TECHNICAL SUPPORTING DOCUMENT

Mary River Project | Phase 2 Proposal | FEIS Addendum | August 2018

TSD 21

Risk Assessment for Introduction of Aquatic Invasive Species from Ballast Waster

AQUATIC INVASIVE SPECIES TECHNICAL SUPPORTING DOCUMENT SUMMARY

The Aquatic Invasive Species (AIS) Technical Supporting Document provides a risk assessment of the the potential for ship-mediated introductions of aquatic invasive species at Milne Port as a result of shipping operations for the Phase 2 Proposal and includes new information collected or published since submission of materials for the Approved Project as well as relevant guidance provided by Fisheries and Oceans Canada. It details a revised version of the risk assessment conducted for the Approved Project, updated to reflect new shipping volumes and ship specifications applicable to the Phase 2 Proposal. The Phase 2 Proposal builds on the extensive baseline studies and assessments carried out since 2011 for the larger Approved Project and is thus closely linked to the FEIS and previous addendums. This document is used as input to the assessment of effects on the marine environment.

Given the increased capacity and operation of the Mary River Project, and anticipated increases in shipping traffic, it is expected that the volume of shipping ballast water discharge will increase. Using the Phase 2 Proposal shipping schedule and vessel information, it was determined that ore carriers will discharge exchanged ballast water 132 times per year to allow for loading of ore upon arrival at Milne Port. A total of approximately 3,586,000 tonnes of ballast water is anticipated to be discharged into Milne Port during the shipping season each year, however mid-ocean exchanges will drastically reduce the potential that any water from a vessel's port of origin will be discharged into Milne Inlet.

The study determined that, with the large volume of ballast water discharged, the probability of AIS being introduced at Milne Port is very high. However, the risk assessment does not take into account potential mitigation measures against the introduction of AIS. Ship ballast water management will be undertaken with due diligence. Conditions and effectiveness of different treatment options can be considered, quantified, and assessed to provide more accurate information for the risk assessment of aquatic invasive species. The best treatment options will be considered as one of the potential mitigation measures. In addition, Baffinland's Shipping and Wildlife Management Plan, and Aquatic Invasive Species Monitoring Programs will be updated to address the increase in ballast water discharge volume as well as ballast water treatment options and monitoring. A new, more strict standard for ballast water management has come into force which will mean the installation of an on-board system to treat ballast water for most ships, which will also greatly reduce the risk of introduction of AIS.

RÉSUMÉ DE LA DOCUMENTATION TECHNIQUE COMPLÉMENTAIRE SUR LES ESPÈCES AQUATIQUES ENVAHISSANTES

La documentation technique complémentaire sur les espèces aquatiques envahissantes (EAE) comporte une évaluation du potentiel de risque d'introduction par bateau d'espèces aquatiques envahissantes au port de Milne à la suite des opérations d'expédition de la proposition de la phase 2 et comprend les nouveaux renseignements recueillis ou publiés depuis la soumission du matériel pour le projet approuvé, ainsi que des conseils pertinents fournis par Pêches et Océans Canada. Cette documentation détaille une version révisée de l'évaluation des risques effectuée pour le projet approuvé, mise à jour pour refléter les nouveaux volumes d'expédition et les spécifications des navires applicables à la proposition de la phase 2. La proposition de la phase 2 est fondée sur les études préliminaires et les évaluations complètes réalisées depuis 2011 pour l'ensemble du projet approuvé et est donc étroitement liée à l'énoncé des incidences environnementales (EIE) et aux addendas précédents. Ce document est utilisé pour l'évaluation des impacts sur le milieu marin.

Compte tenu de l'augmentation de la capacité et de l'exploitation du projet de la rivière Mary et de l'augmentation prévue du trafic maritime, on s'attend à ce que les décharges d'eaux de ballast associées au transport augmentent. À l'aide du calendrier d'expédition de la proposition de la phase 2 et des renseignements détenus sur le trafic maritime, il a été déterminé que les transporteurs de minerais déverseront 132 fois par an leurs eaux de ballast échangées pour permettre le chargement du minerai à l'arrivée au port de Milne. Au total, environ 3 586 000 tonnes d'eaux de ballast devraient être déversées chaque année dans le port de Milne au cours de la saison de navigation. Toutefois, les échanges océaniques réduiront considérablement la possibilité que l'eau du port d'origine du navire soit déversée dans Milne Inlet.

L'étude a déterminé que, compte tenu du volume important d'eaux de ballast rejetées, la probabilité d'introduction d'EAE au port de Milne est très élevée. Cependant, l'évaluation des risques ne prend pas en compte les mesures d'atténuation potentielles contre l'introduction des EAE. La gestion de l'eau de ballast des navires sera exécutée avec diligence. Les conditions et l'efficacité de différentes options de traitement peuvent être considérées, quantifiées et évaluées pour fournir des renseignements plus précis pour l'évaluation des risques associés aux espèces aquatiques envahissantes. Les meilleures options de traitement seront considérées comme l'une des mesures d'atténuation potentielles. En outre, le plan de gestion de la faune et de la navigation de Baffinland et les programmes de surveillance des espèces aquatiques envahissantes seront mis à jour pour tenir compte de l'augmentation du volume de rejet d'eaux de ballast ainsi que des options de traitement et de surveillance des eaux de ballast. Une nouvelle norme plus stricte pour la gestion des eaux de ballast est entrée en vigueur. Elle prévoit l'installation d'un système embarqué de traitement des eaux de ballast pour la plupart des navires, ce qui réduira considérablement le risque d'introduction d'EAE.

ᑕᑎᐅᑉ ᑎᑭᕝᕙᒃᑐᑦ ᐆᒪᔪᕐᒥᑦ ᐱᔭᕆᐊᑐᔪᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᑦ

ᑕᑎᐅᑉ ᑎᑭᕝᕙᒃᑐᑦ ᐆᒪᔪᕐᒥᑦ (AIS) ᐱᔾᕈᐊᑐᔪᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᑦ ᐱᑕᖃᖅᑎᑦᑎᕚᑦ ᐅᓗᕆᐊᓇᕈᑎᔪᓄᑦ ᕿᒥᕐᕈᐃᓂᕐᒥᒃ ᓴᖅᑭᑦᑐᓐᓇᖅᑐᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ–ᐃᑭᒪᔾᔪᐊᓄᑦ ᓴᖅᑭᑕᐅᔪᓂᒃ ᑕᑎᐅᕐᒥᑦ ᑎᑭᕝᕙᒃᑐᑦ ᐆᒪᔪᕐᒥᑦ ᕿᓐᖑᐊᑕ ᐅᒥᐊᕐᔪᐊᓕᕆᖕᕕᐊᓄᑦ ᐅᒥᐊᕐᔪᐊᓂᒃ ᐅᓯᒃᖃᑕᐃᖃᑦᑕᖅᑎᓪᓗᒋᑦ ᐱᓕᕆᐊᑉ ᒪᕈᒋᓕᖅᑕᖓ ᐅᒃᑑᑎᖓᑕ ᐃᓚᖃᖅᐳᓂᓗ ᓄᑖᓂᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᒃᓴᓂᒃ ᑲᑎᖅᓱᖓᑦ ᑎᑎᕋᐅᓯᐅᔪᓪᓘᓐᓅᑦ ᑕᐃᑲᖕᖓᓂᑦ ᑎᑎᕋᐅᓯᑦ ᓯᕗᓪᓕᖅᐹᑦ ᑐᓐᓂᖅᓴᖅᑕᐅᓚᐅᖅᑎᓪᓗᒋ ᐊᖏᖅᓯᒪᔭᒍᑦ ᐅᔾᕋᖕᓂᐊᕐᓂᕐᒧᑦ ᐊᒻᒪᑦᑕᐅᖅ ᐋᑑᑎᔪᑦ ᑐᑭᒧᐊᕈᑏᑦ ᑐᓐᓂᖑᔭᐅᔪᑦ ᑲᓇᑕᐅᑉ ᐃᒪᕐᒥᐅᑕᓕᖅᐹᒃᑯᖏᓐᓄᑦ. ᐃᓚᖅᑲᖅᑐᑦ ᓇᓗᓇᐃᖅᓯᒪᓪᓗᓂ ᓄᑖᕈᑕᒥᒃ ᐅᓗᕆᐊᓇᖅᑐᓄᑦ ᕿᒥᕐᕈᐃᔾᔪᑎᓄᑦ ᑲᒪᒋᔭᐅᓲᑦ ᐊᖏᖅᑕᐅᓯᒪᔪᒧᑦ ᐅᔾᕋᓐᓂᐊᕝᕕᒻᒧᑦ, ᓄᑖᕈᖅᑕᐅᓯᒪᔪᑦ ᓴᖅᑮᓂᖏᓄᑦ ᓄᑖᓂᒃ ᐅᒥᐊᔾᔪᐊᒃᑯᑦ ᐅᓯᓂᖏᓄᑦ ᓇᓗᓇᐃᖅᓯᒪᔪᓂᓪᓗ ᐊᑐᖅᑯᔾᐅᓂᖏᓄᑦ ᐱᓕᕆᐊᑉ ᒪᕈᒋᓕᖅᑕᖓ ᐅᒃᑑᑎᖏᒍᑦ. ᓴᓇᐅᒪᓂᐊ 2 ᐅᒃᑑᑎᖓ ᐃᓚᒋᐊᕆᔭᖅᑲᖅᑐᖅ ᖄᖓᒍᑦ ᐊᖏᔫᔪᑦ ᑐᙵᕕᑦ ᖃᐅᔾᔭᕕᓃᑦ ᐊᕙᑖᓄᑦ ᑕᒪᓐᓇ ᕿᒥᕐᕈᐃᓂᖅ ᑕᐃᑲᖓᑦ 2011–ᒥ ᑖᔅᓯᒍᖓ ᐃᓗᐃᑦᑑᔪᒍᑦ ᐊᖏᖅᓯᒪᔭᒍᑦ ᐅᔾᕋᕐᓂᐊᕐᓂᕐᒍᑦ ᑕᐃᒫᓪᓗ ᓂᒃᓯᒃᓯᒪᓂᖅᑲᖅᐳᖅ ᑭᖑᓪᓕᖅᐹᑉ ᐅᓂᒃᑳᖏᓄᑦ FEIS ᓯᕗᓂᐊᒍᓪᓗ ᐅᐃᒍᒋᐊᖅᑕᐅᓂᑰᔪᒃᑯᑦ. ᐅᓇ ᑎᑎᕋᖅᓯᒪᔪᖅ ᐊᑐᖅᑕᐅᔪᖅ ᐅᓂᒃᑳᓪᓗᒍ ᕿᒥᕐᕈᐃᓂᖏᓄᑦ ᐊᒃᑐᐃᓂᖅᑲᓐᓂᖏᑕ ᑕᑎᐅᑉ ᐊᕙᑖᓄᑦ.

ᐱᓪᓗᒍ ᐊᖏᓛᒋᐊᕐᓂᖓ ᐊᐅᓚᑕᐅᔪᓪᓗ ᓄᓘᔾᐸ ᐅᔾᕋᖕᓂᐊᕐᕕᖕᖓᓄᑦ, ᓂᕆᐅᒋᔭᐅᔪᓪᓗ ᐊᖏᓛᒋᐊᕆᔪᑦ ᐅᒥᐊᕐᔪᐊᑉ ᐃᖏᕐᕋᔭᖕᓂᖏᒍᑦ, ᓂᕆᐅᒋᔭᐅᕗᖅ ᑕᒪᒃᑯᐊ ᐊᒃᑎᒋᓂᖏᑦ ᐅᒥᐊᕐᔪᐊᑦ ᐃᒃᑕᖅᑯᑎᖏᑦ ᐃᒦᑦ ᑯᕕᔭᐅᓃᑦ ᐊᖏᓛᒋᐊᕋᔭᕐᒥᔪᑦ. ᐊᑐᕐᓗᒍ ᐱᓕᕆᐊᑉ ᒪᕈᒋᓕᖅᑕᖓ ᐅᒃᑐᖓᑕ ᐅᒥᐊᕐᔪᐊᑉ ᐅᓪᓗᕐᑯᑎᖏᓂᒃ ᐅᒥᐊᕐᔪᐊᓪᓗ ᑐᑭᓯᐅᒪᔾᔪᑎᖏᑦ, ᓇᓗᓇᐃᓇᓪᓗᑎᒃ ᓴᕙᕋᔭᒃᓴᓂᒃ ᐅᓯᒃᖃᑦᖃᑎᑦ ᐅᒥᐊᕐᔪᐊᑦ ᑯᕙᓯᒃᑖᑦᑕᓂᐊᖅᑐᑦ ᐃᒃᑕᖅᑯᑎᒥᓂᒃ ᐃᒥᕐᒥᒃ ᐃᒻᒪᖅᑲ 132–ᖏᖅᓱᓪᓗᑎᒃ ᐊᕐᕌᒍᑕᒫᖅ ᐅᓯᓕᖅᓯᓕᕌᖓᒥᒃ ᓴᕙᕋᔭᒃᓴᒥᒃ ᕿᓐᖑᐊᑕ ᐅᒥᐊᕐᔪᐊᓕᕆᖕᕕᐊᓂ. ᐃᒻᒪᖅᑲ ᑲᑎᓕᒫᖅᑯᒍ 3,586,000 ᑕᓐᓯᑦ ᐃᒃᑕᖅᑯᑎᑦ ᐃᒥᑦ ᑯᕕᔭᐅᓂᐊᖅᑐᑦ ᕿᓐᖑᐊᑕ ᐅᒥᐊᕐᔪᐊᓕᕆᖕᕕᐊᓄᑦ ᐊᕐᕋᒍᑕᒫᖅ ᐅᒥᐊᕐᔪᐊᖅᑲᖅᑎᓪᓗᒍ, ᑭᓯᐊᓂᓕ ᕿᑎᕋᖅᑐᑦ ᑕᑎᐅᕐᔪᐊᒥ ᑭᐳᒃᑎᓇᓃᑦ ᐃᒥᖓᓐᓂᒃ ᒥᑭᓕᓇᓗᑎᒃ ᓴᖅᑭᑐᐃᓐᓇᓇᐊᓕᓐᓂᒃ ᐃᒪᖓ ᑕᑎᐅᑉ ᐊᑭᐊᓂᖓᖅᑐᖅ ᑎᑭᒃᑲᔾᓐᓂᐊᑕ ᕿᓐᖑᐊᑉ ᑕᑎᐅᖓᓄᑦ.

ᖃᐅᔾᔨᓴᐃᓂᖅ ᓇᓗᓇᐃᖅᓯᓪᓗᓂ, ᐊᖏᔫᓂᖓᓄᑦ ᐃᒪᖓ ᑯᕙᔭᐅᓖᖅ ᐃᒃᑕᖅᑯᑎᕆᔭᐅᔪᖅ, ᐱᑕᖃᑐᐃᓐᓇᓇᐊᖅᑳᓂᖓ ᐆᒪᔪᓂᒃ AIS ᕿᓐᖑᐊᑕ ᐅᒥᐊᔾᔪᐊᓕᕆᖕᕕᐊᓂ ᐊᖏᔫᒻᒪᓇᒃᑐᖅ. ᑭᓯᐊᓂᓕ, ᐅᓗᕆᐊᓇᕐᓂᖓᓄᑦ ᕿᒥᕐᕈᐃᓂᖅ ᐃᓱᒪᒋᔭᖅᑲᕋᓂ ᓴᖅᑭᓰᓄᑦ ᓄᖅᑲᖓᑎᑦᑎᔾᔪᑎᓄᑦ ᐊᑐᖅᑕᐅᓰᑦ ᑎᑭᕝᕈᓇᒋᑦ ᐋᓪᓚᐅᔪᑦ ᐆᒪᔪᑦ. ᐅᒥᐊᕐᔪᐊᑦ ᐃᒃᑕᖅᑯᑎᖏᑦ ᐃᒪᖏᓄᑦ ᑲᒪᒋᔭᐅᔾᔪᑎᖏᑦ ᐸᖅᑭᔭᐅᓂᐊᖅᑐᑦ. ᐃᓚᖅᑯᓯᖏᑦ ᐱᐅᓂᖏᓪᓗ ᐊᔾᔨᒌᖏᑦᑐᑦ ᐃᓱᒪᒋᔭᐅᓂᐊᖅᐳᑎᒃ, ᓇᓗᓇᐃᖅᑕᐅᓗᑎᒃ, ᐊᒻᒪᓗ ᕿᒥᕈᓗᑦ ᓱᓕᓛᒥᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᓂᒃ ᐱᓱᒪᔪᓐᓇᕐᑯᓪᓗᑕ ᐅᓗᕆᐊᓇᐅᑎᖏᓐᓇᓄᑦ ᑎᑭᕝᓱᑦ ᐆᒪᔪᕐᒥᑦ. ᐱᐅᓛᖅ ᐃᓱᒪᒋᔭᒃᓴᑦ ᑕᑯᓇᒃᑕᐅᓂᐊᖅᐳᑎᒃ ᐊᑐᕐᒃᓴᓄᑦ ᓄᖅᑲᖓᔾᔪᑎᓄᑦ. ᖃᒃᑲᓐᓂᐊᒍᑦ, ᐹᕙᓛᓐᑯᑦ ᐅᓯᑲᖅᑕᐃᓂᕐᒧᑦ ᓂᕐᔪᑎᓄᓪᓗ ᑲᒪᒋᔾᔪᑖ ᐸᕐᓇᐅᑎ, ᐊᒻᒪᓗ ᑎᑭᕝᕙᒃᑐᑦ ᐆᒪᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ ᐱᓕᕆᐊᑦ ᓄᑖᕈᑎᐊᖅᑕᐅᓗᑎᒃ ᐊᖏᓛᒋᐊᕐᓂᐊ ᐃᒃᑕᖅᑯᑎᐅᓖᖅ ᐃᒪᖓ ᑯᕙᔭᐅᓂᐊᓄᑦ ᐊᒻᒪᓗ ᑐᕐᑯᓴᐃᓖᑦ ᐃᒪᖓᓄᑦ ᖃᐅᔨᓴᕈᑎᓪᓗ. ᓄᑖᒥᒃ, ᒪᓕᒋᐊᓕᖕᒥᒃ ᐊᑐᖑᒃᓴᒥᒃ ᐃᒃᑕᖅᑯᑎᓄᑦ ᐃᒥᕐᒧᑦ ᓴᖅᑭᑦᑐᖅᑲᖅᓯᒪᕗᖅ ᐃᓕᓯᒪᔭᓇᐊᖅᑲᖅᓗᑎᒃ ᐅᒥᐊᕐᔪᐊᒥᒃ ᐃᒃᑕᖅᑯᑎᖓ ᐃᒥᖓ ᑐᕐᑯᓴᐃᓯᖅᓯᒪᓗᒍ ᐅᒥᐊᕐᔪᐊᓄᑦ, ᑕᒪᓐᓇ ᓴᖅᑮᖏᓐᓂᖅᓴᐅᒐᔭᖅᑐᖅ ᐆᒪᔪᓂᒃ ᐋᓪᓚᐅᔪᓂᒃ ᑕᑎᐅᖓᓄᑦ.

REPORT

Baffinland Iron Mines Corporation
Mary River Project – Phase 2 Proposal

Technical Supporting Document No. 21
Risk Assessment for Introduction of Aquatic Invasive Species from Ballast Water

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Table of Contents

TABLES

FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation and Acronyms	Definition
Baffinland	Baffinland Iron Mines Corporation
Mtpa	Million tonnes per annum
ERP	Early Revenue Phase
DWT	deadweight tonnage
AIS	aquatic invasive species
°C	Degree Celsius
PSU	Practical Salinity Unit
DFO	Fisheries and Oceans Canada
BWM	Ballast Water Management
IMO	International Maritime Organization
No.	Number

1.0 INTRODUCTION

1.1 Background

Baffinland Iron Mines Corporation ("Baffinland" or "the Company") is presently engaged in the Early Revenue Phase (ERP) of the Mary River Project, an iron ore mine located in the Qikiqtani Region of Nunavut, Canada (the Project). A Project Certificate No. 005, amended by the Nunavut Impact Review Board (NIRB) on 28 May 2014 authorizes the Company to mine up to 22.2 million tonnes per annum (Mtpa) of iron ore from Deposit No. 1. Of this, the Company is authorized to transport 18 Mtpa of ore by rail to Steensby Port for year-round shipping through the Southern Shipping Route (via Foxe Basin and Hudson Strait), and 4.2 Mtpa of ore by truck to Milne Port for open water shipping through the Northern Shipping Route during the open water season (July – October) using chartered ore carrier vessels (Figure 1.1).

Baffinland is currently seeking a second amendment to its Project Certificate to allow the Company to implement its Phase 2 Proposal. The Phase 2 Proposal will increase the mining rate by 7.8 Mtpa and will change from road transportation of ore to rail transportation of ore to Milne Port. This will be followed by the subsequent additional development of the originally approved 18 Mtpa South Rail operation. Elements of the Phase 2 Proposal relevant to the marine environment include:

- Further development of the Milne Port area which includes:
  - A second ore dock capable of berthing Cape Size vessels;
  - A freight dock;
  - Relocation of secondary crushing and screening from the Mine Site to Milne Port;
  - A rail maintenance facility;
- Changes to shipping activities which include:
  - An increase in shipping transits through Northern Shipping Route during the open-water season; and
  - An extension of the shipping season into early ice conditions up to when the landfast ice is being used by Inuit, approximately mid-November.

As part of the Phase 2 Proposal, the volume of ore shipped along the Northern Shipping Route will increase from 4.2 Mtpa to 12 Mtpa. In order to account for the increased tonnage of ore being transported, an increase in total vessel traffic serving Milne Port is proposed. Vessels ranging in size from Supramax to Cape Size will be retained by Baffinland depending on availability. An estimated 176 ore carrier round trips will occur per season, with an average voyage time of 26 days per carrier. Shipping will occur seasonally between July 01 and November 15, with each chartered vessel making one to three round trips per season. The final destination for ore shipments will be a European port such as Rotterdam (Figure 1.2). Shipping operations for the Phase 2 Proposal will occur over a total period of 17 years.

This report presents the results of a risk assessment developed to determine the potential for ship-mediated introduction of aquatic invasive species (AIS) to the marine environment as part of the Phase 2 Proposal of the Project.

LEGEND

- PROJECT SITE
- COMMUNITY
- FUTURE SOUTH RAILWAY
- MILNE INLET TOTE ROAD
- NUNAVUT SETTLEMENT AREA
- SHIPPING ROUTE
- SIRMILIK NATIONAL PARK
- WATER

0 125 250

1:5,000,000 KILOMETRES

REFERENCE(S)

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE II PROPOSAL

TITLE
PROJECT LOCATION

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-09-29
DESIGNED	DC
PREPARED	AA
REVIEWED	JK
APPROVED	AO

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	5000	0	1.1

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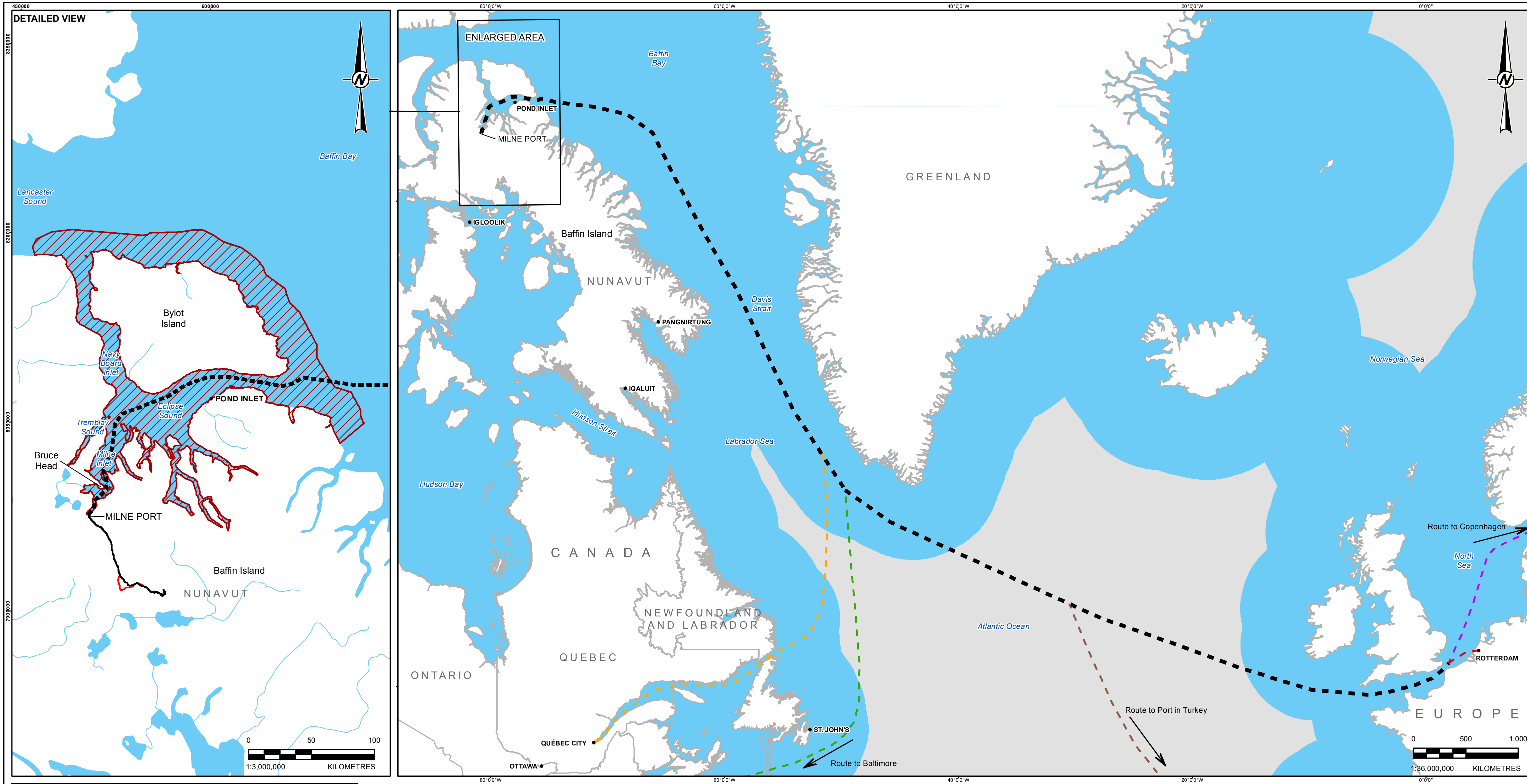

LEGEND

- • COMMUNITY
- MILNE INLET TOTE ROAD
- PROPOSED NORTH RAILWAY
- SHIPPING ROUTE (APPROXIMATE)
- SHIPPING ROUTE TO BALTIMORE (APPROXIMATE)
- SHIPPING ROUTE TO COPENHAGEN (APPROXIMATE)
- SHIPPING ROUTE TO PORT IN TURKEY (APPROXIMATE)
- SHIPPING ROUTE TO QUEBEC CITY (APPROXIMATE)
- SHIPPING ROUTE TO ROTTERDAM (APPROXIMATE)
- WATERCOURSE
- APPROXIMATE AREA OF BALLAST WATER EXCHANGE ZONE - 200 NAUTICAL MILES FROM LAND
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- WATERBODY

REFERENCE(S)
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DETAIL MAP PROJECTION: UTM ZONE 17 DATUM: NAD 83
MAP PROJECTION: WORLD MERCATOR DATUM: WGS84

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT

CONSULTANT
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YYYY-MM-DD	2017-10-25
DESIGNED	JK
PREPARED	VV
REVIEWED	JK
APPROVED	AO

TITLE
SHIPPING ROUTES TO MILNE PORT

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	5000-504	0	1.2

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1.2 Purpose and Objectives

The purpose of this report is to provide the results of a risk assessment undertaken to assess the potential for ship-mediated introductions of aquatic invasive species (AIS) at Milne Port using the best available information to date with the latest methodologies.

2.0 METHODS

A risk assessment for the potential introduction of AIS in Milne Port was previously completed by Baffinland based on shipping volumes applicable to the ERP (SEM 2013). The methodology that was applied closely followed the methods described by Chan et al. (2012), which allowed for a comparison of invasion risks between Milne Port and other Canadian Arctic ports servicing international merchant vessels. The present report consists of a revised version of the original risk assessment, updated to reflect new shipping volumes and ship specifications applicable to the Phase 2 Proposal, as well as relevant guidance provided by Fisheries and Oceans Canada (DFO) (DFO 2012; 2014; Casas-Monroy et al. 2014).

Shipping ballast water estimates were derived using the representative annual shipping schedule for the Phase 2 Proposal presented in Table 2.1. The type of ore carriers anticipated to be used during this period may include:

- Supramax (ice class 1C) vessels ~50,000 deadweight tonnage (DWT);
- Panamax vessels ~65,000 DWT;
- Post Panamax vessels ~90,000 DWT; and
- Cape Size vessels ~150,000 DWT.

Table 2.1: Anticipated Annual Shipping Schedule for Ore Carriers at Milne Port as part of Phase 2 Proposal

Vessel Type	July	August	September	October	Total
Supramax	10	5	5	10	30
Panamax	9	45	45	34	133
Cape Size	0	6	5	2	13
Total	**19**	**56**	**55**	**46**	**176**

Note: This risk assessment assumes ore carrier traffic occurs between July and October; however, shipping may also occur in early November

Shipping during Phase 2 Proposal may extend as late as mid-November. However, for the purpose of this assessment, it was assumed that shipping will primarily occur during the ice-free months of July, August, September and October; and will include an estimated total of 176 ore carrier round-trips. Information provided in Baffinland's ore shipping schedule, including the numbers of ships of each class and their ports of destination (based on their port of origin), was used as the basis for this risk assessment. Ports of origin included both domestic ports such as Deception Bay, Quebec, Halifax, St. John's, and Eastport, and international ports such as Pori, Brunsbuttel, Antwerp, Rotterdam, Copenhagen, Gothenburg, Hamburg, Emshaven, Pasajeas, Baltimore, Nuuk, and a port in Turkey.

The relative level of invasion risk posed by ship ballast water was estimated using a three step process as depicted in Figure 2.1, and as described in more detail in the sub-sections below.

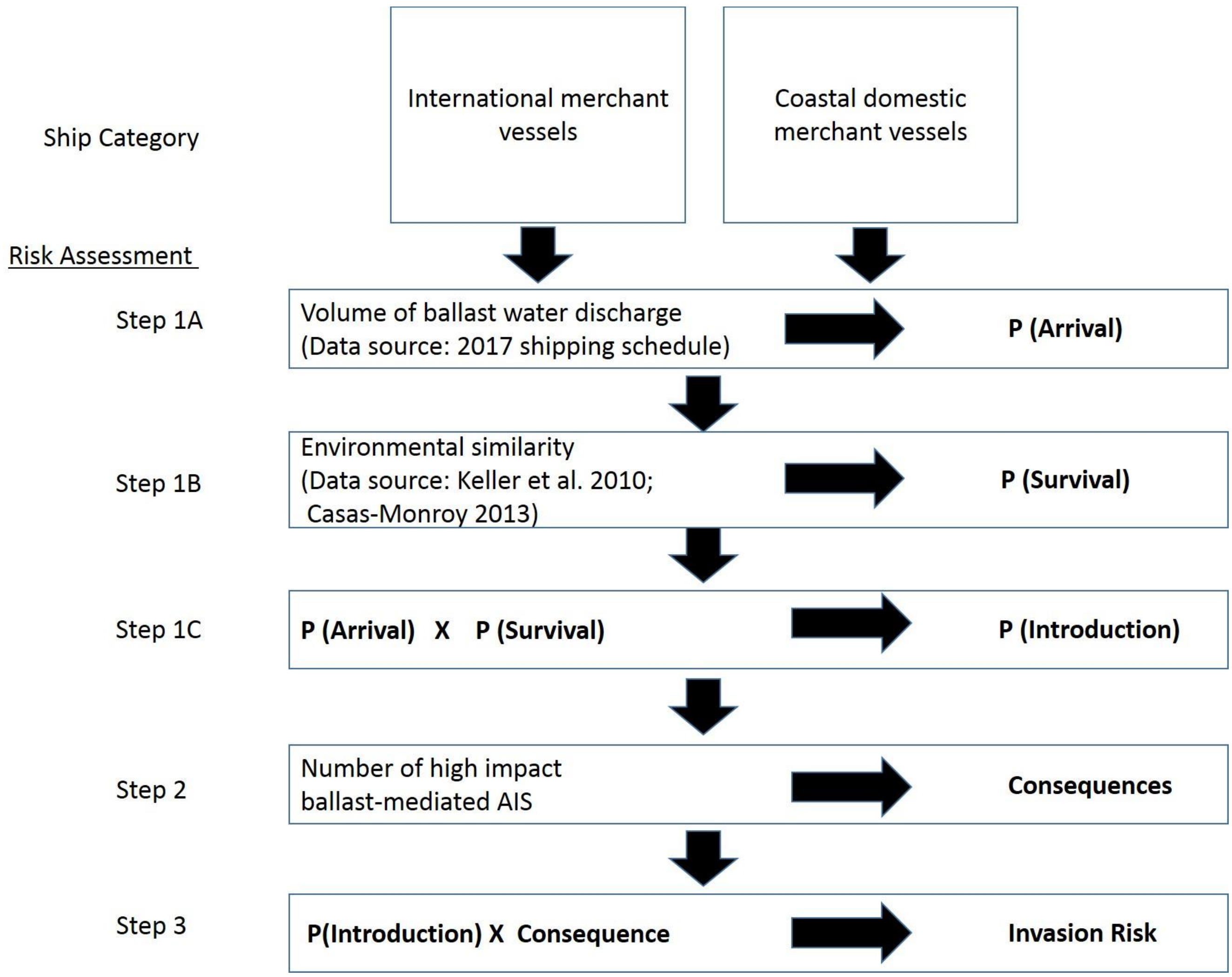

Figure 2.1: Flow chart outlining steps for risk assessment (modified from Chan et al. 2012)

For the purpose of the present risk assessment, the following assumptions were made:

- 'Ports of origin' were assumed to be the same as the 'ports of destination', as listed in Baffinland's ore shipping schedule (Phase 2 Proposal);
- Vessels discharging ballast water will be required to undergo a mid-ocean exchange as required by Transport Canada (the Ballast Water Control and Management Regulations under the *Canada Shipping Act*, 2001; Stewart et al. 2015). To date, the ballast water to be discharged is not expected to have been treated with biocides (Baffinland 2017a);

- Ballast water originating from the North Atlantic and the Labrador Sea is assumed to have a temperature of 6°C and salinity of 34 PSU (Baffinland 2017b);
- Each ship will discharge on average 25% of the vessels Dry Weight Tonnage (DWT) in ballast water volume (David et al. 2012). This is equivalent to the following volumes:
  - Supramax (ice class 1C) vessels: 12,500 tonnes of ballast water;
  - Panamax: 16,250 tonnes of ballast water;
  - Post Panamax: 23,000 tonnes of ballast water;
  - Cape Size vessels: 37,500 tonnes of ballast water; and
- Ballast water estimates were calculated using the maximum ship traffic for a given month in Milne Port.

2.1 Step 1 – Probability of Introduction

Two aspects related to probability were examined – Probability of Arrival and Probability of Survival. These two factors combine to create a Probability of Introduction.

Probability of Arrival is based on the corrected ballast water volume that will be discharged. A correction factor was applied to the total annual volume of ballast water to be discharged due to the fact that the Project will implement mandatory management activities (mid-ocean exchange). This correction factor is employed in order to determine the discharged volume of water that may contain founding individuals of aquatic nonindigenous species, also known as propagules, after a mid-ocean exchange. This correction factor is based on exchange efficiency rates, as determined by total zooplankton abundance, which was defined as 90% for saline water (Ruiz and Smith 2005; Chan et al. 2012). Based on this efficiency rate, a correction factor of 0.1 was applied by Chan et al. (2012) where mid-ocean exchange could be assumed.

Probability of Survival is based on the concept of "environmental distance"; a comparison of environmental similarity between paired source and recipient ports (Chan et al. 2012; SEM 2013; Casas-Monroy et al. 2014). The method used is this analysis is described in Casas-Monroy et al. (2014) and focused on salinity and climate (temperature), which are fundamental physical characteristics for survival and reproduction of all aquatic organisms (Verween et al. 2007). Further, this analysis was limited to two variables, as adding unrelated variables may decrease the effectiveness of an environmental similarity approach (Barry et al. 2008). The salinity and temperature data that was used is from Casas-Monroy et al. (2014).

For salinity classification, all ports were classified by salinity levels into three categories: freshwater (0.0 – 5.0 PSU), brackish (5.1 – 18.0 PSU), and marine (> 18.0 PSU). For climate classification, all ports were categorized by their location using latitude. Each port location was classified into one of four climate zones by latitude: Tropical (0°N-20°N), Warm-Temperate (20°N-40°N), Cold-Temperate (40°N-60°N), and Polar (>60°N) following Casas-Monroy et al. (2014). A matrix approach was used to determine climate similarity between each source-recipient port-pair. The score has three metrics and range from "very low" climate similarity for port-pair to "very high" similarity.

The final step for calculation of probability of survival was combining the salinity and climate score into a single "environmental similarity" measure. Lowest score of salinity and climate classifications was retained to reflect the score of the most limiting environmental variable. For example, for a given source-recipient pair-ports with high similarity for salinity and intermediate similarity for climate, the final environmental similarity is intermediate.

Probability of Introduction depends on the sequential occurrence of arrival and survival of the AIS, thus, lowest value for arrival and survival steps is used to determine the overall introduction potential (Mandrak et al. 2012; Casas-Monroy et al. 2014).

2.2 Step 2 - Consequences

The magnitude of consequences was established by considering the number of high impact aquatic nonindigenous species that may be introduced into the receiving port. The number of harmful nonindigenous species that could potentially be introduced from connected ecoregions is available from two sources - the Marine Invasive Database of the Nature Conservancy (Molnar et al. 2008) and a database available online at http://www.conservationgateway.org/ConservationPractices/Marine/Pages/marineinvasives.aspx. Given the destination of ERP ore carriers, the listings for the North Sea ecoregion were used in the calculation.

2.3 Step 3 – Invasion Risk

Invasion risk associated with the subject port was determined by combining probability of introduction and magnitude of consequences in a symmetrical mixed-rounding matrix (Table 2.2; Chan et al. 2012). Three levels of risk ranking (low - green, intermediate – yellow, and high - red) were assigned as a final relative invasion risk for each pathway, based on the risk matrix.

Table 2.2: Matrix used to Assess Invasion Risk (adapted from Chan et al. 2012)

		Probability of Introduction				
		Very Low	**Low**	**Intermediate**	**High**	**Very High**
Magnitude of Consequence	**Very High**	Intermediate	Intermediate	High	High	High
	High	Intermediate	Intermediate	Intermediate	High	High
	Intermediate	Low	Intermediate	Intermediate	Intermediate	High
	Low	Low	Low	Intermediate	Intermediate	Intermediate
	Very Low	Low	Low	Low	Intermediate	Intermediate

Note: High, intermediate and low 'Invasion Risk' highlighted in red, yellow and green, respectively.

Similar to any risk assessment, there exists a certain level of uncertainty to the risk assessment (Chan et al. 2012; Casas-Monroy et al. 2014). While the uncertainty does not directly apply to the methods, it is important to characterize uncertainty in a standardized way, and as such, levels of uncertainty were assigned based on the quality of data available for analysis. These levels range from very high to very low, as described in Table 2.3.

Table 2.3: Description of uncertainty levels (adapted from Chan et al. 2012)

Levels of Uncertainty	Description
Very high	Little or no scientific information; no supporting data
High	Limited scientific information; circumstantial evidence
Moderate	Moderate levels of scientific information; first hand, unsystematic observations
Low	Substantial scientific information; expert opinion
Very low	Extensive scientific/systematic information; peer-reviewed data sources/information

3.0 RESULTS

3.1 Probability of Arrival

Using the Phase 2 Proposal shipping schedule and vessel information, it was determined that ore carriers will discharge exchanged ballast water 176 times per year to allow for loading of ore upon arrival at Milne Port. This is approximately a 3-fold increase compared to the 2012 estimate (SEM 2013). At the berth, vessels will discharge approximately 12,500 to 37,500 tonnes of ballast water. Other vessels such as tugs, fuel tankers, and cargo vessels are not anticipated to discharge ballast water at Milne Port. Hence, these ships were excluded from the risk assessment. A total of approximately 3,023,750 tonnes of ballast water is anticipated to be discharged into Milne Port during the shipping season each year (Table 3.1).

Ballast water exchange is considered 90% effective for salt-water source water and 99% effective for freshwater sources (Gray et al. 2007; Chan et al. 2012; SEM 2013). Therefore, the volume of ballast water discharged by vessels was corrected to account for the reduction in propagule pressure, using a correction factor of 0.1 (Chan et al. 2012; SEM 2013; Chan et al. 2013).

Table 3.1: Annual Predicted Ballast Water Discharge at Milne Port for Phase 2 Proposal

Port	Year/ Phase	Number of Discharges (per year)	Total Ballast Water Discharged per year (tonnes)	Corrected Foreign Exchange (x 0.1) (tonnes)
Milne[1]	2012	53	662,000	66,200
Milne	Phase 2	176	3,023,750	302,375

[1] From Chan et al. 2012 and SEM 2013

The calculated ballast water discharge estimate for Milne Port was higher than the range of values considered in Chan et al. (2012) and SEM (2013), so the scale of rankings was modified (Table 3.2). The modified range was applied to the top three ports for international merchant vessels – Churchill, Deception Bay, and Milne Port (Chan et al. 2012; SEM 2013).

Table 3.2: Ranking of Probability of Arrival (modified from Chan et al. 2012 and SEM 2013)

Mean annual corrected volume of ballast water discharged (tonnes)	P (Arrival)	Ranking
0 – 60,475	Very Low	Deception Bay (QC)[1], Churchill (MB)[1], Milne Port (NU) (2012)[1]
60,476 – 120,950	Low	
120,951 – 181,425	Intermediate	
181,426 – 241,900	High	
241,901 – 302,375	Very High	Milne Port (NU) (Phase 2 Proposal)

[1] From Chan et al. 2012 and SEM 2013

3.1.1 Uncertainty

The level of uncertainty for the probability of arrival is ranked as moderate. DFO methodologies (Gollasch 2006; Chan et al. 2012; Casas-Monroy et al. 2014) rely on the approximate estimation of volume of ballast water discharged per vessel and number of vessels to estimate the probability of arrival. Using the actual number of species and abundance of AIS present in each ship's ballast water would provide better estimate however, this is not possible.

3.2 Probability of Survival

Source-recipient port-pairs for salinity (Table 3.3) and climate (Table 3.4) were used to determine similarity of the donor region to the recipient region (Casas-Monroy et al. 2014; DFO 2014). Salinity for the majority of ports (71%), which were international ports such as Rotterdam, Antwerp, Nuuk, Baltimore, Pori, Brunsbuttel, Copenhagen, Gothenburg, Hamburg, Emshaven, Pasajeas, and a port in Turkey, ranged from 31.0 to 36.5 PSU in 2005 to 2012 (Zweng et al. 2013; Casas-Monroy et al. 2014). Salinity for the majority (71%) of the source ports was determined to be marine for the donor region. For Milne Port, the mean salinity from 2005 to 2012 was determined to be 31.7 PSU using the latest world ocean atlas database (Zweng et al. 2013; Casas-Monroy et al. 2014), and determined to be marine for the recipient region. Thus, salinity similarity between source and recipient port was determined to be "very high" (Table 3.3). For climate similarity between source-recipient pairs, the majority of the source ports (71%, 12 out of 17 ports) was considered "cold-temperate" (40°N to 60°N), three ports were considered "polar", and two were considered "warm-temperate". For Milne Port (i.e. 71°N) the climate zone was determined to be "polar". Hence, climate similarity was determined to be very high for most port-pairs (Table 3.4). Using the two matrices (Table 3.3 and 3.4), the probability of survival for Milne Port was determined to be very high.

Table 3.3: Matrix used to determine similarity of salinity between source-recipient port-pairs, after Gollasch (2006) and Casas-Monroy et al. (2014)

Recipient Region	Donor Region		
	Freshwater	Brackish	Marine
Freshwater	Very High	Intermediate	Very Low
Brackish	Intermediate	Very High	Intermediate
Marine	Very Low	Intermediate	Very High

Table 3.4: Matrix used to determine similarity of climate between source-recipient port-pairs, after Casas-Monroy et al. (2014)

Recipient Region	Donor Region			
	Polar	Cold-Temperate	Warm-Temperate	Tropical
Polar	Very High	Very High	Intermediate	Very Low
Cold-Temperate	Very High	Very High	Very High	Intermediate
Warm-Temperate	Intermediate	Very High	Very High	Very High
Tropical	Very Low	Intermediate	Very High	Very High

3.2.1 Uncertainty

The level of uncertainty is ranked as moderate for probability of survival because annual salinity may not capture spatial and temporal changes in salinity at all ports, and additional physical and biological factors may influence survival in a species-specific manner. Moreover, it is difficult to predict how climate change will affect the probability of survival (DFO 2014).

3.3 Probability of Introduction

There is a very high probability of aquatic invasive species arriving at Milne Port and there is a very high probability of survival given the environmental similarities between donor and recipient ports (Table 3.5).

Table 3.5: Ranking for Probability of Introduction

Ports	Probability of Arrival	Probability of Survival	Probability of Introduction
Milne Port, NU (2017)	Very High	Very High	Very High
Milne Port, NU (2012)[1]	Very High	Low	Low
Churchill, MB (2012)[1]	Very Low	High	Very Low
Deception Bay, QC (2012)[1]	Very Low	Intermediate	Very Low

[1] From Chan et al. 2012 and SEM 2013

3.3.1 Uncertainty

The uncertainty level was ranked as moderate for probability of introduction, based on uncertainty levels identified for both the probabilities of arrival and survival, as well as the limited background information available on AIS in Arctic ports (Casas-Monroy et al. 2014; Stewart et al. 2015).

3.4 Magnitude of Consequence

In total, a total of 166 AIS have been identified as potentially arriving by vessels to the Canadian Arctic region in the national risk assessment (Casas-Monroy et al. 2014), resulting in a magnitude of consequence ranking of very high.

3.4.1 Uncertainty

The uncertainty level is ranked as moderate for the magnitude of consequence as the list of AIS available for the region is static, may not represent current AIS distribution (Casas-Monroy et al. 2014), and may not account for species that may be more harmful to recipient regions than donor regions or harmful species that are native to the donor region, but nonindigenous to the recipient region.

3.5 Invasion Risk

By combining the probability of introduction and magnitude of consequence using the Risk Invasion Matrix (Table 2.2), the relative level of AIS invasion risk posed by ballast water is ranked as high. The present risk assessment is associated with a moderate level of uncertainty given the limited data/information available, and conservative assumptions incorporated into the risk assessment as a result. For instance, annual salinity may not capture spatial and temporal changes in salinity at all ports, and additional physical and biological factors may influence survival in a species-specific manner. Moreover, it is difficult to predict how climate change will affect the probability of survival (DFO 2014). More importantly, identifying and quantifying the actual proportions of harmful AIS present in the ballast water per each vessel would provide more accurate estimate.

The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention; IMO 2017a), adopted in 2004 and ratified by Canada, entered into force on 8 September 2017 (IMO 2017b). Currently, all foreign ships entering the Canadian Exclusive Economic Zone (EEZ) must meet the D-1 standard, which requires ships to exchange their ballast water in open seas, away from coastal waters (i.e., 200 nautical miles from land and in water at least 200 metres deep). With implementation of the Convention all foreign ships entering Canadian EEZ must implement a Ballast Water Management Plan and comply with the D-2 performance standard, which specifies the maximum amount of viable organisms allowed to be discharged, including indicator microbes harmful to human health. For most ships it means installation of an on-board system to treat ballast water and eliminate unwanted organisms to meet the D-2 performance standard. New ships must meet the D-2 standard from the date of the Convention enetering into force, while for existing ships an implementation timetable for the D-2 standard has been agreed, based on the date of the ship's International Oil Pollution Prevention Certificate (IOPPC) renewal survey, which must be undertaken at least every five years. Once ore carrier's transition to the D-2 standards has been completed, the risk of invasion will be greatly reduced.

3.5.1 Uncertainty

The uncertainty level was ranked as moderate for invasion risk, based on uncertainty levels identified for both probability of introduction and magnitude of consequence.

4.0 DISCUSSION

Given the increased capacity and operation of the Mary River Project, and anticipated increases in shipping traffic, it is expected that the volume of shipping ballast water discharge will increase. With the large volume of ballast water discharged, the probability of aquatic invasive species arrival was determined to be very high. Similar to findings from DFO (2014) and Casas-Monroy et al. (2014), the probability of survival would be rated as very high given the environmental similarities between Milne Port and ports in Canada and international ports from which ore carriers will arrive(Chan et al. 2012; SEM 2013). Consequently, the probability of introduction was calculated to be very high. It was also identified that there are 166 potentially harmful aquatic invasive species for the Canadian Arctic region (Casas-Monroy et al. 2014; DFO 2014), which ranks the magnitude of consequences as very high. Using both the probability of introduction and magnitude of consequences, invasion risk was ranked to be high for aquatic invasive species for the shipping of ballast water at Milne Port, Nunavut.

Uncertainty associated with the invasion risk was determined to be moderate. In particular, there are several factors to consider. Limited studies have been conducted for Canadian Arctic ports and, it is difficult to ascertain the degree and potential effect that climate change will have on the survival potential of AIS and other organisms (DFO 2014). Further, more certain assessment would be possible with knowledge of the actual number of harmful species and their absolute and relative abundance in the ballast of each ship from the different ports, as well as the duration, underlying conditions of ballast water tank, and any treatment associated with each ship, especially once the BWM convention enters into force. It is predicted that the invasion risk will be lower once the BWM Convention D-2 performance standard, which specifies the maximum amount of viable organisms allowed to be discharged (IMO 2017a), is implemented (Casas-Monroy et al. 2014).

As recommended by DFO (2014), ship ballast water management will be undertaken with due diligence. Conditions and effectiveness of different treatment options will be considered, quantified, and assessed to provide more accurate information for the risk assessment of aquatic invasive species. The best treatment options will be considered as one of the potential mitigation measures. While treatment options will likely reduce the number of harmful AIS and their propagule pressures, treatment options themselves could also be harmful to organisms in recipient ports. Implications and potential consequences of shipping ballast water treatment options (IMO 2017c) will be carefully examined to provide the best outcome (Abu-Khader et al. 2011; Jing et al. 2012; Balaji et al. 2014).

5.0 CLOSURE

We trust that this assessment provides sufficient information for your present needs. If you have any questions, please do not hesitate to contact Phil Rouget at 250-419-4945.

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