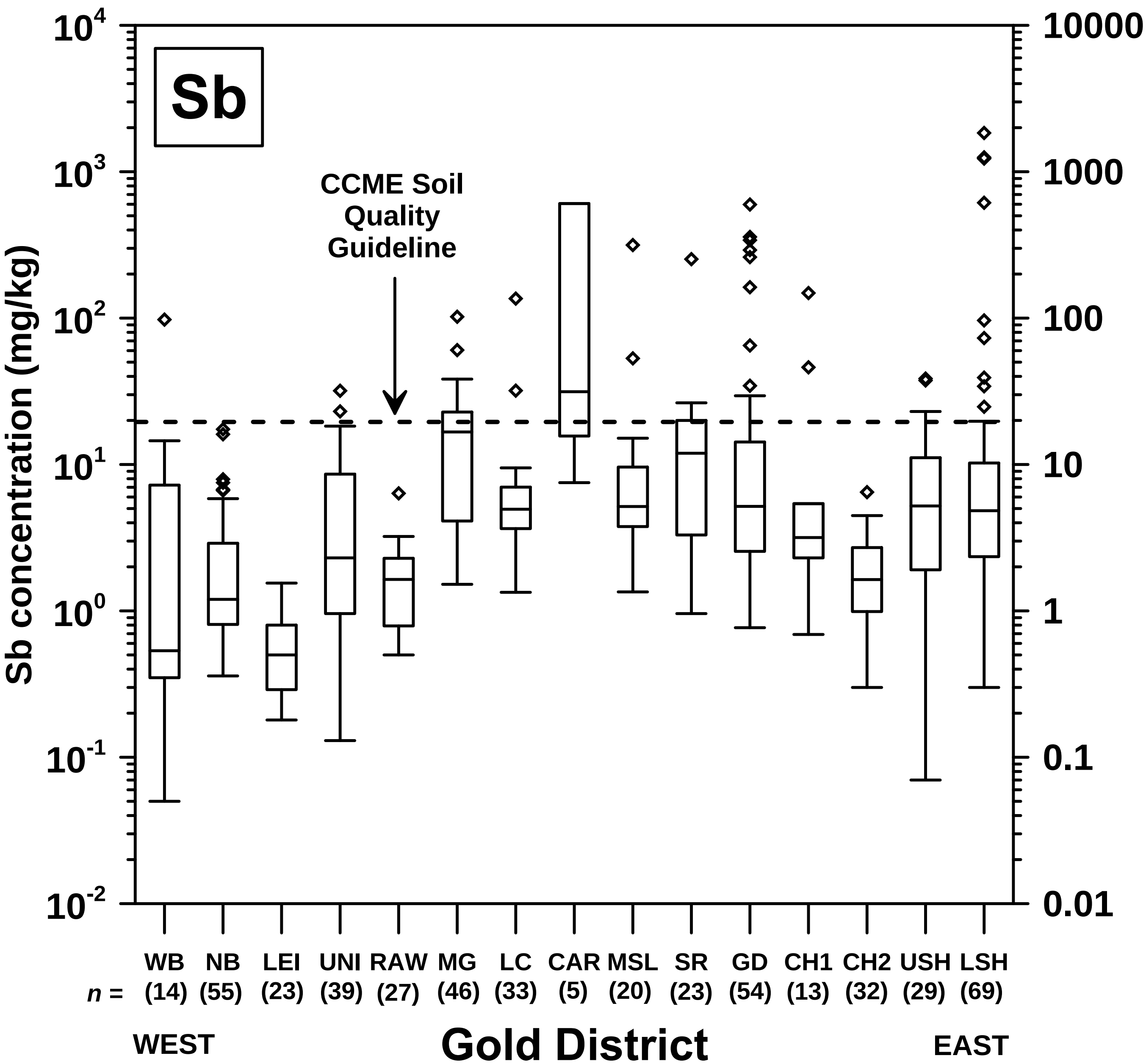
Fig. 109. Box-and-whisker plot showing the concentration of Ni (mg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS

Minimum:	4.4 mg/kg	# samples:	482
Maximum:	6780 mg/kg	Pb > Soil guideline: 17%	
Mean:	137 mg/kg	Pb > Sed. guideline: 26%	
Median:	53 mg/kg		

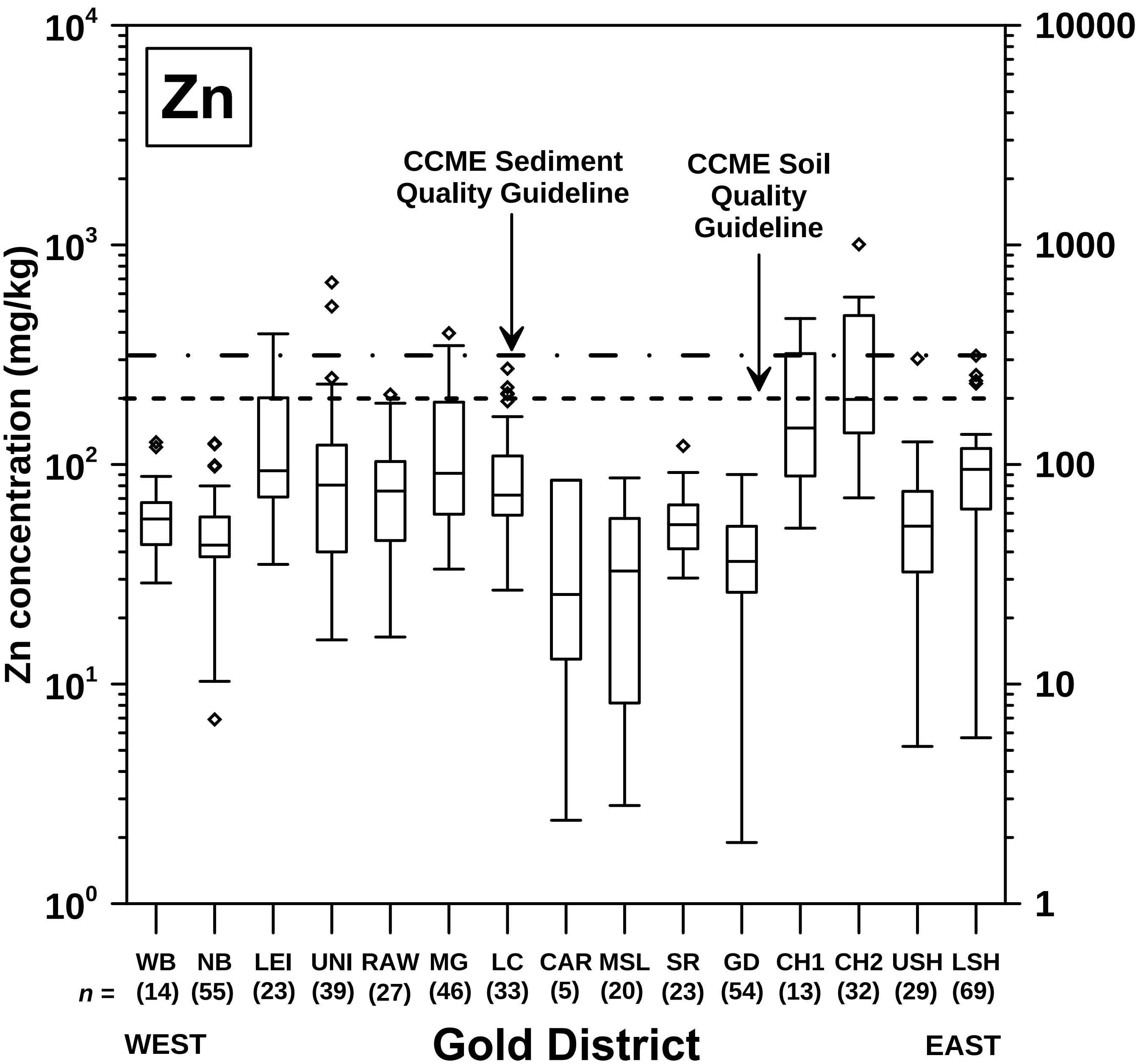
Fig. 110. Box-and-whisker plot showing the concentration of Pb (mg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS

Minimum:	0.1 mg/kg	Median:	3 mg/kg
Maximum:	1840 mg/kg	# samples:	482
Mean:	25 mg/kg	Sb > Soil guideline: 13%	

Fig. 111. Box-and-whisker plot showing the concentration of Sb (mg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.



STATISTICS

Minimum:	1.9 mg/kg	# samples:	482
Maximum:	1000 mg/kg	Zn > Soil guideline: 11%	
Mean:	97 mg/kg	Zn > Sed. guideline: 4%	
Median:	66 mg/kg		

Fig. 112. Box-and-whisker plot showing the concentration of Zn (mg/kg) in tailings from 14 historical gold districts in Nova Scotia. District abbreviations are provided in the text.

From 2003 to 2005, water was collected from approximately 180 sampling sites in nine gold districts throughout Nova Scotia to document the impact of tailings on surface waters. Most sites were sampled from July to November 2003, but additional sampling was carried out at Upper and Lower Seal Harbour in May 2004, August 2004, November 2004, and August 2005 (these seasonal samples from the Seal Harbour districts are designated "SH-S" on the following plots). In general, the waters draining most of these tailings deposits are circumneutral to mildly acidic, with pH values averaging 5.5. With few exceptions, reaction with the tailings tends to increase the pH of local surface waters, reflecting dissolution of carbonate phases (ankerite, calcite, dolomite) in the mine wastes (e.g. Fig. 53). The only locations where pH values less than 3.5 have been measured are in the pore waters of tailings at Montague and Goldenville, where weathering of sulphide concentrates has led to the development of hardpan layers cemented by secondary As minerals (e.g. scorodite, $FeAsO_4{\cdot}2H_2O$; DeSisto *et al.* 2011)

Water chemistry data indicate that the dissolved levels of As are very high in waters impacted by mine tailings (range: 0.2–6580 µg/L; median 117 µg/L; n = 181), as compared to background values of generally <25 µg/L (Fig. 113). The total concentration of As at some background sites is less than the CCME guideline for the protection of aquatic life (5.0 µg/L; CCME 2012), but there are many other sites with naturally occurring As concentrations between 5 and 100 µg/L depending on the degree of exposure to mineralized bedrock in these gold districts. Dissolved As concentrations >800 µg/L are generally restricted to sites where shallow groundwater was sampled from a hole dug in the tailings, or where water was pooled on the tailings surface. This range in As concentrations is consistent with that observed in tailings drainage from similar low-sulfide, gold-quartz vein deposits in Alaska and California (Ashley 2002). Comparison of the filtered and unfiltered concentrations of As in the surface water samples shows that >70% of the total As is "dissolved" (<0.45 µm) at most sites. Samples with <50% "dissolved" As represent shallow groundwaters in the tailings, or standing waters with abundant suspended sediment (e.g. particulate organic matter, bacteriogenic iron oxides, etc.) (Fig. 113).

Dissolved Hg concentrations in tailings-impacted surface waters range from 1.8 to 61 ng/L, and from 1.2 to 17 ng/L at background sites (Fig. 114). In general, the dissolved Hg concentrations in surface waters are relatively low (<25 ng/L) even in close proximity to tailings with high (i.e. >1 mg/kg) levels of Hg, suggesting that Hg in the tailings is present in relatively insoluble forms. Most of the total Hg concentrations exceeding CCME's guideline for the protection of aquatic life (26 ng/L) occur directly within the tailings and do not persist for significant distances downstream. Unfiltered Hg concentrations >100 ng/L were all measured within tailings pore waters and stamp mill drainages. As compared to As, a greater percentage of Hg in these surface waters was bound to particulate matter, especially in waters with >30 ng/L Hg and abundant organic material (Fig. 113). Dissolved organic carbon (DOC) also seems to play a significant role in mobilizing Hg from the tailings in some districts (Fig. 115), and is especially important in determining the concentration of dissolved Hg at background sites (Fig. 116).

Figure 117 shows the sum of dissolved As, Cu, Hg, Ni, Pb, Sb, and Zn plotted versus pH in all surface waters collected from 2003 to 2005. The range in compositions is similar to that shown by Plumlee *et al.* (1999) for waters draining low-sulfide, Au quartz vein deposits in Alaska. On average, As makes up more than 85% of the metalloid sum in most tailings-impacted waters from Nova Scotia, with Zn also present at significant concentrations in waters at Cochrane Hill.

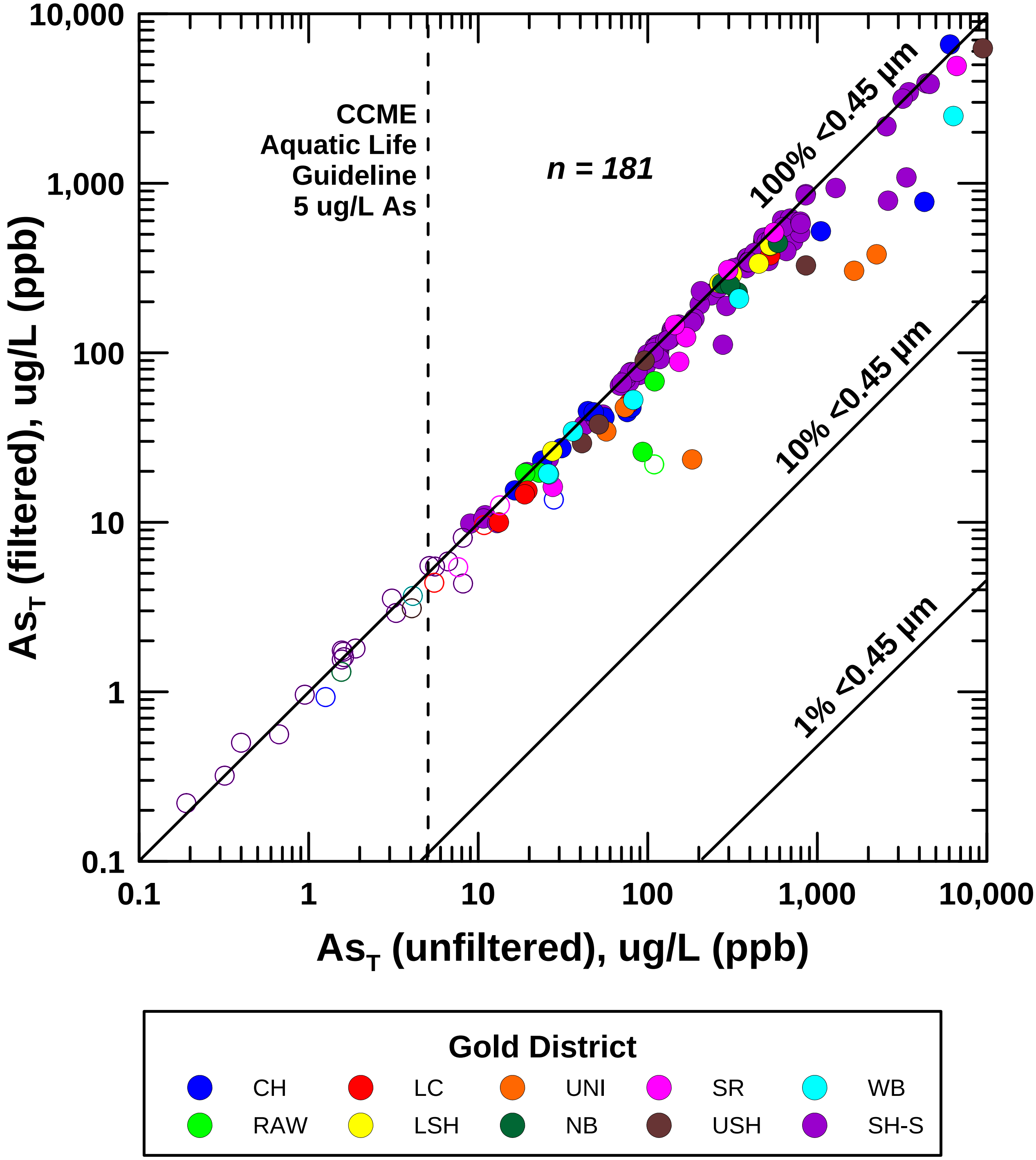


Fig. 113. Filtered (<0.45 µm) and unfiltered As concentrations in surface waters collected from nine historical gold districts in Nova Scotia between May 2003 and August 2005. Open symbols represent background (upstream) locations and filled symbols represent sites that are impacted by mine tailings. District abbreviations are provided in the text.

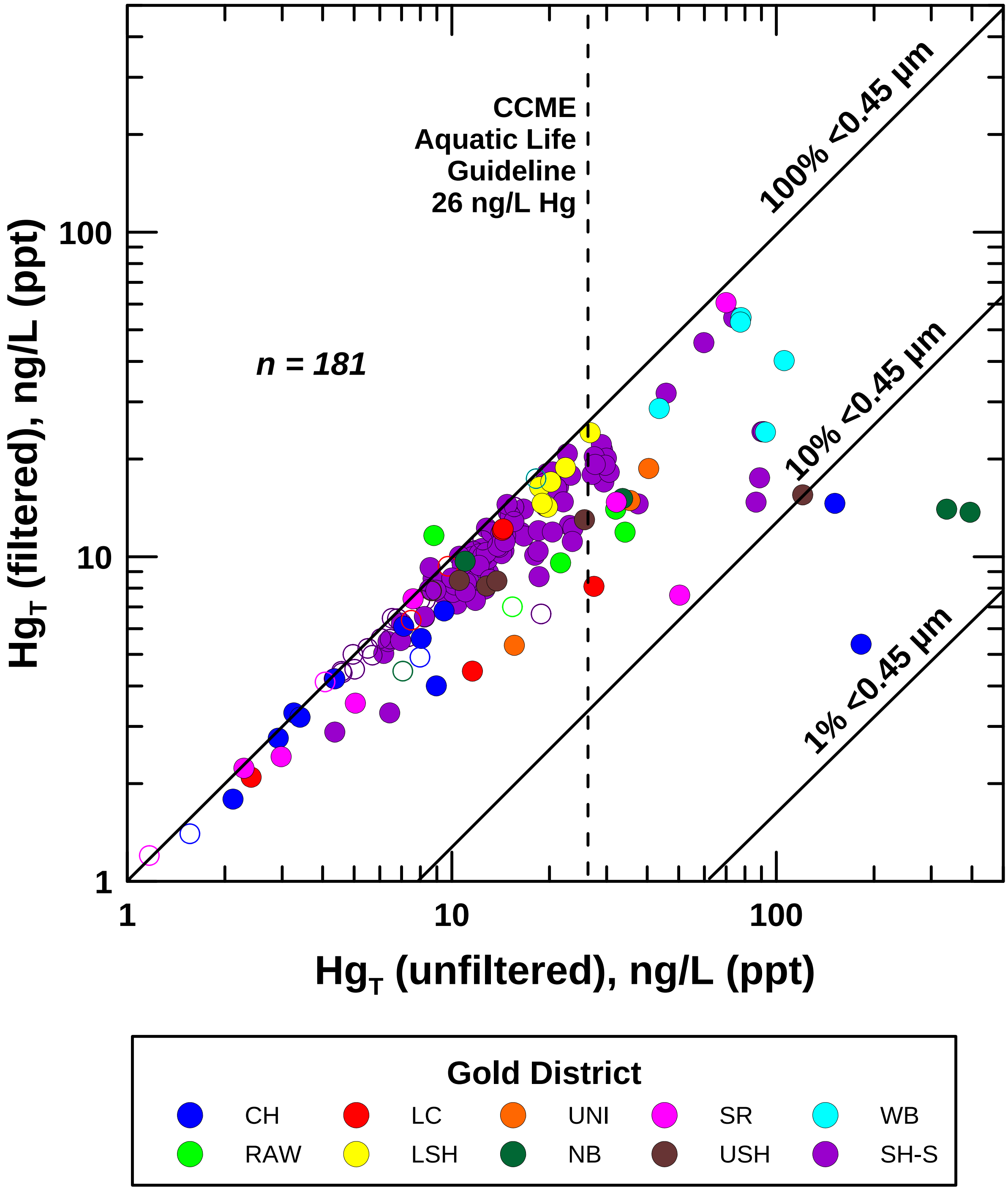


Fig. 114. Filtered (<0.45 µm) and unfiltered Hg concentrations in surface waters collected from nine historical gold districts in Nova Scotia between May 2003 and August 2005. Open symbols represent background (upstream) locations and filled symbols represent sites that are impacted by mine tailings. District abbreviations are provided in the text.

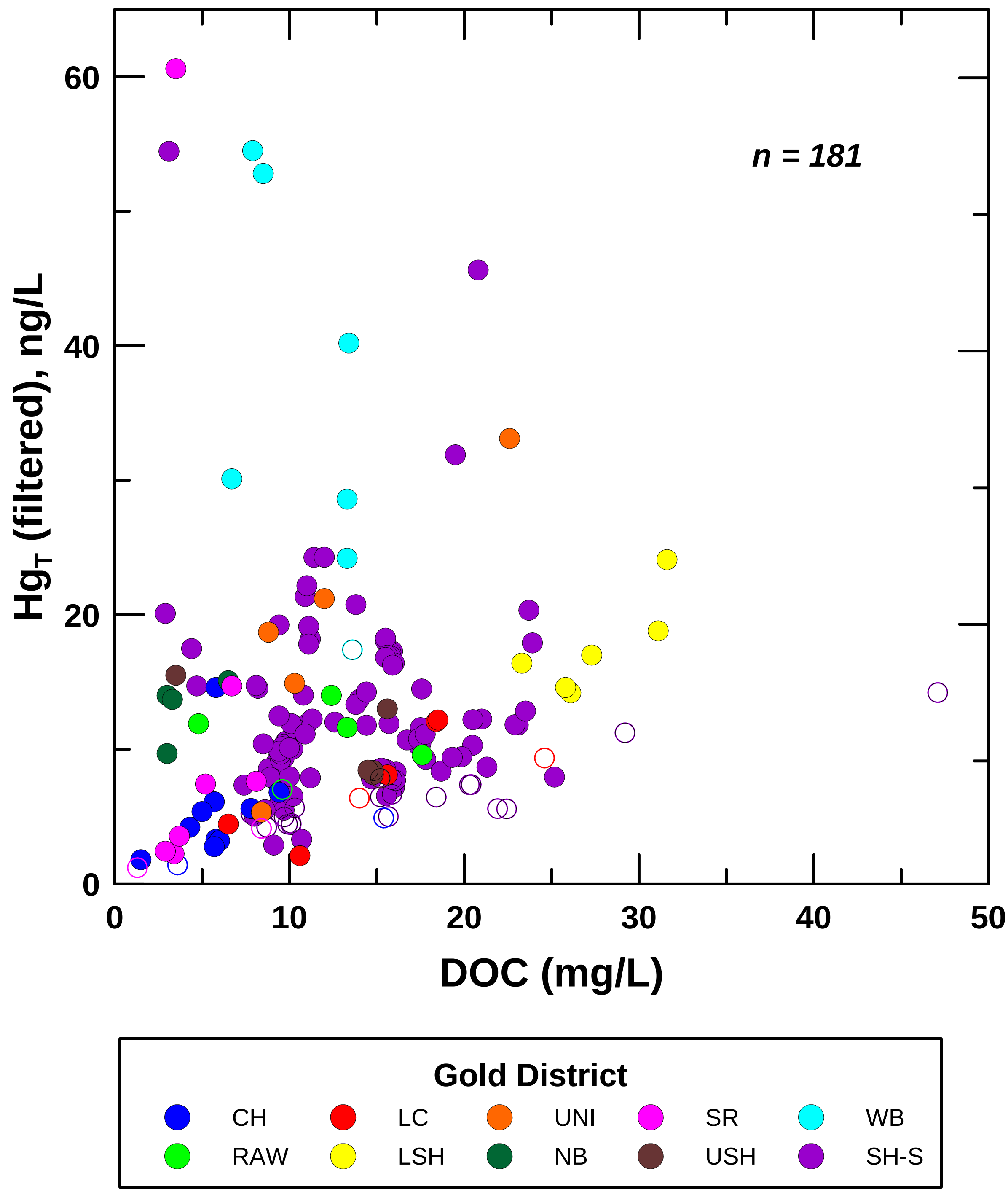


Fig. 115. Filtered (<0.45 µm) Hg versus dissolved organic carbon (DOC) in surface waters collected from Nova Scotia gold districts between May 2003 and August 2005. Open symbols represent background (upstream) locations and filled symbols represent sites that are impacted by mine tailings. District abbreviations are provided in the text.

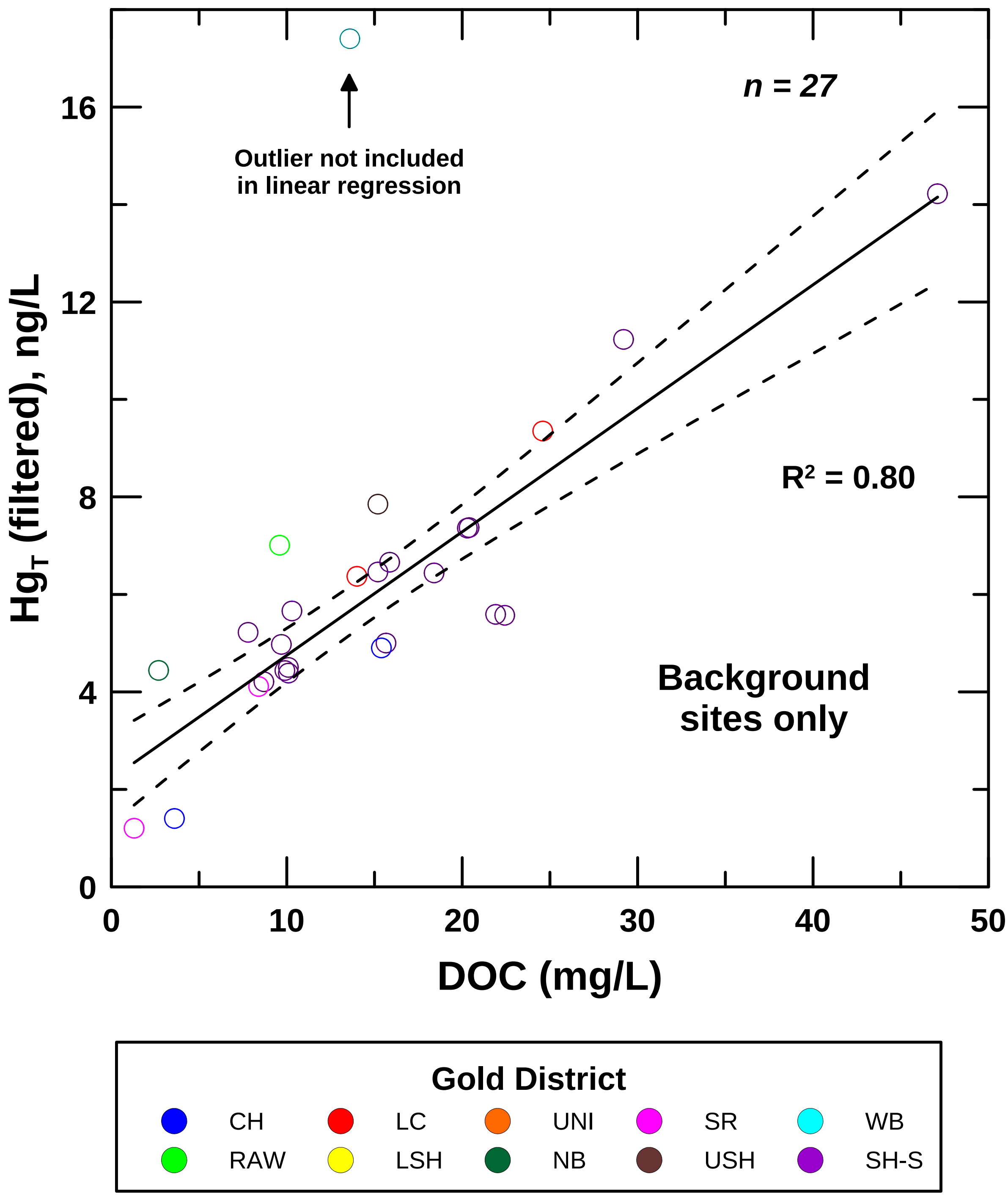


Fig. 116. Filtered (<0.45 µm) Hg versus dissolved organic carbon (DOC) concentrations in background surface waters collected from nine gold districts in Nova Scotia between May 2003 and August 2005. Linear regression of these data suggests that increases in DOC lead to increased Hg mobilization. District abbreviations are provided in the text.

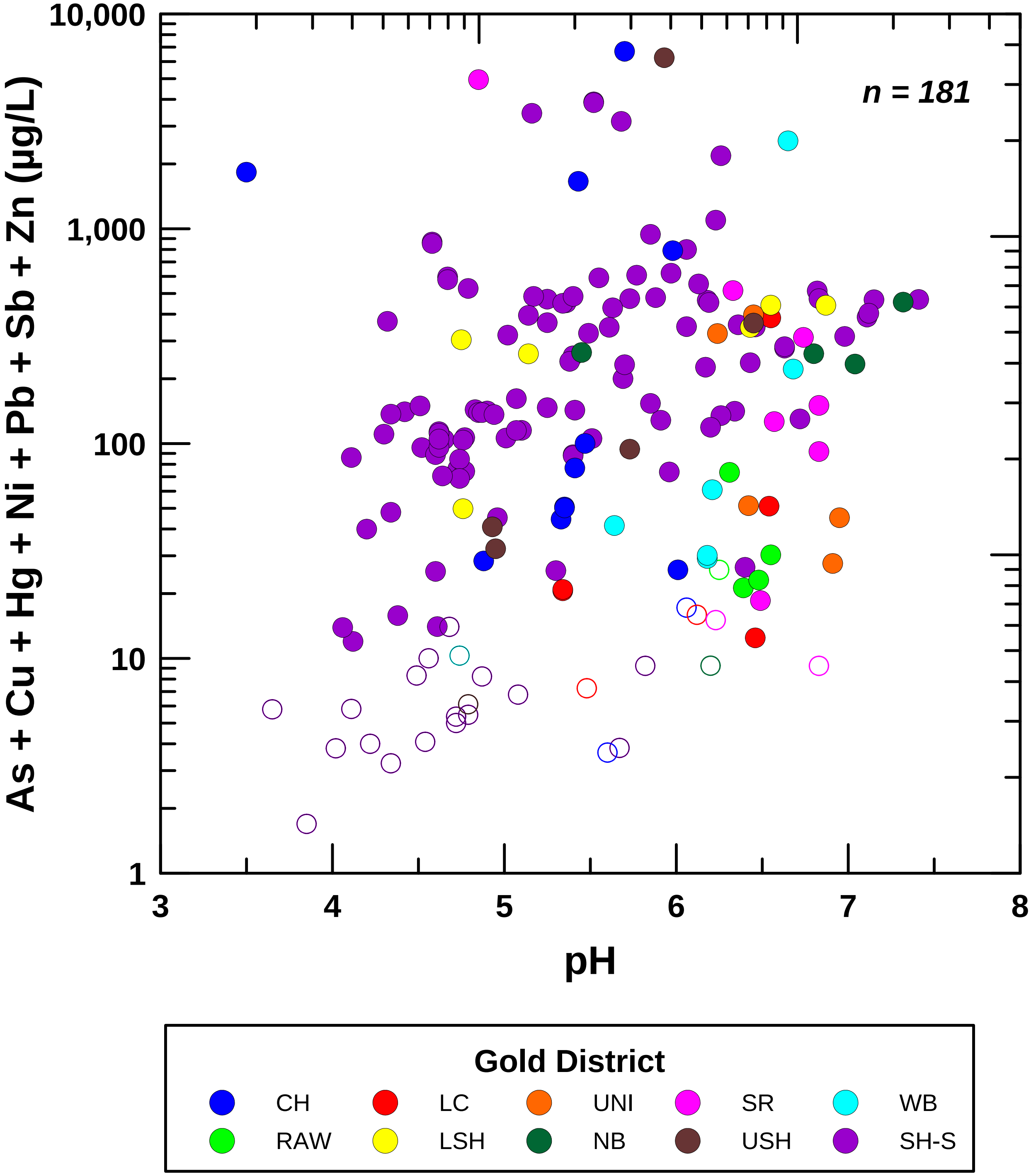


Fig. 117. Ficklin-style diagram [after Plumlee et al. (1999)] showing the sum of dissolved As, Cu, Hg, Ni, Pb, Sb, and Zn plotted versus pH in surface waters collected from nine historical gold districts in Nova Scotia between May 2003 and August 2005. Open symbols represent background (upstream) locations and filled symbols represent sites that are impacted by mine tailings. District abbreviations are provided in the text.

Background concentrations of As and Hg around the Seal Harbour Gold Districts

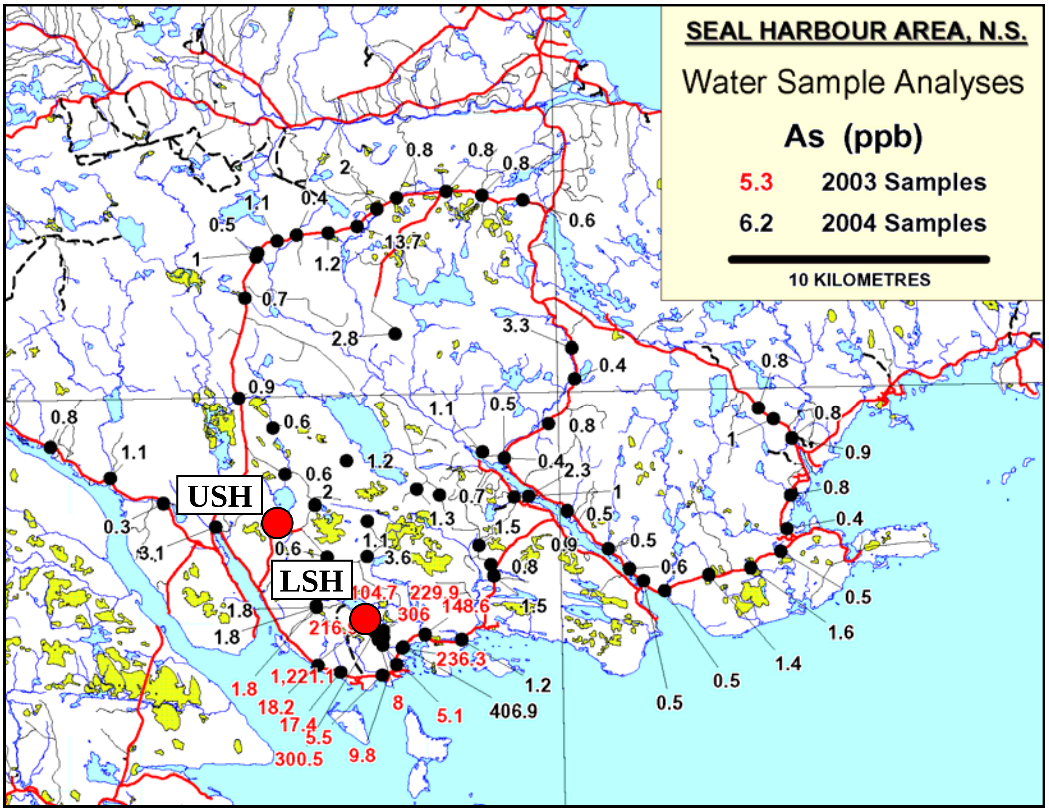
In September 2003 and August 2004, samples of surface waters and organic-rich streambank sediments were collected from approximately 60 sites in total within a 20 km radius of the Upper and Lower Seal Harbour gold districts (Fig. 1). The main purpose of this sampling was to establish ranges in regional background concentrations for both As and Hg in mineralized and unmineralized areas for comparison with mining-impacted waters and sediments. In 2003, most of the samples were collected in streams near the Lower Seal Harbour Gold District (LSH), and included sampling of tailings-impacted drainages for comparison purposes. In August 2004, samples were taken from a much broader area underlain by granites and bedrock of the Meguma Supergroup, but unaffected by mining activities. The range of stream widths included in this survey ranged from 0.5 to 10 m (A.L. Sangster, unpublished data, 2005).

The distributions of As and Hg are shown in surface waters in Figure 118, and in streambank sediments in Figure 119. These concentration ranges are summarized in Table 20, and compared to data for tailings-impacted waters and sediments in the Lower Seal Harbour District. The ranges in As and Hg concentrations are consistent with those observed in other gold mining districts throughout the Meguma Terrane in Nova Scotia (Figs. 105, 108, 114, 115).

Table 20. As and Hg concentrations in stream waters and sediments collected from background and tailings-impacted locations within 20 km of the Seal Harbour Gold Districts.

Stream Waters		
Element	**Medium**	**Concentration Range**
As	LSH tailings drainages	17 – 406 µg/L
As	Background streams	0.3 – 14 µg/L
Hg	LSH tailings drainages	8 – 16 ng/L
Hg	Background streams	1.6 – 10 ng/L
Streambank Sediments		
Element	**Medium**	**Concentration Range**
As	LSH tailings drainages	370 – 6500 mg/kg
As	Background streams	2.5 – 70 mg/kg
Hg	LSH tailings drainages	300 – 3900 µg/kg
Hg	Background streams	19 – 300 µg/kg

a)



b)

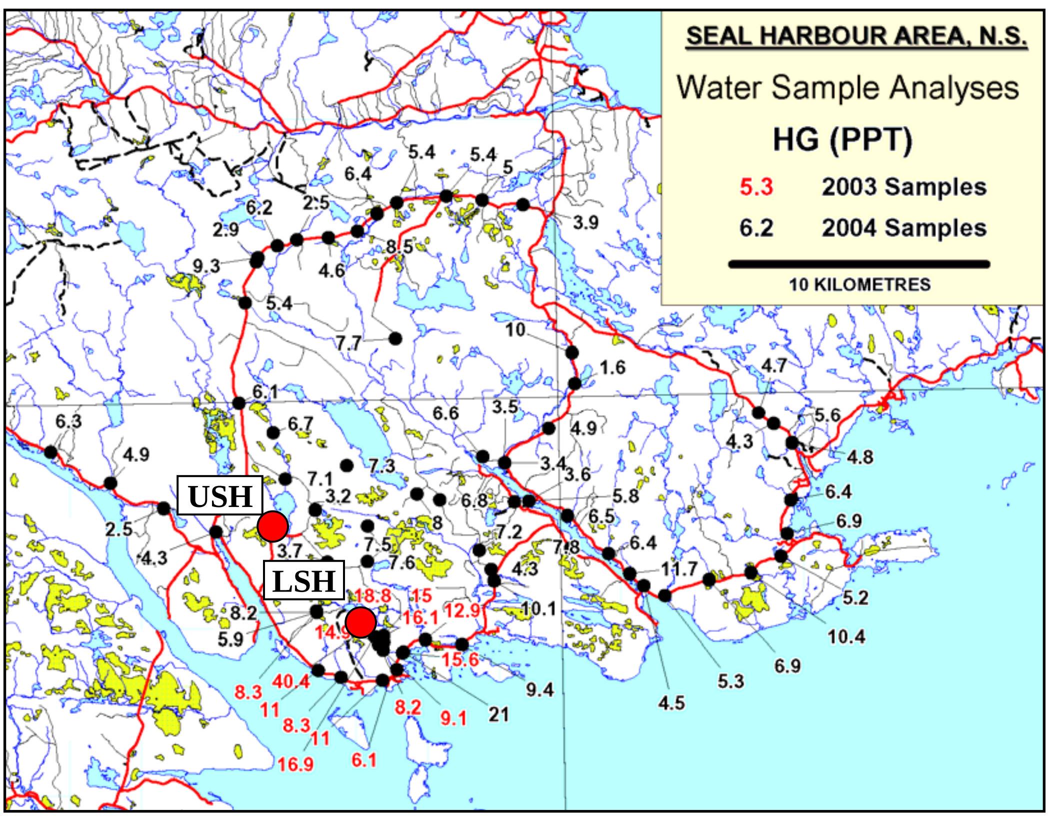
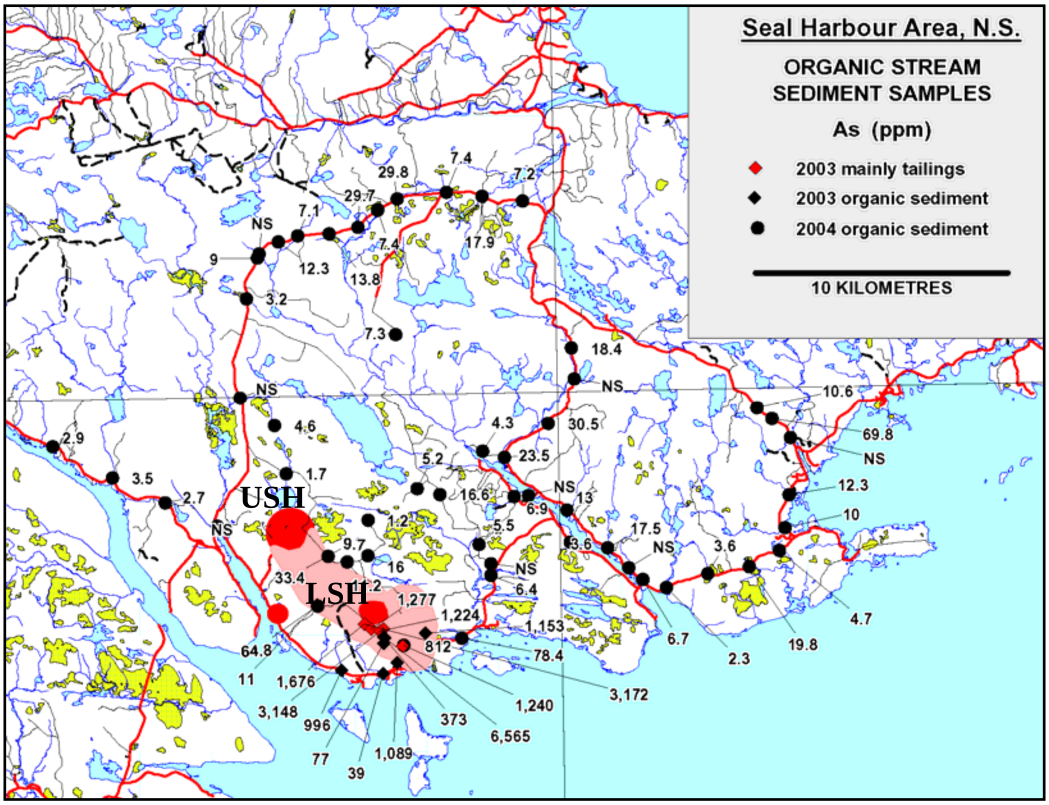


Fig. 118. Concentrations of **(a)** As and **(b)** Hg in filtered (<0.45 µm) stream water samples collected in 2003 and 2004 near the Upper and Lower Seal Harbour Gold Districts, Nova Scotia.

a)



b)

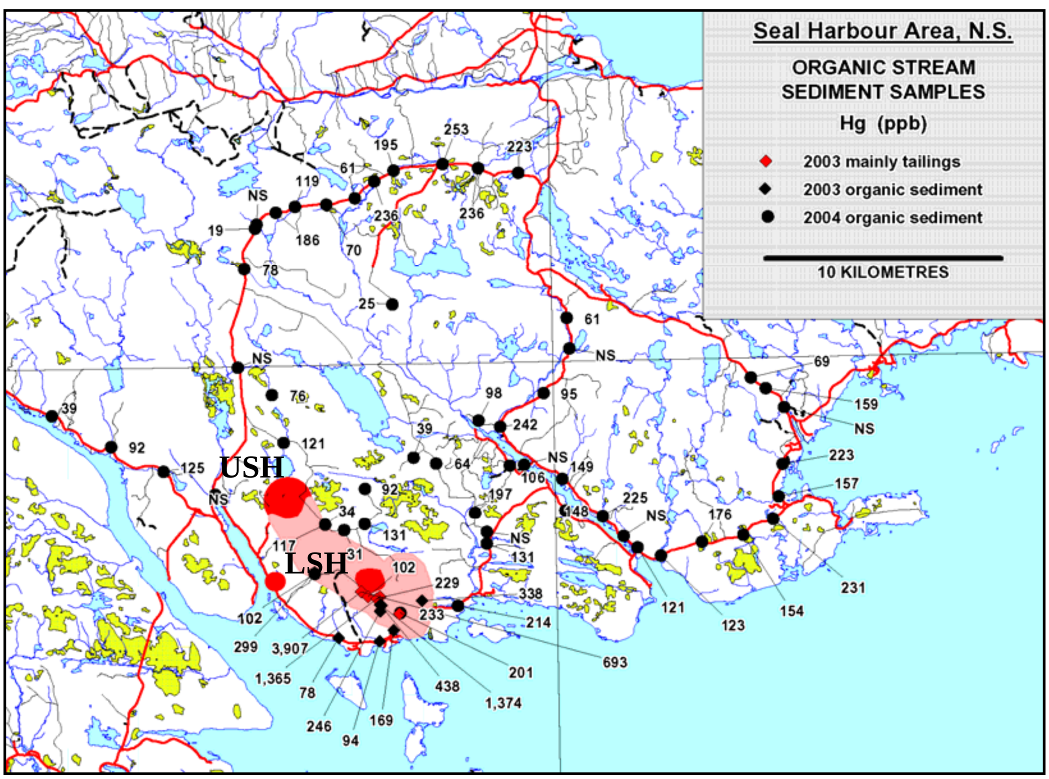


Fig. 119. Concentrations of **(a)** As and **(b)** Hg in organic-rich streambank sediments and tailings samples collected in 2003 and 2004 near the Upper and Lower Seal Harbour Gold Districts, Nova Scotia.

Seasonal variability in As and Hg concentrations at the Seal Harbour Gold Districts

In 2004 and 2005, detailed multi-disciplinary studies were carried out at the Upper and Lower Seal Harbour gold districts to characterize the seasonal variability, speciation, mobility, and bioaccumulation of metal(loid)s in both freshwater and marine environments. A wide variety of methods were employed by NRCan and its partners, including sequential extractions, As and Hg speciation measurements, biological sampling (fish, frogs, clams, invertebrates, mice), and sediment/water toxicity testing. Results from some of these studies have recently been published (Koch *et al.* 2007; Winch *et al.* 2008; Moriarty *et al.* 2009; Saunders *et al.* 2009, 2011; Corriveau *et al.* 2011a, 2011b; Percival *et al.* in press) and additional papers are forthcoming.

Documenting the temporal variations in As and Hg concentrations in surface waters is important for understanding the biogeochemical cycling of these elements in tailings environments, and also has significant implications for environmental monitoring of contaminated sites. Previous studies have shown that the dissolved concentrations of many trace elements exhibit large and consistent variations on both diurnal (24-hour) and seasonal timescales (e.g. Fuller and Davis 1989; Gammons *et al.* 2007; Masson *et al.* 2007). These variations are caused by changes in interrelated physical and chemical characteristics of streams and lakes including temperature, streamflow, dissolved oxygen and carbon dioxide, pH, dissolved organic carbon, and microbial activity (Nimick *et al.* 2011). In general, the magnitude of daily variations is small relative to seasonal cycles, but can be very significant in some environments.

Figure 120 shows the location of all sites at the Upper and Lower Seal Harbour districts where surface waters were collected in August 2003, May 2004, August 2004, November 2004 and August 2005. The identity of these sites are consistent with the water sampling locations shown previously for Lower Seal Harbour (Fig. 49) and Upper Seal Harbour (Fig. 93). The dissolved concentrations of As and Hg on each sampling date are shown in Figs. 121 and 122, respectively. Background concentrations of As and Hg within these districts range from 0.2-8.1 µg/L and 4-14 ng/L, respectively. In general, the concentrations of both As and Hg at most sites are higher during the summer months as compared to the Spring and Fall. The median dissolved concentrations of As and Hg are 3.6 and 1.4 times higher, respectively, in August as compared to May and November. Another important observation shown on Fig. 121 is the relatively high concentrations of As (37-150 µg/L) in the waters of East Brook (Site W21) where it drains into Seal Harbour. These elevated As concentrations most likely reflect the influence of tailings-impacted waters from Upper Seal Harbour draining through Seal Harbour Lake.

As shown in Fig. 123, the aqueous speciation of As also changes with the seasons and varies significantly between sampling sites. Arsenite [As(III)] is generally considered to be the more toxic and soluble form of As in the environment (Smedley and Kinniburgh 2002); therefore, determining the oxidation state of As is important for understanding its mobility, fate and biological impacts. In general, the highest percentages of arsenite occur in areas that receive significant inflows of low-oxygen ground waters (e.g. Sites W15, W17; Fig. 120), or where the surface waters are slow-flowing and organic-rich (e.g. Site W3). The seasonal variability in As concentrations and speciation in the surface waters at Upper and Lower Seal Harbour is controlled by many variables, including changes in water temperature and pH (Fig. 124), both of which increase in the summer months leading to changes in trace element behaviour.

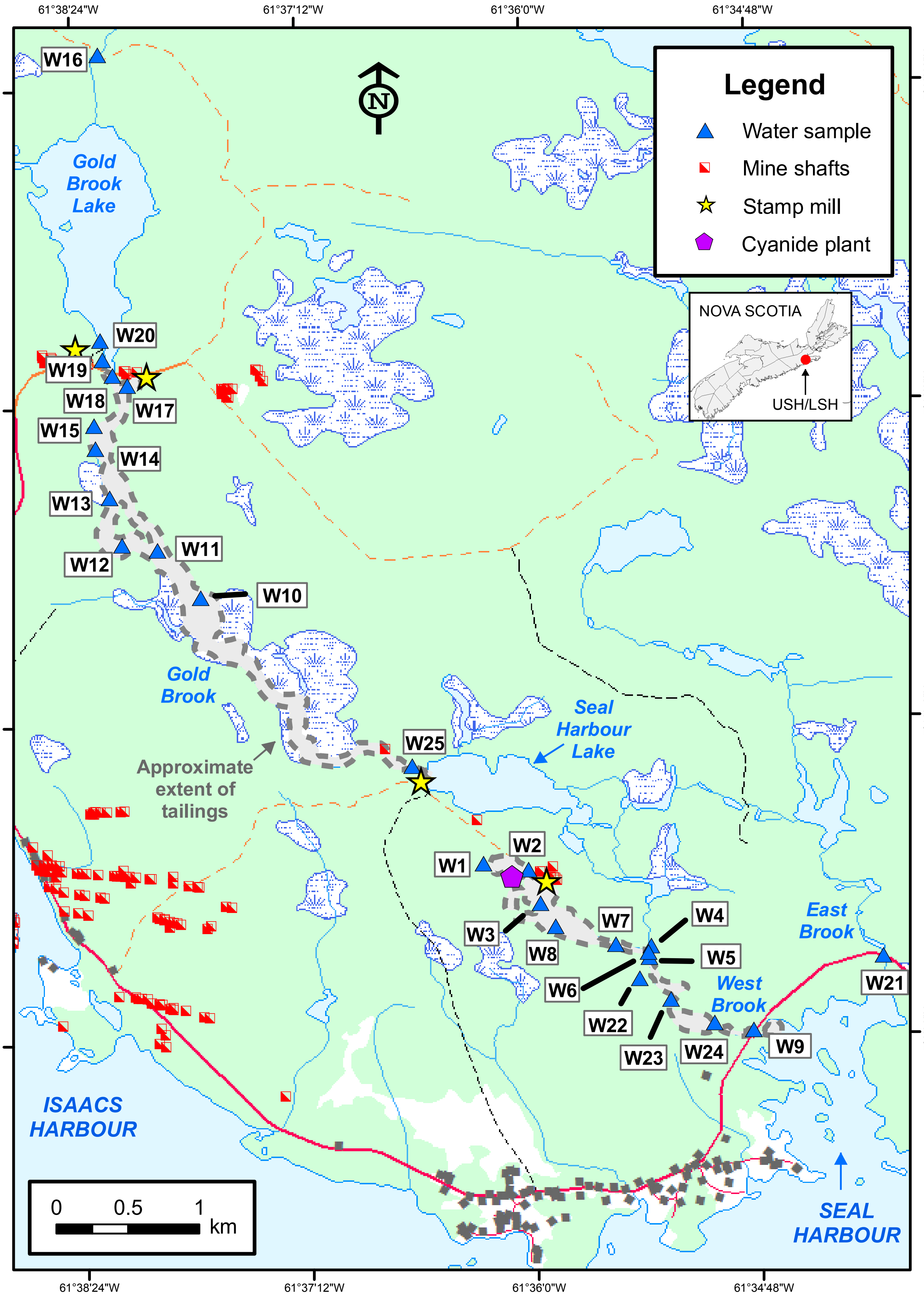


Fig. 120. Location of seasonal surface water samples in the Upper and Lower Seal Harbour gold districts between August 2003 and August 2005.

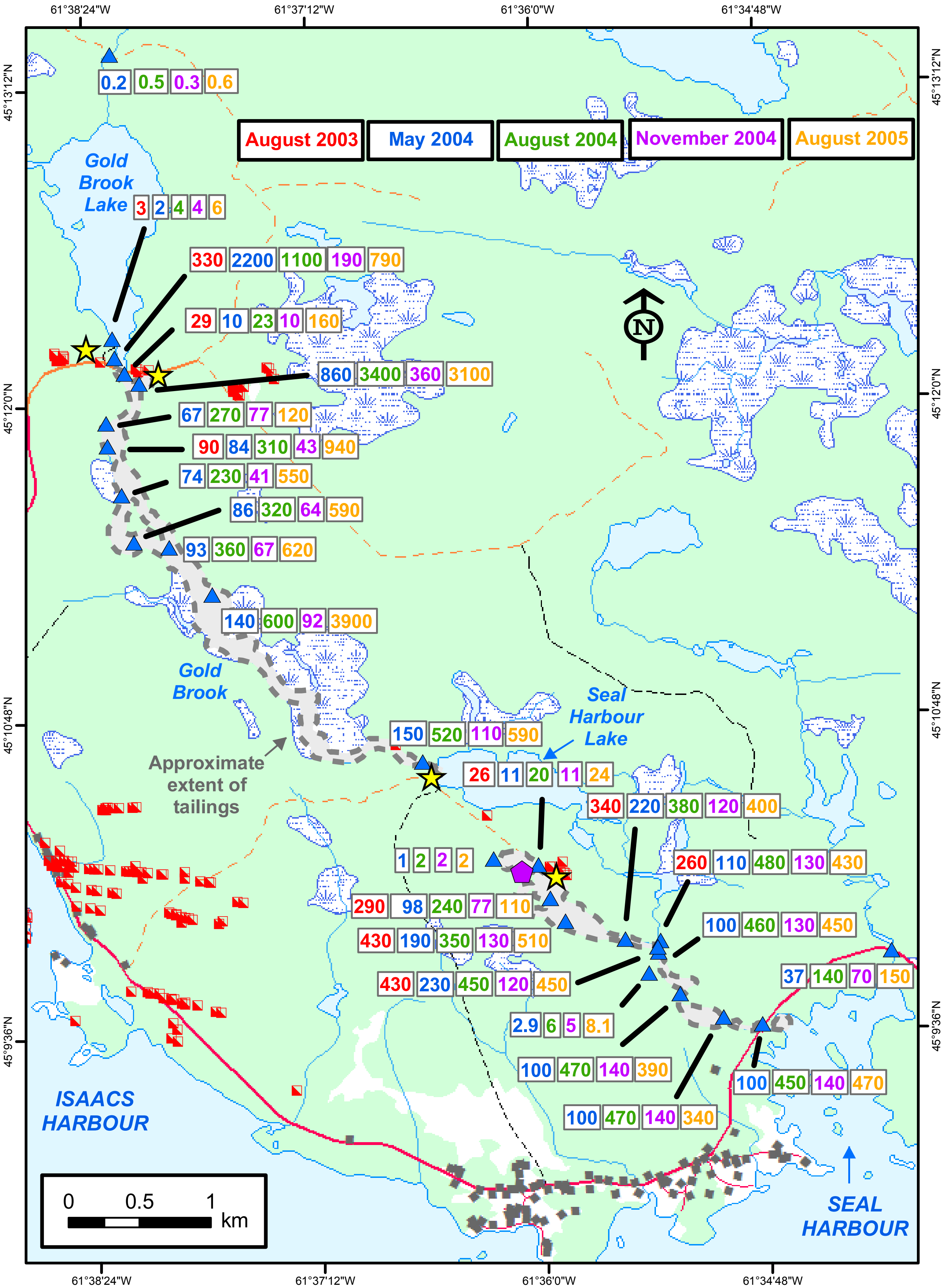


Fig. 121. As concentrations (µg/L) in filtered surface waters collected from the Upper and Lower Seal Harbour Gold Districts from August 2003 to August 2005.

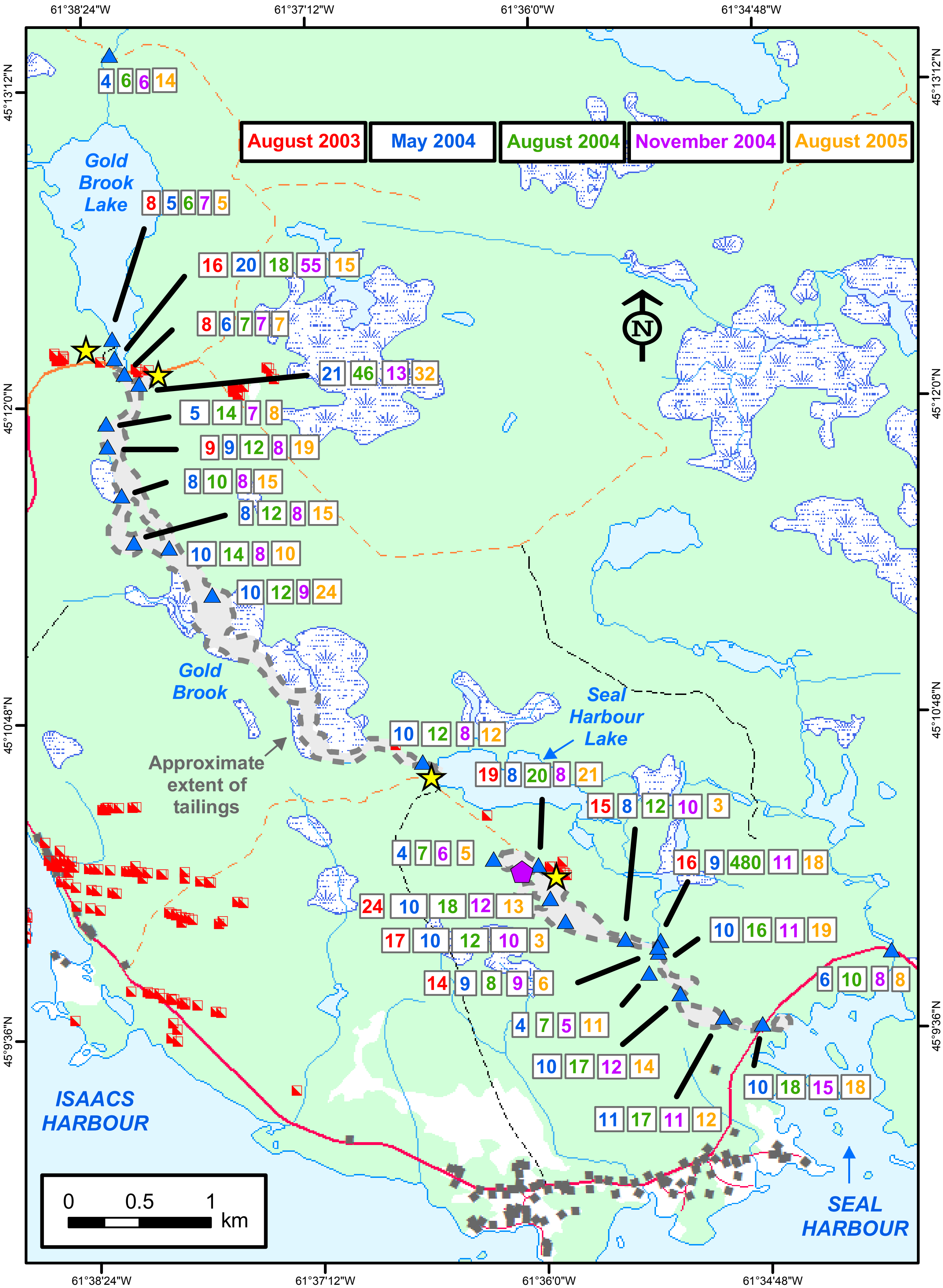


Fig. 122. Hg concentrations (ng/L) in filtered surface waters collected from the Upper and Lower Seal Harbour Gold Districts from August 2003 to August 2005.

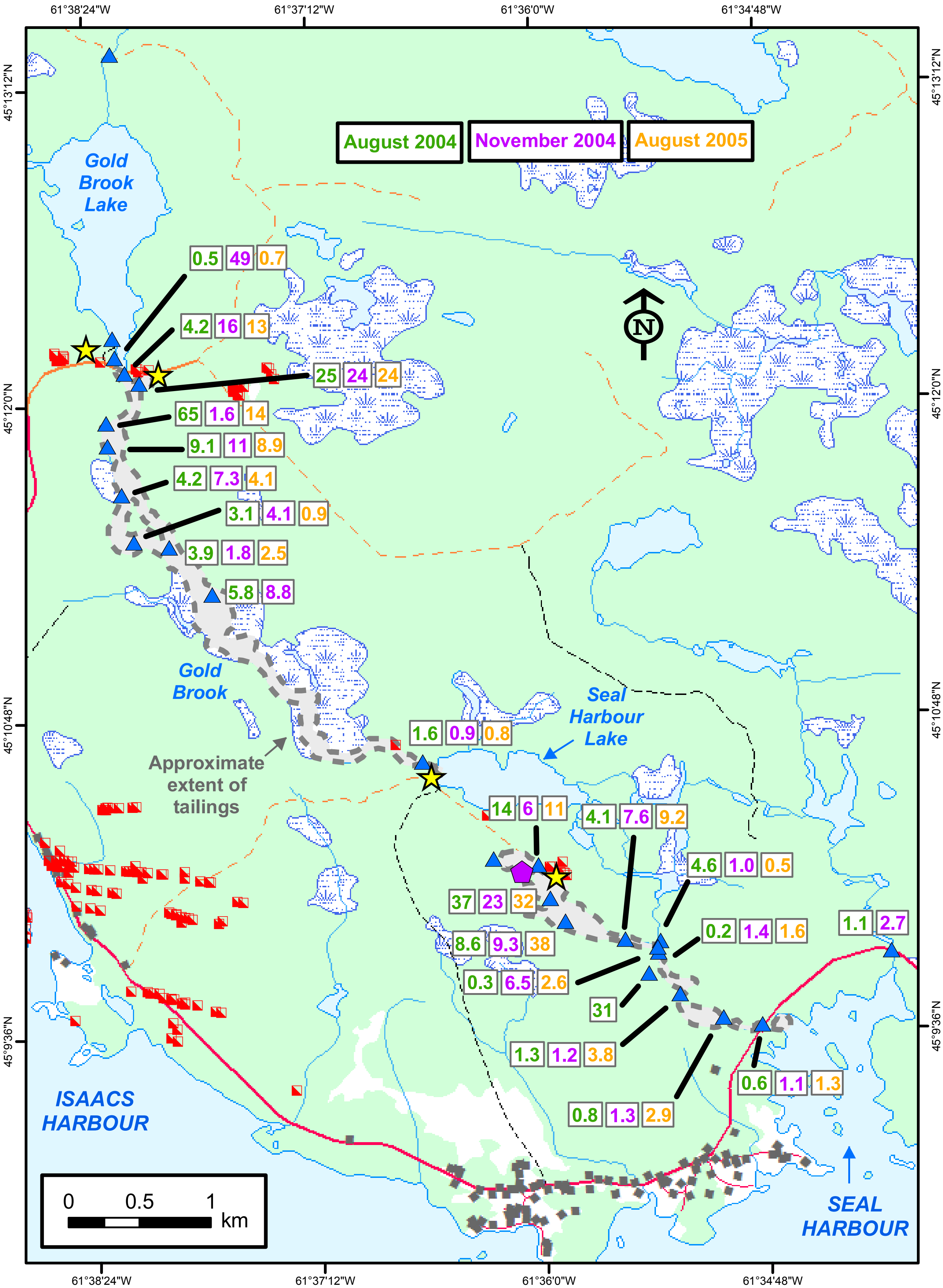


Fig. 123. Percentage of arsenite [%As(III)] in filtered surface waters collected from the Upper and Lower Seal Harbour Gold Districts in August 2004, November 2004, and August 2005.

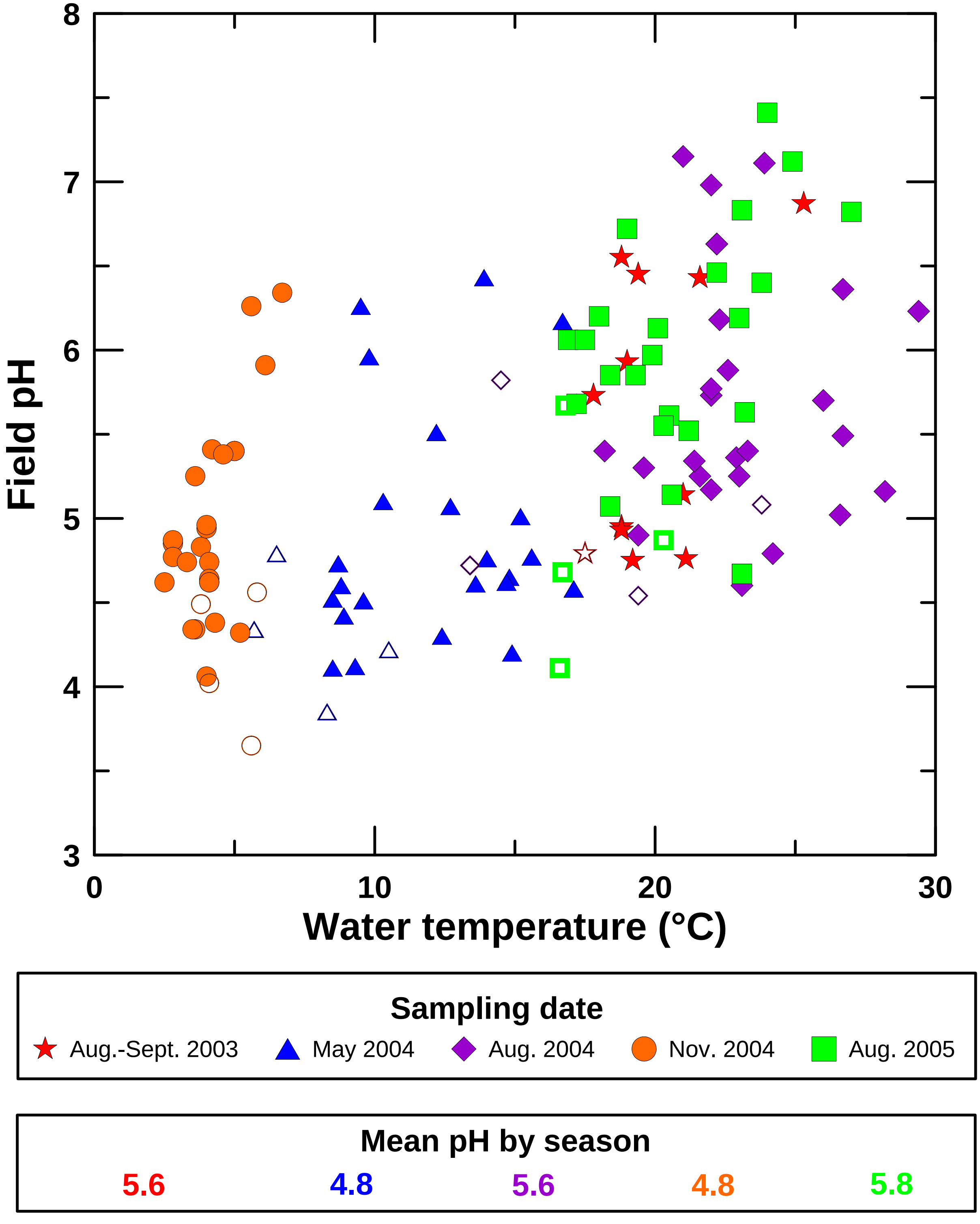


Fig. 124. Field pH and temperature measured in surface waters at the Upper and Lower Harbour gold districts between May 2003 and August 2005. Open symbols represent background locations and filled symbols represent sites impacted by mine tailings.

Sequential extraction results for As and Hg in tailings, Seal Harbour Gold Districts

In 2005, sequential extraction analysis (SEA) was used to investigate the mineral hosts for both As and Hg in selected tailings and sediment samples collected from the Upper and Lower Seal harbour districts. As shown in Table 3, two separate SEA procedures were used to assess the partitioning of As and Hg and the experimental conditions were optimized for each of these elements. The locations of samples from the Upper Seal Harbour and Lower Seal Harbour districts are shown in Figs. 89 and 44, respectively. Brief descriptions of each sample and full results from the SEA are tabulated in appendices D and E.

Sequential chemical extractions can provide important insights into the solid-phase speciation, mobility, bioavailability, and fate of As and Hg in the environment. Many previous studies have employed various SEA schemes to investigate the partitioning of both As (e.g. Keon *et al.* 2001; Wenzel *et al.* 2001; Mihaljevič *et al.*, 2003; Filippi *et al.* 2007; Corriveau *et al.* 2011; Larios *et al.* 2012) and Hg (e.g. Bloom *et al.* 2003; Kim *et al.* 2003; Hall *et al.* 2005; Hall and Pelchat 2005) in sediments, soils, and mine wastes. In environmental studies, SEA analyses can help identify the fractions of As and Hg that are most weakly bound to the solid phase and which may thus have greater mobility and environmental impact. The solid-phase associations in a given SEA scheme are operationally defined and the specificity of the reagents for a given element should be tested using end-member mineral phases (Bacon and Davidson 2008).

Figure 125 shows the percentage of As and Hg leached from end-member minerals using the SEA procedures outlined in Table 3. For As, SEA was carried out on a sample of arsenopyrite, the original host for most of the As in the tailings, and >97 % of As is released during the *aqua regia* step, as expected. Results for scorodite and yukonite, two of the main weathering-related secondary minerals identified in the tailings (Walker *et al.* 2009), show that most of the scorodite (87 %) and yukonite (86 %) reported to the 4M HCl and amorphous Fe-oxyhydroxide steps (0.25 M $NH_2OH{\cdot}HCl$ in 0.25 M HCl), respectively. Both scorodite and yukonite release ~10% of their As during the crystalline Fe-oxide leach. These results show that the leaches designated as "Arsenopyrite-like" and "Scorodite-like" in Table 3 should recover ~90% of these mineral phases, but yukonite cannot be distinguished from amorphous Fe-oxyhydroxides based on this SEA procedure. For Hg, samples of pure cinnabar and cinnabar mixed with granite released 100% and 97%, respectively, of their Hg during the *aqua regia* step. Mercury sulfides (cinnabar, metacinnabar) have been identified in historical gold mine tailings from other mining areas (e.g. Kim *et al*. 2003) and may form from elemental Hg [Hg(0)] under reducing conditions.

Figure 126 shows the SEA results for tailings-impacted surface sediments collected from the Upper and Lower Seal harbour gold districts in 2005. At both sites, As is present mainly in arsenopyrite in samples closer to the stamp mills, and occurs in more labile forms (e.g. Fe/Al oxides) with increasing distance downstream. Mercury does not show the same pattern with increasing distance from the mill site, but it does seem to be associated mainly with organic matter in the oxbow lake 1.5 km downstream of the USH mill, and in the intertidal marine sediments of Seal Harbour, 2.3 km downstream of the LSH mill. In all tailings-impacted sediments, the main hosts for Hg are crystalline Fe/Al oxides and/or organics +/- Hg(0).

The solid-phase speciation of As and Hg was also investigated in vertical profiles through historical amalgamation and cyanidation tailings at Lower Seal Harbour (Figs. 127-129).

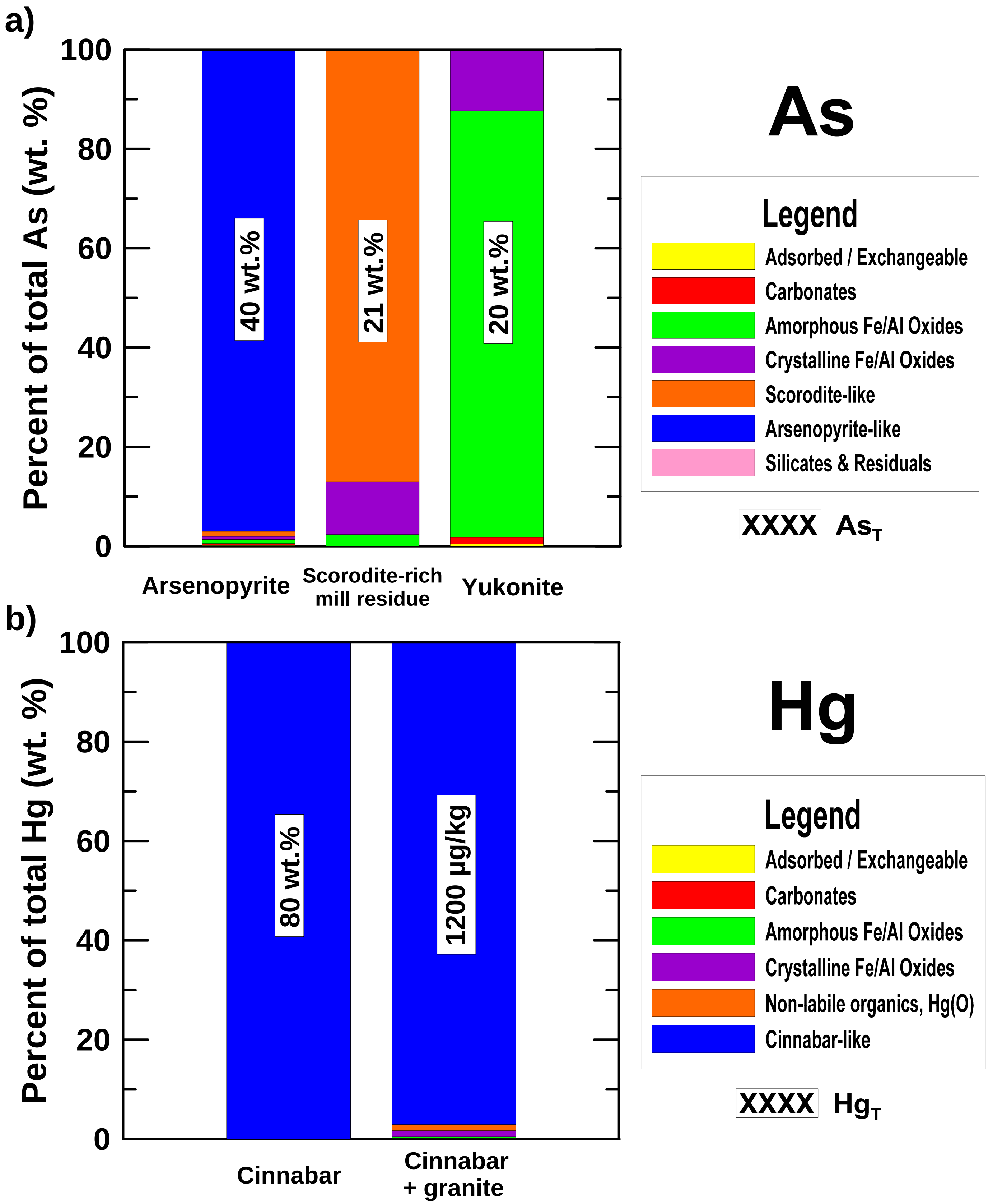


Fig. 125. Percentage of (a) As and (b) Hg leached during sequential extraction analyses of relatively pure end-member mineral phases to test the selectivity of various reagents. Details on the conditions of each leach step are provided in Table 3.

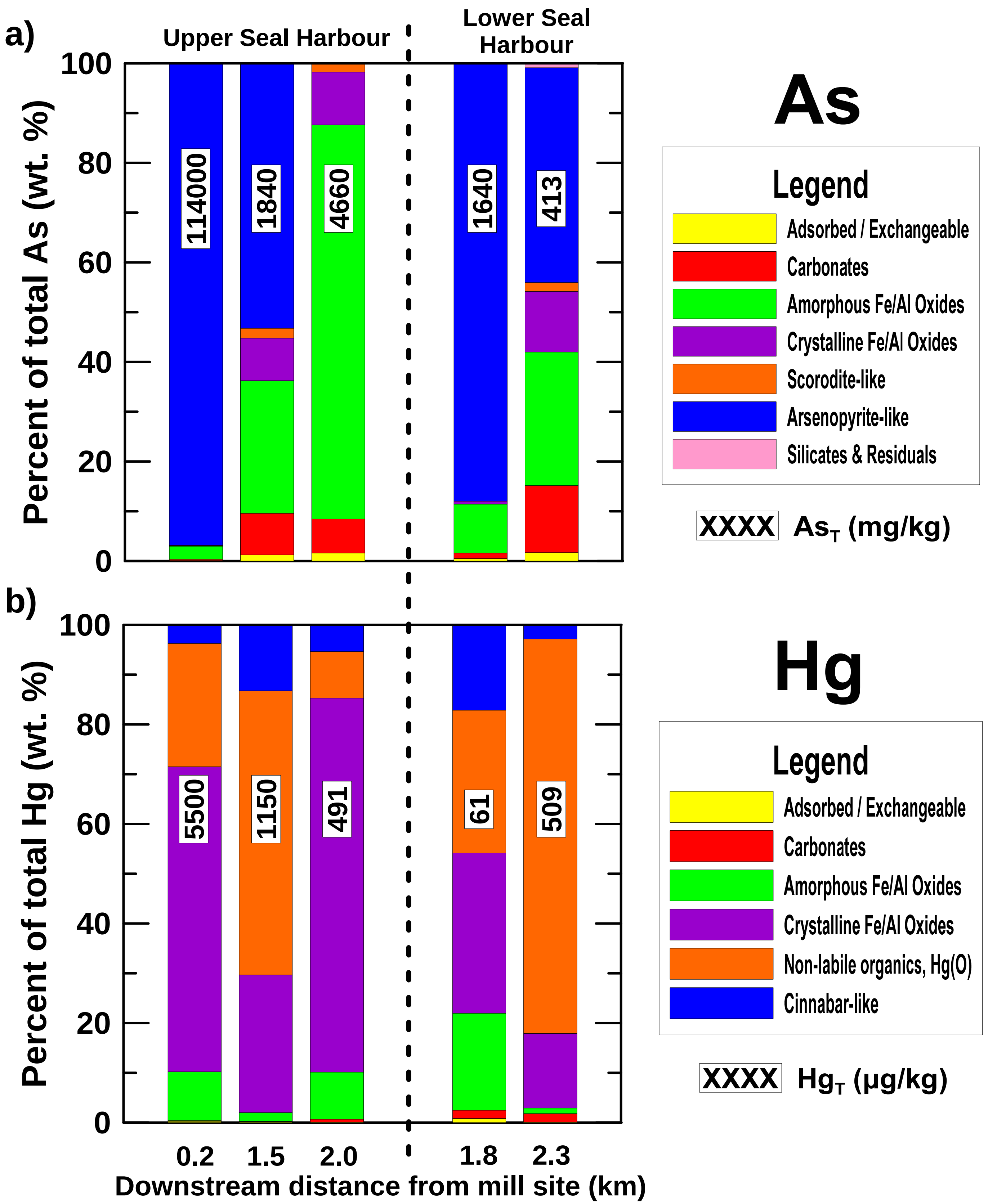
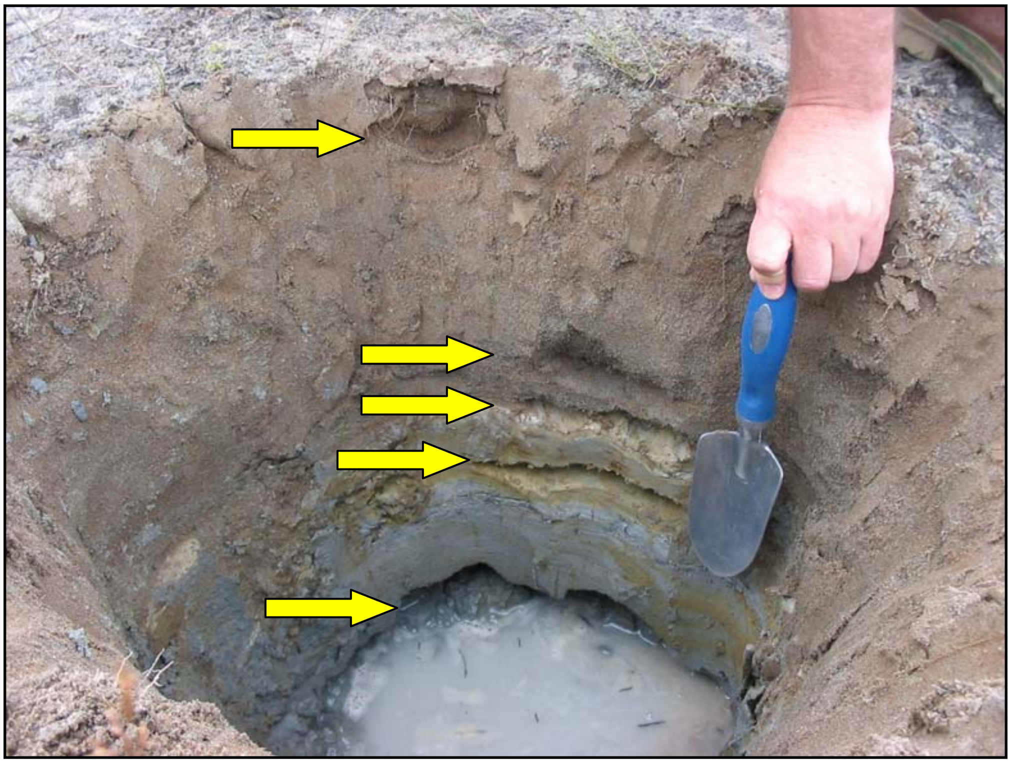


Fig. 126. Percentage of (a) As and (b) Hg leached during sequential extraction analyses of tailings-impacted sediments at the Upper and Lower Seal Harbour gold districts, Nova Scotia. Details on the conditions of each leach step are provided in Table 3.

a)



b)

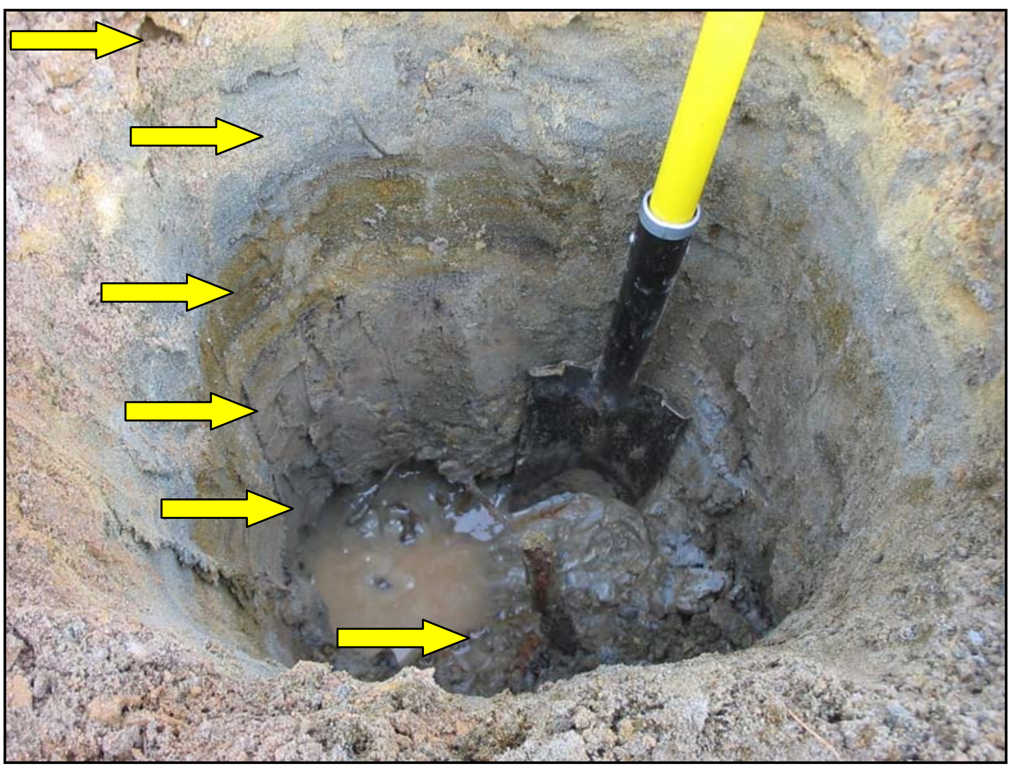


Fig. 127. (a) Depth profile through historical cyanidation tailings at the Lower Seal Harbour Gold District near Site T3 (Fig. 44). **(b)** Depth profile through historical amalgamation tailings at the Lower Seal Harbour Gold District near Site T13 (Fig. 44). In both pictures, the yellow arrows mark the location of subsamples collected for sequential extraction analyses.

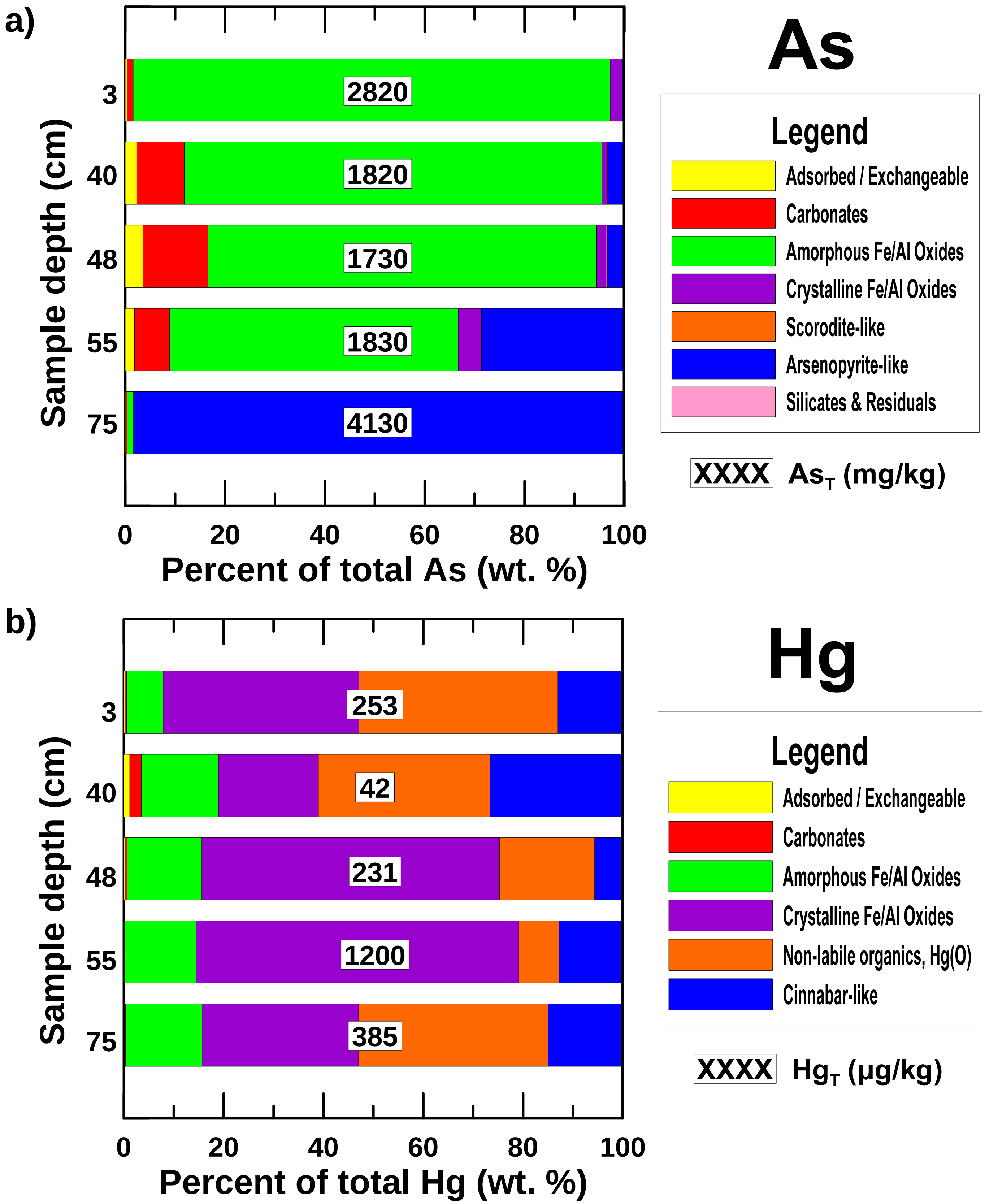
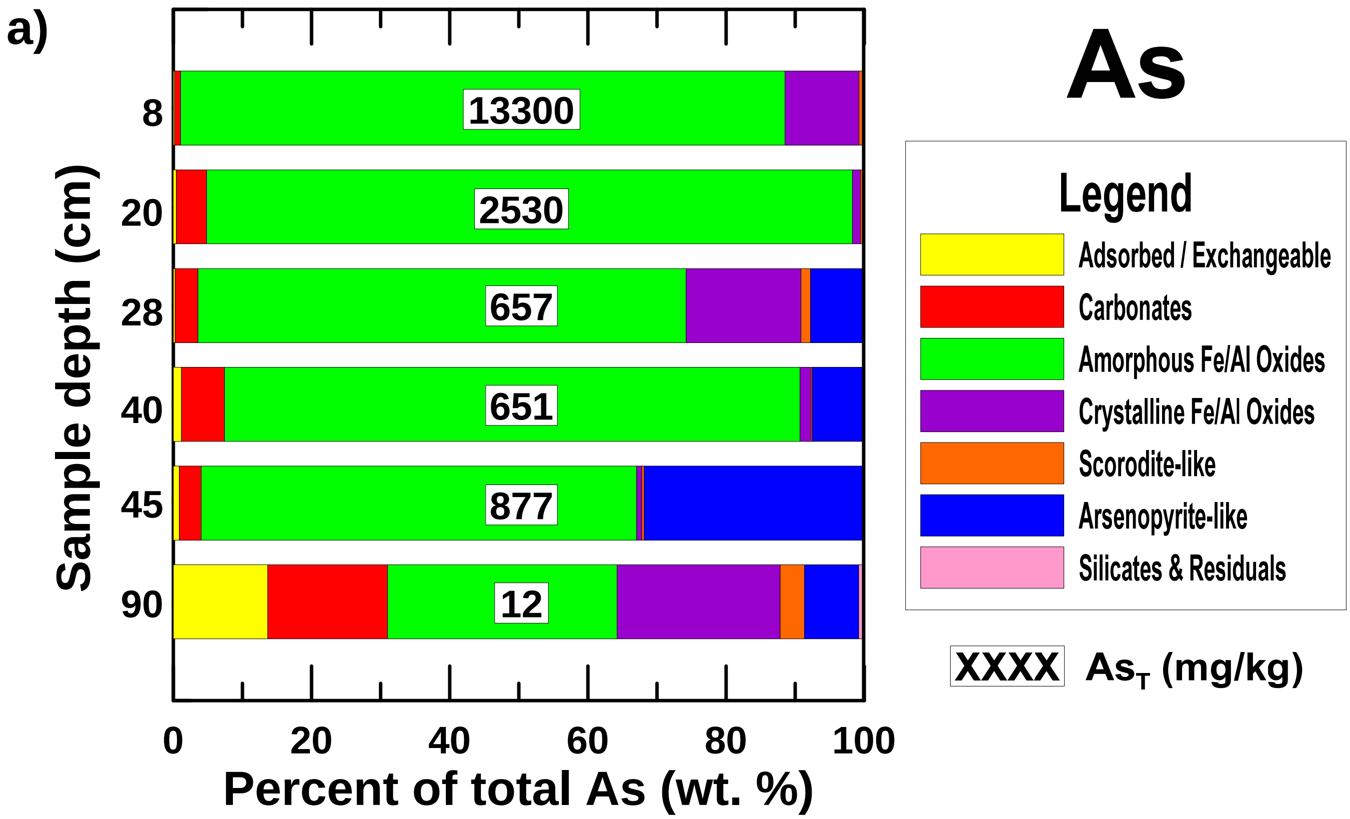


Fig. 128. Percentage of (a) As and (b) Hg leached during sequential extraction analyses of historical cyanidation tailings at the Lower Seal Harbour Gold District (Site T3), Nova Scotia. Details on the conditions of each leach step are provided in Table 3.



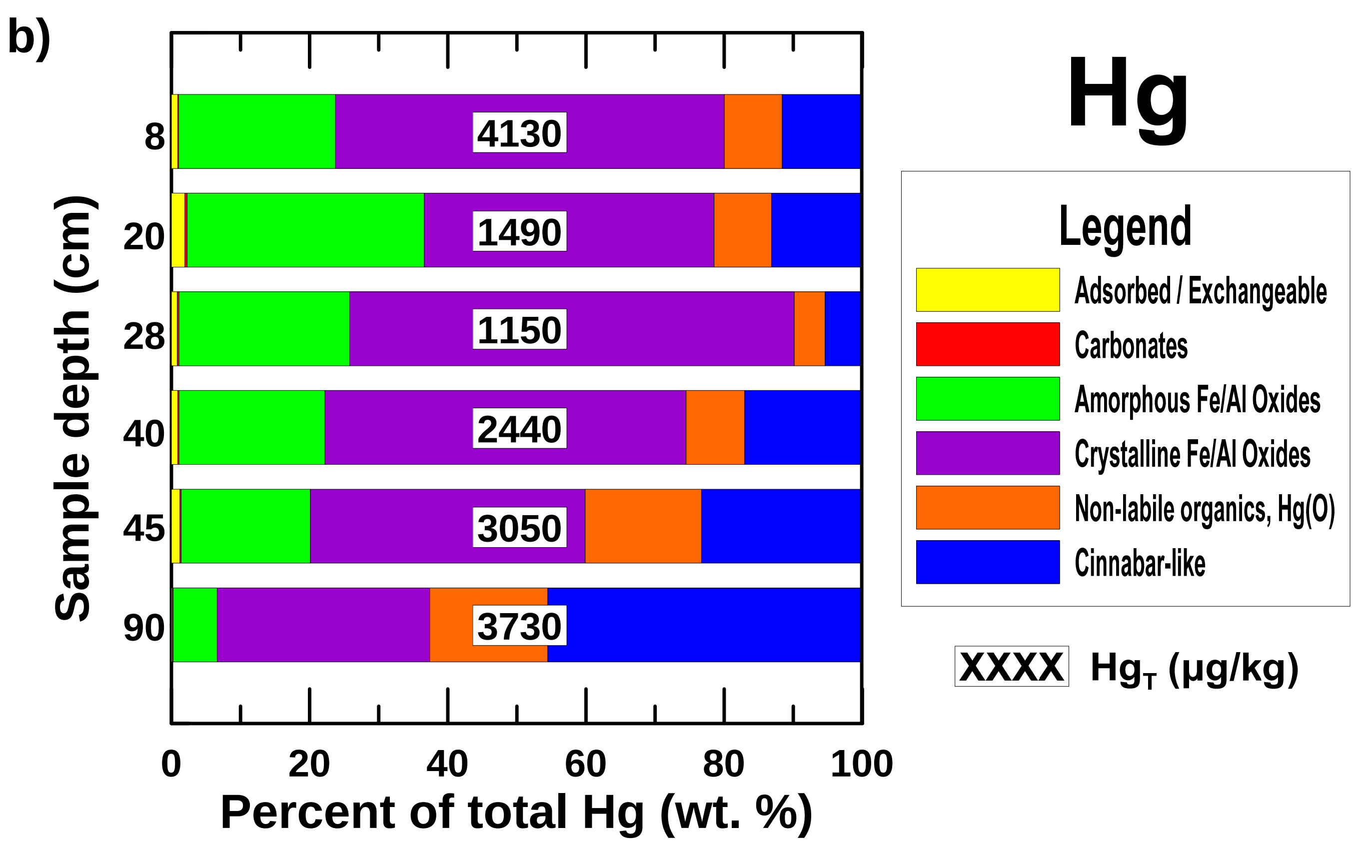


Fig. 129. Percentage of (a) As and (b) Hg leached during sequential extraction analyses of historical amalgamation tailings at the Lower Seal Harbour Gold District (Site T13), Nova Scotia. Details on the conditions of each leach step are provided in Table 3.

In both the cyanidation and amalgamation tailings, the dominant hosts for As in the top 55 cm of tailings are amorphous Fe/Al oxides, indicating that weathering reactions have oxidized most of the original arsenopyrite near the tailings surface. Below this depth, As is hosted mainly by arsenopyrite in the cyanidation tailings. In the amalgamation tailings, the total concentration of As drops to 12 mg/kg in the lowermost sample at 90 cm and is hosted by a range of different phases, suggesting that this sample represents natural soil underlying the tailings deposits. Iron oxides are also the main hosts for Hg in both types of tailings at Lower Seal Harbour. In the amalgamation tailings, the proportion of Hg hosted by sulphide phases generally increases with depth, whereas no such trend is apparent in the cyanidation tailings (Fig. 128, 129). Further interpretation of these SEA results will be published in a separate paper.

CONCLUSIONS AND RECOMMENDATIONS

Recent studies of 14 historical gold mines in Nova Scotia by NRCan and its partners have helped to characterize the environmental and human health hazards associated with these sites. The results of these investigations have led to the following key findings (Parsons 2007):

1) Most abandoned gold mines contain large volumes of tailings. In some areas the tailings have been transported significant distances (>2 km) offsite by local streams and rivers.
2) Tailings and stream sediments near these mine sites contain average concentrations of As and Hg that are about 340 and 140 times background levels in soils, respectively.
3) Dissolved As concentrations in stream waters that drain through tailings are well above Canadian guidelines for drinking water quality and the protection of aquatic life.
4) Since the mines closed, ongoing residential development, industrial construction, and recreational activities at some sites (e.g. ATV, dirt bike, and 4X4 racing) have increased the potential for human exposure to these mine wastes.

In response to the results of this study, the Province of Nova Scotia established the Historic Gold Mines Advisory Committee (HGMAC) in April 2005. The HGMAC has made significant progress in assessing the human health risks associated with these mine wastes, and has taken steps to reduce the public's exposure to these contaminated sites. This Open File Report provides the most comprehensive summary available of the history, distribution, and geochemistry of tailings at gold mines throughout Nova Scotia. The geographic coordinates on each sample location map can be used to quickly explore the tailings deposits via most web-based mapping services. The results of this study should be integrated into existing databases for abandoned mine lands in Nova Scotia and used to inform future land-use planning guidelines and decisions. Finally, these results can be used by industry and regulatory agencies to better understand the key environmental characteristics of orogenic gold deposits, and to help minimize the environmental impacts associated with past, present, and future gold extraction.

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APPENDIX - "B"

Nova Scotia Department of Natural Resources
Mineral Resources Branch

Open File Map ME 2009-1 (Sheet 81 of 84)

Historical Gold Mining, Isaacs Harbour Area, Part of NTS Sheet 11F/04, Guysborough County, Nova Scotia

P.K. Smith and T.A. Goodwin

Scale 1:5500

Halifax, Nova Scotia
2009

Map Notes

Universal Transverse Mercator Projection (UTM), Zone 20, Central Meridian 63°00' West.

North American Datum (NAD) 1983 Canadian Spatial Reference System (CSRS) 98.

Base and digital data derived from the Nova Scotia Topographic Database (NSTDB). Copyright Her Majesty the Queen in Right of the Province of Nova Scotia. The NSTDB is available from Service Nova Scotia and Municipal Relations (SNSMR), Land Information Services Division (LIS), Nova Scotia Geomatics Centre (NSGC), Amherst, Nova Scotia.

Property boundaries derived from the Nova Scotia Property Records Database, maintained by Service Nova Scotia and Municipal Relations. Updated March 1, 2009.

Crown Land Property Database (CLPD) provided by Nova Scotia Department of Natural Resources, Land Services Branch, Surveys Division. Updated March 5, 2009.

Colour aerial photography flown by the Nova Scotia Department of Natural Resources, 1995-2006.

Refer to Bates (1987, p. 33-35) for historical information and numbering of the gold districts.

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Disclaimer

The information on this map has come from a variety of government and nongovernment sources. The Nova Scotia Department of Natural Resources does not assume any liability for errors that may occur. This map is intended for use at the published scale of 1:5500.

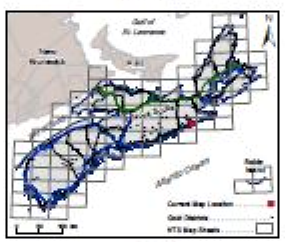
The location and the areal extent of the tailings have not been field checked. Additional tailings may exist. Natural dispersal of tailings has not been determined. The location of shafts and associated mine buildings have also not been field checked.

Please note, some maps in this series do not indicate the presence of former mine tailings. In these instances either, (1) there is no historical information regarding the presence or location of the tailings, or (2) the historical information is too vague to depict the approximate outline of the former mine tailings.

Safety Advisory

A number of safety issues are associated with former gold mining districts. Physical hazards such as open pits and open shafts may exist. Never enter any open holes or shafts. Falling rock debris may occur along high wall rock faces. Tailings may contain high concentrations of arsenic and mercury. Keep off any tailings containment areas.

Index Map



Legend

Approximate area of historical mining activity
Crown lands
Property boundaries
Faribault Data* (Faribault data do not appear on all maps.)
Shafts
Quartz veins
Tailings
Waste rock
Buildings
Buildings (crushers)
Buildings (cyanide plants)
Buildings (mills)
Buildings (stamp mills)
Faribault gold district outline
Basedata
100 Series highway
Trans-Canada Highway
Collector highway
Roads
Railway (active, inactive)
County boundary
Transmission lines (multi, single)
Coastline
Rivers, streams, lakes
Swamps

* Historical mining information digitized from detailed mapping by E.R. Faribault of the Geological Survey of Canada from the late 1800s to the early 1900s. Not all gold districts were mapped. Please contact the Nova Scotia Department of Natural Resources library for a list of the districts that have been mapped. The accuracy of the historical information (as shown on this map) cannot be guaranteed. This map should not be used for legal purposes.

References

Bates, J. L. E. 1987: Gold in Nova Scotia; Nova Scotia Department of Mines and Energy, Information Series No. 13, 48 p.

Faribault, E. R. 1904: Plan and sections, Isaacs Harbour Gold District, Guysborough County, Nova Scotia; Geological Survey of Canada, Map 900, scale 1:6000.

Recommended Citation

Smith, P.K. and Goodwin, T.A. 2009: Historical gold mining, Isaacs Harbour area, part of NTS sheet 11F/04, Guysborough County, Nova Scotia; Nova Scotia Department of Natural Resources, Mineral Resources Branch, Open File Map ME 2009-1 (sheet 81 of 84), scale 1:5500.