Application for Review and Approval of Pre-Development Work

For

Mary River Project

H337697-0000-07-124-0002

Rev. 0, September 14, 2011

Baffinland Iron Mines Corporation

Application for Review and Approval of Pre-Development Work

Prepared by: Baffinland Iron Mines Corporation

Submitted by:

	J. Binns VP Sustain & EHS	Date
PDW-EIS Manager		
	Fernand Beaulac	Date
Engineering Support:		
	John Binns	Date
Hatch Project Manager		
	H. Charalambu	Date

© Hatch 2011/09

Structure of the PDW Application and Distribution List

The Application for Review and Approval of the Pre-Development Work is structures as follows:

- A preamble which provides the context for this application;
- Executive Summary in English and Inuktituk (Section 1);
- Description and Execution of the PDW (Sections 2 to 10);
- Environmental Effects Assessment (Sections 10 to 23);
- List of contributors (Section 24);
- Appendix A contains the permits application for PDW;
- Appendix B contains management plans requested by NIRB in support of this Application;
- Appendix C and Appendix E contains drawings and technical specifications/design basis in support of the Type B Water License Amendment Application;
- Appendix D presents a graphic depiction of the PDW;
- Appendix F presents a detailed equipment list.

The distribution list for this document is presented in the following Table. The format of the distribution is as follows:

- Hard copies of the Application contain Sections 1 through 24, general layout drawings extracted from Appendix C, and, Appendix D in print. All other Appendices are attached in electronic format.
- Electronic copies include the full PDW Application. In order to facilitate cross referencing with the Draft Environmental Impact Statement (DEIS) which is currently under review, a complete copy of the DEIS as submitted in January 2011 and its Addendum (submitted in July 2011) are included.

Copies of the Application for Review and Approval of PDW can be obtained by contacting:

Mr. Oliver Curran

Baffinland Iron Mines Corporation

120 Adelaide Street West, Suite 1016, Toronto, Ontario M5H 1T1

Tel: 416-364-8820 Fax: 416-364-0193

www.baffinland.com

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Distribution List			
Responsible Agency/Key Contact	**Head Office/NU Regional Office**	**Number of Copies**	**Transmission Date**
Nunavut Planning Commission			
Nunavut Planning Commission P.O. Box 2101 Cambridge Bay, NU, X0C 0C0 Ph: 867-983-4625 F: 867-983-4626	**Brian Aglukark** Director, Regional Planning, Nunavut Planning Commission P.O. Box 419, Arviat, NU, X0C 0E0 E-mail: aglukark@nunavut.ca Ph: 867-857-2242 F: 867-857-2243	1 Hard Copies 1 Electronic Copies	September 15, 2011
Nunavut Impact Review Board			
Nunavut Impact Review Board P.O. Box 1360 Cambridge Bay, NU X0B 0C0 E-Mail: info@Nirb.ca Toll Free: 1-866-233-3033 FX: 867-983-2594 or 867-983-2574	**Aliza Weller** Manager, Communications, Nunavut Impact Review Board info@nirb.ca Ph: 867-983-4605 Toll Free: 1-866-233-3033 FX: 867-983-2594 or 867-983-2574	5 Hard Copies 5 Electronic Copies	September 15, 2011
Nunavut Water Board			
Phyllis Beaulieu Manager of Licensing, Nunavut Water Board, Gjoa Haven, NU, X0B IJ0. E-mail: licensing@nunavutwaterboard.org 867-360-6338 ext. 26	**David Hohnstein, Nunavut Water Board** 18831-81 A Avenue Edmonton, AB T5T 5B4	(PB) 3 Hard Copies 3 Electronic Copies (DH) 1 Hard Copy 1 Electronic Copy	September 15, 2011
Aboriginal Affairs and Northern Development Canada			
Jeff Mercer, Manager Land Administration Aboriginal Affairs and Northern Development Canada Box 100, Iqaluit, NU, X0A 0H0 E-Mail: *Jeff.Mercer@aandc.gc.ca* *landsmining@aandc.gc.ca* Ph : 867-975-4780; -4294	**NU Regional Office:** Aboriginal Affairs and Northern Development Canada Box 100, Iqaluit, NU, X0A 0H0	1 Hard Copies 1 Electronic Copies	September 15, 2011

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Distribution List			
Responsible Agency/Key Contact	**Head Office/NU Regional Office**	**Number of Copies**	**Transmission Date**
Qikiqtani Inuit Association			
Robert St. Eloi, Director of Lands and Resources, Qikiqtani Inuit Association, Iqaluit, NU E-Mail: dirlands@qia.ca Ph: 867-975-8400 F: 867-979-1643	Box 1340 Iqaluit, NU X0A 0H0	5 Hard Copies 5 Electronic Copies	September 15, 2011
Fisheries and Oceans Canada			
Derrick Moggy P.O. Box 358 200-626 Tumiit Plaza Iqaluit, NU, X0A 0H0 Email: derrick.moggy@dfo-mpo.gc.ca Ph: 705-522-9909 F: 867-222-3322	**Central and Arctic Regional Office:** Fisheries and Oceans Canada 520 Exmouth Street, Sarnia, ON N7T 8B1 Ph: 519-383-1813 or 1-866-290-3731	1 Hard Copy 1 Electronic Copy	September 15, 2011
Transport, Infrastructure and Communities			
Doug Soloway, Environmental Officer Transport Canada, Box 8550, 344 Edmonton St, Winnipeg, MB, R3C 0P6 E-mail: Doug.Soloway@tc.gc.ca Ph: 204-983-7705 F: 204-983-5048	**Prairies and Territories Regional Office:** Transport Canada Box 8550, 344 Edmonton St, Winnipeg, MB, R3C 0P6 Ph: 1-888-463-0521 or 204-983-3252	1 Hard Copy 1 Electronic Copy	September 15, 2011
Natural Resources Canada			
John Clarke Natural Resources Canada Environmental Assessment Coordination 580 Booth Street, Ottawa, Ontario K1A 0E4 John.Clarke@NRCan.gc.ca Ph 613-943-0773	580 Booth Street, Ottawa, Ontario K1A 0E4	1 Hard Copy 1 Electronic Copy	September 15, 2011

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Distribution List			
Responsible Agency/Key Contact	**Head Office/NU Regional Office**	**Number of Copies**	**Transmission Date**
Other Review Agencies			
Environment Canada			
Warren Fenton, A/Manager Environmental Assessment and Marine Programs Prairie and Northern Region Qimugjuk Building 969 P.O. Box 1870 Iqaluit, NU X0A 0H0 Tel: (867) 975 4639	Environmental Protection Operations Qimugjuk Building 969 P.O. Box 1870 Iqaluit, NU X0A 0H0 Tel: (867) 975 4639	1 Electronic Copy	September 15, 2011
Aboriginal Affairs and Northern Development Canada			
Bernie McIsaac Director of Operations Nunavut Regional Office P.O. Box 100 Iqaluit, NU X0A 0H0		2 Electronic Copies	September 15, 2011
North Baffin Communities			
Hamlet of Igloolik CLO – Community Liaison Officer	Address on letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011
Hamlet of Pond Inlet	Address on Letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011
Hamlet of Hall Beach	Address on Letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011
Hamlet of Arctic Bay	Address on Letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Distribution List			
Responsible Agency/Key Contact	**Head Office/NU Regional Office**	**Number of Copies**	**Transmission Date**
Hamlet of Clyde River	Address on Letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011
Hamlet of Cape Dorset	Address on Letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011
Hamlet of Kimmurut	Address on Letter	**Hamlet:** 1 Hard Copy 1 Electronic Copy **CLO:** 1 Hard Copy 1 Electronic Copy	September 15, 2011
Baffinland Iron Mines			
London Office		1 Hard Copy	September 15, 2011
Toronto Head Office		2 Hard Copy	September 15, 2011
Mississauga Project Office		2 Hard Copy	September 15, 2011

Additional 80 Copies on USB Sticks

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table of Contents

Structure of the PDW Application and Distribution List i

PRE-AMBLE / CONTEXT 3

1. Executive Summary 7

1.1 Regulatory Framework 7
1.2 Purpose and Rationale for Pre-Development Work 8
1.3 Definition of Pre-Development Work for the Mary River Project 8
1.4 Types of Pre-Development Works 9
1.5 Duration of PDW Activities 10
1.6 Abandonment and Reclamation 11
1.7 Financial Security and Bonding Requirements 11
1.8 Relationship to DEIS Submission and DEIS Review Process 11
1.9 Permits Required for PDW 12
1.10 Benefits for Inuit 14
1.11 Conclusion of the Environmental and Socio Economic Effects Assessment for Pre Development Works 14

2. Milne Inlet PDW 20

2.1 Earthworks for Material Unloading and Laydown Area 20
2.2 Quarry – Borrow Source 20
2.3 Fuel 21
2.4 Camp 23
2.5 Administration and Maintenance Facilities 24
2.6 Heavy Equipment, Material And Supplies 25
2.7 Explosives Storage and Use 25
2.8 Water Supply for Milne Inlet PDW 26
2.9 Wastewater Management 26
2.10 Milne Port Waste Management 26
2.11 Abandonment and Reclamation of PDW at Milne Port 27
2.12 Milne Inlet and Monitoring and Follow-up 27

3. Milne Inlet Tote Road 29

3.1 Abandonment and Reclamation 29

4. Mine Site PDW 30

4.1 Earthworks - Material Unloading and Laydown Area 30
4.2 Quarry-Borrow Source 30
4.3 Airstrip 30

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

4.4 Fuel 30
4.5 Camp 31
4.6 Administration and Maintenance Facilities 32
4.7 Explosives Storage and Use 32
4.8 Heavy Equipment and Material 33
4.9 Water Supply for PDW 33
4.10 Wastewater Management for PDW 33
4.11 Mine Site Waste Management 33
4.12 Mine Site Abandonment and Reclamation of PDW 34
4.13 Mary River Monitoring and Follow-up 34

5. Steensby Inlet PDW 36

5.1 Steensby Bay Port 36
5.2 Site Preparation, Material Unloading and Laydown Area 36
5.3 Quarry – Steensby 36
5.4 Explosives Storage and Use 36
5.5 Air Strip 37
5.6 Fuel 37
5.7 Camp 39
5.8 Administration and Maintenance Facilities 40
5.9 Heavy Equipment and Material 40
5.10 Water Supply for Steensby PDW 41
5.11 Wastewater Management for PDW 41
5.12 Steensby Inlet Waste Management 41
5.13 On-Going Geotechnical Investigations 42
5.14 Abandonment and Reclamation for Steensby PDW 42
5.15 Steensby Port and Monitoring Follow-up 43

6. Railway Corridor PDW 44

6.1 North and South Cockburn Lake Camps: 44
6.2 Ravn River and Mid-Rail Camps: 45
6.3 Wastewater Management 45
6.4 Railway Corridor Waste Management 45
6.5 Abandonment and Reclamation of Railway Staging Areas 46
6.6 Monitoring and Follow-Up 46

7. Management Plans Please Refer to Appendix B 47

7.1 EHS Management Framework 47
7.2 Update of Management Plans for the FEIS 49
7.3 Management Plan Updates for PDW Activities 49

© Hatch 2011/09

8. Sequencing of Pre-Development Work Activities 52

9. Workforce for PDW and Training Opportunities 56

9.1 Workforce 56
9.2 Training Opportunities 56
9.3 Air Traffic 57
9.4 Shipping Traffic 59

10. Abandonment and Reclamation Plan - Security 60

11. Environmental Effects Assessment Methodology 61

11.1 Consultation 61
11.2 Regulatory Framework 62
11.3 Effects Assessment Methodology 88
11.4 Environmental Health and Safety Management System 106
11.5 References ..... **Error! Bookmark not defined.**

12. Baseline Summary 108

12.1 Population Demographics 108
12.2 Education and Training 112
12.3 Livelihood and Employment 114
12.4 Economic Development and Self-Reliance 117
12.5 Human Health and Well-Being 121
12.6 Community Infrastructure And Public Services 129
12.7 Contracting And Business Opportunities 130
12.8 Cultural Resources 131
12.9 Resources and Land Use 134
12.10 Cultural Well-Being 136
12.11 Government and Leadership 137
12.12 Climate Baseline Conditions 138
12.13 Air Quality (VEC) Baseline Summary 148
12.14 Noise and Vibration Baseline Summary 151
12.15 Landforms, Soils and Permafrost Baseline Summary 153
12.16 Vegetation 169
12.17 Migratory Birds and Habitat 170
12.18 Terrestrial Wildlife and Habitat 175
12.19 Freshwater Quantity Baseline Condition 175
12.20 Freshwater Aquatic Biota and Habitat Baseline Conditions 191
12.21 Marine Environmental Baseline Conditions 206
12.22 Sea Ice 208
12.23 Water And Sediment Quality 208

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.24 Marine Habitat and Biota 213
12.25 Marine Mammals Baseline Summary 226

13. Human Environment 301

13.1 Introduction 301
13.2 Population Demographics 304
13.3 Education and Training 305
13.4 Livelihood and Employment 307
13.5 Economic Development and Self-Reliance 315
13.6 Human Health and Well-Being 316
13.7 Community Infrastructure and Public Services 327
13.8 Contracting and Business Opportunities 329
13.9 Cultural Resources 330
13.10 Resources and Land Use 331
13.11 Cultural Well-Being 337
13.12 Benefits, Royalty, and Taxation 338
13.13 Governance and Leadership 339
13.14 Summary and Conclusions 340

14. Air Quality and Climate Change 344

14.1 Air Quality 344
14.2 Noise and Vibration 350
14.3 Vibration 355

15. Terrestrial Environment 356

15.1 Landforms, Soils, and Permafrost 356
15.2 Vegetation 364
15.3 Migratory Birds and Habitat 375
15.4 Terrestrial Wildlife and Habitat 397

16. Freshwater Environment 409

16.1 Boundaries 409
16.2 Issues Scoping 415
16.3 Water Quantity 416
16.4 Water Quantity Potential Effects 417
16.5 Water and Sediment Quality 422
16.6 Aquatic Biota and Habitat 450
16.7 Effects Assessment Summary 459
16.8 Follow-Up 460

17. Marine Environment 461

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.1 Marine Environment 461
17.2 Marine Water and Sediment Quality 464
17.3 Marine Habitat and Biota 473
17.4 Marine Mammals 480
17.5 Effects Assessment Summary 487
17.6 Follow-Up 487

18. Effects of the Environment on the PDW 488

18.1 Engineering Hazard Assessment 488
18.2 Potential Effects of Climate Change on the Project 500

19. Accidents and Malfunctions 502

19.1 Identification of Risks and Methodology 502
19.2 Milne and Steensby Ports Ocean Based Activities 508
19.3 Mine Site 511
19.4 Tote Road 517
19.5 Steensby Port 518
19.6 Railway staging related accidents and malfunction 520
19.7 Shipping Related Accidents and Malfunctions 520
19.8 Air Traffic 523
19.9 Major Diesel Spill at Port or Along the Shipping Lane 524

20. Cumulative Effects Assessment (CEA) 537

20.1 Methodology 537
20.2 Scope 538
20.3 Temporal Boundaries 539
20.4 Spatial Boundaries 540
20.5 Other Projects and Activities of Consideration 540

21. Transboundary Effects 542

21.1 Introduction 542
21.2 Boundaries 542
21.3 Relevant International Agreements 542
21.4 Definition and Approach 544
21.5 Assessment 545
21.6 Conclusion 547

22. Water Use and Waste Generated 552

23. List of Contributors 555

24. References 561

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Appendices

Appendix A: Permit Applications in Support of PDW
- Appendix A.1: QIA – 2012 Work Plan – Work on Inuit Owned Land
- Appendix A.2: NWB – Application for Amendment to Water License
- Appendix A.3: AANDC – Crown Land Lease for Steensby Site
- Appendix A.4: AANDC – Quarry Lease for Steensby Site
- Appendix A.5: DFO – Request for Steam Crossing Authorization at Steensby

Appendix B: Management Plans
- Appendix B.1: Emergency Response and Spill Contingencey Plan
- Appendix B.2: Oil Pollution (OP) EP for Milne Port
- Appendix B.3: OPEP for Steensby Port
- Appendix B.4: Site Surface Water and Aquatic Ecosystem
- Appendix B.5: Wastewater Mangement Plan
- Appendix B.6: Waste Management Plan
- Appendix B.7: Quarry Management Plan
- Appendix B.8: Wildlife Management Plan
- Appendix B.9: Shipping Management Plan
- Appendix B.10: Explosives Managment Plan
- Appendix B.11: Health and Safety Mangement Plan
- Appendix B.12: Abandonment and Reclamation Plan

Appendix C: Drawings in Support of Pre-Development Work
- Appendix C.1: Drawing List
- Appendix C.2: Drawings

Appendix D: Model Graphics / Photogenic Views in Support of Pre-Development Work

Appendix E: Technical Documents
- Appendix E.1: Technical Document List
- Appendix E.2: Design Criteria, Design Basis, Technical Specifications

Appendix F: Details Construction Equipment List

Appendix G: Definitions

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Abbreviations

AANDC.....Aboriginal Affairs and Northern Development Canada
Baffinland..... Baffinland Iron Mines Corporation
CLARC ..... Community Land and Resource Committee
CLEY ..... Department of Culture, Language, Elders, and Youth
CLO ..... Community Liaison Officer
CTA.....Canadian Transportation Agency
DEIS .....Draft Environmental Impact Statement Canada
DFO.....Fisheries and Oceans Canada
EHS ..... Environmental Health and Safety
EIS..... Environmental Impact Statement
EMMP .....Environmental Mitigation and Monitoring Plans
FEIS ..... Final Environment Impact Statement
GN..... Government of Nunavut
HADD.....Harmful Alteration, Disruption, or Destruction
HTA/HTO .....Hamlets, Hunters, and Trappers Association/Organization
IIBA.....Inuit Impact and Benefits Agreement
IPG.....Institute of Public Government
IQ ..... Inuit Qaujimajatuqangit (Inuit knowledge, or traditional knowledge)
KI .....Key Indicator
LSA ..... Local Study Area
Mary River ..... Nuluujaak
MDAG ..... Mineral Development Advisory Group
MHTO .....Mittimatalik Hunters and Trappers Organization
MOU ..... Memorandum of Understanding
Mt/a .....Million Tonne-Per-Annum
NBRLUP..... North Baffin Regional Land Use Plan
NIRB .....Nunavut Impact Review Board
NLCA.....Nunavut Land Claims Agreement
NPC .....Nunavut Planning Commission
NRCan ..... Natural Resources Canada
NSA ..... Nunavut Settlement Area
NTI.....Nunavut Tunngavik Incorporated
NWB..... Nunavut Water Board
PDA ..... Potential Development Area
PDW..... Pre-Development Works
QIA.....Qikiqtani Inuit Association
RSA.....Regional Study Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

TC-NWPP.....Transport Canada Navigable Waters Protection Program
the Guidelines.....Guidelines for the Preparation of an EIS
the Project.....Mary River Project
TK.....Traditional Knowledge
VC.....Valued Component
VEC.....Valued Ecosystem Component
VSEC.....Valued Socio-Economic Component

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

PRE-AMBLE / CONTEXT

This preamble provides important contextual background related to the submission of the Mary River Project Pre-Development Work (PDW) Application.

The iron ore deposit, Deposit No. 1, is located on North Baffin Island, in the Qikiqtani Region of Nunavut. The Deposit No. 1 reserves consist of approximately 365 Mt of direct shipping iron ore at an average iron grade 64.66%. The basis of the Mary River Project (the Project) is production and shipment of 18 million tonne-per-annum (Mt/a) of high grade iron ore from this deposit. The high grade ore is suitable for shipment to international markets after crushing and screening with no need for additional processing requirements. Deposit No. 1 has associated resources capable of meeting the production design over the operating period of 21 years.

The Mary River Project consists of the construction, operation, closure, and reclamation of an open pit mine and associated infrastructures for extraction, transportation and shipment of iron ore from a newly constructed port at Steensby Inlet. After crushing and screening, iron ore will be transported from the Mine Site to Steensby Port for shipment.

Milne Port and the existing Milne Inlet Tote Road linking the Mine Site to Milne Port will be upgraded during PDW to improve access from the Milne Port to the Mine Site. A freight dock will be constructed at Milne Port during PDW. At the onset of the Project, much of the construction material and supplies, fuel and mining equipment will be received at Milne Port during the open water season. For the operation phase (post construction), only oversized equipment will be received at Milne Port. The Milne Port will operate during the open water season.

A railway will be constructed to connect Steensby Port to the Mine Site.

It is expected that the Steensby Port facilities and the Railway will take four years to construct. Once the Railway is operational, 18 Mt/a of iron ore will be transported by Railway and shipped from Steensby Port. All equipment, material and supplies required for the on-going operation of the Mine will be received at Steensby Port and transported to the Mine Site by the railway. Shipping of ore will occur year round from Steensby Port and will therefore require vessels with ice breaking capabilities. Figure 1: Location Map shows the location of the Mary River Project.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

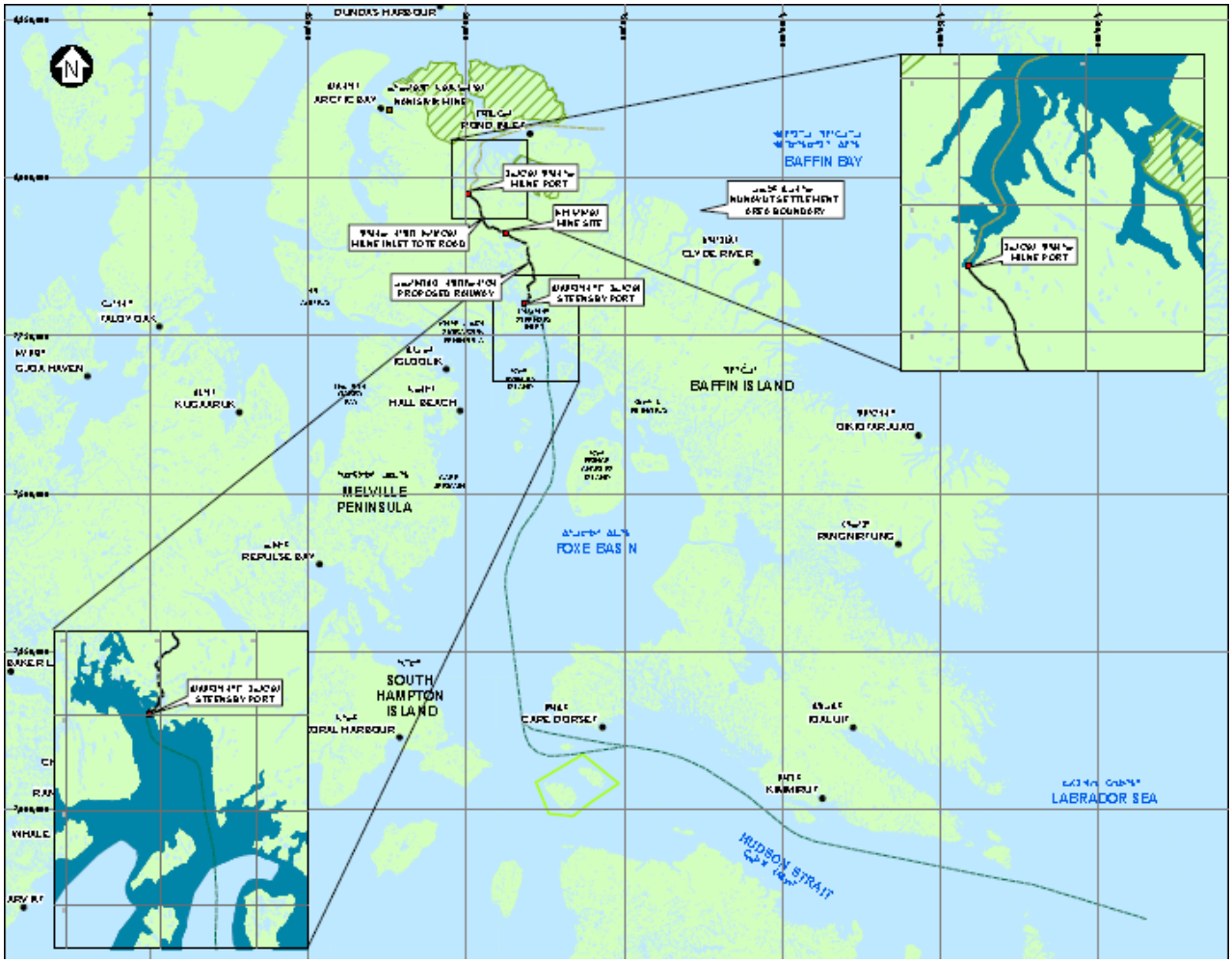


Figure 0-1: Location Map

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The development of the Mary River Project has been on-going since 2006. Due to the isolation and remoteness of the Project site, logistics and execution strategy are a large component of the capital investment required to build the Project and thus greatly influence the economic viability of the Project. Baffinland recognizes that the absence of infrastructure at the Project sites and the limited open water shipping season (August to mid October) for access to Milne Inlet and Steensby Inlet will require a massive effort for site capture and pre-project development work.

Extensive consultations with Inuit communities and regulatory agencies have taken place since 2006. During this consultation period, Baffinland has consistently stated the need to undertake pre-development work activities (PDW) in order to ensure efficient execution of the Mary River Project. In 2008, Baffinland indicated that it would formally request exceptions to proceed with the pre-development work pursuant to Section 12.10.2(b) of the Nunavut Land Claims Agreement ("NLCA") to allow for the required approvals and licences to be granted.

In November 2009, the NIRB issued a guidance document for the preparation of an environmental impact statement (EIS) for the Mary River Project. In accordance with Nunavut regulatory requirements and the NIRB guidelines, Baffinland submitted the draft environmental impact statement (DEIS) in January 2011, followed by an Addendum to this DEIS in July 2011. The technical review of the DEIS is in progress. NIRB expects to render its decision regarding the preparation of the Final Environment Impact Statement (FEIS) by December 2011. Baffinland plans to submit its FEIS on or before January 31, 2012. The public hearing of the FEIS will likely occur in Q2 2012, followed by a NIRB decision regarding the Project Certificate in Q2 2012. The AANDC Minister's decision regarding the Mary River Project and the issuance of the Project Certificate are expected for Q3 2012. Baffinland also expects to obtain its Type A water license by early Q1 2013.

This regulatory approval timeline for the Mary River Project would enable Baffinland to begin construction in Q1 2013. Beginning construction in Q1 2013 can only be accomplished with early staging of material and equipment at the Project sites during the 2012 open water shipping season. Following discussions and consultations with the NIRB, NWB and the QIA, Baffinland made the decision to proceed with the submission of a formal application for Pre-Development Work (PDW) activities and to formally request exceptions to proceed with the pre-development work pursuant to Section 12.10.2(b) of the Nunavut Land Claims Agreement ("NLCA") to allow for the required approvals and licences to be granted. Baffinland believes that much of the PDW could be permitted with the submission of an updated work plan for 2012 and by amendment to its Type B water license (2BB-MRY1114).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The following document is Baffinland's Application for Review and Approval of Pre-Development Work (PDW) for the Mary River Project. At the request of the NIRB, a distinct environmental assessment is presented for the PDW activities (PDW-EIS). It must be noted that the environmental effects assessment of the PDW was an integral part of the Mary River Project DEIS submitted in January 2011. The PDW-EIS must be viewed as a subset of the much larger Mary River Project DEIS and most technical references for baseline information and effects assessment refers to documents and studies presented in support of the DEIS. For this reason, and to enable rapid and convenient cross-referencing for the readers and reviewers, the electronic submission of this PDW application includes a copy of the DEIS and its Addendum.

Note that the planned Mary River Project PDW activities for 2012 and 2013 are intended to be inclusive of activities previously screened by NIRB and subsequently permitted. These NIRB screening decisions were issued for the Exploration and Geotechnical Drilling Program (NIRB File No. 07EN004, March 26, 2007 and NIRB File No. 07CA070, February 22, 2008) and the Bulk Sampling Program (NIRB File No. 07EN012, May 4, 2007). The activities included under these screenings for which there may be activities undertaken during 2012 and 2013 generally include exploration drilling, geotechnical drilling and surveys, regional exploration programs, ongoing environment compliance and scientific/engineering baseline data collection, and continued progressive reclamation of project areas of current and past use. Since these activities have been previously screened and are currently permitted, they are not discussed explicitly within the scope of PDW activities.

Please note : Inuktitut Translations will be provided separately for the **Preamble / Context** and **Executive Summary** sections of this PDW Report.

© Hatch 2011/09

1. Executive Summary

1.1 Regulatory Framework

In the cover letter for the 2008 Project Proposal submission to NIRB, Baffinland outlined its intention to seek approvals for the staging of equipment and materials for the Project prior to completion of the NIRB review. In particular, Baffinland indicated that it would formally request exceptions to proceed with the pre-development work pursuant to Section 12.10.2(b) of the Nunavut Land Claims Agreement ("NLCA") to allow for the required approvals and licences to be granted.

On September 4, 2009, NIRB outlined the coordinated process for the review of the Project, including consideration of approvals for pre-development work.

Volume 3 – Appendix 3G of the Addendum to the DEIS outlined the Pre-development Works Proposal ("PDW") for the Project.

Section 12.10.2 of the NLCA provides that activities related to a Project may be approved pending a Part 5 review where certain conditions are met:

12.10.2 Notwithstanding Section 12.10.1, where a Project proposal has been referred for review pursuant to Part 5 or 6, approvals or licenses for exploration or development activities related to that Project may be issued if:

a) the activity falls within Schedule 12-1; or

b) the activity can, in the judgment of NIRB, proceed without such a review.

Schedule 12-1 lists activities that are exempt from the requirement for screening by the NIRB. Activities exempt from screening under Schedule 12-1 include:

1. Land use activities not requiring a permit or authorization from the Government of Canada or Territorial Government.
2. Land use activities requiring only a Class B permit under the *Territorial Land Use Regulations* (SOR/77-210 4 March 1977).
3. Water uses that do not require a public hearing under Section 13.7.3.

Approvals or licences for exploration or development activities not listed on Schedule 12-1 may be approved under Section 12.10.2(b) if the activities can, in the judgment of NIRB, proceed without a review.

In its letter of August 25, 2011, NIRB outlined the proposed process for consideration of the PDW following submission of this application package for the approvals and licences set out below in Section 1.9.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

1.2 Purpose and Rationale for Pre-Development Work

The Mary River Project is situated in the north west of Baffin Island, within the Arctic Circle. Currently access to Mary River and Milne Inlet sites is by light plane or from Milne Inlet by road (Tote Road) which is in need of maintenance and repair. In Steensby Inlet there is little footprint of current activity and the only access is by helicopter from Mary River or sealift from August-October.

Pre-development activities for Projects in more developed (and southerly) areas typically consist of staging materials for construction, ensuring that long lead items are ordered and everything is geared for starting full construction once the necessary permits and approvals are in place.

Construction execution is optimal when the materials and equipment arrive in the right sequential order and at the right time (so for example, delivering the structural steelwork before the foundations are in place result in unnecessary space constraints on site, or having a grader to grade a road before the road base has been properly placed is costly due to downtime of the equipment.) As a result, pre-development consisting of "just-in-time" staging for construction is key to ensuring optimal Project execution. This is possible on Projects where there is year round access for construction staging.

For the Mary River Project, timing and execution of the pre-development step is much more complicated due to the very limited open-water shipping season and difficult access and logistics entailed in moving materials, equipment and workers inland to the various construction fronts.

Equipment and materials can only be brought in by ship (in other areas south of the Project, road or rail are options) and can only arrive during the shipping window of the open water season (from approximately early August to late October) each year. This means that all the supplies needed for a full year of work, must arrive in a 10 week window. If this shipping window is missed, pre-development or construction cannot begin or be completed for a full year, resulting in delays to the Project and delays in the flow of benefits to the host communities. The success of a Project such as Mary River therefore is highly dependent on being able to carry out sufficient pre-development (such as early staging of equipment and materials and other preparatory work) one full shipping season ahead of when construction is scheduled to start.

Implementing a pre-development program also serves as a training tool for the local labour force to develop the skills necessary for full construction.

1.3 Definition of Pre-Development Work for the Mary River Project

PDW refers to activities considered essential for the timely execution of the Project. It takes into account the unique setting and isolation of the Mary River Project location as well as the absence of infrastructure. The works consist primarily of construction laydown areas, fuel storage, access roads, and, transporting and receiving materials at each of the Mary River Project sites, that is, Milne Inlet, Mary River Mine Site, Steensby Port, and, the railway corridor construction camps. The PDW consist of:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Shipping of equipment and material during a limited open water season of the Canadian Arctic (August to mid October 2012) and receiving this equipment and material at both Milne Inlet and Steensby Inlet Project sites
- The development of the infrastructure at Milne Inlet, Steensby site and the Mine Site for receiving and storing equipment and material that will be used for the construction of the Project. Such infrastructure includes:
  - Reliable all-season access to the Project sites for transportation of personnel; this includes airstrip and access roads;
  - Undertaking the earthworks necessary to support PDW at each Project site;
  - Construction of adequate storage facilities to ensure availability of supply between the shipping seasons (fuel, bulk construction material, equipment, etc.); and
  - Availability of accommodation for housing of personnel; this includes camp, complete with kitchen, water supply, sewage treatment, waste disposal, first aid and recreational facilities.

It should be noted that with the exception of the construction of winter ice roads for temporary access to the railway camp site during the 2012-2013 winter, all pre-development activities will be limited to the boundaries of the "potential development areas" (PDA) established in the DEIS. Baffinland would like to initiate winter road development in Q4 2012 or Q1 2013 depending on ice thickness.

1.4 Types of Pre-Development Works

The Pre-Development Work (PDW) can be classified in four general types of activities:

1.4.1 Earthworks

Earthwork refers to all earth/ground movement activities that will result in modification to the physical landscape. It includes activities such as:

- Clearing, grading and levelling (cut and fill);
- Contouring for adequate drainage;
- Construction of ditches and sedimentation ponds for management of runoff from disturbed areas; and
- General preparation of surfaces where:
  - Access road, air strip will be constructed;
  - Laydown areas where equipment and material will be stockpiled or stored; and
  - Facilities such as fuel depots, landfarms, and buildings will eventually be constructed.

Earthworks may require the use of aggregate (produced locally from borrow pits and quarries) and blasting for cut and fill requirement.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

For fuel depots, fuel tank farm, and landfarm earthworks include the construction of the engineered secondary containment (site preparation, construction of containment berms and installation of impermeable liners).

Earthwork will be remediated and re-contoured in accordance with the abandonment and reclamation plan.

1.4.2 Staging

Staging requires the delivery and temporary storage (until it is utilized) of material and equipment to the laydown areas or the sites where the material and equipment will be used.

Staging requires the construction of access roads and the preparation of laydown areas as described under earthworks above.

1.4.3 Installation

Installation refers to the physical installation/erection of the facilities. Components are assembled for their ultimate utilization. For example:

- Various construction camp facilities may be assembled and readied for commissioning;
- Fold-away maintenance type facilities may be installed;
- Fold-away type warehousing facilities may be installed;
- Field offices (trailers) may be installed; and
- Fuel tanks/depots may be constructed but some not utilized immediately.
- Landfarms an contaminated snow contaminated snow containment dumps may be installed to manage the potential for hydrocarbon spills

1.4.4 Operation

Operation refers to the commissioning and on-going usage of the facilities.

1.5 Duration of PDW Activities

PDW will begin in Q2 2012 and will carry on until the Project Certificate and the Type A water license are granted (expected in Q3 2012 and Q1 2013 respectively). The duration of the PDW is thus up to one year.

Once the Project Certificate and the Type A water license are granted, Baffinland will be in a position to immediately proceed with the construction activities of the Mary River Project at all sites. The Project construction activities and schedule will be presented in the Final Environmental Impact Statement which will be submitted in January 2012.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

1.6 Abandonment and Reclamation

Abandonment and Reclamation of PDW will be initiated if the Project Certificate is not granted by the Minister of AANDC. A decision on the Project Certificate is expected for Q3 2012. Should the Project Certificate be delayed or denied, Baffinland will implement its abandonment and closure plan for the Mary River Project. Demobilization activities would begin during the shipping season of 2013 and complete site remediation would be completed by 2015. This would be followed by a 5 year post closure monitoring period to ensure that closure objectives have been achieved.

At closure, all physical buildings, material and equipment are removed from the site – these activities are thus completely reversible. At closure, re-contouring of areas may be required to facilitate or improve natural drainage patterns; erosion and sediment control structures are left in place. Where secondary containment berms have been constructed, these berms are removed/flattened and the sites are re-profiled and contoured to ensure adequate drainage and prevent erosion. All hydrocarbon contaminated areas will be identified, assessed, and remediated as appropriate.

A discussion of closure activities is presented for each PDW site under their respective section of this application.

1.7 Financial Security and Bonding Requirements

Baffinland recognizes that approval of the PDW does not constitute an approval for the overall Project and will not prejudice NIRB or the Minister's decision on the Project Certificate.

Baffinland is willing to accept the risk and bonding required, and, to take the necessary steps to ensure this pre-development work can be authorized within the NIRB/NWB coordinated review process.

1.8 Relationship to DEIS Submission and DEIS Review Process

The DEIS was submitted for review in January 2011. At NIRB's request, an addendum was prepared and submitted on July 4, 2011. This addendum provided clarifications on the Project Description following the removal of the "Road Haulage Options" from the initial Project Description.

It has always been Baffinland's intention to carry out PDW. However, the scope of this PDW could not be well defined at the time of the DEIS submission in January 2011. As a result, in the January submission, Baffinland presented a brief outline of the scope of PDW under consideration.

With the advancement of the Feasibility study and the development of the Project Execution Plan, the scope of the PDW has been defined. An overview of the scope of the PDW was presented in Appendix 3G of the July 4, 2011, submission of the Project Description Addendum for the DEIS review.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The PDW is an integral part of the overall Mary River Project. The environmental effect assessment of this work is included in the overall effects assessment presented in the DEIS. However, at the request of NIRB, a PDW specific environmental effects assessment was undertaken, which is the purpose of this submission.

Due to timeline constraint with the DEIS review and eventual delivery of the Project Certificate (expected for Q3 2012), after consultation with NIRB and NWB, and to be able to make use of the 2012 open water shipping season, Baffinland has decided to submit a distinct application for these PDW for the following reasons:

i. Article 12.1 of the NCLA allows for the AANDC Minister to authorize PDW for a Project that is under review

ii. A timely favourable decision by NIRB and the AANDC Minister for allowing PDW activities would enable Baffinland to take advantage of the 2012 open water shipping season

iii. The approval of PDW does not constitute an approval for the overall Project or does not prejudice NIRB or the Minister's decision on the Project Certificate.

1.9 Permits Required for PDW

Baffinland believes that much of the PDW could be permitted by amendments or by updated work plans to its existing permits.

- The current Commercial Lease for IOL (Q10C3001) covers Milne, Mary River, and most of the Milne Inlet Tote Road. Under the Permitted Activities it authorizes "pre-construction staging activities" approved by NIRB and subject to submitting an amended Work Plan for approval by the QIA as landlord. The Commercial Lease also addresses quarries under the Quarry Concession Agreement, water rights and associated compensation for limited water use, required Security deposit, and provisions for socio-economic benefits to the Inuit.
- Baffinland currently holds land permits for Crown Land along a 10 km length of the Tote Road (LUP #N2007F004), and for the existing Steensby and Midrail Camps (N2006C0030).
- Baffinland currently holds a quarry permit on Crown Land adjacent to the Tote Road (2011QP0079).
- Baffinland believes that most activities subject to an approval from the NWB could be approved under an amendment to Baffinland's existing Type B water license (2BB-MRY1114 TYPE "B") for all Project Sites.
- Baffinland holds quarry concession agreements under the Commercial Lease for a quarry/borrow pit at Milne Inlet, a quarry/borrow pit at the Mary River Mine Site, and along the Tote Road.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

A complete list of permits for the existing Project is provided in Section 11, Regulatory Framework).

However, Baffinland has identified a number of additional authorizations that will be required to carry out the PDW. These permits are authorizations in Table 1-1: Permits Required for PDW.

Table 1-1: Permits Required for PDW

Project Site	Responsible Agency	Section of PDW Application	Permit
Milne Inlet	QIA	Appendix A.1	Submit 2012 Work Plan for PDW (Q10C3001 S. 4.) and request to revise the Quarry Concession Agreement (Schedule "B")
	NWB	Appendix A.2	Amendment to water license (2BB-MRY1114 TYPE "B")
	Transport Canada	Appendix B.2	OPEP for Milne Port
Mine Site	QIA	Appendix A.1	Submit 2012 Work Plan for PDW (Q10C3001 S. 4.) and request to revise the Quarry Concession Agreement (schedule B)
	NRCan	Appendix A.5	Storage and Use of Explosives
	NWB	Appendix A.2	Amendment to water license (2BB-MRY1114 TYPE "B")
Steensby Site	AANDC	Appendix A.3	Crown Land Lease for Steensby Site
	AANDC	Appendix A.4	Quarry Lease for Steensby Quarry
	Transport Canada	Appendix B.3	OPEP for Steensby Port
	NRCan	Appendix A.6	Storage and Use of Explosives
	NWB	Appendix A.2	Amendment to water license (2BB-MRY1114 TYPE "B")
	DFO	Appendix A.7	Authorization (Letter of advice) for two creek crossings at Steensby
Railway	NWB	To be submitted mid 2012	Water license required for construction of winter road (use of water)
	AANDC	as required 2012 to 2017	Quarry Permits

The Applications for all of the above permits are attached in Appendix A of the PDW Application.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

1.10 Benefits for Inuit

As stated above (Section 1.9), the IOL Commercial Lease Q10C3001 S. 9.0 includes provisions for socioeconomic benefits to Inuit including Inuit employment and procurement (S. 9.02) and Inuit training programs (S. 9.03). In addition, the IIBA negotiations with QIA are proceeding and nearing conclusions.

The approval of the PDW would enable Baffinland to implement many of the provisions of the IIBA such as commencement of Inuit employee training programs as early as Q1 2012, a full year prior to issuance of the Project Certificate.

1.11 Conclusion of the Environmental and Socio Economic Effects Assessment for Pre Development Works

As requested by NIRB, Baffinland has completed a detailed environmental assessment for the PDW. The effect assessments followed the methodology established in the DEIS that is based on NIRB's "Guidelines for the Preparation of an Environmental Impact Statement for Baffinland Iron Mines Corporation's Mary River Project (NIRB File No. 08MN053), November 16, 2009.

The PDW will be designed and executed in a manner that meets all regulatory requirements and that will avoid, limit, and, minimize negative effects where possible and will enhance socio-economic benefits. Management plans (Appendix B) have been developed to ensure that the commitments made by Baffinland will be respected.

The environmental assessment of the PDW concludes that residual effects of the PDW on the valued ecosystem component (VECs) of the biophysical environment will be not significant.

Concerns have been expressed over the possibility of large a diesel spill associated with refuelling at Milne and Steensby Inlets. In the unlikely event that it occurs, such a spill may have significant environmental effects. However, refuelling is a well mastered routine activity for all Arctic communities. Handling of fuel deliveries is regulated under the Canadian Shipping Act and subject to an Oil Pollution Emergency Plan (OPEP) which must be submitted and approved by Transport Canada prior to deliveries. For the PDW, two shipments of fuel will be delivered at each of Milne Inlet and Steensby Inlet by tankers in early August 2012 and late September 2012.

Table 1-2: Summary of Project Residual Effects for VECs presents a summary of the PDW residual effects on the VECs.

Assessments of potential effects on the socio-economic environment have concluded that there will be significant positive effects on local employment and skills development.

The effects of PDW on the human environment are expected to arise mostly from interactions associated with employment of local residents during the thirteen-month duration of these activities.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

An important defining feature of PDW in relation to its effects on the human environment is the short duration of these activities. Developmental processes such as changing attitudes toward the value of education, acquisition of accredited skills and advancement of careers, or the development of entrepreneurial capacity leading to business development simply will begin to "incubate" over the twelve month period of PDW. In addition, PDW will be carried out prior to implementation of the IIBA that is being negotiated in the context of the Mary River Project. Many of the initiatives planned in the IIBA to support attainment of Inuit benefits—including achievement of labour force capacity, business capacity, and overall community development objectives—will be initiated during PDW.

Many of the beneficial effects that might typically be expected to be substantial will not attain the combination of attributes, particularly in terms of their magnitude and duration, to be considered "significant." The short term nature of PDW means that features of "project – human environment" interactions that might otherwise develop over time, such as effects on families and children, community stability, and cultural development, are not expected to be affected, even in the absence of IIBA-related mitigative measures.

In spite of the modest benefits expected to accrue from contributions to community and economic development objectives of importance to the affected communities and to the territory, the strategic value of PDW is evident. PDW activities cannot be fully assessed in isolation from their relation to the potential advancement of the Mary River Project. This context leads to several findings of "significant positive" effects.

PDW is assessed to have no significant negative residual effects on any component of the human environment. PDW is assessed to present significant positive effects related to the Economic Development and Self-Reliance VSEC, the Benefits, Royalty, and Taxation VSEC, and the Government and Leadership VSEC components of the human environment. These arise out of the strategic value of PDW in relation to the potential advancement of the Mary River Project, and to the advancement of potential taxes, royalties and other benefits accruing from that project by a full year.

Table 1-3: VSECs, Potential Effects, Mitigations and Significance of Residual Effects presents a summary of the PDW residual effects on the VSECs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 1-2: Summary of Project Residual Effects for VECs

Landforms, Permafrost and Atmospheric Environment			
VEC	**Potential Effect**	**Mitigation Measure**	**Residual Effect**
Landforms and soil		Ensure adequate drainage and prevent pooling of water	Not Significant
Permafrost	Local subsidence	Drainage and foundation design	Not Significant
Climate Change	GHG emissions	Arctic grade diesel fuel	Not Significant
Air Quality	Degradation of ambient air quality	Apply best management practices for limiting air emissions; where possible, use of granular material for road construction; regular maintenance of road bed, equipment and vehicles; use of low sulphur arctic grade diesel fuel;	Not Significant
Noise and Vibration	Sensory impact on wildlife	Procurement policy for noise for equipment and vehicles; Use of mufflers – regular maintenance of engines and equipment;	Not Significant
Water Quantity			
Philips Creek km 32 Lake	Reduction in volume	Measurement of withdrawal quantities as per Water License	Not Significant
Camp Lake	Changes in lake volume	None	Not Significant
Steensby 3 km Lake		None	Not Significant
Water Quality			
Surface water freshwater quality	Deterioration of surface runoff - negative effects on receiving water quality	Quarries at least 30 m from stream or water body; install range of sediment and erosion control structures as per Surface water Management Plan – use of Best Management Practice; Routine inspection and maintenance of water crossing; ice and freshet management	Not Significant
Treated Effluent Quality	Un treated effluent discharge to lakes or river	Sewage treatment plant and wastewater treatment plant (oily water, truck wash, maintenance facilities, explosives equipment wash water) - Appendix B.5 Wastewater Management Plan)	Not Significant
	Spills	Fuel tank farm and large storage tanks placed in secondary containment structures (lined and impermeable); smaller fuel tanks consist of double wall iso-containers; Refuelling on impermeable surfaces and runoff contained; Emergency and Spill Response Plan and OPEP in place.	Not Significant
Aquatic ecosystems , fish and fish habitat			
Freshwater fish, fish habitat and other aquatic organisms	Loss of Habitat (Steensby)	Minimize footprint of stream crossing	Not Significant
	Movement (all areas of PDW)	Appropriate design of stream/river crossing structures (culvert); no barrier to movement	Not Significant
	Mortality (all areas of PDW)	Monitor low flow stream, fish salvage if necessary; Use of explosives in or near streams/water bodies as per DFO Guidelines;	Not Significant
	Health (all areas of PDW)	Fuel tank farm and large storage tanks placed in secondary containment structures (lined and impermeable); smaller fuel tanks consist of double wall iso-containers; Refuelling on impermeable surfaces and runoff contained; Emergency and Spill Response Plan and OPEP in place.	Not Significant

© Hatch 2011/09

Terrestrial Environment – Vegetation and Wildlife			
VEC	**Potential Effect**	**Mitigation Measure**	**Residual Effect**
Vegetation		Limit physical footprint of facilities;	Not Significant
Caribou	Loss of Habitat	Use of dust suppressant on Tote Road during growing season;	Not Significant
	Mortality	Speed limits for trucks Baffinland has a no hunting policy for all personnel while working on site.	Not Significant
	Movement	Limited traffic outside the PDW areas	Not Significant
	Health	hunter-harvest study conducted in coordination with local HTOs and the GNDoE	Not Significant
Terrestrial Environment – Migratory Birds			
Peregrine falcons Snow geese Common eiders King eiders Red-throated loons	Direct Habitat Loss	Employee awareness / environmental induction program; Minimize footprint of facilities and conduct nest search prior to start of activities; No hunting policy; avoidance of areas of large concentrations of foraging or moulting birds; Avoidance of known nests or nesting areas; To the extent possible, develop appropriate aircraft approach and departure flight paths; Mitigation measures outlines in Appendix B.8 Terrestrial Environment Management Plan	Not Significant
	Indirect Habitat Loss		Not Significant
	Indirect Habitat Loss		Not Significant
	Indirect Habitat Loss		Not Significant
	Health & Mortality		Not Significant
Marine Environment			
VEC	**Potential Effect**	**Mitigation Measure**	**Residual Effect**
Marine water and sediment quality	Discharge of runoff	Sediment control measures for runoff; application of best management practices (Appendix B.4 - Surface water management plan)	Not Significant
	Discharge of treated effluent	Sewage treatment plant; Wastewater treatment plant (oily water, truck wash, maintenance facilities, explosives equipment wash water); (Appendix B5 Wastewater Management Plan)	Not Significant
	Ship-to-shore spills	Emergency and Spill Response Plan; Milne Port OPEP and Steensby Port OPEP	Not Significant
Sea seabed sediments quality	Discharges from Ships	On-board waste management; No discharge at sea; SOPEP	Not Significant
Marine and coastal physical habitat	HADD	Freight dock construction consist of floating barge with minimum footprint on foreshore	Not Significant
Marine mammals and polar bears	Habitat	Shipping Management Plan – shipping only during 2012 open water season	Not Significant
	Movement	Shipping Management Plan – shipping only during 2012 open water season	Not Significant
	Mortality	Shipping Management Plan – shipping only during 2012 open water season	Not Significant
	Health	No discharge from ships at sea	Not Significant

© Hatch 2011/09

Table 1-3: VSECs, Potential Effects, Mitigations and Significance of Residual Effects

VSECs	Potential Effect	Mitigation	Residual Effect
Communities			
Population Demographics	In-migration of non-Inuit from the South In-migration of Inuit into North Baffin from other regions Out-Migration of Inuit from North Baffin	Designation of North Baffin communities as "Point of hire" (Arctic Bay, Clyde River, Hall Beach, Igloolik, Pond Inlet); Iqaluit and southern community are also designated "point of hire"; Free transportation from point of hire to Mine Site;	Negligible
Education and Training	improved life skills amongst many LSA residents	Job readiness components in orientation and training Supportive work environment "No drug, no alcohol" policy	Not significant, positive
	Barriers related to school attendance and success	No planned mitigation	Negligible
	Opportunities to gain skills	Preparatory training opportunities	Not significant, positive
Human health and well-being, including local food security	Substance abuse: affordability, accessibility, attitude	"No drug, no alcohol," baggage search policy Inclusion of components to orientation and training	Not significant, variable
	Changes in parenting	No planned mitigation	Not significant, variable
	Increased household income and food security	Orientation related to health and well-being	Not significant, positive
	Absence from community during work rotation	Short rotations	Not significant, negative
Community infrastructure and public service	Competition for skilled workers	Early start for skills training	Not significant, negative
	Labour force capacity	On-going training, Employment experience	Not significant, positive
Governance and leadership	Participation in initiatives to identify indicators of relevance to regional monitoring programs, share data generated by activities related to the Project, and discuss the interpretation of this data with others involved in these initiatives	Fit well with territorial strategic priorities	Significant positive

© Hatch 2011/09

VSECs	Potential Effect	Mitigation	Residual Effect
Economics and Employment			
Livelihood and employment	Creation of Jobs in the LSA	LSA points-of-hire	Not significant, positive
	Employment of LSA Residents	Inuit hiring Management commitment	Not significant, positive
	Job Progression and Career Advancement	Short duration, no planned mitigation	Negligible
	Indirect Job Creation	Short duration, no planned mitigation	Negligible
Economic development and self-reliance	Support for Nunavut strategic development objectives	Strategic value for advancement of Mary River Project	Significant positive
Contracting and business opportunities	Expanded market —business services to Project	Short duration, no planned mitigation	Not significant, positive
	Expanded market —consumer goods and services		Negligible
	Entrepreneurial capacity		Negligible
Benefits, taxes and royalties	Increase taxes and revenues	Pre-IIBA, No planned mitigation	Not significant, positive
Culture and Land Use			
Culture Resources and Land Use	Disturbance or removal of archaeological sites	Pre-development archaeological surveys; mitigation by SDR prior to construction; implementation of a chance finds procedure	Not significant, negative
	Unauthorized removal of artifacts	Training, flagging and exclusion zones, management plans, implementation of chance finds procedure	Not significant, negative
	Disturbance of Inuit harvesting and travel		Negligible

© Hatch 2011/09

2. Milne Inlet PDW

Milne Inlet will receive the material and equipment required for the development of the Mary River Mine Site and the north section of the railway. Baffinland expects 18 to 20 sealifts during the open water season of 2012 to deliver the material and equipment required for pre-development works. This material and equipment cannot simply be placed on the beach. The following activities and facilities are required for safe storage of material and equipment delivered by sealift.

The drawings and design basis documents for the Milne Port PDW are presented in Appendix C and Appendix E respectively.

2.1 Earthworks for Material Unloading and Laydown Area

The following Earthworks will be undertaken:

- Install Spud Barge (temporary installation) for offloading of sealifts;
- Prepare new laydown area (minimum of 500m x 500m) and upgrade the existing laydown area currently used for existing operation;
- Grading and construction of secondary (base, berms and liners) containment structure for the fuel tank farm, landfarm/contaminated snow dump facility;
- Prepare site for accommodation camp, temporary office and warehousing facilities; and
- Unload and store materials and equipment destined for Mary River and the northern section of the railway staging areas.

Site preparation works will include grading and contouring to ensure adequate drainage and erosion protection. Where necessary, drainage ditches and sedimentation ponds will be constructed.

Drawings attached in Appendix C present the site layout and drainage work for Milne Inlet.

2.2 Quarry – Borrow Source

The existing quarry source at Milne Port will continue to be exploited for the production of aggregate required for the PDW. The estimated volume of aggregate required for the PDW is 200,000 m^3.

The Milne Port quarry is authorized under the IOL Commercial Leas. The volume of aggregate required for PDW exceeds the volume allowed in the existing quarry concession agreement and therefore requires amendment. The quarry management plan for Milne Inlet is presented in Appendix B.7.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

2.3 Fuel

Delivery of fuel is essential to facilitate the proposed Pre-Development Work activities. A new 5ML steel tank is currently under construction. This tank will replace the existing bladder farm. This work will be completed in 2011. The bladders will be decommissioned in 2012 and 2013 and this site remediated. Any fuel in the bladders will be transferred to the new storage tankage and contaminated soil will be treated in landfarm facility.

2.3.1 Alternatives for Fuel Storage

Baffinland has evaluated two alternatives for fuel delivery and storage:

- Expand existing tank farm; or
- Use a fuel barge or tanker to store fuel – a fuel barge or fuel tanker would be anchored and overwinter in Milne Inlet.

Both approaches have their advantages and disadvantages. The key determinants for the Project decision are:

- Quantity of fuel required for both pre-development work, and, eventually for the construction phase of the Project;
- Availability and cost of tankers or fuel barges;
- Useful life of the installation (12 months for pre-development, and up to 5 years for construction);
- Elimination of temporary facilities, that is, construction of fuel storage facilities at the on-set of the pre-development activities that can service the entire construction period; and
- Community acceptance.

The use of tankers or fuel barges would minimize on-ground disturbance at Milne Port. Environmental concerns related to fuel spills occurring during ship-to-shore transfers can effectively be mitigated with well defined procedures and response plans (including Transport Canada approved Oil Pollution Emergency Plans – OPEPs, refer to Appendix B.2).

The construction of a permanent fuel tank farm at Milne Port is the preferred strategy as it poses the lesser environmental risk, and is likely more acceptable to the communities. Furthermore, since a larger fuel storage facility will be required at Milne Inlet to support on-going construction activities, the efficient and logical approach would be to commence development of the larger tank farm at the on-set of the PDW.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

2.3.2 PDW for Fuel Storage

A permit was granted in 2011 for the replacement of the fuel bladder farm by a 5 ML permanent steel fuel tank as part of ongoing site operations and maintenance, as the bladders are reaching their design life. Construction of the 5 ML steel tank is underway. A new 3 ML steel tank will also be constructed for storage of Jet A fuel in early 2012, under existing permits. Once these two tanks are tested and commissioned, the remaining fuel contained in the bladder farm (diesel and Jet A) will be transferred during the working season of 2012.

The pre-development work approach would consist of expanding this fuel tank farm at the on-set of the pre-development work and begin construction of four additional 10 ML permanent steel diesel storage tanks required to support the construction phase. The new tanks will be constructed in accordance with appropriate guidelines and regulations for fuel tank farm construction and would remain in service for the life of the Project. The pre-development activities include:

- Drill geotechnical investigation holes at tank pad site;
- Construct tank base and containment berm for new tank farm;
- Place impermeable membrane liner to provide containment;
- Receive materials for steel fuel tanks;
- Construct the 3 ML Jet A fuel tank;
- Begin construction on four 10 ML permanent steel fuel tanks located inside the containment area;
- Receive and install fuel dispensing and off/on-loading modules for fuel farm;
- Testing of fuel tanks before filling, in accordance with applicable standards and guidelines;
- Install truck off-loading system for new tank farm; and
- Receive up to 40 ML of diesel fuel and 3 ML of Jet Fuel by the end of the 2012 open water season.

2.3.3 Types, Quantities and Uses of Fuel

The following Table 2-1: Types, Quantities and Uses for Various Fuels for the PDW at Milne Inlet presents the types, quantities and uses for the various fuel for the PDW.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 2-1: Types, Quantities and Uses for Various Fuels for the PDW at Milne Inlet

Fuel Type	Location	Storage Quantities
Diesel	Milne Inlet	45 ML (one 5ML steel tank and four 10ML steel tanks), up to 15ML
Jet A Fuel	Milne Inlet	3 ML (receive shipment of Jet A fuel destined for Mine Site

The combined diesel fuel consumption during the PDW at both Milne Port and the Mine Site is estimated at 2.5 ML. The Jet A Fuel consumption is estimated at around 3ML.

Two deliveries of diesel fuel are expected for 2012 (early August and late September).

2.4 Camp

The PDW activities will require a 150 person camp capacity at Milne Port. This includes the peak required to house personnel assisting in handling materials and equipment received during the 2012 Sealifts.

2.4.1 Alternative For Workers Accommodation During PDW

Sixty (60) workers are proposed to be housed at the Existing Camp at the site. For housing of the additional 90 personnel two alternatives were considered for workers accommodation during the PDW:

- Construction of a 90 person camp at Milne Inlet (expansion of existing camp); and
- A self contained floating camp (on a barge) to overwinter in Milne Inlet.

The floating camp would be completely self contained (sewage treatment, potable water system, power supply, incinerator, etc.) and would be similar in construction to camps currently used in remote coastal areas. Although this option would be feasible, there is already an existing camp at Milne Port. Therefore, Baffinland opted for the expansion of the existing 60 person camp to a 150 person camp. This expanded camp will service the activities at Milne Port for the duration of the PDW and construction phase of the Mary River Project.

2.4.2 PDW for Camp Facilities

As part of the pre-development work, Baffinland needs to install additional 90 bed capacity to the existing 60 person camp (total 150 person camp capacity) and have this camp fully functional for the 2012 sealift season.

The camp will be used by the pre-development work crews that unload the construction materials and equipment received by sealifts, place the material/containers on laydown areas and reload transport trucks for shipment of material and equipment to the Mine Site.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The pre-development work activities consist of:

- Preparing the site (earthwork) for expansion of the existing camp;
- Receiving and installing an additional 90 worker camp capacity;
- Expanding the existing sewage treatment plant and potable water treatment of the existing camp to accommodate a total of 150 persons; and
- Installing a second incinerator unit for the incineration of non-hazardous waste.
- Construction of a landfarm/contaminated snow dump facility

The camp will be fully functional during the PDW although the peak capacity is required only during the sealift months (August, September, and October).

2.5 Administration and Maintenance Facilities

Administration (field offices) and maintenance facilities are required at the on-set of the pre-development work to support pre-development activities. The activities of the pre-development work would consist of:

- Receive and install 30 m by 30 m foldaway for warehousing;
- Receive and install 18 m x 18 m foldaway site services/maintenance facility;
- Receive and install two 4 m x 18 m field office trailers;
- Receive and install 18 m x 18 m foldaway ERT & Fire facility;
- Receive and install two 4 m x 18 m office complex and debrief room (ERT);
- Receive and install heaters for sea container storages;
- Receive and install contractor foldaway warehouse and storage facility; and
- Receive and install communications tower.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

2.6 Heavy Equipment, Material And Supplies

Heavy equipment and machinery are required to handle material and equipment received by the sealifts. This equipment will also require maintenance (hence the requirement for the shops mentioned above).

The heavy equipment received during the 2012 sealift is listed in detail in Appendix F.

Additional materials to be received to support construction preparation includes:

- Explosives to be stored at the location shown on the layout drawings in Appendix C;
- Bridge pile steel sections and bridge deck modules for the northern section of the railway (to be transferred to Mary River laydown areas); and
- Ammonium nitrate and pre-packaged explosives in magazine containers (for temporary storage and transfer to Mary River explosives storage area).

2.7 Explosives Storage and Use

Explosives for the Project will be both shipped and airlifted. Packaged explosives and associated primers and detonators will be required for the Mine Site. An additional 5,000,000 kg of ammonium nitrate and detonators will be shipped to Milne where they will be off loaded and stored at Milne Port until they can be trucked along the Tote Road to the Mine Site. A small quantity of explosives may be stored at Milne Port for rock quarry development.

The explosives and primers will be temporally stored in six bermed Type 4 magazines with another Type 4 magazine for detonators in an area 160m x 340m. This area will be located according to D4 and D7 NRC Storage of Explosive Guidelines which requires that the bermed storage pad must be located at least 470m from occupied buildings or work sites and 267m from a road with less than 500 vehicles passing per day.

Explosives, primers, detonators and magazines will be trucked via the Tote Road to Mary River in an expeditious manner.

A licensed contractor has been retained for handling and use of explosives. The Contractor's Explosives Management Plan is attached in Appendix B.10. The contractor will apply for all necessary permits at least six months prior to the start of PDW. PDW at Milne Port is expected to require up to 200,000 kg of explosives.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

2.8 Water Supply for Milne Inlet PDW

Water will primarily be used for domestic consumption at the 150 person camp during the sealift operation. Once the sealifts are unloaded, the crew size at Milne Port will be at a minimum level. Only site service personnel and those required to load construction material onto transport vehicles for transfer to the Mine Site and Milne Port site maintenance personnel will remain.

The water supply may be drawn from Philips Creek during the summer months only, or trucked from "32km Lake" during winter/summer months as currently occurs at Milne Port. Water usage for the PDW at Milne Port is presented in Section 22.

2.9 Wastewater Management

The additional sewage treatment capacity will be installed and commissioned in accordance with the Waste Water Management Plan (Appendix B.5). The discharge quality of the effluent will comply with current Type B water license requirements. The discharge will be to Milne Inlet at the same location as the current discharge. Peak flows are expected at 30 m^3/day during the sealift period. Once the pre-development work is completed, the additional sewage treatment plant capacity may be idled until full construction begins.

2.10 Milne Port Waste Management

Non-hazardous solid waste generated at Milne Port during pre-development activities will be incinerated on site, with bulkier items transported to the Mine Site for secure storage and disposal in the existing landfill as appropriate.

Hazardous waste generated during pre-development activities will be stored within lined containment berms and shipped from Milne Port to off-site approved treatment/disposal facilities, typically located in southern Canada.

Waste oil or lubricant generated during PDW will be stockpiled in barrels on site. These barrels will be shipped off-site to a licensed waste treatment facility during the 2012 and 2013 shipping seasons.

Solid waste generated at Milne Port in pre-development work will be managed according to the Mary River Project Pre-development Work Waste Management Plan (Appendix G.6).

A land farm will be constructed at Milne Port for the treatment of contaminated soils and the storage of snow. Contaminated spring meltwater from the facility will be treated utilizing the existing oily water treatment system that is used to treat hydrocarbon contaminated stormwater each year.

Decommissioning of the bladder farm at Milne Port in 2012 will be performed according to the approved Action Plan for Decommissioning of Milne Inlet Bulk Fuel Storage Facility (July 2011).

Types of wastes and expected quantities that will be generated during PDW are presented in Section 22. Appendix B.6 presents the waste Management Plan for PDW.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

2.11 Abandonment and Reclamation of PDW at Milne Port

The abandonment of the pre-development works (PDW) and site reclamation at Mine Port will be undertaken if the Project is not developed. Reclamation involves removing PDW materials, equipment and infrastructure and reclaiming the site to self sustaining productive ecosystem similar to its original condition. The Abandonment and Reclamation Plan is presented in Appendix B.12.

The general abandonment and reclamation plans include the following:

- Dismantle and transport of fuel/chemical storage and handling infrastructure to an approved facility or for reuse where applicable;
- Dismantle and remove buildings and camp related infrastructure. Any remaining concrete piles will be cut to below grade and covered with overburden;
- Dismantle water and sewage treatment plants for reuse or disposal at an approved facility;
- Remove all hazardous waste and explosives and transport to a licensed treatment facility off-site;
- Regrade disturbed areas as necessary to establish safe slopes and restore the natural drainage to the areas;
- Test soils and granular materials for hydrocarbon content; contaminated soils will be remediated;
- Remove all heavy equipment by sealift; and
- The airstrip will be abandoned, but left in good condition unless otherwise directed by regulatory agencies, to provide an emergency/rescue landing spot for regional aircraft, when no other options are available.

All PDW staging areas will be subjected to a closure inspection by Baffinland representatives. Monitoring and follow-up inspections will be conducted at the Mary River Project area in order to assess the physical and chemical stability of the various components after closure and reclamation of the facilities. Annual inspections will be carried out.

2.12 Milne Inlet and Monitoring and Follow-up

During pre-development work, the existing monitoring points established in the Type B water licence will be maintained as shown in Table 2-2: Existing and Proposed Monitoring Stations.

Additional monitoring stations may be established to monitor runoff from the landfarm/contaminated snow dump and from site storm water ponds.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 2-2: Existing and Proposed Monitoring Stations

Program Surveillance Network	Location Description
MRY-2 and MRY-3	Summer and winter water supply for the Milne Port camp at Phillips Creek
MRY-5	Milne Port camp sewage discharge (existing and PDW camp)
MRY-5a	Milne Port camp sewage discharge from the PWSP into natural drainage
MRY-7	Water collected in the bulk fuel storage facilities at Milne Port before release
MRY-12	Surface discharge from the bulk sample stockpile remnants
Suggested New Monitoring Station	Surface discharged from the landfarm/contaminated snow dump containment area and sptr, water ponds

Post closure monitoring is described in the Abandonment and Reclamation Plan (Appendix B.12).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

3. Milne Inlet Tote Road

The Tote Road is the only overland transportation link between the Milne Port and the Mine Site. During the PDW, the road and stream crossings will be maintained. Sections of the road will be upgraded to reduce hazards and risks. The PDW activities consist of:

- Improvement to the road base
- Realignment of the road where necessary to facilitate passage of large loads and fuel tanker trucks
- Improvement to the grade in certain areas
- On-going efforts to reduce risk at stream crossings through the implementation of the freshet management plan

No work other than routine maintenance and some improvements to stream crossings are envisaged. Therefore, there is no requirement for an additional HADD authorization.

Large heavy loads will be transported during the winter months and over ice at stream crossings that do not have sufficient load bearing capacity. These crossings are likely limited to the four box culvert crossings. Damage to the stream bed and banks will be minimized through proper selection of crossing locations and the adoption of appropriate stream bank protection measures.

3.1 Abandonment and Reclamation

The Tote Road will decommissioned in accordance with the Abandonment and Reclamation Plan. (Refer to Appendix B.12).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

4. Mine Site PDW

The focus of the pre-development activities at the Mine Site will be to prepare laydown areas and pads to accommodate the material, equipment and pre-fabricated buildings received during the 2012 sealift and extend the airstrip. The pre-development work at the Mine Site consists of the following activities.

4.1 Earthworks - Material Unloading and Laydown Area

The following earthworks will be undertaken for PDW:

- Prepare equipment, materials and supplies laydown areas;
- Prepare pads for the accommodation camp, administrative buildings and warehousing;
- Prepare pads for fuel tank farm; and
- Construct access road to the explosive storage and emulsion plant and prepare the sites for construction.

4.2 Quarry-Borrow Source

A new rock quarry will be developed and operated at the Mine Site (refer to Appendix B.7). The existing quarry sources at Mary River will continue to be exploited for the production of aggregate required for the PDW. The total estimated volume of aggregate required for the PDW at the Mine Site is 500,000 m^3. This quarry is authorized under the IOL Commercial Lease. The volume of aggregate required for PDW exceeds the volume allowed under the existing quarry concession agreement and therefore requires amendment. The Quarry Management Plan is presented in Appendix B.7.

4.3 Airstrip

The existing Mary River airstrip will be upgraded and extended in accordance with drawings provided in Appendix C.

4.4 Fuel

Delivery of fuel is essential for pre-development activities. The strategy is to replace the existing bladder farm with a larger steel tank fuel farm. The new tanks will be constructed in accordance with appropriate guidelines and regulations for fuel tank farm construction and will remain in service for the life of the Project. The pre-development activities include:

- Drill geotechnical investigation holes at tank pad site;
- Construct tank base and containment berm for new tank farm, place impermeable membrane liner;
- Receive steel components for three 5ML steel tank fuel tanks and one 3ML Jet fuel tank;

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Begin construction on the permanent steel fuel tanks inside containment area;
- Receive and install fuel dispensing and off/on-loading modules for fuel farm;
- Testing of fuel tanks before filling, in accordance with applicable standards and guidelines;
- Transfer diesel and Jet A fuel from bladders to steel tanks and decommission fuel bladder farm; and
- Transfer up to 15 ML of diesel fuel and 3 ML of Jet fuel by tanker trucks from the Milne Port fuel tank farm.

4.4.1 Types, Quantities and Uses of Fuel at Mine Site

The following Table 4-1: Types and Quantities of Fuel at the Mine Site indicates the types and quantities of fuel at the Mine Site:

Table 4-1: Types and Quantities of Fuel at the Mine Site

Fuel Type	Use	Storage Quantities
Diesel	Heavy equipment, trucks, machinery, power generation	3 prefabricated steel tanks at 5 ML
Diesel	For staging along the northern portion of the railway	100 "20,000L" capacity ISO containers (temporary storage until railway winter roads are constructed – expected transfer to staging areas in February 2013)
Jet A	Helicopter and airplane	Mine Site – Airplane and Helicopter refuelling – quantity 3.5 ML

The combined diesel fuel consumption for PDW at Milne Port and Mary River is estimated at 2.5 ML. The estimated consumption of Jet fuel is 3 ML.

4.5 Camp

For the PDW we will use the existing 120 person camp to its full capacity. Baffinland proposes to house an average of 120 workers at the existing camp during the PDW work-phase. The existing Mary River camp is currently at full capacity. Enlargement of this camp is necessary to allow construction activities to commence once the Project receives full sanction approval in 2013. Therefore, as part of the pre-development activities, Baffinland will begin installation of the construction camp. The pre-development work activities will consist of:

- Receive and store all components for a 1,000 worker capacity camp, including its potable water system and its sewage treatment system and incinerator;
- Begin installation of this construction camp; the camp will be readied but not used during the PDW period;
- Water for the PDW camp will be provided from Camp Lake (existing water supply)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Mid-Rail camp, located 40km from the Mine Site, will be used as an overflow camp that will support other activities at camp currently permitted, including drilling, baseline studies, regional geology programs, etc.
- Construction of a landfarm and contaminated snow dump containment

4.6 Administration and Maintenance Facilities

Administration (field offices) and maintenance facilities are required at the on-set of the pre-development work in order to support the pre-development activities. The activities of the pre-development work would consist of receiving and installing:

- Receive and install 30m x 60m foldaway for warehousing;
- Receive and install 18m x 18m foldaway site services/maintenance facility;
- Receive and install 100 person office complex and vehicle wash station;
- Receive and install 18m x 18m foldaway ERT & Fire facility;
- Receive and install contractor foldaway warehouse and maintenance facility;
- Receive and install two 4m x 18m office complex and debrief room (ERT);
- Receive and install heaters for sea can storage containers;
- Receive and install 18m x 18m foldaway for Explosive Contractor's use;
- Receive and install power modules (gen-sets) for Mary River site;
- Set up communication towers along north end of the railway (from Mine Site to Mid-rail camp); and
- Receive and install waste sorting/storage facility.

4.7 Explosives Storage and Use

A total of 5,000,000kg of Ammonium Nitrate and the associated primers and detonators will be staged at the Mine Site during the PDW. The Mine Site PDW will require 500,000 kg of explosives and will begin in early June. Explosives required for this initial PDW will be air lifted (approximately 100,000 kg).

The explosives, primers and detonators will be stored in six bermed Type 4 magazines with another Type 4 magazine for detonators in an area 160m x 340m. This area will be located according to D4 and D7 NRC Storage of Explosive Guidelines which indicate that the bermed storage pad must be located at least 470m from occupied buildings or work sites and 267m from a road with less than 500 vehicles passing per day.

A licensed contractor has been retained for handling and use of explosives. The Contractor's Explosives Manamgemnt Plan is attached in Appendix B.10. The contractor will apply for all necessary permits at least six months prior to the start of PDW. PDW at mine site is expected to require up to 500,000 kg of explosives.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

4.8 Heavy Equipment and Material

Heavy equipment and machinery are required to handle material and equipment received by the sealifts and transported to the Mine Site via the Tote Road. This equipment will also require maintenance (hence the requirement for the shops mentioned above). The heavy equipment received during the 2012 sealift is listed in detail in Appendix F.

Additional materials to be received include:

- Camps modules for Ravn River (200 person) construction camp (this includes the buildings, potable water system, power supply and incinerators);
- Major bridge material and rail bed material for the north end of the railway; and
- 50 x 20,000L ISO tanks, complete with fuel dispensing modules (for the Ravn River and Mid-Rail camp sites).

4.9 Water Supply for PDW

Currently the water treatment plant has the capacity to support a camp of 200 people. The existing water supply and treatment facility will be used at the Mary River Mine Site, which is currently from "Camp Lake".

The water use for the PDW is presented in Section 22.

4.10 Wastewater Management for PDW

The nominal capacity of Mary River Mine Site wastewater treatment plant is for 120 persons . For the PDW, additional capacity will not be required. The Wastewater Management Plan is presented in Appendix B.5.

4.11 Mine Site Waste Management

During the pre-development work, the major activity at the Mine Site will be the production of aggregate for use at laydown areas, roads and airstrip construction. Once the laydown areas are prepared, work will consist of receiving material in containers and storing it in laydown areas ready for use during the construction phase.

Non-hazardous solid waste generated during the pre-development activities will be disposed of utilizing existing Mary River camp disposal facilities (landfill, incinerator). Solid waste generated at Mine Site in pre-development work will be managed according to Mary River Project Pre-development Work Waste Management Plan (Appendix B.6).

Waste oil or lubricant will be stockpiled in barrels and remain stockpiled on site until it can be shipped off-site to a licensed treatment facility (refer to Appendix B.6).

Hazardous waste generated during pre-development activities will be stored and transported to Milne Port for shipment to an off-site licensed treatment/disposal facility.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

A land farm will be constructed for the treatment of contaminated soils and contaminated snow.

The types and expected quantities of waste generated during PDW are presented in Section 22.

4.12 Mine Site Abandonment and Reclamation of PDW

The abandonment of the pre-development works (PDW) and site reclamation of the Mine Site will be undertaken if the Project is not developed. If the Project's EIS application is approved, the works will integrate into the Project Abandonment and Reclamation Plan. Abandonment and reclamation of pre-development works will involve removing PDW materials, equipment and infrastructure and reclaiming the site to self sustaining productive ecosystem near its original condition.

The general abandonment and reclamation plans include the following:

- Dismantle and transport all fuel/chemical storage and handling infrastructure to an approved facility or for reuse where applicable;
- Dismantle and remove all buildings and camp related infrastructure. Any remaining concrete piles will be cut to below grade and covered with overburden;
- Dismantle water and sewage treatment plants for reuse or disposal at an approved facility;
- Remove hazardous waste and explosives;
- Regrade as necessary to establish safe slopes and restore the natural drainage to the areas;
- Test soils and granular materials for hydrocarbon content; contaminated soils will be remediated;
- Remove all heavy equipment from the site by sealift from Milne Port;
- The landfill will be progressively covered with an interim cover consisting of overburden to allow the contents of the landfill to remain permanently frozen. Landfills will be reclaimed by capping the landfill with overburden or equivalent material; and
- The airstrip will be abandoned, but left in good condition unless otherwise directed by regulatory agencies, to provide an emergency/rescue landing spot for regional aircraft, when no other options are available.
- All PDW staging areas will be subjected to a closure inspection. Monitoring and follow-up inspection will be conducted in order to assess the physical and chemical stability of the various components after closure. Annual inspection will be carried out.

4.13 Mary River Monitoring and Follow-up

During pre-development work, the existing monitoring points established in the Type B water licence will be maintained as shown in Table 4-2: Existing and Proposed Monitoring Stations.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 4-2: Existing and Proposed Monitoring Stations

Surveillance Network Program Station	Location Description
MRY-1	Water supply for Mary River camp at Camp Lake
MRY-4	Mary River camp sewage discharge at the WWTPto Sheardown Lake
MRY-4a	Mary River camp sewage discharge from the PWSP
MRY-6	Water collected in the bulk fuel storage facility at Mary River before release
MRY-9	Surface drainage pumped or released from the bulk sample pit
MRY-10	Mine water and surface drainage pumped or released from the bulk sample weathered ore/waste rock stockpile
MRY-11	Surface discharge from the crusher stockpile
MRY-13a and 13b	Surface drainage from the closed non-hazardous landfill
Suggested New Monitoring Station	Water discharged from the landfarm/contaminated snow containment area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

5. Steensby Inlet PDW

5.1 Steensby Bay Port

Steensby Port will receive the material and equipment required for the pre-development activities at Steensby area as well as materials and equipment required for the south section of the railway. Baffinland expects up to 22 sealifts during the open water season of 2012 to deliver the material and equipment required for pre-development works. This material and equipment cannot simply be placed on the beach, but must be carefully stored in prepared laydown areas. The following activities/facilities are required for storage of material and equipment delivered by sealift.

Minor servicing operations will be carried out to mobile equipment during PDW in the foldaway mobile workshop. Any dirty water generated will pass through an oil/water separator included in the mobile workshop. The oily waste skimmed off the surface will be collected and stored while the water will be returned to the wash water tank.

The drawing and design basis for PDW are presented in Appendix C and Appendix E respectively.

5.2 Site Preparation, Material Unloading and Laydown Area

- Install spud barge (temporary dock) for unloading of Sealifts;
- Prepare laydown area;
- Prepare camp, Administration Building and Warehousing pads; and
- Consultant landfarm and contaminated snow dump containment
- Grade site and construct access road to air strip, camp and laydown areas, 3-Kilometre Lake, and quarry area.

5.3 Quarry – Steensby

A new quarry will be developed and operated at Steensby Port. The location and management plan for this quarry site is presented in Appendix B.7. An estimated 300,000 m^3 of crushed aggregate will be required for the PDW. The application for a quarry lease on Corna Land is attached in Appendix A.4.

5.4 Explosives Storage and Use

A total of 5,000,000 kg of Ammonium Nitrate and associated primers and detonators will be shipped to the port. In addition, 100,000 kg of explosives will be shipped to Steensby Port.

The explosives and primers will be stored in six bermed Type 4 magazines with another Type 4 magazine for detonators in an area 160m x 340m. This area will be located according to D4 and D7 NRC Storage of Explosive Guidelines which indicate that the bermed storage pad must be located at least 470m from occupied buildings or work sites and 267m from a road with less than 500 vehicles passing per day as shown in Appendix C.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

A licensed contractor has been retained for handling and use of explosives. The Contractor's Explosives Management Plan is attached in Appendix B.10. the contractor will apply for all necessary permits at least six months prior to the start of PDW. PDW at Steensby Port is expected to require up to 300,000 kg of explosives.

5.5 Air Strip

The development of the Steensby Port airstrip is essential in order to enable year round access to the Steensby site. Baffinland proposes to begin construction of this airstrip as pre-development work in order to facilitate adequate movement of workers as soon as construction starts in early 2013. The initial airstrip will provide for Twin Otter Service. Partial airstrip installation would be sufficient for pre-development activity stage although this approach will add cost and disruption later in the Project. This work will require blasting and the levelling of the ground (cut and fill). Prior to the development of the permanent airstrip, a winter ice strip on the sea ice at Steensby Inlet will support fixed-wing aircraft between March and May, 2012.

A landing strip will be constructed on ice once weather and ice conditions on Steensby Inlet permit. This on-ice landing strip will be used in Q1 2013.

5.6 Fuel

Delivery of fuel is essential for pre-development activities. The fuel requirement to support the Project during operation is estimated at 160 ML per year. Therefore, the Project plans for the construction of four 40 ML steel fuel tanks as the permanent fuel storage facility for the Project.

5.6.1 Alternatives for Fuel Storage

As per the situation at Milne Port, two options are under evaluation for providing fuel required for the pre-development activities.

One option consists of initiating partial development of the permanent tank farm facility at the on-set of the pre-development activities. As an alternative to this approach, Baffinland has evaluated the option of receiving and storing all the fuel in either a barge or a tanker that would overwinter in Steensby Inlet until the Project Certificate is issued and construction of one of the larger/permanent fuel tank is completed, sometime toward the end of 2013. Under this scenario, the permanent tank farm would be ready to accept fuel delivery during the 2014 open water season. Again, concerns over fuel spills during ship-to-shore transfers will be mitigated with a well defined OPEP. However, since a large permanent fuel tank farm is required for the operation phase of the Project, Baffinland considers that beginning construction on the permanent tank farm is a more efficient use of resources.

The preferred strategy is to begin construction of the containment area for the permanent fuel tank farm required to support construction and operations at the onset of the pre-development work. The tank farm will be constructed in accordance with appropriate guidelines and regulations for fuel tank

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

farm construction and will remain in service for the life of the Project. At the onset of pre-development activities, twenty prefabricated one million litre (1 ML) steel fuel tanks will be installed within the permanent containment of the future 160 ML tank farm. The 20 1ML temporary steel tank will eventually be decommissioned and removed during the construction phase of the Project when the larger 40 ML steel storage tanks are constructed and operational. The initial fuel requirements for Steensby will be provided by a fuel tanker. A 20 ML fuel tanker will be anchored near shore and overwinter in Steensby Inlet. The related work will be contracted to a qualified Operator who has proven experienced in providing such facilities to meet the Canadian Shipping Act 2001 regulations. The contracted vessel will have a valid SOPEP which includes a comprehensive risk assessment.the owner of the vessel will provide a Comprehensive Risk Assessment and a Transport Canada approved SOPEP in due course once the vessel has been selected.

5.6.2 Fuel Storage for Pre-development Work

The pre-development activities include receiving temporary ISO tanks of fuel while the larger tanks are under construction and receive shipment of fuel by barge before the end of the open water season of 2012. The pre-development activities include:

- Drill geotechnical investigation holes at tank farm site and construct tank base and build containment berm for new tank farm, place liner;
- Receive and install twenty (20) x 1 ML prefabricated fuel tanks in Steensby in the tank containment;
- Inspect the tanks prior to filling;
- Receive 42 million litres fuel – 20 ML stored on land (in the 1 ML steel tanks), 20 ML stored offshore; 2 ML stored in multiple ISO containers for immediate use at Steensby site until the 1ML storage tanks are operational;
- Receive up to 100 x 20,000L ISO tanks, complete with fuel dispensing modules at the start of the shipping season for staging at the North & South Cockburn camp sites all along the railway during the winter of 2013; and
- Receive and install fuel dispensing and on/off-loading modules for the fuel system at Steensby Port.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

5.6.3 Types, Quantities and Uses of Fuel at Steensby

The following Table 5-1: Quantities and Uses for the Various Fuel for the PDW presents the types, quantities and uses for the various fuel for the PDW.

Table 5-1: Quantities and Uses for the Various Fuel for the PDW

Fuel Type	Location	Storage Quantities
Diesel and Jet-A	On-land, within permanent tank farm lined and engineered containment	20 1ML prefabricated steel tanks (diesel and Jet-A)
Diesel	Fuel barge	20 ML (anchored and overwinter in Steensby Inlet)
Diesel	Laydown area	100 "20,000L" capacity ISO containers (not filled) (temporary storage until railway winter roads are constructed – expected transfer to staging areas in February 2013)

The expected diesel fuel consumption for the PDW is 5 ML. The airstrip will not be operational until Q2 2013. Until that time, Jet-A will be dispensed utilizing fuel in drums currently stored at the existing tent camp.

Two deliveries of fuel are expected in 2012 (early August and late September)

5.7 Camp

For the pre-development activities, Steensby Port will require a self contained camp on a floating barge that will be anchored and overwintered in Steensby Inlet. This floating camp would be completely self contained (sewage treatment, potable water desalination system, power supply, incinerator, etc.) and would be similar in construction to camps currently used in remote coastal areas. This option is also feasible for the duration of the construction phase, and, will be evaluated during the feasibility study as an alternative to the temporary construction camp to be constructed on land.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The main reason for choosing a floating camp for the pre-development activities (total 300 person capacity) is due to the immediate requirement of accommodation (and facilities to support the accommodation) at the start of the shipping season. There is insufficient capacity at the existing Steensby tent camp facilities to accommodate people prior to erection of a larger camp that would be used during pre-development and large enough for construction. However, during the PDW, the existing and currently permitted 40 person tent camp may be used as overflow facilities for the purpose of support to drilling, geology, and environmental programs planned and permitted for 2012.

5.8 Administration and Maintenance Facilities

Administration (field offices and lunchrooms) and maintenance facilities are required at the on-set of the pre-development work in order to support the pre-development activities. The activities of the pre-development work would consist of receiving and installing the following infrastructure:

- Receive and install 30m x 60m foldaway for warehousing
- Receive and install 18m x 18m foldaway site services/maintenance facility
- Receive and install 100 person office complex and vehicle wash station
- Receive and install 18m x 18m foldaway ERT & Fire facility
- Receive and install two 4m x 18m office complex and debrief room (ERT)
- Receive and install contractor foldaway warehouse and maintenance facilities
- Receive and install heaters for sea can storage containers
- Receive and install 18m x 18m foldaway for Explosive Contractor's use
- Set up communication towers along south end of the railway (from Steensby port to Mid-rail camp)
- Prepare a lined solid waste facility and an incinerator for the permanent camp.

5.9 Heavy Equipment and Material

Heavy equipment and machinery are required to handle material and equipment received by the Sealifts and is detailed in Appendix F. Materials that will be received in the Sealift include:

- Concrete batch plant
- Modular emulsion plant for explosives
- Sea containers containing 1m³ totes of Ammonium Nitrate (AN)
- Explosives magazines and transfer truck
- Fire truck, ambulance and tracked vehicle (ERT vehicle)
- Camp modules for the railway construction camps (this includes the buildings, potable water system, power supply and incinerators)
- Receive bridge pile steel sections and deck modules for the rail.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

5.10 Water Supply for Steensby PDW

A desalination plant for water supply on the floating barge camp will be used for pre-development work. During peak period of the sealift, water demand is expected to reach 90 m^3/day (provided by desalination plant). Minor volumes of water (3m^3/day) may be drawn from 3-Kilometre Lake in support of the existing and permitted Steensby tent camp.

Marginal extraction is expected from the freshwater lakes for industrial use (washing facilities, emulsion plant). The estimated freshwater consumption is less than 50 m^3/day. This water will be drawn from 3 km lake by tanker truck and distributed to the various users (maintenance facilities and emulsion plant) where day storage tanks will be provided. Water use for the PDW is presented in Section 22.

5.11 Wastewater Management for PDW

The floating barge camp has a self contained sewage treatment system and effluent will be discharged to Steensby Inlet.

Small pre-fabricated portable wastewater treatment plants for oily water and AN will be available to treat contaminated oily water generated from the fuel farm containment, landfarm, equipment wash down facilities.

The effluent quality for treated water discharge to Steensby Inlet will meet or exceed current requirements as outlined in the existing water licence for Milne Port.

Wastewater generated from on-shore lunchroom and field offices facilities will be collected in holding tanks and transferred to the floating camp sewage treatment plant with the use of a sucker truck at barge transport.

5.12 Steensby Inlet Waste Management

During the pre-development work, the major activities at Steensby Inlet will be the production of aggregate for use in the development of the first phase of the air strip, laydown areas and roads. Once the laydown areas are prepared, pre-development work will consist of receiving material in containers and storing it in laydown areas ready for use during the construction phase.

Only small amounts of non-hazardous solid waste will be generated, primarily attributed to the blasting packaging and other miscellaneous waste. This waste will be collected and stockpiled in a secured and dedicated area of the laydown area designated to receive equipment and material. The solid waste will be safely stockpiled until the Steensby landfill site is constructed and ready for use, later in 2013. Small quantities of non-hazardous waste generated at the Steensby tent camp will be incinerated utilizing the existing and permitted camp incinerator.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Waste oil and lubricant generated from the maintenance of mobile equipment will be stored in barrels/shipping containers and will remain stockpiled on-site until such waste can be treated/disposed of at permitted facilities.

Waste from the floating camps during pre-development work will be managed/treated on board and will not come ashore at Steensby Inlet.

Hazardous waste generated on land during pre-development activities will be stored in sealed shipping containers and will be shipped to an off-site treatment/disposal facility.

Solid waste generated at Steensby Inlet in pre-development work will be managed according to Mary River PDW Waste Management Plan (Appendix B.6).

The types and expected quantities of waste generated during PDW are presented in Section 22.

5.13 On-Going Geotechnical Investigations

Geotechnical investigations will continue throughout 2012. In addition to land based geotechnical drilling activities, Baffinland will undertake both on-ice and barge based geotechnical investigations for the site focused on the future ore and freight docks.

5.14 Abandonment and Reclamation for Steensby PDW

The abandonment and reclamation of the pre-development works (PDW) at Steensby will be undertaken if the Project is not developed. Reclamation will involve removing PDW materials, equipment and infrastructure and reclaiming the site to self sustaining productive ecosystem similar to its original condition. The Abandonment and Reclamation Plan for the Project is presented in Appendix B.12.

The general abandonment and reclamation plans include the following

- Dismantle and transport fuel storage and handling infrastructure to an approved facility or for reuse where applicable
- Dismantle and remove all buildings and related infrastructure
- Remove the floating barge camp
- Remove all hazardous waste and explosives and transport to a licensed disposal treatment facility off-site
- Re-grade PDW areas (roads, laydown) as necessary to establish safe slopes and restore the natural drainage to the area
- Test soils and granular materials for hydrocarbon content; contaminated soils will be remediated in the landfarm
- Remove all heavy equipment by sealift

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- The airstrip will be abandoned, but left good condition unless otherwise directed by regulatory agencies, to provide an emergency/rescue landing spot for regional aircraft, when no other options are available
- Chemicals including oils and greases and other hazardous liquids and materials will be transported offsite for disposal at an approved facility or for reuse where applicable
- The quarry site will be re-contoured to maintain a safe side slope and restore natural drainage. The airstrip at Steensby will be abandoned but otherwise left intact as it provides an emergency landing location for an aircraft that has no other place to land
- Port closure monitoring is discoid in the Abandonment and Reclamation Plan (Appendix B. 12).

5.15 Steensby Port and Monitoring Follow-up

During pre-development work, laydowns will be constructed for staging of the equipment, portable buildings materials. A permanent fuel farm containment will be constructed because of the fuel required for pre-development work, as well as a landfarm and contaminated snow containment facility. The liners from these facilities will be removed, and drainage will be diverted around these areas. All drainage water from site, including water discharged from settling ponds, will meet water licence effluent requirements.

New surveillance monitoring stations will be established to monitor effluent quality for oily water and ammonium nitrate in treated water discharge to Steensby Inlet.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

6. Railway Corridor PDW

The railway construction is a critical path for the completion of the Project. The pre-development strategy consists of staging the necessary material and equipments at all four railway construction camp locations. Staging will enable construction activities to commence as soon as the Project Certificate and the Type A water license are granted. Baffinland proposes to construct winter roads in Q4 2012 or Q1 2013 depending on ice thickness in order to gain access to and supply the proposed railway camp locations. Three winter roads are considered:

- One winter road from Steensby Port to the north Cockburn Lake camp (200 person) and south Cockburn Lake camp (400 person)
- One winter road from the Mary River Mine Site to the Ravn River camp
- One winter road from the Mary River Mine Site to the Mid-rail camp.

The exact routing of the winter roads will not be determined until Q1 2012. Freshwater will be drawn from various sources along the winter road and used as required. Once the routing is finalized, quantities of water required for the construction of the winter roads can be calculated. Baffinland intends to submit an application for a separate water license for this work in Q2 2012.

All material and equipment required for the railway construction must first be delivered and stored at either Mary River or at Steensby Bay port until these winter roads are ready for use in Q4 2012 or Q1 2013 depending on ice thickness.

6.1 North and South Cockburn Lake Camps:

Once the winter road has been built to the locations of the proposed railway construction camps, the following activities will occur in the first quarter of 2013, in preparation for construction. Initially, they will be prepared by means of minor grading and levelling to provide sufficient areas for safe and secure delivery and storage of the following items:

- Camp bases
- Camp modules to their respective sites
- Explosive magazines
- 18m x 18m foldaway warehouse. This will provide shelter to equipment
- Tunnelling equipment
- Crusher trains
- Major bridge structures and equipment
- Railway bed equipment
- Trucks, excavators, and loaders
- 18m x 18m foldaway site services/maintenance facility. This will provide shelter to equipment

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Administrative/office complex
- Communications tower (to be installed)
- Bridge pile sections and deck modules for the rail.

6.2 Ravn River and Mid-Rail Camps:

Once the ice road has been built to the locations of the proposed railway construction camps, the following activities will occur in the first quarter of 2013, in preparation for construction. Initially, they will be prepared by means of minor grading and levelling to provide sufficient areas for safe and secure delivery and storage of the following items:

- Camp modules
- Camps, power supply, potable water system, incinerator and sewage transfer tanks (at Mid-Rail a sewage treatment plant will be installed)
- 18m x 18m foldaway warehouse. This will provide shelter to equipment;
- Crusher trains
- Major bridge structures and equipment
- Railway bed equipment
- Trucks, excavators and loaders
- Full ISO containers fuel tanks at each camp site
- 18m x 18m foldaway site services/maintenance facility. This will provide shelter to equipment
- Administrative/office complex
- Communications tower (to be installed)
- Bridge pile sections and deck modules for the rail.

6.3 Wastewater Management

PDW consists of staging material and equipment only. No wastewater treatment facilities will be operated. During construction staging, any small quantity of wastewater that is generated will be stored in temporary tanks and transported back to Steensby Port or the Mine Site for proper treatment and disposal.

6.4 Railway Corridor Waste Management

During pre-development work the only activity along the rail corridor will be the development of the winter road access to the four rail camps and the staging of camp material and equipment at the camps ready for construction approval. Minor quantities of solid waste will be transported back to Steensby Port or the Mine Site for proper disposal.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

6.5 Abandonment and Reclamation of Railway Staging Areas

Abandonment of Pre-development Works will involve removing PDW materials, equipment and infrastructure and reclaiming the site to self sustaining productive ecosystem similar to its original condition. Refer to the Abandonment and Reclamation Plan (Appendix B.12).

The general abandonment and reclamation plans include the following:

- Remove all material and equipment from laydown areas
- Dismantle and remove existing Mid-Rail camp and its associated sewage treatment facility
- Re-grade laydown areas as necessary in order to restore adequate natural drainage.

6.6 Monitoring and Follow-Up

All pre-development staging areas related to the Project will be subjected to a closure inspection by a company representative. Monitoring and follow-up inspections will be conducted at the Mary River Project area in order to assess the physical and chemical stability of the various components after closure and reclamation of the facilities and annual inspections will be carried out.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

7. Management Plans Please Refer to Appendix B

7.1 EHS Management Framework

Volume 10 of the DEIS presented Baffinland's EHS Management System – including a framework as well as individual Environmental Mitigation and Monitoring Plans (EMMPs). This EHS Management System and its associated individual management plans are "life of Project" management plans.

Volume 10 outlines Baffinland's Environmental Health and Safety (EHS) System which is a framework that describes the requirements to develop and to maintain the elements of a management system in a manner relevant to:

- The Principle of Sustainability
- ISO 26000:2010, *Guidance for Social Responsibility*
- The practical application of the Precautionary Principle in the decision making process
- The legal and regulatory requirement
- The health and safety risks associated with the Mary River Project
- The Project's environmental impacts
- On-going Stakeholder engagement.

Baffinland's EHS Management System is consistent with the world class *Occupational Health and Safety Management System (OHSAS) 18001*, dated 2007; the International Standards Organization *ISO 14001:2004 (Environmental) Management System Standards* and, the emerging *ISO Standard 26000:2010 related to Guidance for Social Responsibility*.

The EHS system defines the scope and sequence of the following components:

- Policy
- Planning;
- Implementation and Operation
- Checking and Corrective Actions
- Management Review Process.

These components must be in place to ensure that the Mary River Project is executed in an environmentally and socially acceptable manner and in a spirit of continuous improvement. The EHS system and its associated management plans are LIFE OF PROJECT DOCUMENTS, that is, they apply from the onset of the exploration phase, through pre-development activities, construction, operation and closure phases of the Project. Figure 7-1 (reproduced from DEIS Volume 10) illustrates the relationships between the core principles of continuous approach and the elements of an effective EHS Management System.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

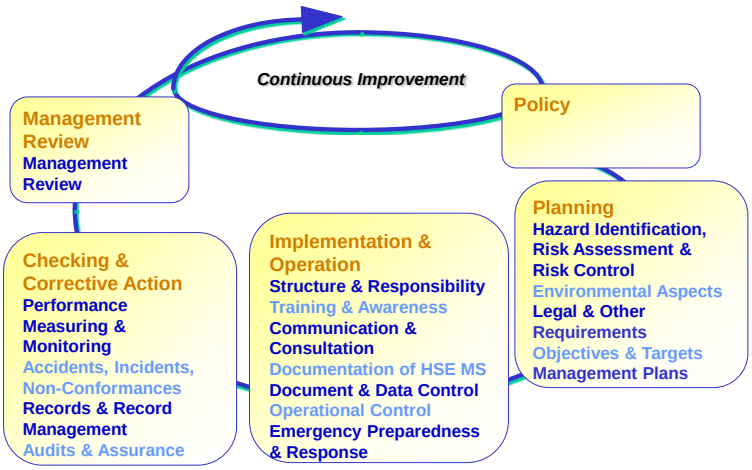


Figure 7-1

In the context of this EHS system, Volume 10 of the DEIS introduces:

- The *Environmental Design Guidelines* used for the Mary River Project which enabled the design team to avoid major impacts on the identified Valued Ecosystem Components VECs and Valued Socio-Economic Components VSECs. Detailed environmental design criteria will be presented in the FEIS
- The *Environmental Protection Plan (EPP)* which regroups detailed procedures and standards for the execution of field activities which will optimize environmental protection; many of the procedures and instruction developed at the exploration phase will be retained throughout the Life of the Project, as exploration is an on-going activity, and, the established procedures are relevant for all phases of the Project
- The *outline of the Company's Hazard Identification and Risk Assessment (Appendix 10A-2), based on OSHA 18001 principle. Emergency Response and Spill Contingency Plan; as per the other management plans, the Emergency Response and Spill Contingency Plan is a Life of Project Plan which is updated regularly to accommodate the level of activities on the Mary River Project sites*
- The purpose and content of the environment monitoring and mitigation plans (EMMPs). The EMMPs outline the specific mitigation measures applied to ensure minimal adverse impacts on the VECs; these EMMPs are "living documents" which are updated regularly in the context of the principle of "continuous improvement". They apply from the onset of exploration activities through to pre-development, construction, operation and the closure phase of the Project. As the Project advances in its "life cycle", the roles and responsibilities changes to reflect the degree of activities on the various sites. Monitoring activities (selection of indicators, targets and

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

thresholds) as well as mitigation measures are also adjusted through adaptive management, if required, on the basis of monitoring information gathered and evaluation of effects;

- The outline of the health and safety management plan (developed on the basis of OSHA 18001 guidelines)
- The outline of the Project's stakeholders engagement plan (developed in the context of ISO Standard 26000:2010 related to Guidance for Social Responsibility)
- The outline of the human resources management plan; the plan will be updated on the basis of the requirement of IIBA, once negotiations have concluded
- The reporting and documentation requirements for all environmental management plans as outlined in Baffinland's EHS Framework (Appendix 10-A)
- The process of management review and adaptive changes, which is outlined in Appendix 10A-1, and is applicable to all management plans.

Several of the EMMPs that were presented in the DEIS are management plans which Baffinland currently executes in its exploration and bulk sampling phase activities (refer to Table 7-1: EHS Management Plan Schedule Reviews and Updates). Some of these plans were presented as-is as they govern current Project activities and are approved plans (e.g. the Environmental Protection Plan (EPP) by the QIA as part of the lease; the Wastewater Management Plan (WWMP) as part of the water license; and the Oil Pollution Emergencies Plan (OPEP) by Transport Canada).

7.2 Update of Management Plans for the FEIS

The FEIS will include the documentation required for the application of a Type A water license. Several management plans will be updated to reflect the advancement in Project design as well as the PDW and construction activities. Table 11-1: Applicable Acts, Regulations and Guidelines (reproduced from the DEIS, Volume 10, Section 11) indicates which management plans will be updated for the FEIS.

7.3 Management Plan Updates for PDW Activities

All of Baffinland's environmental management plans are subjected to audit and annual management reviews to ensure that the policies, procedures and mechanisms put in place lead to the achievement of stated performance goals and objectives. A number of management plans have been submitted in support of the existing water licence (2BB-MRY1114). Where necessary, these management plans have been updated to reflect the enlarged PDW scope of activities. These updates are presented as either a complete revision of the plans, or addendum to existing plans, and are attached in Appendix B. Table 7-1: EHS Management Plan Schedule Reviews and Updates presents an overview of all management plans and their expected next revision dates.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 7-1: EHS Management Plan Schedule Reviews and Updates

Standard, Plan and Identification Number	Document Number	Appendix	Last Revision Date	Next Review/ Revision Date	Status	Revision to DEIS Plans due to PDW
EHS Framework Standard	SD-STD-001	10A-1	December 2010	December 2011	In Effect	NONE
Hazard Identification and Risk Assessment Procedure	SD-STD-002	10A-2	December 2010	December 2011	In Effect	NONE
Environmental Protection Plan	SD-EPP-2.1 to 2.21	10B	December 2010	As required	In Effect	NONE
Emergency Response and Spill Contingency Plan	SD-ERP-001	10C-1	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.1)
Oil Pollution Emergencies Plan – Milne Port	SD-ERP-002	10C-3	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.2)
Oil Pollution Emergencies Plan – Steensby Port	SD-ERP-003	10C-2	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.3)
Explosives Management Plan	SD-ERP-004	10C-4	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.10)
Air Quality and Noise Abatement Management Plan	SD-EMMP-001	10D-1	December 2010	Updated for FEIS Submission	September 2012	Changes introduced on basis of DEIS review
Surface Water, Aquatic Ecosystems, Fish and Fish Habitat Management Plan	SD-EMMP-002	10D-2	August 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.4)
Waste Water Management Plan	SD-EMMP-003	10D-3	August 2010	Updated for PDW Submission	September 2011	Addendum to current WWMP for Mary River (Appendix B.5)
Waste Management Plan	SD-EMMP-004	10D-4	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.6)

© Hatch 2011/09

Standard, Plan and Identification Number	Document Number	Appendix	Last Revision Date	Next Review/ Revision Date	Status	Revision to DEIS Plans due to PDW
Waste Rock Management Plan	SD-EMMP-005	10D-5	December 2010	Updated for FEIS Submission	2012	NONE
Borrow Pits and Quarry Management Plan	SD-EMMP-006	10D-6	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.7)
No Net Loss Plan	SD-EMMP-007	10D-7	December 2010	updated for FEIS Submission	2012 to 2015	Changes in HADD
Roads Management Plan	SD-EMMP-008	10D-8	December 2010	updated for FEIS Submission	In Effect	NONE
Railway Management Plan	SD-EMMP-009	10D-9	December 2010	December 2016	2016	NONE
Shipping and Marine Mammals Management Plan	SD-EMMP-0010	10D-10	December 2010	Updated for PDW Submission	September 2011	Updated (Appendix B.9
Terrestrial Environment Management Plan	SD-EMMP-0011	10D-11	December 2010	Updated for PDW Submission	Several EPP procedures in Effect	Updated (Appendix B.8
Health & Safety Management Plan	SD-HSE-001	10E	December 2010	Updated for PDW Submission	In Effect September 2011	Updated (Appendix B.11)
Stakeholders Involvement Plan	SD-SEMP-001	10F-1	December 2010	Updated for FEIS Submission	In Effect	NONE
Cultural and Heritage Resource Protection Plan	SD-SEMP-002	10F-2	2008	December 2011	In Effect	NONE
Human Resources	SD-SEMP-003	10F-3	December 2010	Updated after IIBA	January 2012	Update on the basis of IIBA
Closure Plan	SD-MP-001	10G	August 2010	Updated for PDW Submission	2035	Addendum to be completed to current A&R Plan for Mary River (Appendix B.12)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

8. Sequencing of Pre-Development Work Activities

A properly developed and executed logistics plan will be critical to the Pre-Development Work plans success. This will ensure the efficient use of the open water season, the access opportunities of winter roads, the planning involved with procuring materials, assembling them at key ports, and then when the shipping season is open, shipping them to site.

The schedule that follows outlines the anticipated timing associated with the logistics during the shipping season and then once the materials and supplies are landed on the sites and set up (staging) for the commencement of construction.

Table 8-1: PDW Phase Schedule presents Phase Schedule by area and activity.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 8-1: PDW Phase Schedule

PDW PHASE SCHEDULE OF EVENTS	2012			2013
ACTIVITY	**Q2**	**Q3**	**Q4**	**Q1**
Milne Inlet Port				
Material Unloading & Laydown Area				
Prepare laydown area	■			
Install Construction Dock		■		
Prepare site for accommodation camp, temporary office, Warehousing facilities		■	■	
Fuel				
Construction of containment berm and fuel tanks (4 @ 10M L)	■	■	■	
Connect fuel dispensing module & receive fuel (15M L)		■	■	
Administration & Maintenance Facilities				
Receive and install foldaway's for warehousing and other maintenance facilities, ERT		■	■	
Receive & install heaters for seacan storage containers		■	■	
Install communication tower		■	■	
Heavy Equipment				
Receive Fuel Trucks (40,000 L)		■		
Receive fire truck, ambulance, track vehicle & other heavy equipment		■		
Mary River Mine Site				
Material Unloading & Laydown Area				
Prepare laydown area	■	■		
Prepare pads for accommodation camp, administration building, warehousing	■	■		
Receive ISO fuel tanks, complete with fuel dispensing modules		■	■	■
Quarry Borrow Source Development				
Receive and install crusher spread		■	■	■
Receive and laydown pre-packaged explosives		■		
Prepare explosive magazine storage areas	■	■	■	
Airstrip				
Extend & re-align airstrip	■	■	■	
Fuel				
Construction of berm and steel tanks (3 @ 5M L) and Jet-A fuel tank	■	■	■	■
Receive & laydown ISO Fuel Tanks		■		
Receive & Install fuel dispensing module & receive fuel up to 5mL		■	■	

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

PDW PHASE SCHEDULE OF EVENTS	2012			2013
ACTIVITY	Q2	Q3	Q4	Q1
Camp				
Receive & install construction camp, potable water system, sewage system, camp incinerator				
Administration & Maintenance Facilities				
Receive and install foldaway's for warehousing and other maintenance facilities, ERT				
Receive & install heaters for seacan storage containers				
Receive & install communication towers				
Heavy Equipment and Materials				
Receive and laydown heavy equipment and materials				
Steensby Bay Port				
Site Preparation, Material Unloading & Laydown Area				
Prepare equipment laydown areas				
Prepare camp, office/washroom/lunchroom, warehousing areas				
Grade site and construct access road to airstrip, camp, laydown areas				
Quarry Borrow Source Development				
Receive emulsion mix plant/building				
Setup concrete aggregate batch plant & storage area				
Receive and laydown pre-packaged explosives				
Prepare explosive magazine storage areas				
Airstrip				
Build airstrip				
Fuel				
Construct fuel berm; Receive pre-fab steel fuel tanks (20 @ 1M L)				
Install steel fuel tanks				
Receive & laydown ISO Fuel Tanks				
Receive fuel barge				
Receive & install dispensing module, receive fuel				
Camp				
Receive floating camp barge				
Receive construction camp, potable water system, sewage system, camp incinerator				

© Hatch 2011/09

PDW PHASE SCHEDULE OF EVENTS	2012			2013
ACTIVITY	Q2	Q3	Q4	Q1
Administration & Maintenance Facilities				
Receive & install foldaway's for warehousing and other maintenance facilities, ERT				
Receive & install heaters for seacan storage containers				
Install communication towers				
Heavy Equipment & Materials				
Ship Heavy equipment & material to site				
Receive and laydown heavy equipment & material				
Railway				
Build winter ice-roads				
Deliver goods & materials to Rail Camp locations (piles, pile caps, girders)				

© Hatch 2011/09

9. Workforce for PDW and Training Opportunities

9.1 Workforce

The following table provides an estimate of the workforce required to execute the pre-development work.

MARY RIVER PROJECT : 2012 Labour required for the Pre-Development Work Phase													
					2012						2013		
Location		Q2			Q3			Q4			Q1		
	M	A	M	J	J	A	S	O	N	D	J	F	M
Milne													
Existing camp	60	60	60	60	60	60	50	50					
Expanded camp							100	100	40	20	20	20	20
Subtotal	60	60	60	60	60	60	150	150	40	20	20	20	20
Mary River													
Existing camp	50	50	120	120	120	120	120	120	120	120	50	50	50
Subtotal	50	50	120	120	120	120	120	120	120	120	50	50	50
Steensby													
Barge camp #1						150	150	150	150	150	150	150	150
Barge camp #2							150	150	150	150	150	150	150
Subtotal						150	300	300	300	300	300	300	300
2012 Manpower	110	110	180	180	180	330	570	570	460	440	370	370	370

Figure 9- 1: Expected Workforce Requirements for Pre-Development Activities

It is estimated that approximately half of the workforce will be employed as equipment/machinery operators (truck drivers, loaders, cranes, forklifts, excavators, etc.). Of the remaining potential workers, approximately 30% will be employed as general labourers, site services, bear monitors, security, housekeeping and, various helper positions. The remaining 20% will be Trades skill based, (workers who normally require apprenticeship training or college/university education). This level includes jobs such as, for example, industrial trades, train crew operating, drillers and blasters, supervisors, administrative occupations, technical occupations, managers, professional occupations.

9.2 Training Opportunities

Baffinland is committed to undertake training once a positive approval is granted for the PDW Project. It is Baffinland's intention to train representatives from the North Baffin communities for positions that will become available during the PDW works. It is recognized that a number of the jobs related to the PDW require skilled positions to undertake the work in a short time frame. However, a number of positions (list below) have been identified as excellent training opportunities for positions required during the summer and fall PDW program:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Polar Bear Monitors
- Environmental Technicians and/or Observers
- Food Services, housekeeping and camp assistants
- Site Services Work - Skilled labourers (Bobcat, IT loader, Zoomboom operators)
- Site Services work - General labourers (security, fuel handling, aircraft safety, waste management, and general maintenance).

Baffinland currently plans to schedule training so that representatives trained will be in the position to directly be hired by the contractors undertaking the PDW. It is proposed that some of the training programs can be administered directly in one or two of the North Baffin communities in January and February 2012. Initial talks have commenced in developing and undertaking a food services/housekeeping program in collaboration with local hotels in the North Baffin. Subsequent training programs for polar bear monitors and environmental trainers/observers can also be administered in one of the North Baffin communities.

Baffinland has also committed pending approvals to proceed with the PDW to open its Mary River camp in March of 2012 and will undertake subsequent training courses for associated site services work (skilled labourer and general labourers), as well as food services/housekeeping and camp services. This will allow participants to train on a rotational basis at the camp and allow them to get familiarized to camp life. Besides obtaining specific job related training the participants will also obtain training that is required to work at the Mine Site, which includes but not limited to: First Aid, WIMIS certification, fire extinguisher training, and site safety procedures.

The programming of this associated training for these types of jobs will be based jointly for on the job training and adult education programs that will assist to assess the participants and develop individualized work programs that will allow the participants to reach his or hers career aspirations. Adult education training will include but not limited to; reading and writing skills, math upgrading, and life skills (banking and budgeting).

The resources to undertake this training will come from a combination of certified adult educators (Nunavut College certified), various consultants, contractors working for Baffinland and Baffinland employees themselves.

The exact schedule for the training programs as well as the number of trainees is pending based on PDW approval. However it is anticipated that between 24-48 individuals can be trained in these various positions between January and June 2012 to take advantage of PDW job opportunities.

9.3 Air Traffic

The Projected air traffic to the various sites over the PDW period March 2012 to March 2013 is projected as follows in Figure 9- 2: Projected Air Traffic.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

	Milne Inlet	Mine Site	Steensby
Plane Passenger Flights	385	643	732
Plane Freight Flights	369	643	763
Helicopter Passenger Flights	245	468	246
Helicopter Freight Flights	0	369	308
TOTAL	**999**	**2123**	**2049**
Max'm monthly number of flights	155	310	310

Figure 9- 2: Projected Air Traffic

The estimated flights are presented below in the Figure 9- 3: Estimated Flights:

Mary River PDW Flights estimated for the Pre-Development Work Phase

	2012										2013			
Location	Q2				Q3			Q4			Q1			
	M	A	M	J	J	A	S	O	N	D	J	F	M	
days/month	31	30	31	30	31	31	30	31	31	31	31	28	31	
MILNE INLET														
Plane Flights	1p/d,1f/d	1p/d,1f/d	1p/d,1f/d	1p/d,1f/d	1p/d,1f/d	1p/d,1f/d	2p/d,2f/d	2p/d,2f/d	1p/d,1f/d	3p/w,2f/w	3p/w,2f/w	3p/w,2f/w	3p/w,2f/w	
Helicopter		1p/d	1p/d	1p/d	1p/d	1p/d	1p/d	1p/d	1p/d					
Worker plane flights	1	1	1	1	1	1	2	2	1	3/w	3/w	3/w	3/w	
sub total	31	30	31	30	31	31	60	62	31	12	12	12	12	385
Freight plane Flights	1	1	1	1	1	1	2	2	1	2/w	2/w	2/w	2/w	
sub total	31	30	31	30	31	31	60	62	31	8	8	8	8	369
Helicopter worker flights		1	1	1	1	1	1	1	1					
sub total		30	31	30	31	31	30	31	31					245
TOTAL	62	90	93	90	93	93	150	155	93	20	20	20	20	999
MARY RIVER														
Plane Flights	1p/d,1f/d	1p/d,1f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	1p/d,1f/d	1p/d,1f/d	1p/d,1f/d	
Helicopter			1p/d,1f/d	1p/d,1f/d	1p/d,1f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d				1p/d,1f/d	
Worker Plane flights	1	1	2	2	2	2	2	2	2	2	1	1	1	
sub total	31	30	62	60	62	62	60	62	62	62	31	28	31	643
Freight Plane Flights	1	1	2	2	2	2	2	2	2	2	1	1	1	
sub total	31	30	62	60	62	62	60	62	62	62	31	28	31	643
Helicopter worker flights			1	1	1	2	2	2	2				1	
sub total			31	30	31	62	120	124	62				8	468
Helicopter freight flights			1	1	1	2	2	2	2				1	
sub total			31	30	31	62	60	62	62				31	369
TOTAL	62	60	186	180	186	248	300	310	248	124	62	56	101	2123
STEENSBY														
Flights					1p/d,2f/d	2p/d,2f/d	3p/d,3f/d	3p/d,3f/d	3p/d,3f/d	3p/d,3f/d	3p/d,3f/d	3p/d,3f/d	3p/d,3f/d	
Helicopter					1p/d,2f/d	1p/d,2f/d	2p/d,2f/d	2p/d,2f/d	2p/d,2f/d					
Worker Plane flights					1	2	3	3	3	3	3	3	3	
sub total	0	0	0	0	31	62	90	93	93	93	93	84	93	732
Freight Plane Flights					2	2	3	3	3	3	3	3	3	
sub total	0	0	0	0	62	62	90	93	93	93	93	84	93	763
Helicopter worker flights					1	1	2	2	2					
sub total			0	0	31	31	60	62	62	0	0	0	0	246
Helicopter freight flights					2	2	2	2	2					
sub total			0	0	62	62	60	62	62	0	0	0	0	308
TOTAL	0	0	0	0	186	217	300	310	310	186	186	168	186	2049

Figure 9- 3: Estimated Flights

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

9.4 Shipping Traffic

The following table presents the expected number of ship passage in Milne Inlet and the Hudson Strait-Foxe Basin shipping lanes.

Table 9- 1: Shipping Traffic

Location	Cargo Type	Type of Ship	Number of ship	Number of passages
Milne Port Milne Inlet and Eclipse Sound	Delivery of equipment and construction material	Combination of ocean barges and ship	up to 20	40
	Delivery of diesel fuel and Jet fuel	Fuel tanker	2	4
Steensby Port Steensby Inlet, Foxe Basin and Hudson Strait	Delivery of equipment and construction material	Combination of ocean barges and ship	up to 22	44
	Delivery of diesel fuel and Jet fuel	Fuel tanker	1	2
	Fuel storage (tanker/barge)	Fuel tanker	1	1

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

10. Abandonment and Reclamation Plan - Security

Baffinland will accept the risk and provide the security required for closure and reclamation and take the necessary steps with regard to closure to ensure that pre-development work can be authorized within the NIRB/NWB coordinated review process. In the event that a Project Certificate is denied, Baffinland would implement its closure plan for the site. The general approach, objectives and criteria, and post reclamation monitoring applied to PDW would be the same as presented in the current 2011 Abandonment and Reclamation (A&R) Plan (February 2011) for the existing project under the current water licence and commercial lease.

The PDW site specific A&R activities are discussed in Section 2 (Milne Port), Section 3 (Tote Road), Section 4 (Mine Site), Section 5 (Steensby Port), Section 6 (Railway Staging Areas) of this document and a schematic is presented in Appendix A that shows the changes to various sites during PDW and what they would look like after reclamation and closure should the project not proceed as planned. Baffinland will adhere to the objectives and approach taken as outlined in the current A&R plan and provide an integrated cost estimate for closure that includes both the existing project and the PDW. The current A&R plan for the existing project is provided in Appendix B.12.

An addendum to the current A&R Plan is under preparation and will provide an appropriate level of detail concerning the PDW final closure and execution plan. The estimate of projected PDW closure costs will be correlated with the project schedule and current estimate of closure costs for the existing project. An accurate estimate of PDW closure costs will be derived from planned PDW project budgets that are currently under development and are being finalized shortly. After these costs become available, the addendum to the existing A&R plan will be submitted as supplementary information under separate cover.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

11. Environmental Effects Assessment Methodology

11.1 Consultation

PDW has been part of "the Project" since its inception. It was identified in the 2008 development proposal and Baffinland consulted the communities on PDW activities as early as Sept 2007. An abbreviated description of the PDW was included in the DEIS (Volume 3, Section 1.3)[(1)]. A more comprehensive description of the PDW scope of work was presented in Appendix 3G of the Addendum to the DEIS submitted on July 4, 2011[(2)].

Baffinland employees and their consultants have been involved in various meetings, presentations, workshops, site visits in relation to this PDW submission package and applications. From these various engagements there has been lots of question and answer sessions and BIM has received valuable assistance and advice in preparing this submission. A list of these various meetings is outlined below:

- May 13, 2011 – Baffinland consultants & Nunavut Impact Review Board (NIRB) and Nunavut Planning Commission (NPC) – Cambridge Bay – Discussion with NIRB on the approach that should be taken to PDW
- June 19, 2011 – Baffinland consultants meet with Nunavut Water Board (NWB) and NIRB– Cambridge Bay - to discuss initial scope of the PDW
- July 8, 2011 – Site tour & presentation/maps with QIA working group from Pond Inlet
- July 9, 2011 – Site tour & presentation/maps with QIA working group from Arctic Bay
- July 11, 2011 – Site tour & presentation/maps with QIA working group from Igloolik
- July 20 & 21, 2011 – NIRB and NWB Workshop – Edmonton Alberta. Representatives from Baffinland, NIRB, NWB, QIA, and AANDC attended to review coordination process for PDW submission
- July 26, 2011 – Site tour & presentation/maps with working QIA group from Hall Beach
- August 16, 2011 – NIRB & NWB workshop – Yellowknife, N.T. Representatives from Baffinland, NIRB, NWB, QIA, AANDC attended the workshop to discuss requirements in applicable regulatory applications
- August 31 & September 1, 2011 – QIA Executive workshop at the Mary River site.

September 7, 2011 – Site tour - various regulatory agencies (AANDC, Transport Canada, Environment Canada, Parks Canada, and CANOR).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

11.2 Regulatory Framework

11.2.1 Regulatory Process Overview

The prominent legislation that directs the regulatory process in Nunavut is the Nunavut Land Claims Agreement (NLCA). For additional federal and territorial legislation and guidelines applicable to development of the Project, see Table 11-1: Applicable Acts, Regulations and Guidelines and the sections following.

Pre-development works may be authorized prior to the completion of the Project review by NIRB. Section 12.10.2(b) gives NIRB the expressed authority to provide an exception to the requirements of Article 12 so that authorizing agencies may approve or issue licenses for certain exploration or development activities related to the Project if, in its judgment, it is appropriate to allow the activity to proceed prior to completion of the full review. Section 12.10.2 of the NLCA provides that activities related to a Project may be approved pending a Part 5 review where certain conditions are met:

12.10.2 Notwithstanding Section 12.10.1, where a Project proposal has been referred for review pursuant to Part 5 or 6, approvals or licenses for exploration or development activities related *to that Project may be issued if:*

(a) the activity falls within Schedule 12-1; or

(b) the activity can, in the judgment of NIRB, proceed without such a review.

Schedule 12-1 lists activities that are exempt from the requirement for screening by the NIRB.[1] Approvals or licences for exploration or development activities not listed on Schedule 12-1 may be approved under Section 12.10.2(b) if the activities can, in the judgment of NIRB, proceed without a review.

In its letter of August 25, 2011, NIRB outlined the proposed process for consideration of the PDW following submission of this application package for the approvals and licences set out below in Section 1.9.

[1] Activities exempt from screening under Schedule 12-1 include:

1. Land use activities not requiring a permit or authorization from the Government of Canada or Territorial Government.
2. Land use activities requiring only a Class B permit under the *Territorial Land Use Regulations* (SOR/77-210 4 March 1977).
5. Water uses that do not require a public hearing under Section 13.7.3.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Several permits, licences, and approvals will be required to allow the PDW to proceed, as follows:

- A land lease from Aboriginal Affairs and Northern Development Canada (AANDC) for works on Crown land at Steensby Port and along the south end of the railway alignment
- An amendment to Type B water licence (#2BB-MRY-1114) for water use and waste disposal activities associated with the PDW
- DFO authorization for stream crossings at Steensby.

Baffinland's commercial lease with the Qikiqtani Inuit Association (QIA) contemplates the completion of pre-development works on Inuit Owned Land (IOL) including Milne Port, the Milne Inlet Tote Road, and the Mary River Mine Site area in 2012. Completion of the PDW on IOL will require approval of the 2012 work plan by the QIA.

The applicable regulatory processes are described further in the section following.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-1: Applicable Acts, Regulations and Guidelines

Act	Regulation	Responsible Agency	Guideline
FEDERAL			
Aeronautics Act, [R.S. 1985, c. A-2]	Canadian Aviation Regulations, [SOR/96-433]	TC-Civil Aviation	
Arctic Waters Pollution Prevention Act [R.S.C. 1985, c. A-12]	Arctic Waters Pollution Prevention Regulations [C.R.C., c.345]	TC-Marine Safety	Guidelines for the Operation of Tankers and Barges in Canadian Arctic Waters (Interim)
	Arctic Shipping Pollution Prevention Regulations		Arctic Ice Regime Shipping System Standards; Arctic Waters Oil Transfer Guidelines
Canada Shipping Act 2001 [2001, c.26]	Ballast Water Control and Management Regulations SOR/2006-129	TC-Marine Safety	A Guide to Canada's Ballast Water Control and Management Regulations
	Anchorage Regulations SOR/88-101		
	Oil Pollution Prevention Regulation		
	Response Organization and Oil Handling Facilities Regulation		

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
Canada Transportation Act [1996, c. 10]	Handling of Carloads of Explosives on Railway Trackage Regulations SOR/79-15	TC	
	Railway Employee Qualification Standards Regulations SOR/87-150		
	Railway Prevention of Electric Sparks Regulations SOR/82-1015		
	Railway Third Party Liability Insurance Coverage Regulations SOR/96-337		
	Railway Traffic Liability Regulations		
	Railway Service Equipment Cars Regulations SOR/86-922		
Canada Marine Act 1998, c. 10	Natural and Man-made Harbour Navigation and Use Regulations SOR/2005-73	TC	
	Port Authorities Management Regulations		
	Port Authorities Operations Regulations SOR/2000-55		
	Seaway Property Regulations SOR/2003-105		
Canada Water Act, [R.S.C. 1985, c. C-11]		EC	
Canada Wildlife Act (R.S., 1985, c. W-9)	Wildlife Area Regulations (C.R.C., c. 1609)	EC	

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Act	Regulation	Responsible Agency	Guideline
Canadian Environmental Protection Act 1999, [1999, c.33]	Environmental Emergency Regulations [SOR/2003-307]	EC	CCME Canada Wide Standards for Dioxins and Furans CCME Canada Wide Standards for Mercury Emissions Health Canada Federal Contaminated Sites Guidance on Human Health Risk Assessment in Canada
	Federal Registration of Storage Tank Systems for Petroleum Products and Allied Petroleum Products on Federal Lands or Aboriginal Lands Regulations (SOR/97-10)		
	Fuels Information Regulations, No. 1 (SOR/C.R.C., c. 407)		
	Interprovincial Movement of Hazardous Waste Regulations (SOR/2002-301)		
	Sulphur in Diesel Fuel Regulations (SOR/2002-254)		
	Sulphur in Gasoline Regulations (SOR/99-236)		
	Proposed - Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations		
	Proposed - Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations		
	Proposed - Regulations Amending the Environmental Emergency Regulations		www.ec.gc.ca/CEPARegistry/guidelines
Explosives Act [R.S.C. 1985, c. E-17]	Ammonia Nitrate and Fuel Order, [C.R.C., c. 598]	NRCan	
	Explosives Regulations [C.R.C., c. 599]		

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
Fisheries Act [R.S.C. c. F-14]	Metal Mining Effluent Regulations, [SOR/ 2002-2222]	DFO	DFO Policy for the Management of Fish Habitat; Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters; DFO - Freshwater Intake End-of-Pipe Fish Screen Guideline; DFO-Habitat Conservation and Protection Guidelines, 1998; Various DFO Operational Statements
Marine Transportation Security Act (R.S. 1994, c.40)	Marine Transportation Security Regulations (SOR/2004-144)	TC-Marine Safety	
Migratory Birds Convention Act 1994 [1994, c.22]	Migratory Bird Sanctuary Regulations, [C.R.C., c.1036]	EC	
	Migratory Birds Regulations, [C.R.C., c.1035]		
Navigable Waters Protection Act [R.S. 1985, c. N-22]	Navigable Waters Bridges Regulations (C.R.C., c. 1231)	TC - NWPP	
	Navigable Waters Works Regulations (C.R.C., c. 1232)		
Nunavut Act [1993, c. 28]	Nunavut Archaeological and Palaeontological Sites Regulations, [SOR/2001-220]	GN-CLEY	
Nunavut Land Claims Agreement		NTI	A Guide to Mineral Exploration and Development on Inuit Owned Lands in Nunavut
NLCA Article 12-Development Impact		NIRB	
NLCA Article 13-Water Management		NWB	
NLCA Article 26-Inuit Impact Benefit Agreement		DIO	
NLCA Article 6-Wildlife Compensation			

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
NLCA Article 20-Inuit Water Rights		NWB/DIO	
NLCA Article 21-Entry and Access Part 4			
Nunavut Waters and Nunavut Surface Rights Tribunal Act [2002, c.10]	Application of Regulations made under paragraph 33(1)(m) or (n) of the Northwest Territories Waters Act in Nunavut Order	INAC	
Species At Risk Act [2002, c.29]		EC	Species at Risk Act: A Guide
Territorial Lands Act [R.S. 1985, c. T-7]	Canada Mining Regulations, [C.R.C., c. 1516]	INAC	INAC Mine Site Reclamation Policy for Nunavut
	Territorial Land Use Regulations, [C.R.C., c. 1524]		
	Territorial Quarrying Operations, [C.R.C., c. 1527]		
	Northwest Territories Mining District and Nunavut Mining District Order		
Transportation of Dangerous Goods Act [1992, c.34]	Transportation of Dangerous Goods Regulations	TC	
TERRITORIAL			
Apprenticeship, Trade and Occupations Certification Act [R.S.N.W.T. 1988, c. A-4]	Apprenticeship, Trade and Occupations Certification Regulations, R.R.N.W.T. 1990 c. A-8		
	Occupation Designation Order, N.W.T. Reg. 026-96		
	Trade Advisory Committees Order, R.R.N.W.T. 1990 c. A-9		
	Trade Designation Order, R.R.N.W.T. 1990 c. A-10		
Boilers and Pressure Vessels Act, [R.S.N.W.T. 1988, c. B-2]	Boilers and Pressure Vessels Regulations, N.W.T. Reg. 006-93		

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
Child and Family Services Act[R.S.N.W.T. 1997, c. 13]	Child and Family Services Regulations, N.W.T. Reg. 142-98		
Commissioner's Land Act (Nunavut), [R.S.N.W.T. 1988, c C-11]	Commissioner's Airport Lands Regulations, N.W.T. Reg. 067-97		
	Commissioner's Land Regulations, R.R.N.W.T. 1990 c. C-13		
Electrical Protection Act [R.S.N.W.T. 1988, c. E-3]	Electrical Protection Regulations, R.R.N.W.T. 1990 c. E-21		
Environmental Protection Act (Nunavut), [R.S.N.W.T. 1988, c. E-7]	Spill Contingency Planning and Reporting Regulations, N.W.T. Reg. 068-93		Spill Contingency planning and reporting in Nunavut: A Guide to the new regulations
	Asphalt Paving Industry Emission Regulations, R.R.N.W.T. 1990 c. E-23		Government of Nunavut (GN) Environmental Guidelines for: Site Remediation; Management of Waste Lead and Lead Paint; Air Quality Sulphur Dioxide and Suspended Particulates; Dust Suppression; General Management of Hazardous Waste; Industrial Waste Discharges; Waste Antifreeze; Waste Asbestos; Waste Batteries; Waste Paints; Waste Solvents
Emergency Medical Aid Act, [R.S.N.W.T. 1988, c. E-4]			
Explosives Use Act, R.S.W.N.T. 1988, c.E-10	Explosives Regulations, R.R.N.W.T. 1990 c. E-27		
Fire Prevention Act, R.S.N.W.T. 1988, c. F-6	Fire Prevention Regulations, R.R.N.W.T. 1990 c. F-12		
	Propane Cylinder Storage Regulations, N.W.T. Reg. 094-91		
Gas Protection Act, [R.S.N.W.T. 1988, c. G-2]	Gas Protection Regulations, R.R.N.W.T. 1990 c. G-1		

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
Hospital Insurance and Health and Social Services Administration Act, [R.S.N.W.T. 1988, c. T-3]	Baffin Regional Health and Social Services Board Order, N.W.T. Reg. 059-98		
	Hospital Standards Regulations, R.R.N.W.T. 1990 c. T-6		
	Territorial Hospital Insurance Services Regulations, R.R.N.W.T. 1990 c. T-12		
Liquor Act, R.S.N.W.T. 1988, c. L-9	***Various general and community specific regulations and orders***		
Mine Health and Safety Act, [S.N.W.T 1994, c.25]	Mine Health and Safety Regulations, [R-125-95]		
	Mine Health and Safety Regulations, amendment, Nu. Reg. 016-2003		
Public Health Act, R.S.N.W.T. 1988, c. P-12	Camp Sanitation Regulations, R.R.N.W.T. 1990 c. P-12		
	General Sanitation Regulations, R.R.N.W.T. 1990 c. P-16		
	Public Water Supply Regulations, R.R.N.W.T. 1990 c. P-23		
	Public Sewerage Systems Regulations, R.R.N.W.T. 1990 c. P-22		

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
Safety Act, R.S.N.W.T. 1988, c. S-1	Asbestos Safety Regulations, N.W.T. Reg. 016-92		
	General Safety Regulations, R.R.N.W.T. 1990 c. S-1		
	General Safety Regulations, amendment, Nu. Reg. 021-2000		
	Safety Forms Regulations, N.W.T. Reg. 102-91		
	Silica Sandblasting Safety Regulations, N.W.T. Reg. 015-92		
	Work Site Hazardous Materials Information System Regulations, R.R.N.W.T. 1990 c. S-2		
Scientists Act [R.S.N.W.T. 1988, c. S-4]	Scientists Act Administration Regulations, N.W.T. Reg. 174-96		
Transportation of Dangerous Goods Act [R.S.N.W.T. 1988, c. 81 (Supp.)]	Transportation of Dangerous Goods Regulations, 1991, N.W.T. Reg. 095-91		

© Hatch 2011/09

Act	Regulation	Responsible Agency	Guideline
Wildlife Act, [R.S.N.W.T. 1988, c. W-4]	Wildlife General Regulations, N.W.T. Reg. 026-92		
	Critical Wildlife Areas Regulations, R.R.N.W.T. 1990 c. W-3		
	Polar Bear Defence Kill Regulations, N.W.T. Reg. 037-93		
	Wildlife Management Barren-Ground Caribou Areas Regulations, N.W.T. Reg. 099-98		
	Wildlife Management Grizzly Bear Areas Regulations, N.W.T. Reg. 155-96		
	Wildlife Management Muskox Areas Regulations, R.R.N.W.T. 1990 c. W-11		
	Wildlife Management Polar Bear Areas Regulations, R.R.N.W.T. 1990 c. W-13		
	Wildlife Sanctuaries Regulations, R.R.N.W.T. 1990 c. W-20		
	Wildlife Preserves Regulations, R.R.N.W.T. 1990 c. W-18		
Workers' Compensation Act, R.S.N.W.T. 1988, c. W-6	Workers' Compensation General Regulations, R.R.N.W.T. 1990 c. W-21		

© Hatch 2011/09

11.2.2 Conformance with Land Use Plans

The Nunavut Planning Commission (NPC) was established under Article 11 of the NLCA with responsibilities to:

- Establish broad planning policies, objectives, and goals for the Nunavut Settlement Area (NSA) in conjunction with government
- Develop, consistent with other provisions of Article 11 of the NLCA, land use plans that guide and direct resource use and development in the NSA
- Generally, fulfill objectives of the Agreement in the manner described, in accordance with the general principles in Section 11.2.1 of the NLCA as well as such additional functions as might be agreed on from time to time by government and designated Inuit organization (QIA in the Baffin Region).

Under Article 11 of the NLCA, the NPC has the authority to review development proposals to ensure conformity with approved land use plans, where they exist. NPC has provided Baffinland with positive conformity decisions with the North Baffin Regional Land Use Plan for its activities to date, including use of the established Milne Inlet Tote Road (an existing transportation corridor).

11.2.3 Existing Mineral Titles and Land Access

Baffinland is the sole owner of the three mining leases at Mary River, the locations of which are shown on Figure 11-1: Regional Land Ownership and Administrative Boundaries and Figure 11-2: Current Mary River Site Layout Showing Land Ownership and Lease Boundaries. Lease 2484 covers the iron ore deposit referred to as Deposit No. 1, Lease 2485 covers Deposit Nos. 2, 3, and 3B, and Lease 2483 covers Deposit No. 4. The leases cover a total area of 1,593 ha and are renewable beyond the current 21-year period expiring August 27, 2013.

The Nunavut Land Claims Agreement (NLCA) establishes the requirements and expectations for development activities occurring in Nunavut. The mining leases at Mary River predate the May 25, 1993 NLCA, but are surrounded by Inuit-owned surface and mineral (subsurface) rights. Inuit owned surface rights in the area are administered by the QIA while Inuit-owned mineral rights are administered by the Inuit birthright corporation Nunavut Tunngavik Incorporated (NTI). The Mary River mineral leases are administered by INAC under the Canadian Mining Regulations of the *Territorial Lands Act* on federal (Crown) land. Access to the surrounding surface lands is provided through land use permits and leases issued by QIA or INAC.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

In addition to the three original mining leases described above, Baffinland holds the following mineral exploration instruments:

- NTI Exploration Agreement - signed on May 1, 2008, identifies an NTI Exploration Area that includes an initial area of 16,695 ha in the vicinity of Deposit No. 1 and the original Lease 2484, and an additional area of 1,425 ha covering a portion of Deposit No. 5. The NTI Exploration Agreement will become a Joint Venture between Baffinland and NTI, only if and when a feasibility study is completed on the NTI Exploration Area
- McOuat Lake Claim Block - 18 federal claims registered with INAC covering lands covering and surrounding both Deposits No. 4 and 5
- Glacier Lakes Claim Block - 20 federal claims surrounding Deposit No. 6
- Turner River Claim Block - 9 federal claims covering Deposit No. 7
- North Cockburn River Claim Block - 8 federal claims covering Deposit No. 8
- North Rowley River Claim Block - 4 federal claims covering Deposit No. 9.

Deposits No. 6 through 9 are all recent discoveries identified during Baffinland's 2010 regional exploration program.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

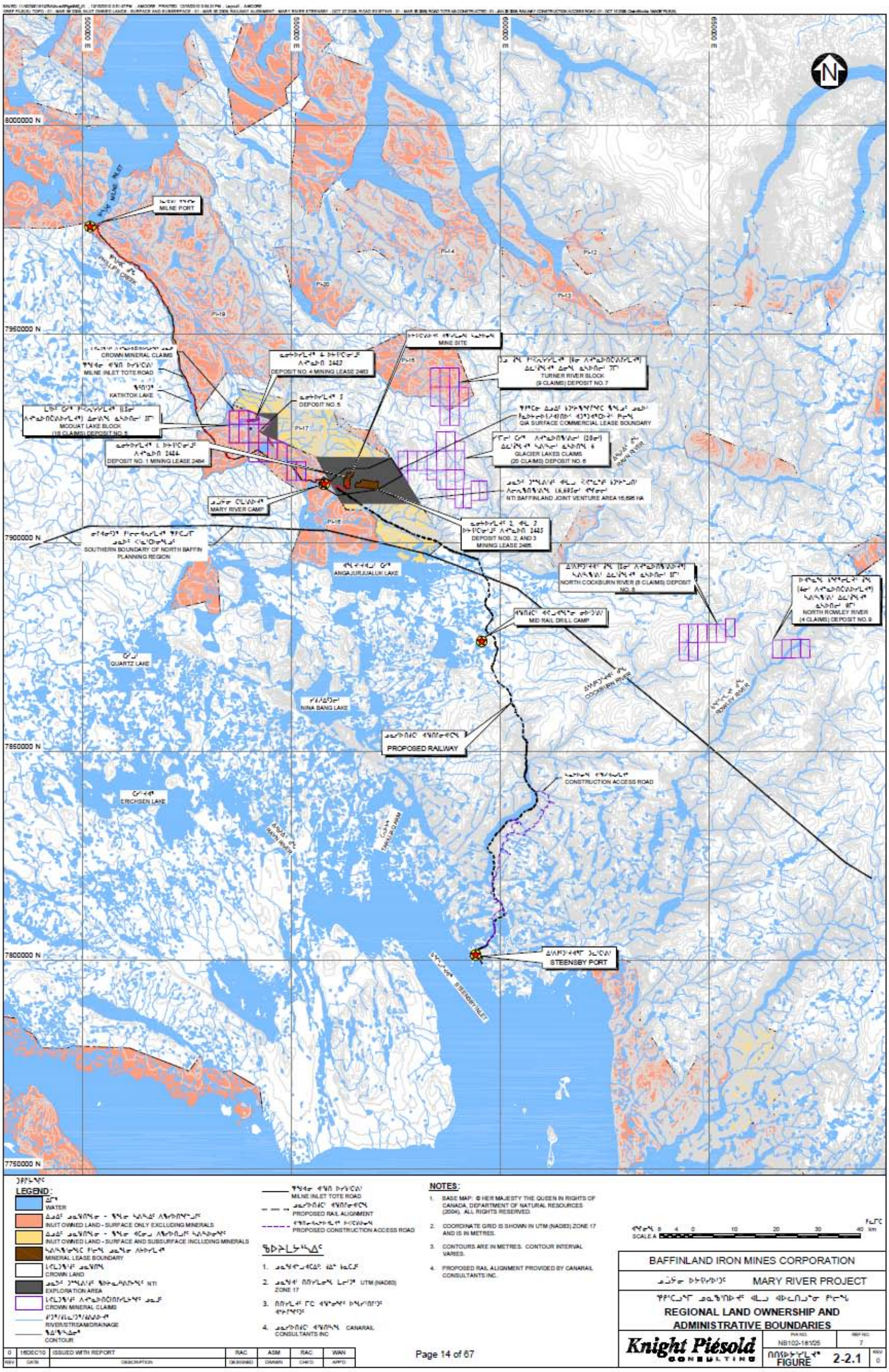


Figure 11-1: Regional Land Ownership and Administrative Boundaries

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

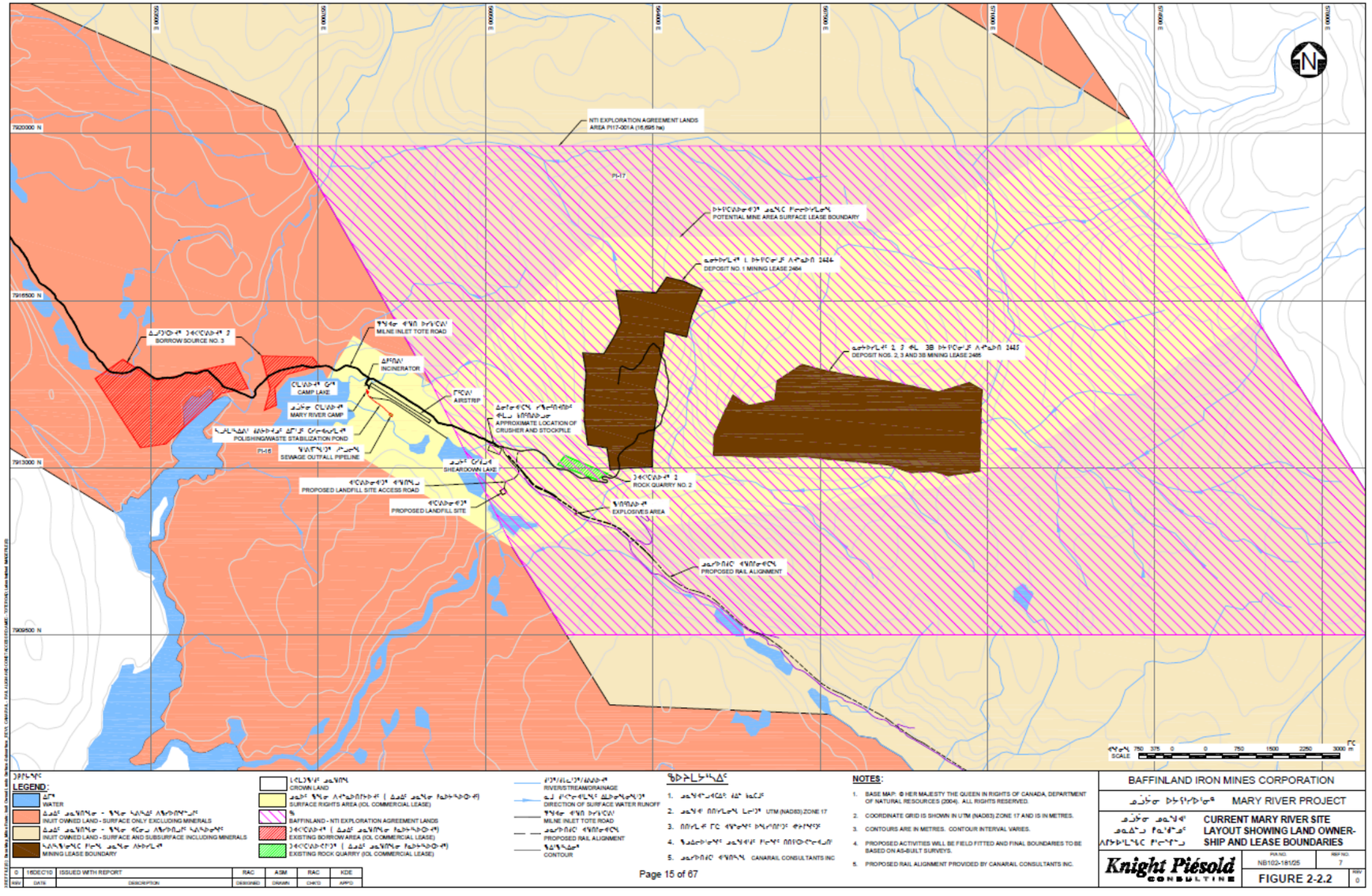


Figure 11-2: Current Mary River Site Layout Showing Land Ownership and Lease Boundaries

© Hatch 2011/09

11.2.4 Nunavut Environmental Assessment

The Nunavut Impact Review Board (NIRB) was established under Article 12 of the NLCA with the following primary functions:

- to screen Project proposals to determine whether or not a review is required
- to gauge and define the extent of the regional impacts of a Project
- to review the ecosystemic and socio-economic impacts of Project proposals
- to determine, on the basis of review, whether Project proposals should proceed, and if so, under what terms and conditions, and then report its determination to the Minister of INAC
- to monitor Projects in accordance with Part 7 of Article 12 of the NLCA.

As described in Section 12.2.5 of the NLCA, NIRB's primary objectives are:

"At all times to protect and promote the existing and future well-being of the residents and communities of the Nunavut Settlement Area, and to protect the ecosystemic integrity of the Nunavut Settlement Area. NIRB shall take into account the well-being of residents of Canada outside the Nunavut Settlement Area."

The term "ecosystematic" is defined in the NLCA as follows:

"'Ecosystemic'" means relating to the complex of a natural community of living organisms and its environment functioning as an ecological unit in nature."

NIRB is responsible for coordinating environmental screenings and reviews in Nunavut that are subject to Part 5 of Article 12 of the NLCA, which is the designated review process currently underway for the Mary River Project. Unless an exception is granted by NIRB, screenings or reviews by NIRB must be completed before authorizing agencies may issue permits, approvals or licences to a proponent for development Projects such as a mine.

11.2.5 Inuit Impact and Benefit Agreement

Baffinland initiated negotiations with the QIA on an IIBA for the Project in 2006. These discussions are currently ongoing in anticipation of completing a mutually acceptable IIBA before Project start, as required by NLCA. As mentioned in Section 1.4, Baffinland and the QIA have already reached agreement-in-principle on the economic provisions of a future IIBA through the signing of an MOU on March 31, 2009. The IIBA must be consistent with the terms and conditions of Project approvals, including those established pursuant to the environmental review process. The EIS is expected to inform the IIBA negotiations. Consequently, the IIBA will not be finalized until completion of the environmental review process.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Once Baffinland and QIA finalize the IIBA, a copy is sent to the INAC Minister. The IIBA goes into effect 30 days following its receipt by the Minister unless the Minister determines, within that timeframe, that the IIBA does not conform to the provisions of the terms and conditions established in the social and environmental review process or the provisions set out in Article 26 of the NLCA.

The QIA has been consulted on the PDW plans and is considered a major stakeholder, focused on the derivation of benefits to Inuit from the PDW program outside of the context of the IIBA for the main mine development Project.

11.2.6 Water Compensation Agreement

Article 20 of the NLCA assigns exclusive rights to the use of water on, in or flowing through Inuit-owned land to the local Inuit organization (in this case the QIA). A water compensation agreement is in effect under the Commercial Lease # Q10C3001 Article 2.07.

11.2.7 Permits, Approvals, and Licences

Once NIRB grants the exception under Article 12.10.2(b) allowing the PDW activities to proceed before completion of the environmental review process for the main mine development Project, all other authorizations can be issued.

The core authorizations were identified through consultation with the applicable regulatory agencies to facilitate a conformity determination to the North Baffin Regional Land Use Plan by NPC and the environmental screening by NIRB:

- Application for an amendment to Water Licence #2BB-MRY-1114 Type B for Water Use and Waste Disposal
- Submission of a Work Plan to QIA as per the terms of the Commercial Lease (Q10C3001)
- Application for lease of Crown Land at Steensby
- Application for Fisheries Authorization for Harmful Alteration, Disruption, or Destruction (HADD) of Fish or Fish Habitat for the crossing of streams at Steensby
- Application for a quarry lease at Steensby; and,

Current authorizations are summarized in Table 11-2: Current Authorizations Governing Exploration Activities. Applications for amendments are included in Appendix A of this PDW application.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-2: Current Authorizations Governing Exploration Activities

Type of Authorization	Permit No.	Authorizing Agency	Period Valid
Water Licence (Type B)	2BB-MRY-1114	NWB	April 5, 2011 to April 5, 2014
Letter of Advice (July 25, 2007)	File No. NU-06-0084	DFO	No expiry
Authorization under S.35(2) of *Fisheries Act*	File No. NU-06-0084	DFO	No expiry
Approvals under S.5(1) of *Navigable Waters Protection Act*	8200-09-10414	Transport Canada	June 22, 2009 to June 30, 2015
	8200-09-10415		
	8200-09-10424		
	8200-09-10425		
Inuit Land Use Lease and Aggregate Concession	Q07L3C001	QIA	November 1, 2010 to December 31, 2012
Land Use Permit (Crown Land)	N2007F0004	INAC	July 4, 2011 to July 4, 2012
Land Use Permit (Crown Land)	N2006C0036	INAC	April 3, 2011 to April 3, 2012
Quarry Permit (Crown Land)	2007QP0079	INAC	June 28, 2010 to May 12, 2012

Tied to the water licensing process is the approval of an (or Abandonment and Reclamation Plan), and the posting of financial assurance in the form of a bond, letter of credit or other instrument to cover the costs to close the mine. The financial assurance is normally held by the Nunavut Water Board on behalf of the Crown and may also be held by other landowners (i.e., the QIA for Inuit Owned Land). Financial assurance covering the existing exploration Project is currently held by the QIA. Submission of an updated A&R Plan and additional financial assurance will be necessary for the PDW program. (Refer to Section 10).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

11.2.8 Air Quality

For chemical compounds that have potential effects to human health, government health and environmental agencies have established threshold levels. These levels are effects-based levels in air, based on health, odour, vegetation, soiling, visibility, corrosion, or other effects, depending on the pollutant.

There are ambient air quality guidelines for Nunavut for TSP and SO_2 (Government of Nunavut, 2002). National Air Quality Objectives, Canada-Wide Standards (CWS), and criteria from other Canadian jurisdictions are useful thresholds for the remaining contaminants.

The National objectives are divided into three categories, described as follows (Environment Canada, 2010b):

- "Maximum desirable level is the long-term goal for air quality and provides a basis for an ant degradation policy for the unpolluted parts of the country, and for continuing development of control technology."
- "Maximum acceptable level is intended to provide adequate protection against effects on soil, water, vegetation, materials, visibility, personal comfort, and well-being."
- "Maximum tolerable level denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general public."

In addition, the World Health Organization (WHO) is a widely-consulted authority that has developed air quality guidelines for selected key contaminants of concern. The guidelines are intended for world-wide use, to support the achievement of air quality that protects public health in various contexts (WHO, 2005). They are based on an extensive body of scientific evidence on air pollution and its health effects. Ambient air quality guidelines from the WHO for particulate matter, NO_2, SO_2, and O_3 (WHO, 2005) are also included for reference.

Table 11-3: Ambient Air Quality Criteria, Standards, and Objectives identifies and compares the Federal objectives, the Northwest Territories (NWT) criteria, the Nunavut guidelines, the CWS, and the WHO guidelines. The criteria refer to different averaging periods to account for potential short-term acute exposures and long-term chronic exposures.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-3: Ambient Air Quality Criteria, Standards, and Objectives

Contaminant	Averaging Time	Federal Air Quality Objectives			CWS	Nunavut	NWT	WHO	Indicator Threshold
		Desirable	Acceptable	Tolerable					
TSP (µg/m^3)	24 hr	-	120	400	-	120	120	-	120
	Annual	60	70	-	-	60	60	-	60
PM_{10} (µg/m^3)	24 hr	-	-	-	-	-	50*	50	50
$PM_{2.5}$ (µg/m^3)	24 hr	-	-	-	30**	-	30	25	30
SO_2 (µg/m^3)	1 hr	450	900	-	-	450	450	-	450
	24 hr	150	300	800	-	150	150	20	150
	Annual	30	60	-	-	30	30	-	30
NO_2 (µg/m^3)	1 hr	-	400	1,000	-	-	-	200	400
	24 hr	-	200	300	-	-	-	-	200
	Annual	60	100	-	-	-	-	40	60
CO (µg/m^3)	1 hr	15,000	35,000	-	-	-	-	-	15,000
	8 hr	6,000	15,000	20,000	-	-	-	-	6,000
O_3 (µg/m^3)	1 hr	100	160	300	-	-	-	-	-
	8 hr	-	-	-	127***	-	127	100	-
	24 hr	30	50	-	-	-	-	-	-
	Annual	-	30	-	-	-	-	-	-

NOTE(S):

1. *ONTARIO INTERIM AMBIENT AIR QUALITY CRITERION (AAQC). ONTARIO MINISTRY OF THE ENVIRONMENT, SEPTEMBER 2001.
2. ** ANNUAL 98TH PERCENTILE 24-HOUR CONCENTRATION, AVERAGED OVER 3 YEARS.
3. *** ANNUAL 4TH HIGHEST 8-HOUR CONCENTRATION, AVERAGED OVER 3 YEARS.

Because the PDW activities do not involve the mining of ore, ambient air quality criteria were not identified for metals.

Table 11-4: Dust Deposition Criteria identifies dust deposition criteria for Alberta and Ontario. The basis for these criteria appears to be based on nuisance considerations. The Ontario values have been recalculated to be in the same units as the Alberta criteria. Dust deposition, while not indicative of effects to air quality, have been calculated for use in assessing the effects of dust on other VECs and Key Indicators such as vegetation, water quality, and wildlife.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-4: Dust Deposition Criteria

Averaging Time	Alberta Residential and Recreation Areas	Alberta Commercial and Industrial Areas	Ontario Ambient Air Quality Criteria	Indicator Threshold
1 Month	53 mg/100cm^2/30 d	158 mg/100cm^2/30 d	70 mg/100 cm^2/30 d	5.3 g/m^2/30 d 15.8 g/m^2/30 d
	5.3 g/m^2/30 d	15.8 g/m^2/30 d	7 g/m^2/30 d	
Annual	-	-	4.6 g/m^2/30 d	55 g/m^2/yr
	-	-	55 g/m^2/year*	

The Clean Air Strategic Alliance and the Province of Alberta have potential acid input (PAI) deposition loading criteria. These criteria refer to PAI deposition averaged over a 1° longitude by 1° latitude grid cell. This grid cell corresponds to a region that is about 65 km by 112 km, with a total area of 7,280 km^2. For comparison, the LSA has nominal areas of 56 km^2, 141 km^2 and 156 km^2 for Milne Port, Mine Site, and Steensby Port, respectively. The LSA average deposition can be conservatively compared to the 1° longitude by 1° latitude grid cell criteria to provide an indication of the local PAI status.

The CASA/AENV PAI deposition criteria are shown in Table 11-5: Thresholds for Potential Acid Input Loads, and the implications of exceeding them are listed as follows:

- **Monitoring Load** - If a grid cell deposition exceeds the monitoring load, then Alberta Environment requires industry and non-industry stakeholders to discuss appropriate monitoring approaches. Monitoring loads are set below target loads to allow sufficient time for the development of a management plan before deposition levels reach target load levels
- **Target Load** - Target loads are viewed as an environmental objective or regulatory instrument, similar to the ambient air quality objectives. If a grid cell deposition exceeds the target load, then an emission reduction plan will have to be developed
- **Critical Load** - Critical loads identify a level of deposition that can lead to long-term harmful changes to the environment. In the event that a critical load is exceeded, an emission reduction plan will have to be developed and implemented on an accelerated schedule. Exceeding a critical load, however, does not indicate environmental damage is imminent unless it is sustained over many years.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-5: Thresholds for Potential Acid Input Loads

Receptor Sensitivity *	Deposition Load	Potential Acid Input (keq H^+/ha/a)
Low sensitivity	Critical	**1.00**
	Target	**0.90**
	Monitoring	**0.70**
Moderately sensitive	Critical	**0.50**
	Target	**0.45**
	Monitoring	**0.35**
Sensitive	Critical	**0.25**
	Target	**0.22**
	Monitoring	**0.17**

SOURCE: CASA and AENV (1999)

NOTE(S):

1. REFERS TO BUFFERING CAPABILITY OF THE SOIL. FOR THE PROJECT SITE, THE RECEPTOR SENSITIVITY WAS DETERMINED TO BE MODERATE.

While CASA indicates these loading criteria may be used as benchmarks on a local scale (i.e., for distance scales less than the 1° longitude by 1° latitude grid cell), they are not intended to be applied on a local scale as environmental objectives or as the basis for determining the acceptability of an individual Project. Values exceeding criteria loadings on a local scale indicate the potential need for management options that could include monitoring or mitigation.

In general, if the concentration or deposition level of an airborne pollutant can be maintained below its threshold, then either no health effect is observed or the effect is small enough that it presents an acceptably low risk to the population and the environment.

11.2.9 Water Quality

In Nunavut, effects of Projects on water quality are regulated as part of water licences issued by the Nunavut Water Board. Water licences identify Project-specific compliance targets for effluent discharges and concentrations in receiving waters. Additionally, the federal Metal Mining Effluent Regulations (MMER), under the federal *Fisheries Act*, regulate mining effluent discharges including water from tailings ponds (not applicable to this Project), and runoff (effluent) from ore and waste rock stockpiles. However, since PDW does not involve mining activates only discharge criteria of the water license are relevant.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

In addition to the above and for the purpose of comparison in the effects assessment, water and sediment quality predictions were compared with the following guidelines:

- CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life (PAL) (2003)
- Health Canada Canadian Drinking Water Guidelines (2004)
- Interim Sediment Quality Guidelines (ISQG) and Probable Effects Level (PEL) identified in the CCME Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (2003).

As a general rule, the CCME PAL was ultimately used for defining thresholds for key (PAL) indicators of the surface water and sediment quality VEC, as the CCME PAL thresholds are typically the most stringent of those identified above. In order to fill gaps for those key indicators that have no thresholds identified in the sources listed above, the following secondary sources were adopted:

- BC Ministry of Environment (MOE) Approved and Working Water Quality Guidelines and Alert Levels
- Suter Thresholds (Aquatic Toxicity Reference Values)
- Criteria Continuous Concentration (Chronic) National Recommended Water Quality Criteria, USEPA (2006).

The relationship between potential surface water and sediment quality effects, key indicators, and thresholds are summarized in Table 11-6: Potential Effects, Key Indicators, and Thresholds for the Surface Water and Sediment Quality VEC.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-6: Potential Effects, Key Indicators, and Thresholds for the Surface Water and Sediment Quality VEC

Potential Effect	Key Indicator	Thresholds (Magnitude and Extent)			
		MMER[1]	CWQG (PAL)[2]	CDWQG[3]	NWB[4]
Water Quality from Mine Contact Water and Site Runoff	TSS (mg/L)	15	+5		**35**
	pH (pH unit)	6.0 - 9.5	6.5 - 9.0	6.5 - 8.5[12]	**6.0 - 9.5**
	Hardness $CaCO_3$ (mg/L)				
	Alkalinity $CaCO_3$ (mg/L)				
	Chloride (mg/L)		230[5]	<250[12]	
	Sulphate SO4 (mg/L)			<500[12]	
	Ammonia N (mg/L)		1.78 - 38.6[6]		
	Nitrate N (mg/L)		2.93	10	
	Nitrite N (mg/L)		0.06	3.2	
	Total P (mg/L)		Narrative Table 7-3.6		
	Total Aluminum (mg/L)		0.005 - 0.1[7]		
	Total Antimony (mg/L)			0.006	
	Total Arsenic (mg/L)	0.5	0.005	0.005[13]	
	Total Barium (mg/L)			1	
	Total Beryllium (mg/L)		0.0053[8]		
	Total Boron (mg/L)		1.50[8]		
	Total Cadmium (mg/L)		0.000097[9]	0.005	
	Total Chromium (mg/L)		0.001[8]	0.051	
	Total Cobalt (mg/L)		0.004		
	Total Copper (mg/L)	0.3	0.002 - 0.004[10]	<1.0[12]	
	Total Cyanide (mg/L)	1.0			
	Total Iron (mg/L)		0.3	<0.3[12]	
	Total Lead (mg/L)	0.2	0.001 - 0.007[10]	0.01	
	Total Manganese (mg/L)			<0.05	
	Total Mercury (mg/L)		0.000026		
	Total Molybdenum (mg/L)		0.073		
	Total Nickel (mg/L)	0.5	0.025 - 0.15[10]		
	Total Selenium (mg/L)		0.001		
	Total Silver (mg/L)		0.0001		

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Potential Effect	Key Indicator	Thresholds (Magnitude and Extent)			
		MMER[1]	CWQG (PAL)[2]	CDWQG[3]	NWB[4]
	Total Thallium (mg/L)		0.0008[11]		
	Total Uranium (mg/L)		0.0026[11]		
	Total Vanadium (mg/L)		0.02[11]		
	Total Zinc (mg/L)	0.5	0.03	<=5.0[12]	
	1-2 Propylene Glycol		500 (interim)		
Water Quality from Fuel Contact	Benzene (µg/L)		370		
	Toluene (µg/L)		2		
	Ethyl benzene (µg/L)		90		
	Lead (µg/L)		1		
	Oil and Grease (µg/L)		15,000		
Water Quality from Discharge of Sewage	BOD_5 (mg/L)				**30**
	Fecal Coliform (CFU/100mL)				**1,000**
Sediment Quality	Arsenic (mg/kg)	5.9	17		
	Cadmium (mg/kg)	0.6	3.5		
	Chromium (mg/kg)	37.3	90		
	Copper (mg/kg)	35.7	197		
	Lead (mg/kg)	35.0	91.3		
	Mercury (mg/kg)	1.7	4.86		
	Zinc (mg/kg)	123	315		

NOTE(S):

1. Mean monthly maximum averages in schedule 1 of the metal mining effluent regulation under the federal fisheries act.
2. Canadian council of ministers of the environment (ccme) canadian water quality guidelines for the protection of aquatic life (pal) (2003).
3. Health canada canadian drinking water guidelines (2004).
4. Nunavut water board wastewater criteria.
5. Criteria continuous concentration (chronic) national recommended water quality criteria, usepa (2006).
6. Varies with temperature and ph.
7. Varies with ph and calcium concentration.
8. Bc moe approved and working water quality guidelines.
9. Criteria continuous concentration (us epa), varies with hardness.
10. Varies with caco3 concentration.
11. Suter thresholds.
12. Aesthetic objective.
13. Proposed guideline.
14. Interim sediment quality guidelines (isqg) and probable effects level (pel) identified in the ccme canadian sediment quality guidelines for the protection of aquatic life (2003).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The thresholds identified in Table 11-6: Potential Effects, Key Indicators, and Thresholds for the Surface Water and Sediment Quality VEC were applied in the effects assessment in the following manner:

- CCME PAL were applied as receiving environment criteria for all sources
- CCME DWQG were applied as receiving environment criteria for all sources
- NWB were applied as 'end of pipe' criteria for wastewater (sewage effluent) discharge.

11.2.10 Terrestrial Environment

The terrestrial environment consists of soils and landforms, vegetation, and terrestrial wildlife. Biological diversity is protected through the identification and listing of species of conservation concern or 'at risk' with the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the federal *Species at Risk Act* (SARA).

As no plant species with formal recognition as "rare plants" were identified during baseline studies, rare vegetation was not included as an issue in the assessment. No terrestrial mammals are designated as "at risk" though it is recognized that North Baffin caribou are in a population low within their natural cyclic pattern of abundance and decline. Several bird species at risk are assessed.

Measurable parameters for wildlife species include percent changes in habitat loss or population changes due to mortality.

11.2.11 Marine Environment

As with freshwater quality, mine-related effluent discharges to the marine environment is regulated by the MMER. Water licences specify sewage effluent discharges to the marine environment.

Fish and marine wildlife are regulated by the *Fisheries Act*.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

11.3 Effects Assessment Methodology

The environmental effects assessment identifies potential effects of the PDW on the biophysical and socio-economic environments. The objectives of the environmental effects assessment are as follows:

- to identify and avoid or reduce potential adverse PDW effects
- to identify and promote potential positive PDW effects
- to engage Inuit, stakeholder, and government consultation
- to consider plausible alternatives for certain components of the PDW.

Various methods were adopted for the assessment, including the following:

- identification of potential environmental and socioeconomic concerns
- environmental and socio-economic baseline and Inuit knowledge studies
- consultation with local public, Inuit organizations, and government agencies
- determination of valued components (VCs) to focus the environmental effects assessment
- identification of key potential PDW interactions between VCs and environment or socio-economic receptors
- identification of mitigation measures and adaptive management plans
- evaluation of the significance of residual environmental and socio-economic effects
- development of monitoring programs to distinguish PDW related effects from natural variability in the environment, to verify effects assessment predictions, and as a component of adaptive management.

The same methodology employed for the DEIS has been applied to this evaluation of the PDW.

With regard to terminology, Baffinland used definitions and concepts applied in the DEIS, in NIRB's (2007) terminology guide, and the *Canadian Environmental Assessment Act*.

11.3.1 Boundaries

Spatial and temporal boundaries were determined to set maximum limits within which the environmental assessment was conducted.

11.3.1.1 Spatial Boundaries

The starting point for defining study areas was the delineation of potential development areas (PDAs) at PDW sites, including the Mine Site and port sites, based on the physical extent of Project activities. These areas conservatively define the PDW footprint to account for the possibility of minor changes to the location of Project infrastructure that might occur as the Mary River Project moves forward through detailed engineering and construction.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Spatial boundaries for the effects assessment were determined on a VEC- and VSEC-specific basis for biophysical effects, and are described in the applicable section. Spatial boundaries were defined by the anticipated zone of influence of PDW effects. As well, spatial boundaries can serve to prescribe the extent to which traditional Inuit land use could be affected, as well as the set of past, present, and reasonably foreseeable Projects and activities that could interact with the PDW. A nested approach was adopted as follows:

- Local study area (LSA) - Area where there exists reasonable potential for direct interaction due to PDW activities, ongoing normal activities, or to possible abnormal operating conditions (i.e., accidents and malfunctions). The LSA includes all existing and proposed Mary River Project facilities (PDAs), and the nominal shipping route in the NSA. Individual LSAs were defined for each biophysical environmental component, and for land use and other socio-economic components
- Regional study area (RSA) - Area within which there exists the potential for direct, indirect, and/or cumulative biophysical and socio-economic effects. This area includes lands, waters, and potentially affected communities within the NSA. Effects extending beyond the NSA were addressed in a separate transboundary effects assessment. RSAs were defined for each of the major environmental components (human, atmospheric, terrestrial, freshwater, and marine) and are defined in each respective volume. Confidence and accuracy of predicted effects was generally reduced at this scale, with qualitative analysis more common than quantitative analysis.

11.3.1.2 Temporal Boundaries

Temporal boundaries define the period analyzed within which the PDW activities interact with environmental or socioeconomic components. Temporal boundaries were defined in the DEIS for the mine development Project, and temporal boundaries for the pre-development works fit within the overall Project timeline. The temporal boundaries for PDW are defined as the four year period of 2012 to 2015, with the PDW activities carried out in 2012, and closure activities (if the full Project does not proceed) occurring in 2014 to 2015.

11.3.2 Baseline Studies

Baseline studies, starting in 2005, were undertaken for socio-economics, physical environment, terrestrial ecology, and marine ecology (see Table 11-7: Baseline Study Components). These baseline studies were presented in the DEIS and support the assessment carried out for the PDW application.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-7: Baseline Study Components

Subject	Description
Socio-economics	Includes demographics, workforce experience, health, social services, youth, education, economic development, opinions, perceptions, and the spiritual aspects of archaeology.
Physical Environment	Includes climate, air, noise, water, waste rock characterization, soils, and the physical aspects of archaeology.
Terrestrial Ecology	Includes terrestrial wildlife and wildlife habitat (e.g., caribou and carnivores), birds (e.g., raptors, geese, loons, shorebirds and songbirds), freshwater fish and fish habitat, vegetation, habitats, and biodiversity.
Marine Ecology	Includes marine mammals, marine fish and lower trophic levels, physical and chemical oceanography, and marine and shoreline habitats.

Objectives of the baseline studies included:

- defining existing social and environmental conditions (baseline studies were run concurrent to the bulk sampling program)
- identifying potential social and environmental concerns and sensitivities
- providing information for Project design.

Baseline studies were conducted using the following:

- Literature review
- Site investigations
- Stakeholder, Inuit, and government consultation
- Inuit knowledge studies.

As with the scientific baseline studies referred to above, Inuit knowledge studies were carried out for the Project over the period of 2006 through 2010. Pre-existing IQ studies by others, such as the Inuit Land Use and Occupancy Project (Milton Freeman Research Ltd. 1976) and the Nunavut Wildlife Harvest Study (Priest and Usher, 2004) were also incorporated in a land use baseline report (see DEIS, Appendix 4D[1]) and wildlife baselines and effects assessments. IQ was used to identify and substantiate VECs and VSECs, to help focus the effects assessments on the issues identified by local communities and knowledge-holders, and in identifying mitigation and monitoring plans.

These studies supported the effects assessments presented in both the DEIS[1] and this PDW application. The methodology for conducting these Inuit knowledge studies is described in DEIS Volume 2, Section 1.5 and Appendix 2B.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

11.3.3 Issues Identification

Environmental and socio-economic issues of concern were identified through the North Baffin Regional Land Use Plan (NPC, 2000) and through Inuit, stakeholder, and government consultation to focus the environmental effects assessment. Issues were identified through the following:

- public meetings
- Inuit knowledge and IQ working group meetings
- intervener comments during NIRB's screening of Baffinland's bulk sampling program
- North Baffin Regional Land Use Plan
- issues raised in NIRB reviews of other mining Projects
- Information requests and public/community feedback on the DEIS.

Issues of concern led to identification of VCs, described in the section following.

11.3.4 Identification of Valued Components

VCs identify key species or topics to focus the effects assessment. NIRB (2007) distinguishes between valued ecosystem components (VECs) as the VCs of the biophysical environment, and "valued socio-economic components" (VSECs) relating to the human, economic, and spiritual environment. VECs and VSECs are defined by NIRB as follows:

- VECs include those aspects of the environment considered to be important to a particular region or community and might include:
  - resources that are either legally, politically, publicly, or professionally recognized as important, such as parks, land selections, and historical sites
  - resources that have ecological importance, such as keystone species which, if affected, have a disproportionate effect on their surroundings relative to the types and numbers of other species in a community, and those species that are suitable ecological indicators
  - resources identified for their importance to local communities because they are either harvested or of prominent spiritual importance.
- VSECs include those aspects of the social and economic environment that are identified to be important to a particular region or community, including components relating to the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and community and local government organizations.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The effects assessments are organized according to resource component themes (e.g., socio-economic environment, atmospheric environment, terrestrial environment, freshwater aquatic environment, marine environment). VECs and VSECs were identified within each of these themes based on the issues identified.

Key indicators (KIs), or environmental indicators, are subsets of VECs or VSECs used to communicate information about the environmental effects of the Project. The use of indicators is a pragmatic approach to conducting environmental effects assessment, where evaluating every potential effects on the receiving environment is not practical. KIs have been identified under each VC. For a summary of Project VCs and KIs, see Table 11-8: Valued Components and Key Indicators.

The VC's and key indicators were established in the DEIS, based on consultation with potentially affected communities during public meetings and independently confirmed by NIRB and identified in NIRB's EIS guidelines (NIRB, 2009).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-8: Valued Components and Key Indicators

Themes	Guideline VCs	Key Indicators
Atmospheric Environment	Climate change	Greenhouse gases
		Climate change
	Air quality	Particulate matter, SO_2, NO_X
	Noise and vibration	Atmospheric noise levels, marine noise levels, vibration
Terrestrial Environment	Landforms, soil and permafrost	Sensitive landforms
	Vegetation	Plant abundance and diversity Plants important to Inuit Plant health
	Terrestrial wildlife and habitat	Caribou
	Migratory birds and habitat	Peregrine falcon, snow geese, eider ducks, red-throated loons
Freshwater Aquatic Environment	Surface water include freshwater quality and quantity	Water quantity Water and sediment quality
	Freshwater fish, fish habitat and other aquatic organisms	Arctic char
Marine Environment	Sea ice	Area of shore fast ice in Steensby Inlet
	Water and sediment quality	Water and sediment quality parameters with established guidelines
	Marine habitat and biota	Arctic char
	Marine mammals	Ringed seals, bowhead whale, walrus, beluga whale, narwhal, polar bear
Communities	Population demographics	Demographic stability
	Education and training	Life skills; education and skills
	Human health and well-being, including local food security	Well-being of children; substance abuse; community social stability
	Community infrastructure and public service	Municipal staff recruitment and retention
	Governance and leadership	[subject of note only]

© Hatch 2011/09

Themes	Guideline VCs	Key Indicators
Economics and Employment	Livelihood and employment	Wage employment; job progression and career advancement
	Economic development and self-reliance	Economic development and self-reliance
	Contracting and business opportunities	Business opportunities
	Benefits, taxes and royalties	Territorial government own-source revenues
Culture and Land Use	Cultural resources	Cultural resources
	Resources and land use	Harvesting Travel routes and camps Public safety
	Cultural well-being	[subject of note only]

11.3.5 Measurable Parameters and Thresholds

Measurable parameters are clearly defined aspects of an indicator (VEC/VSEC) that can be quantified and compared against a baseline value or condition. Each measurable parameter has an associated performance level or standard that can establish an effect magnitude or indicate compliance with formal standards.

Thresholds are limits of acceptable change determined from regulated guidelines or by professional opinion. For this assessment they were determined on a VEC-specific basis. Wherever possible, quantitative thresholds, determined by relevant regulatory bodies, were adopted for biophysical VEC, however, where these did not exist, qualitative thresholds were considered based on professional judgement. Qualitative thresholds were commonly applied to VSECs; for example, establishing thresholds for demonstrating broad community support.

11.3.6 Effects Assessment

11.3.6.1 Assessment Methodology

Identification and assessment of environmental and social effects was based on the following steps:

- identification of major PDW activities, as defined in the PDW Description (see Sections 2 through 6)
- identification of PDW interactions that are likely to result in a change/effect to a VEC/VSEC or its indicator and mapping the interactions and effects on linkage diagrams
- assessment of the magnitude of the effect of the PDW interaction with the VEC or VSECs depending on the relative importance (scale, frequency, duration, intensity) and certainty/uncertainty around the effects

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- selection of appropriate measurable parameters and thresholds based on established performance criteria or professional judgment
- establishment of the framework for evaluating significance of residual impacts
- identification of mitigation measures to reduce or eliminate negative effects
- determining the potential for a residual effect, and if anticipated, its significance
- identifying monitoring plans and adaptive management objectives.

Baffinland has used best practice methods to predict the nature and extent of effects that might result from Project implementation. For each effects assessment, relevant references, analyses, and explanations appropriate to the resource theme being analyzed are included, defining:

- how scientific, engineering, community, and Inuit knowledge was used in the assessment
- which studies included assistance of communities and individuals, who was involved (if the information can be made public), and how participants were selected
- data collection methods and limitations
- model assumptions and study methodologies
- study and model outputs, calculations, support analyses, and explanation of results
- reference literature or other information sources for any contributions, including Inuit knowledge.

In some instances, additional studies such as modelling exercises carried out to support the DEIS were relied upon as a proxy to evaluate the relative effects of the PDW activities.

11.3.6.2 Effect Categories

NIRB defines an environmental effect as a positive or negative change in the biophysical and/or socioeconomic environment caused by or directly related to a proposed activity. Effects are defined as direct, indirect, and cumulative as follows (NIRB, 2007):

- **Direct Effects** - Refers to changes in the VEC/VSEC that result from direct interactions between PDW activities and the environment.
- **Indirect Effects** - Refers to effects on the environment that are not a direct result of the PDW. For example, fugitive dust fallout could have the potential direct effect of causing losses of local vegetation species. An indirect effect results when the availability of that vegetation as forage becomes limited and reduces the food supply for certain terrestrial mammals.
- **Cumulative Effects** - Refers to effects that result from incremental changes caused by interactions between the PDW and other past, present, or reasonably foreseeable future Projects or activities. Cumulative effects are addressed in Section 22.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

11.3.6.3 Mitigation Measures

Mitigation measures are management actions or strategies applied to minimize or eliminate negative environmental effects. Mitigation of environmental effects can be achieved through Project design and adaptive management. Design considerations and alternatives used to minimize or eliminate the potential for residual effects are identified in the PDW description (see Sections 2 through 6). Mitigation measures are also used to reduce or eliminate the potential residual effects of the PDW and are identified in each of the effects assessments, along with potential residual effects of the PDW. Monitoring results during execution of the PDW activities can be used to verify effect predictions and to modify mitigation measures or monitoring activities in the Mitigation and Monitoring Plan and discipline-specific management plans for full mine development.

11.3.6.4 Determining Significance of Residual Effects

Residual Projects effects refer to the environmental effects identified for the PDW, post-mitigation. The significance of residual environmental effects was determined from the following criteria (NIRB, 2009):

- direction or nature of an effect (i.e., positive/beneficial versus negative/adverse)
- magnitude and complexity of an effect
- extent of the effect, including such as the geographical area that will be affected, the size of the affected human populations, and/or the size of the affected wildlife populations and habitat
- frequency and duration of an effect
- reversibility or irreversibility of an effect
- probability of occurrence of the effect
- confidence in the effect prediction
- context of the effect.

These criteria were used in the DEIS and were adopted for this assessment, as specified by NIRB (2009) and because the criteria have precedence of use for other environmental assessments in the Canadian Arctic (NIRB, 2007, 2009; Lawrence Environmental 2000, 2004; Wolfden Resources Inc., 2006; De Beers Canada Inc., 2004).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-9: Attributes Used to Evaluate Significance of Residual Effects

Attribute	Definition and Rationale	Role in Significance Determination
Direction and Nature	The ultimate long-term trend of an environmental effect - positive, neutral, or negative.	**Qualifier** Only negative effects are assessed for significance
Magnitude	The amount or degree of change in a measurable parameter or variable relative to existing conditions (the exposed population). This attribute can also consider complexity - the number of interactions (Project phases and activities) contributing to a specific effect.	**Primary Criterion** High magnitude = high significance
Extent	The geographic area over which the interaction will occur.	**Secondary Criterion** The larger the zone of influence, the higher the potential significance
Frequency	The number of times during a Project or a Project phase that an interaction or environmental effect can be expected to occur.	**Secondary Criterion** Greater the frequency of occurrence, the higher the potential significance
Duration	The period over which the environmental effect will occur.	**Secondary Criterion** The longer the duration of an interaction the higher the potential significance
Reversibility	The likelihood that a VEC/VSEC or Indicator will recover from an environmental effect, including consideration of active management techniques. Reversibility is considered for biological VECs at the population level. Therefore, although an effect like mortality is irreversible, the effect at the population level might be reversible.	**Primary Criterion** The greater the potential to reverse an effect, the lower its potential significance

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Attribute	Definition and Rationale	Role in Significance Determination
Probability	The likelihood that an interaction and a consequent effect will, in fact occur.	**Qualifier** (considered only for potentially significant effects) The higher the probability of occurrence, the greater the significance
Certainty	The level of confidence in the knowledge or analysis that supports the prediction, in particular with respect to limitations in overall understanding of the ecosystem, and limitations in the ability to foresee future events or conditions.	**Qualifier** (considered only for potentially significant effects) The lower the certainty of occurrence, the more conservative the approach to prediction of significance
NOTES(:) **CRITERION** - DIRECTLY CONTRIBUTES TO THE DETERMINATION OF SIGNIFICANCE. **PRIMARY CRITERIA** ARE GIVEN GREATER WEIGHT THAN S**ECONDARY CRITERIA**. **QUALIFIER** - ACTS AS A MODIFIER TO BE CONSIDERED WHEN ASSIGNING VALUES/RANKINGS TO ASSESSMENT CRITERIA.		

Sections 3 through 17 present the effects predictions for the resource-specific component themes. Section 20 presents the cumulative environmental effects assessment.

11.3.6.5 Rating of Residual Biophysical Impacts

For the categories for criteria and qualifiers applied directly to the determination of significance for residual biophysical effects, with due consideration to the NIRB requirements cited above, see Table 11-10: Ratings for Evaluating Residual Biophysical Effects.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-10: Ratings for Evaluating Residual Biophysical Effects

Criteria	Classification	
Magnitude (Specific to the VEC and the impact)	Level I	An effect on the exposed indicator/VEC that results in a change that is not distinguishable from natural variation and is within regulated values
	Level II	An effect that results in some exceedance of regulated values and/or results in a change that is measurable but allows recovery within one to two generations
	Level III	An effect predicted to exceed regulated values and/or results in a reduced population size or other long-lasting effect on the subject of assessment
Extent The physical extent of the effect, relative to study area boundaries	Level I	Confined to the LSA
	Level II	Beyond the LSA and within the RSA
	Level III	Beyond the RSA
Frequency How often the effect occurs	Level I	Infrequent
	Level II	Intermittent
	Level III	Frequent or continuous
Duration The length of time over which a Project effect will occur	Level I	Short term (effect lasts up to four years)
	Level II	Medium term (up to 25 years, for the life of the Project)
	Level III	Long term (beyond the life of the Project) or permanent
Reversibility The likelihood of the VEC to recover from the effect	Level I	Fully reversible
	Level II	Reversible with cost/effort
	Level III	Irreversible
Qualifiers		
Certainty Limitations in the overall understanding of the ecosystem and ability to predict future conditions	High	Baseline data are comprehensive; predictions are based on quantitative data; effect relationship is well understood
	Medium	Intermediate degree of confidence between high and low
	Low	Baseline data are limited; predictions are based on qualitative data; effect relationship is not well understood
Probability The likelihood that the predicted impact/residual effect will occur	Unlikely	Less than 20% likelihood of occurrence
	Moderate	Between 20 and 60% likelihood of occurrence
	Likely	Over 60% likelihood of occurrence

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Each of the five criteria contributes to the determination of significance. Criteria are categorized in three levels (Levels I, II, and III), where Level I is indicative of a negligible or limited potential to contribute to an overall significant environmental effect, and Level III is indicative of a high potential to contribute to an overall significant environmental effect. Level II represents the intermediate condition.

For the assessment table formats used to summarize the effects assessment of biophysical VECs, see Table 11-11: Effects Assessment Summary for Selected VEC/Key Indicator and Table 11-12: Significance of Potential Residual Biophysical Effects. Note that adjustments and adaptations can be made to suit the individual analyses. These are noted in each VEC discussion.

Table 11-11: Effects Assessment Summary for Selected VEC/Key Indicator

Project Activity	Direction and Nature of Interaction	Mitigation	Evaluation Criteria				
			Reversibility	Extent	Frequency	Duration	Magnitude

Key:
Direction and nature: Positive; neutral; negative
Magnitude: 1 = Level I; 2 = Level II; 3 = Level III; includes consideration of environmental sensitivity
Extent: 1 = Level I; 2 = Level II; 3 = Level III
Frequency: 1 = Level I; 2 = Level II; 3 = Level III
Duration: 1 = Level I; 2 = Level II; 3 = Level III
Reversibility: 1 = Level I; 2 = Level II; 3 = Level III

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-12: Significance of Potential Residual Biophysical Effects

Effect	Significance of Predicted Residual Environmental Effect		Likelihood (1)	
			Probability	Certainty
	Significance Rating	Level of Confidence		

Key
Significance Rating: S = Significant, N = not Significant, P = Positive
Level of Confidence[1] : 1 = Low; 2 = Medium; 3 = High
Likelihood - only applicable to significant effects
Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely
Certainty[2]: 1 = Low; 2 = Medium; 3 = High

NOTE(S)
1. LEVEL OF CONFIDENCE IN THE ASSIGNMENT OF SIGNIFICANCE.
2. CERTAINTY AROUND THE ASSIGNMENT OF LIKELIHOOD.

Qualifier 1 - Level of Confidence

The level of confidence with predictions is an important qualifier in that a low level of certainty will require that a conservative approach be taken to each of the evaluation criteria. Level of confidence is related to limitations in the overall understanding of the ecosystem and limitations in accurately foreseeing future events or conditions. Uncertainties associated with each prediction are described in each effects assessment at a level of detail that corresponds to the relative uncertainty (i.e., where effects predictions have greater certainty, more emphasis was placed on articulating the uncertainties). A degree of confidence is assigned to qualify significance rankings relative to the quality and confidence in the data used and the evaluation methodology.

"Low" is assigned where there is a high degree of confidence in the inputs, **"Medium"** when there is moderate confidence, and "High" when there is a low degree of confidence in the inputs. Where rigorous field baseline data were collected and scientific analysis performed, the degree of confidence will generally be high.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Qualifier 2 - Likelihood

The likelihood parameter is assigned both a probability dimension as well as a level of certainty, to qualify significance rankings relative to the likelihood that the predicted effects will actually occur**. "Unlikely"** indicates a low probability of occurrence, **"Moderate"** a moderate probability, and **"Likely"** a high probability of occurrence. For example, where effects are associated with unplanned accidental releases against which mitigation and emergency response protocols are in place, the probability is low. Certainty is assigned to indicate the relative level of confidence in the probability prediction. Collectively, the probability and certainty assignments indicate the overall likelihood of an effect.

11.3.6.6 Rating Criteria for Residual Socio-Economic Impacts

Similar criteria were applied to the socio-economic effects assessment with some modification and additional criteria in consideration of the nature, complexity, and multiple perspectives associated with socio-economic issues. For the attributes (criteria and qualifiers) identified as the determinants of significance of socio-economic effects, see Table 11-13: Rating Criteria for Evaluating Residual Socio-Economic Impacts.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 11-13: Rating Criteria for Evaluating Residual Socio-Economic Impacts

Criteria	Classification
Direction	**Positive**
	Variable
	Negative
Geographic Extent	**Description of the area and communities most affected**
Social Extent	**Demographic groups or social units identified as most affected**
Equity	**Engaged individuals**
	Involuntary bystanders
Magnitude Intensity of the effect	**Low**
	Moderate
	High
Frequency How often the effect occurs	**Infrequent**
	Intermittent
	Continuous
Duration Length of time over which a Project effect will occur	**Short term (less than four years)**
	Medium term (up to 25 years, life of the Project)
	Long term (beyond the life of the Project)
Reversibility Likelihood of recovery from effect	**Reversible**
	Partly reversible with cost/effort
	Irreversible

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Additional description of each criterion follows:

Direction

This criterion considers whether an effect is "positive" or "negative." The perceived direction of a given socio-economic effect is sometimes a subjective assessment that can vary across the population, so a "variable" option is also included in the classification. Determination of "direction" is based on values expressed during the community research and through existing documentation such as community economic development plans.

Geographical Extent

This attribute identifies whether the effect will be experienced in the smaller communities, in Iqaluit, or in both these areas. Some impacts might be relevant to specific communities, so a "community-specific" classification is included.

Social Extent

The "social extent" identifies the specific groups or social units most likely to experience an effect. These could include children, youth, women, family, or the entire community.

Equity

"Equity" considers whether those experiencing an effect have made a choice to engage in the Project, i.e., "engaged individuals," or are simply bystanders who have not voluntarily associated with the Project, i.e., "bystanders." This criterion seeks to provide insight into how equitably the benefits and negative impacts are distributed.

Magnitude

"Magnitude" is the level of change relative to the appropriate baseline rated as low; moderate; or high. These magnitude ratings are linked to measurable parameters where appropriate. Measurable parameters may be applied in a conceptual sense.

Frequency

The "frequency" of an effect provides an indication of how commonly the effect will occur during the Project. Frequency is rated as low; intermittent; or continuous. Unless otherwise indicated the following definitions are associated with these levels:

- Infrequent - Occurring only occasionally
- Intermittent - Occurring during periodic points in the Project
- Continuous - Occurring throughout the Project life.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Duration

"Duration" refers to how long an effect will continue to affect those who experience it. It is rated using the following definitions:

- Short term - Over a period of several years
- Medium term - Within the life of the Project life
- Long term - Beyond the Project life.

Reversibility

The "reversibility" criterion considers the likelihood of recovery from an effect, including consideration of the active management interventions that may be required to bring the residual effect to an acceptable level.

Three definitions are used in considering reversibility:

- Spontaneously Reversible - Effect reverses with no intervention within an acceptable time frame
- Management required - Active intervention is required to bring the effect to an acceptable level
- Non-reversible - Effect will not be reversed.

11.3.6.7 Overall Evaluation of Significance

NIRB (2009) stated that impact significance is based on comparing the predicted state of the environment with and without the Project, and expressing a judgment as to the importance of the changes identified.

The overall significance of an effect is derived from the experience and professional judgment of the environmental practitioners who prepared the assessment, considering the rankings of the contributing attributes of significance. While substantially based on professional judgment, the following are general rules of thumb applied in determining significance:

- If the magnitude of the effect is low, then the predicted effect is "not significant," recognizing that magnitude includes consideration of sensitive species, habitats, or populations. If effects on measurable components such as air or water quality meet applicable performance criteria, standards, or guidelines, then the magnitude of the effect is negligible to moderate, and therefore the prediction will be for an effect that is "not significant"
- If the geographic extent of the effect is confined to the PDA or LSA, then the predicted effect is likely to be "not significant"
- If the extent of a negative socio-economic effect is limited to individuals who also receive a corresponding positive benefit, then the predicted effect is likely to be "not significant"
- If the effect has a moderate to high reversibility, the predicted effect is likely to be "not significant"

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- If the duration of the effect is short term (i.e., construction period only, for example) then the effect prediction is also likely to be "not significant"

Baffinland has integrated a summary of the significance determination within each of the individual effects assessments in Sections 13 through 17.

11.4 Environmental Health and Safety Management System

Mitigation measures are incorporated in the Project design to avoid, reduce, or mitigate the severity of the expected adverse impacts of the Project. Once these mitigation measures are implemented, it is necessary for Baffinland to monitor and report on the effectiveness of the proposed mitigation measures and introduce corrective action as required. This process of monitoring, reporting, evaluating, reviewing, and continuous improvement is achieved with Baffinland's Environmental Health and Safety (EHS) Management System. The EHS Management System which is described in Volume 10 of the DEIS[1]. The EHS Management System includes a number of specific, life of Project, Environmental Mitigation and Monitoring Plans (EMMP), which define the:

- processes by which the mitigation measures will be implemented
- monitoring systems that will be put into place to document the adequacy of each mitigating action in reducing impacts to insignificant levels
- roles and responsibilities of individuals responsible for implementation and follow-up;
- reporting and documentation requirements
- methods by which modifications to the impacts predictions and/or mitigating actions, will be managed and improved in the event that those impacts and/or mitigation measures do not accurately reflect actual site conditions (review and continuous improvement).

Each EMMP focuses on a specific VEC or VSEC and outlines how monitoring results are used to refine or modify the design and implementation of mitigation measures and management activities (operating procedures). These plans also make it possible to ensure the proper operation of works, equipment, and facilities connected to the Project. If necessary, the plans help reorient the work and make improvements at the time of construction and implementation of the various elements of the Project.

Each EMMP:

- specifies criteria or thresholds to trigger corrective action based on its monitoring results
- identifies the position of the person responsible for the implementation of the corrective action
- presents the system of accountability and the phase and component of the Project to which the mitigation measure would be applied.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Implementation of mitigation and monitoring measures will continue throughout all phases of the Project. For the general organization and content of the EMMPs, see Volume 10, and for detailed content of each EMMP, see Appendix 10D.

EMMPs vary in detail, reflecting the significance and complexity of the issues and information available relative to the current stage of Project development. Proposed mitigation could include additional baseline work, further research, and plan development. The purpose of these plans is to provide an applicable framework and in some instances spell out the specific steps for implementing the impact-mitigating actions. They reflect current understanding of the local and regional environmental, social, and economic conditions. Each plan will be updated as the Project progresses to provide timely actions and responses to the issues they address, and task-specific procedures will be developed to define and detail each relevant job procedure.

The EMMP enables assessment of the effectiveness of the mitigation measures implemented. These monitoring requirements ensure that:

- the Project is conducted as proposed
- the predicted adverse environmental effects are promptly mitigated at the earliest possible time
- the conditions set at the time of the Project's authorization and the requirements pertaining to the relevant laws and regulations are met.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12. Baseline Summary

A comprehensive description of baseline conditions and supporting studies were presented with the DEIS(1). For this convenience, a summary of the baseline conditions is presented in this Section. Throughout this section the "Project" refers to the "Mary River Project."

12.1 Population Demographics

The following section provides a brief summary of baseline data that is of relevance to the Population Demographics VSEC. Further detail is provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010).

12.1.1 Inuit and Non-Inuit Components of the Population

The population of the North Baffin region consists mostly of Inuit (94%), with non-Inuit accounting for just 6% of the area's population. In Iqaluit the balance between Inuit and non-Inuit is more even, with 60% Inuit and 40% non-Inuit.

The age profiles for the Inuit and non-Inuit components of the population are of particular interest in understanding the demographic make-up of the region. The distinction between Inuit and non-Inuit components of the population is most pronounced in North Baffin where nearly all non-Inuit residents are of working age. In Iqaluit, non-Inuit make up a majority of residents aged 40 to 64—accounting for 58% of the population in that age group. Non-Inuit men make up 66% of the male population of Iqaluit aged 40 to 64, and 53% of the male population aged 25 to 39 years of age.

The picture suggests that non-Inuit residents move to North Baffin communities primarily to work and that relatively few are raising families or living out their retirement in these communities.

12.1.2 Gender Ratios

The ratio between males and females is an indicator that can provide useful insight into a population. Within the working-age population, for example, an imbalance could suggest that the local labour market is attracting more of one sex than the other.

Under baseline conditions the ratio of non-Inuit males to females is approximately even in the younger half of the working-age population. However in the older age categories (40 years and over) there are substantially more men, with a ratio of 60% males to 40% females. The sex ratio among non-Inuit aged 40 to 64 years in North Baffin is roughly similar to Iqaluit, with 58% being male.

Amongst the Inuit population, more males than females are resident in North Baffin, across all age groups. The opposite picture is seen in Iqaluit, where the number of Inuit females is greater than that of males.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.1.3 Stability of Residency

The Inuit population of North Baffin communities was very stable over the five-year period leading up to the 2006 census. Only one-in-ten Inuit had re-located from another community during this period (see DEIS Appendix 4A, Table 6 and Figure 5). A similar picture of stability in the Inuit population can be seen during the period before 2001. Evidently the decentralization of territorial government jobs to Igloolik and Pond Inlet during this period did not lead to major relocation of Inuit workers from other communities, although some instances, no doubt, did occur.

This contrasts sharply with the non-Inuit population of North Baffin, where only one-in-three (35%) of non-Inuit residents had been resident in the same community five years earlier. The level of instability of the non-Inuit population had been even slightly higher during the five years leading up to the previous census in 2001. At that time, only slightly more than one in four (27%) non-Inuit residents had lived in the community five years before.

The residential stability of the Inuit population in Iqaluit is significantly less than that seen in the North Baffin. In the five years leading up to 2006, two-in-ten Inuit moved to Iqaluit from another community, province, or territory. This level of mobility declined from a rate of one-in-four (24%) during the period before 2001.

Stability of the non-Inuit population is considerably higher in Iqaluit than it is in North Baffin, and appears to be trending in a direction of greater permanency. Before 2001, 41% of this population had been resident in the capital for at least five years. By 2006, this stable population had increased to 50%.

12.1.4 Net Migration into the Baffin Region

There are indications of an increasing net movement of Inuit from communities in the north to urban centres in the south. During the ten year period between the 1996 and 2006 censuses, the Inuit population in regions outside the traditional Inuit lands, or “Inuit Nunaat,” increased 62% from 6,795 to 11,000 individuals. In 2006, Inuit living outside the Inuit Nunaat accounted for 21.8% of the 50,480 Inuit living in all regions of Canada. There are, however, few data on the specific flow of Inuit migrants from North Baffin and Iqaluit components of the RSA, and the south. Nor have data been located to indicate flow back into Inuit Nunaat from southern locations.

As suggested by the analysis of the non-Inuit component of the LSA population, there has been tremendous movement between southern points-of-origin and Iqaluit and North Baffin, with nearly half the population changing-over within five years. The majority of this group comes to pursue employment opportunities and, as indicated by the age profile, does not settle permanently in the region.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

More detailed insight into migration can be drawn from taxfiler data. This analysis indicates that during the period from 1997 through 2002—leading up to division of Nunavut from the Northwest Territories, and for several years into the establishment of the territorial government—the net flow of people between the Baffin and other parts of Canada was mostly into the region. Since around 2002, this has reversed, with more people leaving the Baffin than moving into the region (see DEIS Appendix 4A, Table 7 and Figure 6). However, this net migration number is small, in the order of 150 individuals per year, or less than 1% of the total population of the region.

Other regions of Nunavut as well as the Atlantic region of Canada have consistently seen more people leave for the Baffin region than they saw arrive from the Baffin. Since 1995/96, 548 more individuals moved to the Baffin region from Atlantic Canada than returned to that region. By contrast, the Baffin region provided a net contribution of 497 people to the population of Ontario during the same period, as well as 373 to the Northwest Territories (NWT) and 383 to western Canada.

12.1.5 Family Structure

Most Inuit across the LSA live with immediate family members. Amongst non-Inuit residents, a substantial number either live alone or with unrelated individuals. In the North Baffin, 94% of Inuit live with immediate family members (i.e., in a "census family"). Only 3% live either alone or with unrelated people, with the remaining 3% living with relatives. Perhaps unexpectedly, this picture extends to Iqaluit as well. The picture for non-Inuit is rather different, with approximately three-in-four living with immediate family members, while most of the remainder either live alone—14% in Iqaluit and 21% in North Baffin-or with unrelated people-9% for Iqaluit and 6% for North Baffin.

The highest incidence of individuals living in situations where they are presumed to not have economic relationships with anyone else in their household is seen among non-Inuit over the age of 25 years. Close to one-third of these individuals are living in non-economic family settings. While this sort of arrangement is fairly uncommon in the Inuit population, there is a small group of about one-in-ten Inuit in the 25- to 39-year-old and 40+ years' age categories living in this type of setting in Iqaluit. In total, 140 non-Inuit males (110 females) and 55 Inuit males (40 females) age 25 to 39 years are living in non-economic families in Iqaluit.

This analysis does not lead to any specific conclusions related to social stability. However, it does set a baseline for monitoring the structure of households. In particular, the data provide insight into the baseline level of "unattached, young, single males" often associated with boom and bust resource developments.

12.1.6 Children in Single-Parent and Two-Parent Families

One-in-four children in Nunavut live with a single-parent, while the remaining three quarters live with two parents (see Baseline Report, Table 10). The incidence of children living in single parent families in Iqaluit is similar to this territorial average at 26%, while in North Baffin communities the rate ranges from 26% in Hall Beach and Igloolik to 20% in Arctic Bay, Pond Inlet, and Clyde River.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

In comparison, approximately 22% of Canadian children live in single-parent families, suggesting that the incidence in the LSA is in line with the national situation.

12.1.7 Language

The Inuktitut language is prevalent in North Baffin LSA communities (see Baseline Report, Table 11, Figure 8, and Figure 9). Nearly all Inuit residents of the North Baffin LSA learn this language as their mother tongue, and for nine-in-ten residents, Inuktitut is the language spoken most prevalently at home. A small portion of the population, ranging from 6% in Hall Beach to 24% in Igloolik, consists of unilingual Inuktitut speakers. Of importance, though, is the use of Inuktitut in the workplace environment. In North Baffin, nearly two-in-three Inuit work in settings where Inuktitut is the prevalent language. The lowest rate of use is in Hall Beach, at 44%, ranging to a high of 75% in Clyde River and 72% in Igloolik.

The linguistic picture in Iqaluit is dramatically different from that of North Baffin. In the capital, slightly more than one-fifth of the Inuit population did not learn Inuktitut as their mother tongue and fewer than half speak Inuktitut at home. Only 20% of Inuit in Iqaluit speak Inuktitut in the workplace and only 3% are unilingual Inuktitut speakers. It seems clear that while Inuktitut is healthy in North Baffin, it is under considerable threat in Iqaluit. Integration of Inuktitut language into Nunavut's public sector has been a goal of the Nunavut government. Results of language training of senior bureaucrats have been perceived, however, to have greatest value in demonstrating respect toward Inuit.

12.1.8 Expected Trends in the Absence of the Project

The following scenario sets out what is believed to be a reasonable expectation for future trends in key areas covered under the Population Demographics VSEC.

In the absence of the Project, the composition of the North Baffin population is expected to remain predominately Inuit. In Iqaluit the relative proportion of Inuit versus non-Inuit will depend on the success of the education system in providing students with the tools they need to successfully enter the labour market. Given the high proportion of Inuit in the student population, the potential for Iqaluit to increase the proportion of Inuit in the working aged population over time is high. However, if today's students do not become the skilled knowledge workers required by Iqaluit's major employers the capital will continue to import labour from the south.

Net migration out of the LSA may also be expected to continue in the absence of the Project. The prospect that expansion of employment opportunities within the public sector will keep up with population increase is considered to be unlikely. This may continue to drive migration toward regions of Canada where opportunities are available.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Future prospects for the Inuktitut language in the LSA appear to be good, for the near-term at least. However, various pressures on the language exist, ranging from the increasing prevalence of English-based social media such as Bebo and Facebook to the use of English as the technical language in government.

12.2 Education and Training

The following section provides a summary of baseline data that is of relevance to the Education and Training VSEC. Further detail and underlying data is provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010).

12.2.1 Early Childhood Education

Early childhood education (pre-school) opportunities are not widely available across the study area. Those that are might be available for only part of the day. Before-school and after-school programs, which are important for parents working during the day, are absent in nearly all LSA communities, except for Clyde River, where an after-school program was in place as of 2008.[2] The level of service in Iqaluit is better, with full-day and part-day preschool programs available as well as after-school programs.

12.2.2 Enrolment and Progression through School

From a population of 135 North Baffin students who started Grade 9 in 2003, just over half were still in school to begin Grade 12 in 2006. A similar progression rate can be seen for Iqaluit, while in South Baffin, three-quarters of the Grade 9 class seem to make it to Grade 12.

However, the picture may be worse than these numbers suggest. Grade 10 is the grade that youth who have previously dropped out of school can re-enter in order to try again. In North Baffin, for example, an additional 75 students enrolled into Grade 10, beyond the entry of the previous year's Grade 9 cohort. Starting from this class size of 210 students, by Grade 12 only 72 are enrolled, suggesting that 138 students dropped out along the way with only one-in-three making it through to start Grade 12. Similar rates are seen in Iqaluit and in South Baffin. The bottom line is that dropout rates in the North Baffin LSA are very high.

During the years during which Baffinland engaged in advanced exploration and bulk sample activities, the Company provided laptop computers to high school graduates of the five North Baffin LSA communities as an incentive to succeed. A total of 198 computers were provided between 2007 and 2010.

[2] Refer to DEIS Appendix 4A, Table 47.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.2.3 Grade 12 Enrolment

The number of students starting Grade 12 in Nunavut increased by 19%, from 336 to 399 students, between 2003 and 2006. There is considerable regional variation in this trend.[3] However, most of this increase has come from the Kivalliq, where an increase of 60 students was experienced. In the Baffin region, Iqaluit has shown a modest increasing trend, while enrolment in the North Baffin region declined over this period.

Not all communities in the North Baffin region share the overall declining trend in Grade 12 enrolment. While enrolment in Clyde River, Arctic Bay, Igloolik, and Hall Beach has been trending down, Pond Inlet has seen a robust increase in its high school student population.

12.2.4 Grade 12 Graduation

The number of high school graduates has been increasing both in Iqaluit and across North Baffin over the past 20 years. During the five-year period from 1992 to 1996, for example, 71 individuals in Iqaluit and 54 from North Baffin communities gained their Grade 12 diplomas. Between 2002 and 2006, 148 Iqaluit students and 182 North Baffin students successfully obtained Grade 12 diplomas. In total, 390 North Baffin and 393 Iqaluit residents have graduated from high school since 1987.

The number of male students and female students graduating in Nunavut has generally been well balanced both in Iqaluit and in North Baffin. In Iqaluit, 52% of the graduates have been males, and 48% females, while the North Baffin ratio is 50:50. In contrast, South Baffin seems to produce more female than male graduates at a ratio of 58 females per 42 males.

12.2.5 Post-secondary Qualifications and Training

While education levels are low across the study area, many residents of the RSA have been engaged in the pursuit of training and upgrading through the local college system and through various specialized programs. Arctic College, which has Adult Learning Centres in every community reports that between 1,200 and 1,350 Nunavummiut enrol in full-time programs at the college. This equates to roughly one quarter of the population between 20 and 29 years of age, or one-fifth of the 20-to-34 year old age group.

Because of the low rate of high school completion in North Baffin, a majority (62%) of the population 25 to 64 years of age has earned no formal educational credentials. However, of those who have, only a small proportion, 7%, have settled with high school—most have gone on to other programs. As a result, nearly one-third of the North Baffin Inuit population between 25 and 64 years of age have attained some post-secondary training qualification. In Iqaluit this proportion is similar.[4]

[3] Refer to DEIS Appendix 4A, Table 49 and Figure 45.
[4] Refer to DEIS Appendix 4A, Table 52.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The focus of post-secondary training varies between Inuit males and females, but is fairly consistent across the RSA. Based on data collected during the 2006 census, Inuit men acquired post-secondary qualifications in areas that fall within the "Classification of Instructional Programs" categories of "architecture, engineering, and related technologies" and "personal, protective, and transportation services fields." In the context of Nunavut, the former category would be expected to include construction trades and mechanical/repair technology, while the latter category could encompass areas such as culinary services; corrections officer/services; peace officer/police; fire protection; heavy truck driver; commercial driver; heavy equipment operation; and commercial fishing.[5]

In pursuing post-secondary qualifications, Inuit women have focused more on the fields of business, management, and public administration, social and behavioural sciences and law, and education. Some men, particularly in Iqaluit, have pursued programs focused on business, management, and public administration.[6]

12.2.6 Literacy and Numeracy

Low baseline levels of literacy and numeracy present a major challenge to labour force development in the LSA and across Nunavut. In a report on adult learning in Nunavut, the largest group of adult learners in the territory are said to be at the lowest two levels of the four-level scale used in the International Adult Literacy and Skills Survey (Government of Nunavut and Nunavut Tungavik Incorporated, 2006). As a consequence:

"The largest group of adult learners in Nunavut needs programming that focuses on literacy, life skills, completion of high school or high school equivalency, adult basic education and personal empowerment."

Similar observations are made in the 2008 Nunavut Economic Outlook (Clinton and Vail, 2008):

"Low levels of adult literacy and numeracy create additional training challenges. The task of bringing individual math and literacy skills up to the needed level must be carried out as part of training programs. In the context of construction trades programs such as that being implemented under the Nunavut Housing Trust Delivery Strategy, this is typically done by incorporating pre-trades math and science into trades training programs. This challenge has been also noted previously, where low levels of literacy and numeracy across Nunavut's Inuit population are seen to raise challenges to training by adding an extra upgrading or access step to the training process."

12.3 Livelihood and Employment

The following section provides a summary of baseline data that is of relevance to the Livelihood and Employment VSEC. Further detail and underlying data are provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010), and, in relation to indirect job creation, in DEIS Appendix 4B (Howe, 2010).

[5] Statistics Canada 2000: Classification of Instructional Programs. See Catalogue 12-590-XIE for a full list.
[6] Refer to DEIS Appendix 4A, Table 53 and Figure 47.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.3.1 Importance of the Land-based Economy to North Baffin Livelihoods

The land-based economy is a major component of the livelihoods of many residents of the LSA, particularly in North Baffin. The North Baffin land-based economy generates productive, but unpaid, work equivalent to 356 full-time jobs on an annual basis, or approximately one-third of the labour demand from the formal wage economy in the region. This amount of work roughly translates to 600,000 hours of labour.

The harvest effort of residents of the five North Baffin LSA communities is estimated to yield approximately 830,000 kilograms of food. The cost to purchase an equivalent amount of imported foods through local retailers is estimated at $12 million. This is the in-kind value to households of harvest activity in the land-based economy. Since retail foods are subsidized through the food mail (and now through the Nutrition North) program, the "economic value" of the land based harvest should take this into account. This leads to a total economic value of the land-based harvest of approximately $20 million.

12.3.2 Demand for Labour in the LSA Wage Economy

The current amount of work opportunity generated by the wage economies of the study area amounts to the equivalent of 3,700 to 3,900 full-time, year-round jobs, of which 1,100 are located in North Baffin and 2,600 to 2,800 in Iqaluit.[7] This equates to approximately 2 million hours of work in the North Baffin, and 4.7 million hours of work in the Iqaluit labour markets each year.

The number of jobs occupied by women has generally increased at a greater rate than those occupied by men. In North Baffin, the growth in demand for male labour has not kept pace with the growth of the Inuit male population. In Iqaluit, male-occupied job growth and Inuit male population growth rates appear to be increasing at similar rates. The jobs occupied by women are more narrowly concentrated in public sector industries. While these sectors might be fairly stable in terms of boom and bust cycles, they are less likely to experience dramatic growth, suggesting that women coming into the labour market may need to find work in sectors not traditionally filled by women.

In terms of the skills required by the LSA labour market, approximately 18% of occupations in North Baffin, and 21% in the Iqaluit labour markets require a university education. One-quarter to one-third of occupations in the study area require college or apprenticeship levels of training and skills. A similar number of occupations require high school education and/or occupation-specific training. The remainder of jobs can be accessed by unskilled workers capable of undertaking on-the-job training.

[7] Refer to Section 4 of DEIS Appendix 4A for details related to the LSA labour market.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.3.3 Supply of Labour to the LSA Wage Economy

A total of 2,255 North Baffin residents worked to "fill" 1,100 North Baffin jobs, a rate of 2.0 workers per "job." In Iqaluit, 3,665 individuals worked to "fill" the 2,600 to 2,800 "jobs" in that labour market, a rate of 1.3 to 1.4 workers per "job." Looked at from another angle, wage-earners in North Baffin deliver some 1.7 to 2.0 million hours less than they would if they were all working full-time, full-year. Wage earners in Iqaluit deliver 3.0 million hours less than they would if they all worked full-time, year round.

Demand amongst residents for wage employment in the study area is very high, even when this work requires working in remote locations away from the community. For example, one-in-five working-age residents in North Baffin, and one-in-six in Iqaluit applied for work with Qikiqtaaluk Logistics (QL) at some point during the three-year period between 2007 and 2009.

Inuit employment in North Baffin is characterized by many individuals earning small levels of income, well under what full-time work would pay, and a small number earning full-time, year round income levels. The picture of Inuit employment in Iqaluit suggests a blend of work patterns with many individuals earning small wage income and many earning full-time wage levels. Most residents working in full-time jobs in Iqaluit work these jobs year-round. In North Baffin, many more full-time workers are engaged in these jobs for only short periods. The highest rate of short-term employment among full time workers is seen among the younger North Baffin male workforce. Women who work full-time jobs in North Baffin are more likely to work year round than are men.

12.3.4 Supply of Labour during Exploration and Bulk Sample Activities

A total of 1.3 million hours of fly-in/fly-out labour was delivered to exploration and bulk sample activities by 776 workers from across Canada over a three year period. Of this labour, 400,000 hours were provided by 265 North Baffin residents, and 212 residents of Iqaluit. Women accounted for 11%, of the total number of people involved at the Project. During peak activity in 2008, a total of 800,000 hours was worked at the Project, of which 200,000 hours were provided by residents of the LSA.

Approximately four-in-six workers hired from North Baffin worked for at least three rotations of two weeks in, followed by two weeks back home ("two in/ two-out"). A substantial number of those hired, one-in-five, did not manage to complete one full fourteen day rotation. Among workers hired from Iqaluit, one-in-eight did not complete one full rotation.

Exploration and bulk sample activities did not "tap out" the labour force of the study area. Both the North Baffin and Iqaluit labour forces were able to continue supplying new workers throughout the three year period for which data was analyzed.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.3.5 Sources of Income

In addition to the $12 million in-kind income generated for North Baffin households through harvest activities in the land-based economy, residents of the LSA gain monetary income through employment and various social transfers. In 2007 the personal income reported by residents of the five North Baffin LSA communities and Iqaluit amounted to $83 million and $196 million respectively.

Personal income in North Baffin is comprised primarily of income earned from labour activities and government transfers. Among the resident Inuit population, earned income accounts for between 70% (Clyde River) and 81% (Pond Inlet) of total income. Most of the remaining income, ranging from 17% (Pond Inlet) to 27% (Clyde River) is derived from government transfers. Other income, such as investment income, accounts for less than 3% of total income. In Iqaluit, the role of government transfers is much lower than in North Baffin LSA communities, accounting for only 8% of the total income of the Inuit population of the city.

12.4 Economic Development and Self-Reliance

The following section provides a summary of baseline data that is of relevance to the Economic Development and Self-Reliance VSEC. Further detail and underlying data is provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010), and in the Economic Impact Report, DEIS Appendix 4B (Howe, 2010).

12.4.1 Size and Composition of the Nunavut Economy

Government Sector

The public sector accounts for a large portion of Nunavut's economic activity. Public administration accounted for $271 million, or 24%, of the territory's total $1.1 billion GDP in 2008 (GN Department of Finance, 2010a). Education and health expenditures account for another $202 million. Combined, these public expenditures account for 42% of the territory's GDP. Publicly funded construction activity—social housing, and various public infrastructure—further bolsters the contribution that arises from the public sector.

The GN Department of Finance (2010a) notes that public sector jobs in administration, education, and health areas account for about half of all earnings in the territory. As observed by the Conference Board of Canada (2010) this large public administration sector provides stability to the territory's economy. In the study area, this will particularly be the case in Iqaluit. In the LSA, the communities of Igloolik and Pond Inlet can be expected to be more insulated from economic ebb and flow in the private sector since these communities have a significant number of decentralized government jobs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Mining Sector

Nunavut's mining sector is once again expanding following the closure, in the previous decade, of the Nanisivik and Polaris mines in the Baffin Region and the Lupin and Jericho mines in the Kitikmeot Region. The recent opening of the Meadowbank Mine outside the study area in the Kivalliq region is expected to begin contributing over $90 million to Nunavut's GDP now that it has entered production (GN Department of Finance, 2010a). Medium-term prospects for expansion in the sector include Newmont's Hope Bay development in the Kitikmeot, and AREVA Resources' Kiggavik Project in the Kivalliq region.

The Mary River Project is the only Project In the LSA that has progressed to the point of having a Project description and definitive feasibility study completed. Exploration activities have been taking place at Roche Bay, and early exploration activities are being carried out by Peregrine Diamonds in the South Baffin Region, particularly at their Chidliak Property. A number of exploration activities mostly related to diamonds are at a very early stage of exploration.

A major challenge for the territory is to develop the labour force and entrepreneurial capacity to participate in the economic activity generated by the mining sector. The Conference Board of Canada (2010) points out that the shortage of skilled workers is expected to lead to local workers filling between 15% and 20% of Meadowbank jobs. Major investments in training will be required to improve these numbers.

The Nunavut Government (GN Economic Development and Transportation, 2005) formally recognizes the potential for the mineral sector to contribute to sustainable community development and the requirement that communities, government, and the mining companies work effectively together to achieve this potential. For example, the following statements are made under "Pillar 2 Community Benefits" of the territory's strategy for mineral exploration and mining:

"The mineral exploration and mining industries have the potential to contribute significant and sustainable benefits to Nunavummiut, including infrastructure, jobs, education, skills, career development and local business opportunities."

"Economic development, however, also has the potential for negative socio-economic impacts, which could include wealth mismanagement, loss of traditional lifestyle, and increased stress on already struggling community social infrastructure."

"It is essential that strong and functional relationships between developers, government and communities be established to manage impacts and maximize benefits, and to ensure that the development of Nunavut's mineral resources is beneficial to all Nunavummiut."

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Construction

The construction industry in Nunavut is driven by a combination of government-funded infrastructure Projects and major private sector developments such as the Meadowbank mine. Construction at Meadowbank peaked in 2008, contributing some $250 million to territorial GDP that year. Residential construction is also an important component of the construction sector. For example, residential construction in Iqaluit varied between $33 million and $53 million from 2006 to 2009 (GN Department of Finance, 2010a). For the 2010/11 fiscal year, a total expenditure of some $111 million is envisioned in the territorial government's capital expenditure plan, with another $23 million in capital Projects funded jointly by the territorial government and various third-party funders (GN Department of Finance, 2010b).

Planned capital expenditures for the LSA total $32.3 million for the five-year planning period, 2010/11 to 2014/15, while a similar amount of $33 million is planned for Iqaluit. Across the territory, a total of $381.6 million in capital expenditures is envisioned.

Transportation

Transportation sector provides a critical link between Nunavummiut in small communities to the specialized medical and educational services that are only available in larger centres. For the 2010 to 2011 fiscal year, for example, the territorial government has budgeted $47.9 million for medical travel, an expenditure item that has increased at a rate of 6.9% year-over-year, from a level of $32.6 million in 2005/06.

The Department of Finance (2010a) notes that imports of goods into Nunavut by air and marine transport totalled $900 million in 2008, and comments that the Iqaluit airport moved into the top 20 busiest airports in Canada, based on the number of flights. In spite of the tremendous importance of air and marine transport, the sector is largely based outside of the territory. As a result, transportation contributes less than $21 million to the territorial GDP.

Locally, snow machines, ATVs, and small boats are important components of the transportation sector. These permit harvesting of country food and inter-community travel along well-used traditional travel routes.

The high cost of transportation means that many Nunavummiut face limited mobility options. For example, ownership of snow machines, ATVs, or boats is out of reach of those who are solely dependent on social assistance. Passenger airfares, typically in the $1000+ range, are also well beyond reach. As a consequence, for many Nunavummiut medical travel or other publically-provided travel becomes the only means to get out of town.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Renewable Resources

Nunavut has a small commercial fishery based on turbot and shrimp that is fished offshore primarily in Baffin Bay and Davis Strait. Nunavut's share of this fishery has grown significantly during the past half decade. Turbot quota allocated to Nunavut interests totalled 9,350 tons for the 2010 season, up from 5,326 tons in 2005. This increased quota has come as a result of concerted efforts by Nunavut industry and government officials to influence federal decisions related to stock allocation. In addition to gaining access to the resource, and the "royalty" value inherent in this access, the territory has worked hard to maximize the value of this fishery to Nunavummiut through ownership of fishing vessels and supply of labour. These offshore products enter the market as commodities.

In addition to the offshore fishery, some commercial char production is carried out at plants in Pangnirtung, Iqaluit, Rankin Inlet and Cambridge Bay. Although the economic value is modest, the quality of this product is high and potential for value-added processing and marketing, including supplying the local Nunavut market where high retail food prices are the norm, continues to be realized. A modest commercial caribou and musk ox harvest is also carried out, the former predominantly from Coral Harbour and the latter from Cambridge Bay. As with the char fishery, these products high value specialties that sell for premium prices. Recent changes in the federal food subsidy program (Food Mail) might facilitate intercommunity trade of these commercial products in the territory.

Given the importance, and precedence under the Nunavut Land Claims Agreement (NLCA), of the traditional non-commercial harvest of these species, the potential for expansion of commercial fish and wildlife operations is subject to inherent biological limitations.

Tourism, Arts, and Cultural Industries

Most visitors to Nunavut come to the territory in the course of their work activities. These business travellers are estimated to account for approximately three-quarters of all tourists[8] to Nunavut. It is thought that between 3,000 to 6,000 visitors come to the territory each year for purposes not related to their work and that this component spends between $6 to $12 million annually (see GSGislason and Associates, 2005).

Among these expenditures, an estimated $4 to $8 million is allocated to non-hunting tourism-related expenditures, of which no more than 10% to 20%, or an average of $100,000 per year, would be spent in these smaller Nunavut communities.[9]

[8] It is common to include business travelers within the broad "tourist" category. Their expenditure pattern is similar to that of other visitors—hotel accommodations, food, transportation, purchase of souvenirs and gifts.

[9] GSGislason and Associates (2005) considered seven communities ranging from Pangnirtung and Pond Inlet to Kugaaruk and Repulse Bay. They note that Pangnirtung would attract the largest expenditures.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Applied to the five North Baffin communities, this would lead to a total estimate of some $500,000 allocated each year across the LSA to tourism outside the business travel and sport-hunting areas. In addition to spending by tourists who come to visit friends and family living in the north, these expenditures would also include those of cruise ship visitors, visitors to the national park, and adventure tourists.

An estimate of the value of cruise ship tourism is suggested from the Arctic Bay Community Economic Development (CED) Plan (Hamlet of Arctic Bay, 2007) which noted three cruise ship visits in 2006 with between 20 and 100 passengers coming ashore with each ship, and spending an average of between $70 and $100 each. This leads to a total local expenditure in the neighbourhood of $15,000 from the cruise ship sector for one community.

As noted frequently over the past decade, tourism in Nunavut is characterized more by its "potential" than its current reality.[10] The Hamlet of Arctic Bay (2007) CED Plan notes that in addition to the three cruise ships, there were also, in 2006, six sport hunters. The plan implies that visitors who come for business purposes may be the real target for generating increased revenues: "There are no tourists per se that really come to Arctic Bay, mostly business people, government officials, contractors, doctors, dentists and optometrists." The plan goes on to note that "There aren't any tours offered through the hotel. There aren't any tour guides and again, this should be developed with the ever-growing potential tourism market in Nunavut." The potential that one or two-day packages that start from the hotel might be developed and marketed is recognized by local governments and the GN.

The market for local arts and crafts created by visitors is an important benefit of the tourism sector. This is true both for business travellers as well as for those engaged in some form of recreational tourism. A challenge for artists is to build up inventory that is adequate to meet demand. This can be particularly challenging in relation to cruise ship visits, when several hundred passengers may come through the community over the course of a few weeks.

12.5 Human Health and Well-Being

The following section provides a summary of baseline data that is of relevance to the Human Health and Well-Being VSEC. Further detail and underlying data is provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010).

[10] For example, Clinton and Vail (2008), suggest the "tourism industry remains largely undeveloped." The Department of Finance (2010a) suggests "tourism has sizeable potential to add value."

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.5.1 Population Health Status

Life Expectancy

Life expectancy at birth in Nunavut is ten years shorter than it is for the Canadian population overall. Over the three-year period between 1999 to 2001 life expectancy at birth in Nunavut was 68.7 years (GN Health and Social Services 2004). This indicator has ranged from 67.5 years during the early 1990s to 70.4 years in the mid-1990s. In comparison, life expectancy at birth across the overall Canadian population has increased steadily from 77.9 years during the early 1990s to 79.3 years by the beginning of the new millennium, and to 80.3 years as of 2007 (CIA, 2007). Life expectancy at birth in Nunavut is only slightly lower than that of Greenland, which was 70.2 years in 2007.

Life expectancy at age 65 is fairly similar among the male populations of Canada and Nunavut. In Canada, men age 65 can expect to live an additional 17.1 years on average, while men in Nunavut have a life expectancy of an additional 16.3 years. For women, however, the picture is much different. Canadian women age 65 can expect to live an additional 20.6 years while in Nunavut, women's life expectancy at age 65 is only 11.4 years, on average.

Birth Rate

In Nunavut the birth rate is roughly twice that of Canada generally, and has remained consistent for the period between 2003 and 2006. In the year 2005–2006, for example, the rate in Nunavut was 23.5/1000 whereas in Canada for the same year the birth rate was 10.8/1000. As noted by the Conference Board of Canada (2010), Nunavut's high fertility rate will more than make up for net migration out of the territory, leading to continued population growth into the future.

Infant Health and Mortality

The incidence of both pre-term delivery and low birth weight are both high in Nunavut relative to Canada overall. One in 10 births in Nunavut (10.4%) are pre-term. The incidence of low birth weight (under 2,500 g) births in Nunavut between 1991 and 2003 is between 6.7 and 8%. This is slightly higher than the rate of 5.7% for Canada overall.

Nunavut's infant mortality rate has been improving. During the period from 1991 to 2001, the number of infants who die before their first birthday has declined from a rate of 18.3 infant deaths per 1,000 live births, to 13.9, an improvement of 24% over 10 years. However, these rates continue to be much higher in Nunavut than in other regions of Canada. In 2001, for example, the Nunavut infant mortality rate of 15.6 per 1,000 births was 3½ times the Canadian rate of 4.4. The comparable rate for the NWT was 4.9 and for Yukon was 8.7. It is noted that the current rate of infant mortality in Greenland is quite similar to that of Nunavut, at 15 deaths per 1,000 births. Globally, infant mortality rates vary widely, ranging from lows below 3 in countries like Singapore, Sweden, and Japan, to over 75 in various poor tropical countries and more than 150 in some war-torn regions of the world. The median rate among 221 countries is 20 deaths per 1,000 births (CIA, 2007).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Self-Assessed Health Status

Middle-aged men in Nunavut perceive themselves to be experiencing significant health issues more frequently than their peers across Canada and more frequently than women of a similar age in Nunavut. On a territory-wide basis, more men than women reported "health problems that limit activities or participation" in the 2005 Canadian Community Health Survey. The difference in this perception of health between the sexes was small among the 12 to 19 and 20 to 34 years age groups. However, among those age 35 to 44 years, more than 40% of men reported some activity-limiting health problem, compared with fewer than 15% of women in this age group.

Cause-of-Death and Death Rate

The major causes of death in Nunavut are cancer, suicide, heart disease, and accidents. Cancer accounted for 23% of territory deaths in 2004, while suicide made up 20%. Heart and other cardiovascular diseases accounted for 17% of deaths in that year, and accidents were responsible for another 12%.

The profile of causes of death in Nunavut differs from that of Canada overall, where cancer and cardiovascular disease is of greater importance, accounting for 30% and 32% of deaths. Suicide is much less important nationally, accounting for only 2% of deaths in 2004.

However, Nunavut has a very young population. It is known that the rate of cancer increases with age and that most suicides are committed by the younger segment of a population. To gain insight into what the cause-of-death can tell us about Nunavut's population behaviour, it is necessary to separate out the influence of the territory's age profile.

Age-standardized death rates for provinces and territories reported by Statistics Canada (2004) can be used to compare death rates in Nunavut's young population with those of the aging Canadian population. These transformed data allow the following observations to be suggested:

On an age-standardized basis the proportion of deaths by suicide in Nunavut is nearly four times that of Canada.

- Transportation-related deaths are more than twice as common in Nunavut as in Canada
- Cancer accounts for a slightly higher share of deaths in Nunavut than in Canada
- Heart and other cardiovascular disease account for a lower share of deaths in Nunavut
- Other causes of death account for a greater share of deaths in Canada than in Nunavut.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.5.2 Social Issues Related to Health and Well-being

Alcohol and Drugs in the LSA

The use of alcohol is considered a serious issue across the territory due to its link with domestic abuse, violence, fetal alcohol effects, and impacts on the local economy. Interview data from community members, frontline workers and health officials in the Baffin region reveal that spousal assaults, violence, and numbers of children in care are often linked to alcohol abuse. For this reason, many communities have chosen to put controls on legal access to alcohol.

There are three distinct approaches to alcohol access across Nunavut. Iqaluit is an "open" access community where alcohol can be ordered by individuals for personal use and where one can walk into a bar and buy a drink. Other communities have voted to legally designate themselves as "dry" communities where no alcohol is allowed. While these alternatives represent the opposite ends of the spectrum in terms of access to alcohol, the most common policy for communities across the territory is a "restricted" alcohol policy, requiring residents to apply to bring in wine, beer or spirits.

In the Baffin region, Iqaluit is the only "open" community, while Kimmirut, Pangnirtung, and Sanikiluaq are the only "dry" communities. The rest of the region consists of "restricted" access. The five communities of the North Baffin LSA each have policies in place to restrict access to alcohol. Residents in each case apply to a local Alcohol Education Committee (AEC) with their requests for wine, beer, or spirits. The amount of alcohol allowed depends on the community.

Quantitative data related to alcohol and drug use in the LSA was not available. Across Nunavut's legal alcohol sector, beer is by far the drink of choice. NLC sales by volume are as follows: 87% beer, 7% spirits, 4% wine, and 2% coolers.[11] It is expected that the bootleg sector focuses more on spirits, with vodka being an important segment of this market.

Incidents of Reported Crime

The rate of violent crime in Nunavut is the highest across Canada, varying from between six and eight times the national rate during the period 1999 to 2007. The incidence of total reported crime ranks second, behind the Northwest Territories, and has been four to six times the national rate.

The rate of violent crime across the LSA has been essentially stable over the past decade. Violent crime has been particularly high in Iqaluit, at an incidence rate of 100 per 1,000 population, ten times higher than the national average of 10 per 1,000 people. The rate of violent crime across the North Baffin LSA has been slightly over half the rate in Iqaluit, or five times higher than the rate of violent crime experienced in the Canadian population generally.

[11] Nunavut Liquor Commission, personal communication, 2010.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

A territorial breakdown of crime incidents provides insight into the nature of this violence. The rate of sexual assault across the territory reached a peak in 2003 at 10 per 1,000 population—well over ten times the national rate. While rates of sexual assault continued to be high into the later part of the decade, a significant decline has been noted, with the 2008 rate of 6.7 being the lowest of the ten years for which data were available.

The rate of other assaults, including domestic violence, also peaked in the mid-2000s. The slight decline in 2005 and 2006, however, appears to be losing ground with rates in 2008 setting a new high of 67.8 per 1,000. Disturbingly, assaults with weapons and those causing bodily harm have increased consistently and dramatically over the decade. The 2008 rate of 11.7 per 1,000 was nearly 350% higher than the 1999 rate.

Accidents and Unintentional Injury

Potential years of life lost (PYLL) amongst the male population across Nunavut is 3,465 per 100,000 population per year. The corresponding rate for Nunavut women is 673 per 100,000 population. This is the equivalent of roughly 110 PYLL per year for men and women due to unintentional injury in the North Baffin LSA and 140 PYLL in Iqaluit.[12]

Workplace injury frequency is measured in days of work lost or modified. In the Nunavut/NWT mining sector an average of 27 days of lost/modified work is experienced per 200,000 hours of labour supplied. Over a three-year period these territories experienced one workplace fatality, which could be equivalent to up to 60 PYLL.[13]

Housing

Across the communities of the North Baffin LSA, approximately four-of-six people live in social housing. In Iqaluit, only one-in-six people live in social housing.[14]

The amount of rent paid by social housing tenants varies across the LSA. Two-thirds of tenants in Igloolik pay $60 per month, while in Hall Beach the rate is less than half this level. Hall Beach is also the community with the highest proportion of social housing units being assessed $1,000 or more per month. Clyde River and Pond Inlet also stand out as communities with relatively more tenants paying rents at the higher scale.

[12] Refer to DEIS Appendix 4A, Section 6.5.1, "Injury in the Community."
[13] Refer to DEIS Appendix 4A, Tables 60 and 61.
[14] Refer to DEIS Appendix 4A, Table 76.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Insight into the level of inadequate housing can be gained from the waiting list for housing. In the LSA communities between 4% to 6% of the population is living in housing arrangements that are sufficient to motivate individuals to maintain an active application for improved housing and to be approved for inclusion on the waiting list. Criteria for inclusion involves a blend of factors ranging from housing standards related to numbers of people per room, and to the placement of children over the age of five into separate bedrooms, as well as to other factors such as personal safety and multiple generations of families living in the same unit.

The waiting list is highest in Clyde River and Arctic Bay and lowest in Iqaluit. In Igloolik and Pond Inlet, the population living in inadequate housing has been stable over the past few years, while in other communities it has been edging upward. After a jump in Clyde River toward the end of 2007, new construction has served to bring the waiting list more in-line with other communities.

Household Income

The level of income of households in across the LSA is influenced tremendously by the configuration of the household structure.[15] Lone parent (single parent) families have income levels that are substantially lower than those of couple (two parent) families. In four of the five communities of the North Baffin LSA, the median income of lone-parent families ranged between $19,760 (Clyde River) to $23,830 (Igloolik) in 2007. The median income in Hall Beach was substantially higher, at $28,930 in that year. This contrasts with a median income for this household configuration of $42,390 in Iqaluit, a level twice that of Arctic Bay and Clyde River, and substantially higher than the other communities of the LSA.

Two-parent families appear to be better off, financially. The median income of these households ranged between a high of $66,440 (Pond Inlet) to a low of $48,400 (Clyde River). Again, the picture in Iqaluit is one of much higher incomes, at a median of $104,730 in 2007.

Couple families have also improved their financial position at a greater rate over the past decade than have lone-parent families, in most cases. The 2007 median incomes for Arctic Bay and Clyde River couple families increased at twice the rate as those of lone-parent families in these communities. Couple families in Pond Inlet fared even better, with median incomes of this group nearly doubling while lone-parent families in this community experienced less than a one-third increase.

The situation in Hall Beach and Igloolik is different, with more narrow differences between couple families and lone-parent families. A similar situation is seen in Iqaluit where the rate of increase of median income of lone-parent families kept pace with that of couple families, though, as previously noted, at a much lower level.

[15] Refer to DEIS Appendix 4A, Section 7.3.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Children Living in Lone-Parent Families

The number of children living in lone-parent versus couple parent family situations is a relevant indicator of the economic well-being of children in light of the significantly lower incomes experienced by lone-parent versus couple parent families. The rate of children living with a single parent is generally similar to the Canadian rate of 28%, ranging from a low of 14% in Arctic Bay to 31% in Pond Inlet. The picture in Hall Beach is a little different, with four-in-ten children living with a single parent. In Iqaluit nearly half of all children live in a lone-parent setting. Generally, the proportion of children in lone-parent settings has increased during the past decade. Arctic Bay is an exception, where there has been a modest decline.

Income and Gender

The distribution of income among men and women provides some insight into the economic structure of households. Who is bringing in the income? There is also a reasonable expectation that the individual who brings income into a household is going to have some greater degree of influence over decisions about how this income is allocated.

Across North Baffin, women have somewhat less income than men, ranging from a low of about two-thirds that of men, in Arctic Bay, to slightly more than 45% of what men have in Igloolik and Pond Inlet. Generally, the proportion of income reported by women has increased over the past decade or so. The most dramatic changes have been in the communities of Igloolik and Pond Inlet where the proportion of income reported by women has increased from 38% in the mid 1990s to 47% and 45%, respectively, in 2007. This increase in income to women can be explained by the decentralization of territorial government positions that occurred between 2000 and 2002. During this short period, the proportion of income to women jumped by 5% in these communities. Women in Iqaluit also reported some 45% of total income, although in this location the rate of increase has been modest, increasing only 2% from a level of 43% in 1995.

Most of the increase in income among men can be accounted for by an increase in the number of individuals reporting incomes of $75,000 or more. In the North Baffin communities, this number grew from under 20 to more than 170 over the past decade.[16] Among women, growth in income can be accounted for by a doubling of the number of individuals reporting incomes in the $15,000 to $35,000 range as well as the emergence of a significant number reporting incomes of $75,000 or more. Before 2002 the number of high income earning women was negligible. The situation in Iqaluit is similar, with most of the growth in income being accounted for by an explosion of both men and women earning incomes above $75,000. Again, however, there has been a significant growth in women earning lower income levels, in this case, at the $35,000 to $75,000 level. This latter group presumably relates to those in the clerical and other modest paying jobs generated by the Iqaluit economy.

[16] Refer to DEIS Appendix 4A, Table 81, Table 82, Figure 54 and Figure 55.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.5.3 Food Security

The fundamental importance of wildlife as a key food source was made during many public meetings and in other sessions with the HTOs and other community groups. Across the North Baffin LSA, an estimated 830,877 kg of edible food is harvested each year. This equates to approximately 150 kg of harvested edible food per person. By way of comparison, at the time of the Nunavut Wildlife Harvest Study (Priest and Usher, 2004), the purchase of "nutritious, perishable foods" from local retailers totalled approximately 165 kg per capita in 1999. It is clear that country food is a critical component of the diet for many households in the North Baffin LSA.

Some limited research on nutrition in North Baffin households has been carried out. A study commissioned by the federal government under the former food mail program estimated that country food accounted for over half of the protein, and more than one-third of Vitamin A consumed by residents of Pond Inlet in 1997. At the same time, this source of nutrition added only 6% of sodium and less than one-quarter of the saturated fat of local diets—supporting the widely-held understanding that country foods are superior from a nutritional point-of-view.

Insight into the per capita consumption of retail foods can be gained by considering the level of foods shipped to local retailers. Nutritious perishable foods have been highly subsidized through the federal government's food mail program (now the Nutrition North program), which offsets the high cost of air transport. Records of food shipments indicate that the amount of nutritious, perishable food shipped per person to the North Baffin LSA has increased steadily since 1999. During the decade, the total per capita shipments, presumably equal to per capita consumption of these store-bought foods, has increased by 52%.[17]

This observed increase in per capita retail food consumption would be consistent with an increasing reliance on retail foods to meet household nutritional requirements. While updated harvest data are not available,[18] a reasonable expectation is that the per capita harvest of country food is decreasing. This does not, though, imply that the total harvest has declined, since population growth has been robust over the same period.

A consequence of increasing reliance on retail foods is that the importance of household income in food security is also increasing. A positive relationship appears to exist between increasing income reported by women and the amount of nutritious, perishable foods purchased from retailers. This relationship does not extend to income reported by men, possibly suggesting gender differences in household spending decisions.[19]

[17] Data for "nutritious, perishable foods" is from Canada Post records of Food Mail A shipments to retail and individual customers in the five LSA communities.

[18] The NWHS has not been repeated and its data is now more than a decade old.

[19] This analysis is based on community-level rather than household-specific data (which was not located). It should be considered indicative only. Further investigations into household expenditure and decision-making would be useful here.

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

12.6 Community Infrastructure And Public Services

The following section provides a summary of baseline data that is of relevance to the Community Infrastructure and Public Services VSEC. Further detail and underlying data is provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010).

Public investment in public infrastructure typically arises from government sources. Nunavut is composed of 25 communities which are, with the exception of Iqaluit, incorporated as hamlets. With no tax base, the hamlets are dependent on contributions provided by the territorial government. These allow them to deliver such local programs and services as:

- general government services
- general works
- protective services (e.g., bylaw enforcement, emergency planning)
- transportation (road maintenance, access roads)
- building maintenance
- utilities (water, sewage)
- recreation facilities and program coordination
- land administration
- community planning administration.

Iqaluit was incorporated as a city in 2001 and raises revenue from its business and residential tax base. Given the small size of this tax base, equalization grants are provided by the territory to help the city maintain programs and services.

Per capita value of municipal infrastructure across the North Baffin LSA ranges from $12,475 in Igloolik to $25,958 in Arctic Bay. Generally, the per capita values are higher in the smaller communities, reflecting the high cost of basic infrastructure required to support the community, regardless of its population. Essential infrastructure and services in the LSA includes water and sewage treatment facilities, water and sewage trucking services, public roads to provide access to houses for water and sewage haulage. Power generation and fuel storage are also essential services that require dedicated infrastructure.

Additional Infrastructure to support community economic and social well-being is also needed. This may include harbours or docks, recreational facilities, training and educational facilities, youth drop-in centres, community centres, access roads. Across the LSA and RSA, this level of infrastructure is often considered to be inadequate to meet local demand for services.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

These infrastructure gaps are frequently suggested as presenting important barriers to business, social, and cultural development in communities across the LSA. Hamlet CED plans, for example, call for many types of infrastructure: space for small businesses, workshop space for carvers, visitor centres, fish plants, swimming pools, day cares, youth centres, healing centres.

12.7 Contracting And Business Opportunities

The following section provides a summary of baseline data that is of relevance to the Contracting and Business Opportunities VSEC. Further detail and underlying data is provided in the Socio-economic Baseline Report, DEIS Appendix 4A (Brubacher Development Strategies, 2010), and in the Economic Impact Report (Appendix 4B) (Howe, 2010).

12.7.1 Local Business Profile

The business community of the LSA is small, reflecting the small populations and low income levels of these communities. This is particularly the case in the North Baffin LSA communities, where two dozen businesses are registered with NTI as Inuit firms, and/or with the *Nunavummi Nangminiqaqtunik Ikajuuti* (NNI) program as Nunavut firms. The business sector in Iqaluit is substantially larger, with a total of 129 enterprises registered with either or both of these registries.

In addition to these are a number of businesses that have not registered either with the NTI or the NNI programs. These generally include enterprises such as local bed and breakfasts, taxi services, outfitters and others. As an example, while there are seven businesses from Arctic Bay registered with NNI and/or NTI, the Arctic Bay Economic Development Plan (2007) identifies a total of 26 local businesses. A total of 25 local businesses are identified in the Pond Inlet CED Plan (2010), compared with the 11 listed with either or both of the registry schemes.

Self-employment is an important indicator of entrepreneurial capacity, as it can be a stepping-stone toward larger-scale business activities. The level of self-employment across the RSA is fairly low, as is the amount of income earned through self-employment activities. In 1996 a total of 270 Baffin residents reported some income from self employment business activities. By 2004, this number had increased to 410 individuals. Most (six out of ten) of these self-employed entrepreneurs live in Iqaluit, with the remaining 40% being distributed across the other Baffin communities. In the North Baffin LSA, approximately 70 individuals earned self employment income in 2004.

Most North Baffin LSA residents reporting self-employment income earned less than $5,000 through their business activities. In Iqaluit, self-employment earnings are a little higher, with half of self employment income earners reporting more than $5,000, and one-in-five reporting $35,000 or more.

One-in-four self-employment income earners in Iqaluit had family incomes with no other source of market income. Most people, however, who report self-employment income live in families where there is also wage income being earned. This other income can be substantial. In Iqaluit in 2004, 100 of the 240 self-employment income earners, or 42%, had family wage incomes of $85,000 or more. In the rest of the Baffin Region, a similar proportion of self-employment earners (24%) have no

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

other family wage income. However, in these communities, the level of other family wage income is lower, with only 41% of families having wage incomes of $35,000 or more.

These data suggest that employment income plays an important role as a "spring-board" to self employment. While a few families rely on self-employment as their main source of income, it is more common that self-employment activities are nurtured by the wage employment earnings of either the self-employed person or a family member, or both. This pattern appears to be stronger in Iqaluit than it is in the other communities of the Baffin region.

12.7.2 Capacity to Capture Business Opportunities

The ability of local business to take advantage of the opportunities presented by a major Project such as the Baffinland Project is an important issue. This is particularly the case for smaller businesses and sole proprietorships. In the absence of intentional and proactive measures there may, in the end, be little progress made. In a study carried out for the Government of Nunavut just before the Nanisivik mine closure, (see Brubacher and Associates, 2002) a local hamlet leader perceived that there were some lost opportunities with Nanisivik:

"Nanisivik has had relatively little impact on the local business community. Things could have been different. The mine should have been more visible in the community so opportunities would be known."

Clearly, the achievement of community economic development goals doesn't happen simply because an opportunity arises. Achievement of these goals requires work on the part of many different people and organizations.

12.7.3 Supply of Goods and Services to the Mining Sector

During the course of exploration and bulk sample activities, from 2006 through August 2010, a total of $49.7 million worth of goods and services was procured by Baffinland from vendors based in the North Baffin LSA and Iqaluit. Of this amount, $10 million was purchased from businesses based in the North Baffin LSA and $39.9 from vendors based in Iqaluit. These expenditures accounted for 3% and 11% of total procurement, respectively (see Table 12-11: Characterization of River Systems in the Project Area, below).

12.8 Cultural Resources

Archaeological studies were conducted in field seasons in 2006, 2007, 2008 and 2010. A more detailed summary appears in DEIS Appendix 4D. Areas assessed for the presence of cultural resources have included the Milne Inlet Tote Road and associated borrow areas, Milne Port, the Mine Site, the proposed Railway between the Mine Site and Steensby Port, proposed camps and quarries along the Railway, and proposed port and rail infrastructure at Steensby Port. In addition, high resolution coastal shoreline photographs of Milne Inlet and Steensby Inlet were reviewed by a licensed archaeologist to identify archaeological sites to provide a regional context (Appendix 4E).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Figure 12.1 shows the areas surveyed and identified archaeological sites from all these activities, at a 1:1,000,000 scale. Detailed figures showing archaeological sites in relation to the Project have been submitted confidentially to the Department of Culture, Language, Elders and Youth (CLEY).

The sites recorded contain a variety of stone features, including circles that probably represent tent rings, caches, traps, cairns and Inukshuit as well as more recent features such as wood cabins and modern artifacts such as a plastic sled runner. The remains found throughout the study area cover a long period of occupation from the earliest Arctic Small Tool Tradition (up to 4500 years old) to the present. Some of the sites contain remains from a variety of stone tools and by-products of their manufacture. Several artifacts that may be attributable to the Arctic Small Tool Tradition have been recovered.

Mitigation measures implemented and proposed have included systematic data recovery (SDR), including detailed mapping and excavation, as well as staking and flagging or roping off sites to facilitate their avoidance.

These investigations have established that this general area has seen substantial degrees of use throughout the human past. Both Milne Port and Steensby Port have revealed high densities of archaeological remains indicating repeated use both now and in the past. The presence of large numbers of sites in the Phillips Creek valley has confirmed its importance as a travel corridor to the interior for a considerable time. No sacred places or burial sites were found. The knowledge gained from this work has been used to locate Project facilities away from important archaeological sites where possible, to assess any residual effects and to formulate preservation and mitigation plans for any important archaeological resources to be affected by Project development.

In addition, “old things” were included in the scope of Inuit knowledge (IQ) studies carried out for the Project (DEIS Appendix 2B). Figures 12.2, 12.3 and 12.4 present the identified locations of Special Places, Historic Sites and Gravesites, respectively.

12.8.1 Archaeological Survey Findings

Milne Port

Five sites with potential direct effects have been identified; 4 sites with potential indirect effects. An additional 2 sites have already been mitigated.

The archaeological remains found at Milne Port indicate repeated use over a long period of time from over 2000 years old to more recent times after the year 1900. Stone tool manufacture is clearly represented at sites in this area. The sites recorded are distributed in an almost linear manner on the beach ridges along the shore from Phillips Creek to the east of the unnamed eastern creek valley, and features have been observed along the latter creek. One of the sites has a large scatter of artifacts, one site contains numerous stone features suggestive of a range of time periods, and other sites exhibit smaller quantities of remains of stone tools and their manufacture.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Milne Inlet Tote Road

Thirty-four sites with potential direct effects were identified along the Milne Inlet Tote Road and 4 sites with potential indirect effects. Another eighteen have been mitigated.

Most of the sites were found in the area of Phillips Creek. Fewer sites were found along the remainder of the length of the road. The large number of sites in the Phillips Creek Valley has confirmed its use as a travel corridor to the interior over a long period of time. The numerous remains include some of the oldest known in the Eastern Arctic and are therefore very important. Discovery of a completely buried site provides confirmation that surface indications for all sites cannot be expected. The sites contain stone features heavily dominated by circles, most of which can be interpreted to represent tent rings. Many of them have associated hearths or windbreaks, both inside and outside, further indicating camp sites. The styles of the tent rings suggest a range of time periods. A significant number of the rings that are closely associated with the creek terraces and are partly covered by sediments and vegetation likely pre-date the road and may be considerably older. Some rings are fairly open and with a recent appearance. Some of these recent rings have an approximate square appearance, suggesting use of canvas tents; others have a larger outside ring of six or eight boulders indicating a modern tent ring, likely dating to the period following road construction in the 1960s.

Unfortunately, the inland sites that were excavated contain few artifacts that could assist in narrowing down the occupation period. In addition excavations revealed a lack of distinct layers of rock that would help identify the age in all sites investigated. Therefore, relative age based on the appearance of features appears to be the best possible age approximation. One site represents the only inland site found to contain a complete stone tool. However, it was an isolated surface find adjacent to the road making the meaning of that find equivocal. A flake found at another site on the same landform suggests that there may be some lithic artifact deposits at one or both of these sites. If so, these findings could provide an indication of inland use and travel patterns over several time periods through the Phillips Creek valley, up to and including the present.

Mine Site

Only 2 archaeological sites were found at the Mary River Mine Site and their archaeological importance is considered to be relatively low to moderate since they are of relatively recent origin. One of the sites has already been mitigated.

Railway

Twenty-one sites were found that could have potential direct effects and 5 were identified with potential indirect effects. No sites have been mitigated along the proposed railway corridor to date.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The sites discovered along and in the general vicinity of the proposed Railway indicate that the area crossed by the rail line served as an important travel corridor between Steensby Port and the communities to the north from prehistoric times to the present. It was also a significant location for caribou and trapping for wolves and foxes.

A system of uninterrupted navigational markers was found stretching from the east shore of 10 km Lake towards the west shore and Ikpikitturjuaq Bay, delineating a well-traveled route 6.5 km long. At one site a double row of Inukshuit, possibly a caribou drive lane and a single row of Inukshuit pointing towards the mouth of Ikpikitturjuaq Bay may be seen. Of these sites, only one is within the proposed railway alignment. At another site, outside the Project boundary, there is a small river which is a good location for Arctic Char (Theo Ikumak, pers. comm. 2010). The abundance of structures and features, such as kayak stands show that the area was popular for a good length of time.

Steensby Port

Fifty-two sites with potential direct effects were identified and forty-one with potential indirect effects. An additional four sites have previously been mitigated.

The area between Ikpikitturjuaq Bay and Steensby camp contains many archaeological sites. Steensby Port represents an area of convergence and concentration of resources. The investigations support the hypothesis that people congregated at Steensby Port and surrounding area for thousands of years. The breadth of types of sites in this area illustrates that there was important occupancy back to Paleo-Eskimo times.

One gravesite was identified during IQ study workshops at the Steensby Port (Figure 12.4). This gravesite was not located during the course of archaeological surveys at Steensby Port.

12.9 Resources and Land Use

The information collected for the land use baseline provides an overview of the history of the region, information on land use during the contact-traditional period, and an overview of current land use activities in the North Baffin and Foxe Basin areas. Based on guidelines from NIRB (2009), regarding the Mary River Project, the land use study area depicted in Figure 12.5 encompasses both the LSA and the RSA. The study area was delineated based on historical land use (Milton Freeman Research, 1976) and more contemporary land use (Priest and Usher, 2004). Published sources, personal communications and the Project's Mary River Inuit Knowledge Study (MRIKS) were used to describe land use in the Mary River Project and surrounding areas. The Nunavut Wildlife Harvest Study (Priest and Usher, 2004), interviews and discussions with local communities determined contemporary Inuit land use. The complete Land Use Baseline Report is available in DEIS Appendix 4C.

Connection to the land through the pursuit of cultural land base activities such as harvesting, travel, and camping continue to be of importance to Inuit. Harvesting in the land use study area includes varies resources such as caribou, marine mammals, fish, soapstone, berries, and sea resources.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Harvesting of certain resources varies in importance between North Baffin and the two South Baffin communities in the land use study area. For example, residents in Cape Dorset and Kimmirut indicated that they mainly rely on sea mammals and other sea resources such as mussels as a source of food. In comparison in North Baffin, sea resources such as mussels and seaweed are less commonly harvested. Harvesting locations of marine mammals and sea resources are identified in Figures 12.6 and 12.7 for both North Baffin and South Baffin.

Caribou harvesting is commonly pursued by Inuit in the land use study area. The Nunavut Wildlife Harvest Study (NWHS) (Priest and Usher, 2004) documented reported harvest locations for caribou. Caribou move around Baffin Island over the course of a number of years and during the NWHS were quite abundant in the North Baffin region. Recently, caribou abundance has declined in the land use study area as referenced in the terrestrial mammal baseline report and impact assessment (DEIS Appendix 6F and Volume 6, Section 5.0, respectively). As such, Inuit must travel further to hunt caribou.

Harvesting of other resources such as berries and soapstone are also pursued by Inuit. Berry picking is conducted as a secondary, opportunistic harvesting activity, while individuals are already out on the land. There is a soapstone deposit at Mary River that is an important resource commonly harvested by residents of North Baffin for carving purposes. The deposit (like all soapstone deposits) is protected under the Nunavut Land Claims Agreement (NLCA) giving Inuit inherent right to harvest the soapstone. Figure 12.8 in Volume 3 demonstrates the location of the deposit.

Travel and camping are activities that are largely pursued in combination with harvesting and visiting with other communities by following well established historical routes (in their ancestors' footsteps). An interpretation of the main travel routes identified by North Baffin and Cape Dorset and Kimmirut communities are illustrated in Figures 12.8 and 12.10 (the original travel route figures are Figures 3.13 and 3.15 in DEIS Appendix 4C), while camping locations are illustrated in Figures 12.11 and 12.12.

Travel routes exist on ice, in water, and over land. Ice travel is limited to the landfast ice, which in South Baffin extends only a few kilometres from the coast. Important travel routes in North Baffin include:

- A route across Steensby Inlet used by residents from Igloolik and Hall Beach to access inland harvesting locations and by Clyde River residents travelling to Igloolik and Hall Beach
- A travel route from Pond Inlet through Eclipse Sound into Milne Inlet and through Navy Board Inlet
- The Phillips Creek valley which is used as a guide for inland travel from Milne Inlet.

Although these are travel routes with the greatest interaction with the Project, many other travel routes exist within North Baffin as demonstrated in Figure 3.13 in DEIS Appendix 4C. In addition, hunters travel across the land, beyond the main travel routes, in search of caribou.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.10 Cultural Well-Being

Cultural well-being may be defined as the ability of an individual or community to enjoy creative and cultural activities as well as having the freedom to express and retain their traditions (Ministry for Culture and Heritage, n.d.). A component of Inuit culture is IQ, which is defined as "the Inuit way of doing things: the past, present and future knowledge, experience and values of Inuit Society" (Inuit Qaujimajatuqanginnut Task Force, 2002). Baffinland has worked with the communities in the LSA and the QIA in the collection of IQ through the Mary River Inuit Knowledge Study (MRIKS), and through various workshops and public meetings.

Cultural well-being is the purview of the Inuit and is taken into consideration in the Nunavut Land Claims Agreement (NLCA), Government of Nunavut and other organizations such as CLEY/DIA. The QIA is the steward and custodian of IQ and cultural well-being for the Inuit in the study area (Qikiqtani Inuit Association, 2007). The QIA ensures that Inuit needs are being met by the Government of Nunavut and the Government of Canada.

As a feature of the NLCA, Baffinland has begun negotiations with the QIA for an Inuit Impact and Benefits Agreement (IIBA). Cultural well-being is addressed in the IIBA as follows:

- Inuktitut speaking work groups within sub-activities of the Project
- Baffinland recognizes the importance of maintain social and cultural well-being of communities and individuals in order to ensure a productive workforce and will provide support in addressing potential impacts on cultural well-being as a result of the Project
- Workplace conditions will be respectful of Inuit culture and will provide cultural recognition programs to employees
- A senior Executive Committee to oversee the implementation of the economic, social/cultural and environmental provisions of the IIBA
- Development of the *Ilagiiktunut Nunalinnullu Pivalliajutisait Kiinaujat Fund* to support various social and cultural community activities as outline in Section 10.2 of the IIBA.

Baffinland recognizes that the cultural well-being of the Inuit in the LSA is an Inuit activity and responsibility. Baffinland will not become paternalistic nor will it assume a central role in preserving Inuit cultural well-being – rather, Baffinland will be supportive in Inuit and QIA activities relating to cultural well-being.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Traditionally, IQ consists of six basic guiding principles (Inuit Qaujimajatuqanginnut Task Force, 2002):

1. **Pijitsirnjiq** - The concept of serving (a purpose or community) and providing for (family and/or community)
2. **Aajiiqatigiingni** - The Inuit way of decision-making. The term refers to comparing views or taking counsel
3. **Pilnimmaksarniq** - The passing on of knowledge and skills through observation, doing and practice
4. **Piliriqatigiingniq** - The concept of collaborative working relationships or working together for a common purpose
5. **Avatittinnik Kamattiarniq** - The concept of environmental stewardship
6. **Qanuqtuurniq** - The concept of being resourceful to solve problems.

Therefore, cultural well-being is considered in context of these principles being realized.

Baseline conditions relating to cultural well-being are addressed in various sections of the socio-economic baseline report (DEIS Appendix 4A, Section 2.4 Language and Culture).

Inuit beliefs, stories, special places, and knowledge of the land and wildlife are rooted in IQ or Inuit traditional knowledge. Traditional values continue to be of importance to residents of Baffin Island as made evident through the MRIKS. Special places valued by ancestors are still accessed and valued by individuals. Other cultural activities such as going out on the land and harvesting are central to most Baffin Island residents.

12.11 Government and Leadership

12.11.1 Strategic Value of the Project

"Fit" with Territorial Strategic Plans

The Project fits well with both the Nunavut Economic Development Strategy and the Mineral Exploration and Mining Strategy, "*Parnautit.*" In addition to its contribution to development of Nunavut's mining sector—a strategic sector as identified in these documents, the Project is assessed as having significant beneficial effects on the development of Nunavut's labour force, or "human capital"—particularly amongst youth. This is another major strategic area addressed in the territorial strategic plan for economic development.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

"Fit" with Local CED Strategic Plans

Development of opportunities related to the mining sector is identified as a strategic priority in local community economic development plans. These plans particularly identify the need to build local capacity to participate in near-by mining Projects both through direct employment relationships as well as through the direct and indirect business opportunities that may arise from these Projects.

The Project fits well with these local strategic objectives. The various mitigation measures identified to build labour force capacity, hire local labour, and build business capacity to deliver goods and services to the Project fall well within the local strategic plans.

12.11.2 Project Agreement Governance Regime

IIBA Governance

As provided for under Article 26 of the NLCA, agreement with respect to an IIBA for the Project will be concluded between Baffinland and the Qikiqtani Inuit Association. Unless otherwise stipulated, as set out under Part 11 provisions of Article 26, this agreement will be signed prior to commencement of the Project. The governance of the IIBA agreement, as well as processes for conflict mediation, will be set out in the agreement itself.

12.12 Climate Baseline Conditions

An understanding of weather and climate in the Project area is required for design, construction, and operation of Project facilities, including transportation corridors. An understanding of weather and climate is also important in assessing the effects of the Project on ambient air quality in the Project area, and understanding trends in climate change. The following provides a summary of baseline meteorological conditions within the Project study area, with a detailed baseline report in DEIS Appendix 5A (RWDI AIR Inc., 2010).

The regional study area (RSA) for climate and climate change includes the terrestrial and marine RSAs, and the local study area (LSA) for climate and climate change includes the North Baffin Region focusing on the Project sites. Regional data exists from various Environment Canada (EC) climate stations in the RSA, and to obtain more precise climate data within the LSA, Baffinland established on-site meteorological station at the exploration camp at Mary River in June 2005 and at each of Milne Port and Steensby Port in June 2006.

EC operated a climate station at the Mary River camp (Mine Site) during the summer months from 1963 to 1965. Given the limited availability of site-specific climate data, a regional assessment of available data was undertaken and the following six locations were identified, reviewed, and incorporated into the analysis:

- Pond Port (160 km): Pond Port is the closest station for which long term climate data are available (1975 - 2007). The meteorological station at Pond Port is approximately 55 m above

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

sea level (masl) compared with elevations at the Mary River camp (180 to 200 masl) and at the top of the deposit at Mary River (698 masl)

- Igloolik (240 km): Igloolik has long term climate data available from 1977 - 2002. The meteorological station at Igloolik is approximately 21 masl
- Nanisivik (260 km): Nanisivik has long term climate data available from 1976 - 2007. The meteorological station at Nanisivik is approximately 642 masl
- Hall Beach (290 km): Hall Beach has long term climate data available from 1957 - 2007. The meteorological station at Hall Beach is approximately 8 masl
- Clyde River (400 km): Clyde River has long term climate data available from 1933, 1942 - 1943, and 1946 - 2007. The meteorological station at Clyde River is approximately 27 masl
- Dewar Lakes (400 km): Dewar Lakes has long term climate data available from 1958 - 1993 and 2000 - 2007. The meteorological station at Dewar Lakes is approximately 527 masl.

12.12.1 Climate Setting

The North Baffin region is located within the Northern Arctic and the Arctic Cordillera Ecozones, as delineated in the National Ecological Framework for Canada. Northern Baffin Island has a semi-arid climate with relatively little precipitation. The region experiences near 24-hour darkness, with less than two hours of twilight, from early November to late January. During winter months (December to April), the treeless topography and fine powdery snow produce blowing snow conditions resulting in restricted visibility. Steam fog may occur in areas of open water, but does not persist more than a few miles downwind. Ice fog is infrequent, due to the lack of moisture in the air.

Frost-free conditions are short and occur from late June to late August. There is continuous sunshine from early May to early August. The months of July and August bring maritime influences and are usually the wettest (snow may still occur). Fog increases at this time due to arrival of moist air from southern Canada.

During September to November, temperature and the number of daylight hours start to decrease, and by mid-October the mean daily temperature is well below 0ºC. The highest amount of snowfall typically occurs during this period. A condition called “Arctic white out” often occurs during this time, where diffuse white clouds blend into the white snow-covered landscape, reducing visibility and increasing the likeliness of disorientation. This condition can also occur in April and May.

12.12.2 Air Temperature

Monthly mean temperatures at long-term EC climate stations range from approximately -34ºC in February at Pond Port to about 7ºC in July at Igloolik. The monthly average temperatures at Nanisivik are between 0.7 and 7.3ºC colder than other stations during the summer and fall. Temperatures at Pond Port are between 1 and 5.6ºC colder than other stations during the winter months.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Average annual temperatures recorded at the EC sites range from -12.8ºC at Clyde River to -16.3ºC at Pond Port. The highest annual mean temperatures consistently occurred at Clyde River, with exception of a few years where Dewar Lake and Igloolik recorded higher annual mean temperatures. The lowest annual mean temperatures occurred at Pond Port and Nanisivik, which are located at higher latitudes than Clyde River and Dewar Lakes. Annual mean temperatures generally increased over the measurement period at all locations, although there is considerable year-to-year variability. The trend line plotted for Pond Port indicates that the annual mean temperature has increased by about 2.1ºC since 1975 at Pond Port.

It appears that the data from Pond Port are most representative of temperatures at all three Baffinland stations compared to the other long term EC stations, although there is a tendency for warmer temperatures at the Baffinland stations during the summer months. The data from the Pond Port climate station, corrected upward by 2.4ºC during the summer months, are assumed to be reasonably representative of baseline conditions at Mary River Project site and provide the best source of long-term temperature information for the Project sites.

12.12.3 Precipitation

Mean monthly precipitation at long-term EC climate stations range from 4 mm in February at Pond Port, Hall Beach, and Nanisivik, to about 64 mm in August at Dewar Lakes. There is some variability in precipitation at the long-term EC stations, ranging from about 5 mm in January to about 30 mm in August. Mean monthly precipitation reaches a maximum between August (Igloolik, Pond Port, Dewar Lakes, and Hall Beach) and October (Clyde River).

Mean annual precipitation at Pond Port is 190.8 mm, with 144.5 cm of snowfall (equivalent to 105.4 mm of rain) and 85.4 mm falling as rain. Historical records show that snow can occur in any month and rainfall may occur from April through November. The wettest month of the year is August, receiving an average 32.9 mm of rain. October receives the most snow, an average snowfall of 32.8 cm. The lowest annual precipitation of about 74 mm occurred at Clyde River in 1958; however, the measurement techniques have likely become considerably more reliable since that time. The maximum annual precipitation of 500 mm occurred at Nanisivik in 2005. Data indicates that precipitation has increased slightly over the entire measurement period (about 0.24 mm/year).

Total rainfall is the only precipitation measurement available at the Project stations, and mean temperatures are typically above 0ºC from May to October. As such, these months were used to compare the Project-measured precipitation data with measurements from the EC stations. Mary River rainfall measurements were consistently higher in the summer months among all other Project stations, whereas rainfall in Milne Port and Steensby were mid-low range with the exception of the autumn months, where rainfall measurements were higher than all the other stations. Based on a comparison of the monthly trends, it appears that the data from Hall Beach are most representative of rainfall in Mary River, and data from Pond Port and Igloolik are most representative of rainfall from Milne Port and Steensby, respectively.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Data from Hall Beach are assumed to be reasonably representative of baseline rainfall conditions at the Mary River Project site and provide the best source of long-term precipitation information. Likewise, an average of precipitation data from Pond Port and Igloolik are assumed to be reasonably representative of baseline conditions at both Milne Port and Steensby Port.

12.12.4 Wind-Blown Snowfall

Wind-blown snow accumulates in topographic depressions, on the leeward side of ridges and buildings, and in strands of vegetation, which trap snow by reducing surface wind speeds. This accumulation presents challenges in terms of snow loads on structures, and accessibility to buildings, infrastructures, and road networks. If wind-transported snow is not deposited in some kind of drift trap, and if a blowing-snow event is of sufficient duration (and the air remains unsaturated), then the particles can eventually sublimate away. Particle transport distance is the distance an average-sized snow/ice grain can travel before it completely sublimates. Transport distances of 2 to 3 km for a region south of Barrow, Alaska have been calculated. As a consequence of the vigorous wind transport, a significant portion (5% - 50%) of the arctic snowcover is returned to the atmosphere by sublimation of the wind-borne snow particles. Estimates of the amount of solid precipitation that sublimates are 20% to 47% in the Trail Valley Creek area of the western Canadian Arctic.

Measurements of wind-blown snow are difficult to acquire. Models have been developed to estimate wind-blown snow events from wind speed and snowfall data. Unfortunately, accurate arctic snowfall measurements have proven nearly impossible to achieve because this precipitation generally falls when it is windy, and precipitation gauges located in windy environments significantly underestimate solid precipitation amounts.

Measurements of snow depth and snowfall are available from long term EC stations. Although these values can provide an estimate of snow conditions in the region, snow depth and accumulation is heavily dependent upon wind distribution and sublimation of snow, which are in turn strongly influenced by local topography.

Visual observations at the Mary River Site indicate that snowfall drifts across the open terrain and accumulates in valleys and against obstacles, while most of the flat terrain is swept free. Some of the mountain regions have mini glaciers where it would be snow covered year round, and some of the valleys might have snow most of the year. Based on visual observations it is estimated that during the winter months 60% of the total land area has snow cover. From June to September, snow cover is less than 5% for much of the area around Mary River and Steensby, exposing dirt (for Mary River) or rock (for Steensby).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.12.5 Evaporation

Evaporation is not currently measured at the Project or the EC stations. Observational evaporation data specific to the Canadian Arctic have cited evaporation measurements over the entire Arctic Ocean at approximately 0.4 mm/day on an annual basis. Observational evaporation data on Baffin Island are not available; however climate model simulations of precipitation and evaporative fluxes in the Canadian Arctic and northern land areas have been conducted. The Atmospheric Model Inter-comparison Project (AMIP) compiled outputs from 23 different model simulations. The simulated evaporation from the Canadian Straits and Foxe Basin Watershed shows a strong seasonality, ranging from approximately 0.1 to 0.15 mm/day in the winter (primarily represented by sublimation) to 0.4 to 3.4 mm/day in the summer. Similar evaporation fluxes were predicted between models with the exception of predictions in the summer months. While there was a wide range between models, each model predicted a similar value for precipitation as evaporation in the summer months.

Evaporation is often calculated using measurements of wind speed, solar radiation, temperature, and humidity. Several methods have been developed to assess theoretical evaporation rates from these parameters, including the FAO Penman-Monteith Evapotranspiration (ET) method (FAO - Food and Agriculture Organization of the United Nations). The FAO Penman-Monteith method is recommended as the standardized method for determining reference ET from meteorological data. Evapotranspiration is the combination of two separate processes whereby water is lost either from the soil surface by evaporation and from the crop by transpiration. Five years (1982 - 1986) of meteorological data from Hall Beach were used to calculate ET using the Penman-Monteith method from March through September only.

Evapotranspiration levels are expected to be low to negligible during the winter season since mean temperatures are well below the freezing point limiting the available moisture for ET. In addition, low solar radiation during the winter season results in bias and errors in solar radiation observation data. Since solar radiation measurements are a component of the FAO Penman-Monteith method, ET results for these months have not been included in this analysis.

Mean daily and monthly ET values for Hall Beach for the years 1982 to 1986 are available. The mean daily ET over these months is 0.9 mm/day. Total annual ET over these months is 193 mm.

12.12.6 Wind Speed and Direction

Wind speed and direction are strongly affected by local influences, such as terrain. There is typically little variability in the average wind speeds on a year-to-year basis. Therefore, short-term data sets from the Project stations are expected to be fairly representative of average long-term conditions (or more representative than any of the EC data sets). The long-term EC data provide a better indication of extreme wind events that could possibly occur at the site.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Monthly average winds at the EC stations range from 1.8 m/s in February at Pond Port to 6.7 m/s in October at Hall Beach. Measured monthly average wind speeds at the Project stations are generally within the observed ranges from the EC stations, with the exception of Milne Port during the month of March and summer months (June - August), which experienced higher monthly average wind speeds. This could be a function of the smaller data set at the Project stations. Wind rose plots produced for the Mary River site indicates that winds from the southeast occur most frequently (15.5% of the time), followed by winds from the east-southeast (9% of the time). Histograms were used to indicate the frequency of the various wind speed categories. “Light air” conditions (0.3 to 1.6 m/s) occur most frequently at 26.3% of the time, followed by calm winds (0 to 0.3 m/s) which occur 21.7% of the time. Strong breezes (10.8 to 13.9 m/s) occur 5.0% of the time. Near gale winds (13.9 to 17.2 m/s) occur 1.4% of the time.

The wind rose for Milne Port indicates that winds from the northeast and south southeast occur most frequently (nearly 13% of the time for both directions), followed by winds from the southeast and northeast (about 11.5-12.0% of the time respectively). “Light air” conditions (0.3 to 1.6 m/s) occur most frequently at 26.1% of the time, followed by “light breeze ” conditions (1.6 to 3.4 m/s), which occur 18.4% of the time. Strong breezes (10.8 to 13.9 m/s) occur 6.9% of the time. Near gale winds (13.9 to 17.2 m/s) occur 1.9% of the time.

The wind rose for Steensby Port indicates that winds from the northwest occur most frequently (23% of the time), followed by winds from the southeast (nearly 12% of the time). “Gentle breeze” conditions (3.4 to 5.5 m/s) occur most frequently at 31.5% of the time, followed by “light breeze ” conditions (1.6 to 3.4 m/s), which occur 22.6% of the time. Strong breezes (10.8 to 13.9 m/s) occur 4.1% of the time and “near gale winds” (13.9 to 17.2 m/s) occur 0.9% of the time.

The wind rose for Pond Port (2003 to October 2010) indicates that winds from the south occur most frequently (23% of the time). "Light breezes" (1.6 to 3.4 m/s) occur most frequently at 33.8% of the time, followed by “light air” conditions (0.3 to 1.6 m/s), which occur 30.6% of the time. “Strong breeze” conditions (10.8 to 13.9 m/s) occur about 1% of the time.

12.12.7 Solar Measurements

Solar radiation data are considered in the determination of atmospheric stability for air quality dispersion modelling as well as theoretical evapotranspiration calculations. Mean daily global solar radiation at Hall Beach range from 0 in December to 23 MJ/m^2 in June. The annual mean daily global solar radiation of 9 MJ/m^2 at Hall Beach is consistent with other estimates in this region. The Atlas of Canada estimates the annual mean daily global solar radiation to be between 8 - 10 MJ/m^2 for Baffin Island. The measured values at the Project stations are much higher than those recorded for both Hall Beach and the Atlas of Canada. As such, the Project measurements are considered to be unreliable.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The maximum number of hours of bright sunshine occurs in May at Pond Port with 362 hours and in July at Clyde River with 279 hours, respectively.

Since the solar radiation measurements from the Project stations are suspect, data from Hall Beach are expected to provide the best estimate of mean daily solar radiation at the Project site. Data for Pond Port are expected to provide the best estimate of hours of bright sunshine.

12.12.8 Atmospheric Moisture

Relative humidity varies diurnally and seasonally. Relative humidity tends to be highest at sunrise when temperatures are coolest and lowest in the late afternoon/early evening when temperatures tend to be warmest. Seasonal variability in relative humidity is related to temperatures and precipitation amounts.

The lowest monthly average humidity typically occurs in February or March at all stations, which corresponds to the period of time with the lowest precipitation and the lowest temperatures. The relative humidity data from the Project stations seems to be generally consistent with the monthly trends observed at the EC stations, although it is somewhat higher in the winter months and somewhat lower in the summer months at the Project stations. Again, this could be attributed to the length of the monitoring program.

The Project's relative humidity data are expected to be most representative of long-term conditions at the Project sites.

12.12.9 Climate Change Forecasts

Prediction Methods

Global Climate Models (GCMs) are used to simulate potential changes in climate due to future greenhouse gas emissions, land-use changes and other driving forces. The Intergovernmental Panel on Climate Change (IPCC) has assimilated numerous emission scenarios to study the range of possible outcomes of climate on our planet. Based on the availability of model results from the most recent IPCC study (2007), scenarios A2 and B1 from the Special Report on Emissions Scenarios (SRES) were assessed. These two scenarios combined cover a wide range of potential future emissions scenarios as A2 falls above the middle of the SRES range of future emissions, and B1 falls below the middle of the range. Briefly, scenario A2 describes a more divided world characterized by high population growth and slow technological change, and scenario B1 describes an integrated and ecological friendly world characterized by low population growth and medium technological change focusing on efficiency and dematerialization. Climate predictions from these two scenarios provide a sufficient range of various possible changes in weather trends that could result from future human activity.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The Arctic Climate Impact Assessment (Arctic Council and International Arctic Science Committee, 2005), which is the first body of work to evaluate climate change across the entire Arctic region, was drawn upon to predict some of the climate change parameters in the Baffin Island area.

As with any model, GCMs are imperfect at reproducing a natural system, especially when considering the uncertainty of future emissions input into the model. Although absolute climate values from GCMs are typically not very accurate when compared to observed data, the changes in climate predicted from GCMs from a baseline period to a future period are very useful. In this assessment, GCM predicted changes in climate were applied to the observed baseline data to develop an estimate of future climate conditions. Three future time periods were considered: 2011 to 2040; 2041 to 2070; and 2071 to 2100.

Historical Climate Data

Representative baseline climate parameters specific to the Mine Site are shown in Table 12-2: Baseline Dustfall Deposition Rates. The climate variables presented include mean temperature, mean daily maximum/minimum temperature, precipitation, mean wind speed, average snow depth, and incident solar radiation. The Baseline Meteorological Report (DEIS Appendix 5A) includes a detailed discussion of historical climate conditions at the Project Site.

In a climate change assessment, it is ideal to determine trends over a long-term period (i.e. 30 years or more). The Project meteorological stations do not contain sufficient data to determine long-term trends, therefore, climate normals from EC were used in this assessment. Data comparisons between EC stations and the Project stations were made to determine the most representative EC station for each climate variable. Climate normals from 1971 to 2000 (where available) from the representative EC stations were used to develop a climate baseline, with the exception of wind speed. Since wind speed is strongly affected by local influences, and since there is typically very little variability in the average wind speeds on a year-to year basis, the short-term data sets from the Project stations were used as these data are expected to be fairly representative of average long-term conditions (or at least more representative than any of the EC data sets). The mean wind speeds presented in Table 12-2: Baseline Dustfall Deposition Rates are taken from the Mary River Site Station from June 2005 to July 2010.

Global Climate Models

Global Climate Models were used to simulate baseline climate conditions as well as to provide an estimate of the future predicted change in climate variables. Comparison of GCM predicted baseline conditions to actual climate normals provides an estimate of accuracy of GCM behaviour and its ability to simulate complex climate variables. If the GCM is successful in its replication of past weather trends, then a level of confidence is established when developing a future climate scenario based on GCM predicted changes, barring any uncertainties associated with future greenhouse gas emissions.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

GCM results based on the most recent IPCC study (2007) were available from several different sources. Based on the availability of climate data, two main sources were selected: the EC Canadian Climate Change Scenarios Network (CCCSN) website (http://www.cccsn.ca), and the Pacific Climate Impacts Consortium (PCIC) website (http://pacificclimate.org). The CCCSN website provided temperature, precipitation, and wind speed data, and the PCIC website provided snow depth, and incident solar radiation data. Five different time periods were assessed including two baseline periods, 1961 - 1990 and 1971 - 2000, and three future periods: 2011 - 2040 (2020s), 2041 - 2070 (2050s), and 2071 - 2100 (2080s). Where available, the more recent baseline data (1971 - 2000) was used in place of the 1961 - 1990 baseline period.

Climate data were extracted from a region covering approximately 400,000 km^2 over the northern half of Baffin Island. The area was selected to maximize the land area and minimize the grid cells that are over the sea.

Five different GCMs were used: CGCM3T47, ECHAM50M, GFDLCM2.0, HADCM3, and NCARCCSM. Climate variables extracted from the GCMs include mean temperature, mean daily maximum/minimum temperature (where available), precipitation, mean wind speed, average snow depth (where available), and incident solar radiation. All GCM results are reported as seasonal and annual averages.

Climate Baselines

Table 12-2: Baseline Dustfall Deposition Rates provides a summary of current climate conditions based on GCM results and historical climate observations from both on-site and EC weather stations. The historical climate observations were compared to the GCM predicted baseline to validate the model. The GCMs compared reasonably well with the historical climate observations. The GCM predicted precipitation and average snow depth values were within the observed ranges for the region. Annual average temperature, mean wind speed, and solar radiation were typically under-predicted by the GCMs by an average of 2.3 °C, 1.9 m/s, and 18 W/m^2, respectively. Since this report considers the difference between the GCM predicted baseline and the future periods and not the absolute values predicted from the GCMs, this underestimation is of little consequence.

GCM Future Climate Predictions

Table 12-3: Baseline Metals Deposition Rates for Select Metals, Table 12-4: Baseline Noise Monitoring Results and Table 12-5: Total Amounts of Organic Matter and Primary Nutrients in Soils in the Project Area contains detailed summaries of the GCM predicted change in climate along with predicted future seasonal and annual climate averages for the three future time periods representing the 2020s, 2050s, and 2080s, respectively. The predicted future climate data in these tables were calculated by adding the GCM predicted change to the historical climate observation data. Table 12-6: Preliminary Seismic Parameters for the Project Area presents a summary of the predicted future climate, providing a range of values based on all models and both SRES scenarios.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Figures 12.13 through 12.17 provide a visual representation of the predicted change in annual mean temperature, annual daily precipitation, annual mean wind speed, annual average snow depth, and annual average solar radiation, respectively. Upper and lower ranges of predictions are presented, representing the five GCM models (CGCM3T47, ECHAM50M, GFDLCM2.0, HADCM3, and NCARCCSM) as well as the two emission scenarios (A2 and B1).

Long-term Temperature Trends

A discussion of temperature trends is included in DEIS Appendix 5A and is summarized here. The trend indicates that the annual mean temperatures have increased by about 0.07°C per year at Pond Port from 1975 on. As shown in Figure 12.13, the GCM models predict that annual mean temperature will increase between a rate of approximately 0.03°C (lower range) and 0.08°C (upper range) over the next century. The average predicted increase of 0.055°C is relatively close to that observed at Pond Port, thus providing a level of confidence in the GCM results.

Long-term Precipitation Trends

Long-term precipitation trends, based on historical data, are discussed and shown in Figure 6 of DEIS Appendix 5A. Historically, annual precipitation has increased slightly, by an average of 0.24 mm every year. Figure 12.14 shows the trends in average daily precipitation, indicating that over 100 years, the average daily precipitation will increase by approximately 0.05 mm (low range) to 0.35 mm (high range). These values equate to a future increase in annual precipitation of 0.18 mm (low range) to 1.28 mm (high range) per year. Given that these increases are in agreement with the historical trend of 0.24 mm/year, a level of confidence is provided in the GCM predicted precipitation trends.

Long-term Wind Speed Trends

Wind Speed is highly dependent on many factors including topography, pressure gradients, local weather conditions, etc. The GCM predicted change in annual mean wind speed is shown in Figure 12.15. The figure shows inconsistencies between the predicted trends; the upper range of predictions indicates that wind speed will increase while the lower range indicates that wind speed will decrease over the next century. However, overall wind speed is predicted to change only slightly.

As wind speed is dependent on numerous factors, the GCMs ability to accurately predict changes in wind speed for future periods is questionable.

Long-term Snow Depth Trends

As shown in Figure 12.16, annual average snow depth is predicted to remain fairly constant over the next century.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Long-term Solar Radiation Trends

As shown in Figure 12.17, annual average solar radiation is predicted to decrease over the next century by approximately 3 W/m^2 (low range) to 16 W/m^2 (high range) on an annual average. Confidence in these results is achieved through studying the relationship between precipitation and solar radiation. As precipitation increases, cloud cover also increases, leading to a decrease in solar radiation. As shown in Figures 12.14 and 12.17, the increase in precipitation seems to coincide with the decrease in solar radiation.

12.13 Air Quality (VEC) Baseline Summary

Historically, air quality assessments for new mining operations in the north of Canada have relied on long-term ambient quality data from monitoring stations elsewhere in the north, and site-specific monitoring has not always been conducted. For this study, limited ambient monitoring was conducted to estimate the background air quality where Project activities will occur. Although the air quality monitoring program provided only a brief snapshot in time, its results are more representative of site-specific background levels than long-term data from the Northwest Territories EPD monitoring stations, which are located near human activities that affect the environment (e.g., Yellowknife).

Ambient air concentrations of selected air contaminants were measured in the vicinity of the Mine Site over the course of two weeks in July 2007. Air contaminants monitored as part of the program included:

- total suspended particulate (TSP)
- inhalable particulate matter (PM_{10})
- total particulate deposition (dustfall)
- sulphur dioxide (SO_2)
- nitrogen dioxide (NO_2)
- ozone (O_3)
- dust deposition
- metals deposition.

The selection of air contaminants considered air contaminants typically associated with mining operations and with the anticipated Project activities. In addition, RWDI consulted with Dave Fox, Air Quality Specialist with Environment Canada based in Yellowknife who is generally consulted on air quality assessments by regional government authorities for such Projects.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The base line ambient air quality monitoring program had two components; an active monitoring program and a passive monitoring program, both of these were conducted in July 2007.

- Active Monitoring Program: measured ambient concentrations of TSP. Samples were collected simultaneous from two locations near the Mine Site using battery-powered Airmetrics "MiniVol" samplers. Each sample was collected over a 72-hour period. Samples are typically collected over a 24-hour period, but it was decided to increase the sampling time to ensure adequate capture of particulate and to increase the accuracy of the measurements, as low particulate levels were anticipated. This program also involved the use of a DustTrack to monitor particulate matter with aerodynamic diameters less than 10 μm (i.e., PM_{10})
- Passive Sampling Program: collection of SO_2, NO_2, and O_3 samples simultaneously at two different locations near the Mine Site. Passive monitors (duplicate monitors for each contaminant) were installed at each location for a 49-day period. This program also involved collection of particulate deposition (dustfall), including metals at the same locations also over the same monitoring period.

Further details on the monitoring program are provided in the baseline air quality report included as DEIS Appendix 5C-1.

The results did not vary meaningfully between samples, but the maximum value was selected as the baseline concentrations to compensate for the relatively short monitoring period. Dust deposition was analyzed for a full range of metals (see DEIS Appendix 5C-1), however, only a few metals were selected for presentation based on a metals analysis of an ore sample. The metals with a combination of relatively high content in the ore and a low indicator threshold for ambient air were selected. Overall baseline results for each air quality parameter are summarized in Table 12-1: Measured Baseline Concentrations, Table 12-2: Baseline Dustfall Deposition Rates, and Table 12-3: Baseline Metals Deposition Rates for Select Metals. These baseline levels are assumed to apply throughout the Project area.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-1: Measured Baseline Concentrations

Parameter	Baseline Concentration ($\mu g/m^3$)
24-hour TSP	7.0
24-hour PM_{10}	3.8
30-day SO_2	0.262
30-day NO_2	0.188
30-day O_3	52.8

Table 12-2: Baseline Dustfall Deposition Rates

Parameter	Baseline Deposition Rate ($mg/100cm^2$/30-day)
Total Dustfall	0.398

Table 12-3: Baseline Metals Deposition Rates for Select Metals

Parameter	Baseline Deposition Rate ($\mu g/100cm^2$/30-day)
Al	26.9
Co	0.5
Cr	0.3
Fe	30.6
Mg	23.9
Mn	1.7

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

In general, the measured baseline concentrations and metal deposition rates are extremely low compared to values in southern Canada.

In addition to baseline air quality conditions, an understanding of meteorological conditions in the Project area is required for the air quality effects assessment. A meteorological baseline report is included in DEIS Appendix 5A, and Section 1.1 summarizes the collection of baseline meteorological data at each Project site and the incorporation of long-term meteorological data from regional EC stations. Although these data were not applied directly in the dispersion modelling assessment, they were used as a basis for comparison of the meteorological modelling results.

12.14 Noise and Vibration Baseline Summary

A detailed baseline assessment was conducted in 2007, documented in a baseline noise assessment report (RWDI, 2008; DEIS Appendix 5D-1). The basic procedure to establish baseline noise levels consisted of:

- conducting measurements and recordings of sound levels at three Project locations (Milne Port, the Mine Site, and Steensby Port);
- validating the data based on the recordings and weather information; and
- calculating the resulting validated sound level data.

In the absence of specific requirements for Nunavut, the noise measurement requirements of D038 and Ontario Ministry of the Environment Publications NPC-103 were followed (MOE, 1977).

Monitoring Locations

Sound level meters were operated for a period of approximately 10 days in July 2007 near the Mine Site, Steensby Inlet, and Milne Inlet. The locations of sound monitoring stations were chosen such that there would be minimal effect from the exploration activities underway at the time. Effects from frequent low-flying aircraft were unavoidable, but were removed during the data validation analysis. Distances of approximately 2 km from the exploration activities at the Mary River site, and approximately 1 km from the exploration activities at the Steensby and Milne sites were found to be sufficient to prevent interference from noise from most other human activity. Locations of the sound monitoring stations are shown in Figure 12.18.

Baseline Noise Environment

The Local Study Areas are not presently influenced by any existing permanent anthropogenic noise sources due to their remote location. The only anthropogenic noise generated in the Project area comes from the existing mineral exploration, baseline environmental data collection activities associated with the Project, and the occasional traditional use of the area by hunters, trappers, and fishermen.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Background atmospheric noise levels in remote areas are typically low, ranging from about 25 to 40 dBA. These typical values are similar to those measured for the Mine Site, Steensby Inlet and Milne Inlet sites. Table 12-4: Baseline Noise Monitoring Results shows measured ambient noise values for each of these three sites. At these levels, noise would be described as faint.

Table 12-4: Baseline Noise Monitoring Results

Site	L_{eq} (24 h)	L_{eq} (Day, 15h)	L_{eq} (Night, 9h)	Minimum L_{eq} (1 h)	Maximum L_{eq} (1 h)
	(dBA)	(dBA)	(dBA)	(dBA)	(dBA)
Mary River	25	25	26	20	34
Steensby Inlet	29	31	26	23	35
Milne Inlet	30	31	29	21	35

Noise observed at all three sites consists mainly of wind, insect, and small animal or bird noise. At the Steensby Port and Milne Port sites, some noise from the water (i.e. flowing water sounds and waves breaking) contributes to the baseline noise levels as well. Differences observed between daytime and nighttime sound levels are generally small, and are attributed mainly to very low level noise from human activity which could not be screened out. Daytime and night-time sound levels are expected to be very similar in the absence of human activity.

Comparison with Other Northern EIAs

The measured ambient sound levels presented in Table 12-10: Qualitative Characterization of River Systems are quieter than those used as the basis of D038, which assumes an average rural ambient sound level of 35 dBA, and are quieter than those measured in ambient surveys conducted for other northern locations (e.g., in the Northwest Territories), and those measured by the Ontario Ministry of the Environment for wind noise in rural locations (MOE, 2004). The main reason for this is likely the relative lack of noise from vegetation for the Baffin Island locations (lichens and low-lying grasses/bushes at the Project sites, versus trees, shrubs and tall grasses at other more southern sites).

Baseline Vibration Environment

As there are no anthropogenic sources of vibration in the area, other than Baffinland-related activities, no baseline vibration measurements were judged necessary.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Local Study Area

Local Study Areas (LSAs) were selected to represent areas where noise and vibration effects associated with the Project are likely to occur, and to illustrate the spatial distribution of these effects. Boundaries of the LSAs were located where sound levels with the Project were anticipated to be similar to background sound levels without the Project. LSAs are offset from the PDA by 3 km.

No regional study area has been defined where there are other local anthropogenic noise effects. This is consistent with the approaches taken in other environmental assessments in Nunavut and the Northwest Territories.

12.15 Landforms, Soils and Permafrost Baseline Summary

An understanding of ground conditions is essential for any Project development, and is particularly important when selecting the locations of mine related facilities, including infrastructure and transportation corridors. Surface and subsurface conditions must be considered in the design of any Project, and investigations were conducted at the Mary River Project sites to confirm the conditions. A key aspect of the Mary River Project is related to permafrost management and the designs must address the need to minimize disturbances so as to preserve the integrity of the ground surface, protect the natural resources, and also protect Project infrastructure and operations.

In addition to permafrost, other aspects related to ground conditions that are addressed in this EIS include:

- landforms and soils - identification of soil types and landforms in areas likely to be affected by Project implementation;
- bedrock geology - focussing on rock types and structural geology;
- geotechnical and geomechanical conditions - identification of the geotechnical properties of the soil and bedrock relating to permafrost, slope stability and bearing capacity of foundations;
- geochemistry - characterization of waste rock, stockpile materials, borrow materials, and ultimate pit wall rocks to determine the potential of the materials to react upon exposure to atmospheric conditions; and
- groundwater - the physical and chemical characteristics of groundwater flows and the interactions with permafrost.

The effects of the Project on landforms, soils and permafrost will be limited to the area of development. Therefore, the Local Study Area (LSA) for landforms, soils and permafrost is defined as the Potential Development Area (PDA) for the various Project components. Investigations on landforms, soils and permafrost were completed within the PDA.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.15.1 Landforms and Soils

Topography

The raised Canadian Shield forms a discontinuous longitudinal mountain range termed the Arctic Cordillera, part of which occurs along the northeast coast of Baffin Island. The Penny ice cap in the southeast and the Barnes Ice Cap on the central part of Baffin Island are the largest icefields on Baffin Island.

Topography varies considerably across the Project's terrestrial RSA. Figure 12.21 shows the relief across North Baffin Island, and the topography as it relates to Project features is described below, starting in the north at Milne Inlet and extending towards Steensby Port in the south.

The PDA at Milne Port is situated on a relatively broad, deep and flat sand beach. Milne Inlet itself is closed in by steep fiord walls measuring approximately 60 to 600 m above sea level.

Moving inland, the Milne Inlet Tote Road follows the Phillip's Creek valley, which starts near sea level at Milne Inlet and rises to an elevation of 188 m above sea level (asl) at the Mine Site. The Phillip's Creek valley is confined by hills or mountains on both sides. To the west of the Phillip's Creek valley in particular is mountainous terrain with some occurrence of glaciers.

At the Mine Site, Deposit No. 1 (Nulujaak) rises quickly to 679 m asl from the fairly flat and sandy outwash plain at 188 m asl where the exploration camp is currently located. Nulujaak is a major landmark for Inuit travelling on the land and is part of a ridge trending approximately north-south, and the land to the west is equally mountainous with some minor coverage of glaciers. East of Nulujaak the land is somewhat rolling with several elevated plateaus formed by horizontal sedimentary deposits.

Moving south from the Mine Site, the undulating outwash plains end near the Ravn River and the area to the south is quite flat and poorly drained. The land begins to drop steeply approaching the Cockburn Lake valley, which has an elevation of approximately 1.5 m on the lake and 359 m (southern) to 379 m (northern) on the adjacent cliffs. South of Cockburn Lake to Steensby Port, the land becomes more flat with mainly undulating bedrock and boulder expressions.

Surficial Geology

The drainage features, landforms and surface deposits of the region all attest to the widespread and relatively recent glaciation of Baffin Island. Residual snow fields and vertical ice caps still present in the mountainous regions on the eastern part of the island support this. Thick, unconsolidated deposits of glacial till that lie relatively undisturbed on the slopes and hillsides despite the lack of vegetation, further reinforces this theory.

The surficial geology of the area generally consists of locally abundant Holocene glacio-lacustrine sediments, alluvial sediments (alluvial deposits), marine and glacio-marine deltaic sediments and end moraine till, with occasional outcrops of pre-Quaternary bedrock and sedimentary rock formations

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

(Figure 12.22). The Holocene glacio-lacustrine sediments are typically in the range of 1 to 10 m thick, consisting of proglacial sand and gravel outwash. The sediments commonly form braided floodplains, terraces, and fans. The early Holocene and Wisconsinan tills are mainly veneers and blankets. Till veneers are 0.5 to 2 m thick and discontinuous. Some veneer surfaces are reinforced with boulders, either due to washing by subglacial meltwater or permafrost processes, and restrict outcrop exposures. Till blankets are undulating and in the range of 2 to 10 m thick with drumlins and ribbed moraines in places.

Boulder tills are the dominant surface material, blanketing the majority of the region and restricting outcrop exposures to the high ridges, stream canyons and steep escarpments. In general, drainage in the region is poorly developed on the till plains as insufficient time has elapsed since glacial recession to allow good drainage to evolve. As a result, vast areas, particularly on the higher plateaux, are water saturated during the melt period.

Alluvial benches and kame terraces of sand and coarse gravel typically cling to the walls of the canyons and fill the stream valleys along the western flank of the precambrian mountains. These localized valley deposits are typically well drained making land travel over these areas very good within a short period of time after the snow melts.

The following provides some more specific observations associated with the surficial geology at some of the proposed Project infrastructure locations/sites.

Mine Site - The Project is located in a major glaciofluvial outwash deposit in what appears to be a classic "U' shaped valley. In addition to the glaciofluvial deposits, there are some direct glacial deposits consisting of kames, moraines and eskers in and around the south-eastern portion of Sheardown Lake. The outwash valley is essentially a relatively flat plane with very little local relief, the major exceptions being along water bodies, esker deposits and adjacent to valley edges. Valley walls are generally steep and abrupt, often with distinct terraces. The surficial geology of the Mine Site area is shown on Figure 12.23.

Milne Inlet Tote Road - The Tote Road alignment generally follows a glacial valley oriented northwest-southeast to the Mine Site. The surficial deposits along this alignment include till veneer or blankets on the higher elevations with some drumlins and moraines. Glaciofluvial outwash sediments (gravel and sand) forming braided floodplains, terraces and fans or stratified glacial drift (gravel and sand) are typically found in the valley floors. Limited bedrock exposure is present along the Tote Road.

Milne Port - The dominant landforms in the Milne Inlet area are typically a result of glacial activity, marine and mechanical forms in various degrees. Glacial activity is not overly apparent on the immediate Port site but is more pronounced in the higher elevations south of the site. Marine and mechanical features are most predominant with terraces and strand (beach) lines formed by marine action which have been cut by mechanical features, some of which may be attributed to permafrost. Wind appears to have been responsible for some drifting on the finer grained soils on the lower part

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

of the site. Recently deposited colluvium is present on many of the slopes and side hills in the area. The action of surface water has produced numerous sharp gullies along water-ways. Marine clays were also noted at some locations at the site.

Railway - The topography of the RSA is generally quite hilly, with the exception of the Ravn River area which is relatively flat. Glaciated valleys are evident along a significant portion of the alignment. The surficial geology of the RSA is also characterized by the relatively recent glacial activity of Baffin Island. Surficial geology consists of several types of deposits including glacio-lacustrine sediments, alluvial sediments (alluvial deposits), end moraine till, and till veneers and blankets. Occasional outcrops of pre-Quaternary bedrock and sedimentary rock formations are also common along the southern section of the SRA.

Steensby Port - Near surface bedrock is dominant in the Steensby Port area. Limited overburden is in the form of marine sediments and localized deposits of till. The majority of the overburden is located in depressions between the numerous bedrock outcrops and is typically overlain by a layer of vegetation and boulders.

Surficial Soils Composition

A soils evaluation was carried out in 2007 and 2008 by an arctic soils specialist (Veldhuis, 2010). Regionally, soil formation is controlled and limited by year-round low soil temperatures, low precipitation rates and near-surface permafrost. Soil formation occurs in the thin layer overlying the permafrost that is subject to seasonal thawing, known as the active layer. The thickness of the active layer varies substantially across the region with topography, depth to bedrock, and vegetative or water cover but is typically between 1 to 2 m thick in the Project area depending on the local soil cover.

Project area soils were classified based on the Canadian System of Soil Classification (Soil Classification Working Group, 1998), and included primarily Cryosols (permanently frozen soils or soils with permafrost within 100–200 cm of soil surface) and Brunisols (soils with weak B horizon development). In general, Project-area soils all showed weakly developed horizons, with a general lack of organic material accumulation. Fine- to medium-textured soil materials were generally cryoturbated, and patterned ground phenomena related to permafrost and freeze-thaw cycling were also commonly observed throughout the RSA. Soils throughout the RSA were generally poor in nutrients (Table 12-5: Total Amounts of Organic Matter and Primary Nutrients in Soils in the Project Area). This factor, in combination with the depressed level of pedogenic development in the area and thinness of soils where present, generally make local soils unsuitable for stockpiling for revegetation purposes (Veldhuis, 2010).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-5: Total Amounts of Organic Matter and Primary Nutrients in Soils in the Project Area

Parameter	Concentration Range per Horizon, %			
	B Horizon (sandy)	C Horizon (sandy)	B and C Horizons (loamy)	A Horizon
Organic Matter	0.83 (0.17 - 2.21)	0.34 (0.17 - 0.51)	2.81 (0.17 - 5.44)	13.72 (2.38 - 26.00)
Nitrogen	0.04 (0.02 - 0.08)	0.03 (0.02 - 0.04)	0.15 (0.012 - 0.36)	0.93 (0.09 - 1.14)
Phosphorous	0.03 (0.01 - 0.09)	0.07 (0.04 - 0.11)	0.04 (0.02 - 0.10)	0.06 (0.06 - 0.11)
Potassium	0.13 (0.05 - 0.36)	0.15 (0.09 - 0.25)	0.47 (0.16 - 0.69)	0.08 (0.06 - 0.11)
Sulphur	< 0.01	< 0.01	0.02 (0.01 - 0.05)	0.06 (0.01 - 0.10)

NOTE(S):

1. FROM VELDHUIS, 2010.

Permafrost

The Project is located in a zone of continuous permafrost. The active layer through the Project area typically ranges from approximately 1 to 2 m but may be greater in areas where there is loose, sandy soil at the edges of lakes or ponds and less in areas with a substantial surface layer of wet organics. Unfrozen 'taliks' can exist within areas of continuous permafrost below lakes, under major rivers or near the coast. Taliks may exist under lakes within the terrestrial RSA, particularly larger lakes such as Mary Lake, Angajurjualak Lake and Cockburn Lake; however, this was not fully investigated because the presence of taliks under these lakes is inconsequential to the Project. No taliks have been confirmed in any of the on-land drilling completed for the Project, including Steensby Inlet.

Permafrost thickness in and around the RSA is considered to be deep, typically in the 400–700 m depth range (Knight Piésold, 2010a). In 2007, a 400 m thermistor installed into Deposit No. 1 showed that the depth to permafrost is predicted to extend to 610 m at this location (Figure 12.24) which is well below the planned depth of mining. This is consistent with regional measurements at the former Nanisivik Mine, where permafrost was measured at depths greater than 430 m (Gartner Lee, 2003), and at drillholes located 450 km west and 450 km south of Pond Inlet, with measured permafrost depths of 500 m and 400 m, respectively (Geological Survey of Canada, 2006).

Over fifty ground temperature monitoring instruments (thermistor cables) were installed and sporadically monitored between 2006 and 2008 to determine typical ground temperatures in the

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

overburden soils and bedrock across the RSA. Many were installed to depths sufficient to define the typical stable temperatures in the permafrost soils below the depth of zero annual amplitude. The depth of zero annual amplitude in temperature fluctuation appears to exist at depths of between 10 and 15 m in the valleys. At that depth, the "typical" permafrost temperature is roughly -10°C.

In general, permafrost greatly increases ground stability at depth but at surface it can affect the rates of soil erosion through the formation of ice wedges and patterned ground, pingos and palsas, massive ground ice, solifluction, etc. Changes to the thermal regime resulting from surface disturbance or climate warming can lead to thawing of the permafrost causing the formation of thermokarst topography and mass wasting. Thaw instabilities or soil weakening can also occur either naturally as part of the annual cycle within the active layer or as a result of increased thaw due to change. A more detailed description of issues associated with ice-rich and thaw sensitive soils in relation to Project components and proposed design measures to offset these issues is provided in Section 2.3. Additional detail related to the potential implications of climate change on the permafrost and recommended design measures is provided in Volume 9, Section 2.2.

Unique and Valuable Landforms

The surficial landforms and deposits in the RSA are evidence of the recent, widespread glaciation on Baffin Island. The surficial deposits include thick, undisturbed and unconsolidated deposits of till on slopes and hillsides, glacio-lacustrine sediments associated with historic lakes or coastal regions, glaciofluvial and alluvial deposits along waterways in valley bottoms, marine and glacio-marine deltaic sediments and lateral or end moraine till deposits. These surficial landforms are not particularly unique in themselves; however, subsequent periglacial processes (including the presence of and development of ground ice, and soil and rock weathering, mass movement and erosion) continue to be the dominant forces shaping the landscape of the region. These processes result in ground ice accumulation, frost heaving, sorting of materials within the upper soil matrix, fracturing of the upper bedrock profile and the development of patterned ground (tundra polygons), drumlins, pingos and thermokarst lakes.

Fragile landscapes in the RSA are generally associated with frost/thaw sensitive till blankets and the presence of massive ground ice within glaciofluvial deposits. Pingos are one such phenomenon. No pingos were identified during the geotechnical investigations. A number of significant polygons and areas of high potential for ground ice content are present along the Tote Road alignment and in the vicinity of the Mine Site.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.15.2 Bedrock Geology

The following sub-sections summarize the baseline information available on bedrock geology in the Project area, based on field geological exploration programs conducted by Baffinland geologists from 2004 to 2008 and summarized by Aker Kvaerner (2008).

Regional Bedrock Geology

The North Baffin Island region and Mary River area lie within the Committee Belt, a granite-greenstone terrane mixed with rift basin sediments and volcanic rocks. The belt lies within the Churchill Province, extending from Baker Lake to Greenland, and is divided into five major assemblages: the Archean, the Mary River Group, the Piling Group, the Bylot Supergroup, and the Turner Cliffs-Ship Formation (Aker Kvaerner, 2008).

The Mary River iron deposits are located within the Mary River Group, an assemblage of Late-Archean (2.76 to 2.72 Ga) metasedimentary to metavolcanic rocks that have been folded and preserved in greenstone belts (Aker Kvaerner, 2008). The Mary River Group greenstone belts are present as fragmented remnants stretching from Bylot Island south to Eqe Bay (Figure 12.25), with a maximum thickness of 4,000 m. Major sequences within the Group consist of a lower series of metavolcanic rocks and an upper series of turbidite pelitic-greywacke; the stratigraphic position of iron formation, quartzite, conglomerate, minor marble, and volcanic breccia units within the belts, which varies across the region. The Mary River Group is part of the regional Committee Belt, an Archean-aged (2.9 to 2.5 Ga) assemblage of granite-greenstone terranes, granitic migmatites gneissic granitic intrusions, and clastic and carbonate sedimentary units reworked during the Paleo-Proterozoic (2.5 to 1.6 Ga).

Iron Ore Deposit Geology

Iron formations occur in varying thicknesses discontinuously within the Mary River Group metasedimentary units but are typically not present in economically extractable thicknesses or configurations except in the Mine Site area. The high-grade iron ore at Deposits No. 1, 2, 3 and 4 were discovered in 1962, and these initial hematite-magnetite mineralized zones were mapped within extensive belts of banded iron formation in the area over the next three years. Deposit No. 5 was discovered and surface mapped in 2009. The deposits are characterized by zones of massive layered to brecciated hematite to magnetite, variably intermixed with banded oxide to silicate facies iron formation. As typified at Deposit No. 1, the high-grade iron formations are interlayered with thin bands of chlorite-actinolite schist, staurolite-garnet-mica schist, amphibolite, and banded iron formation across their strike width, with the entire assemblage up to 400 m thick.

The Mary River iron deposits are considered to belong to an Algoma-type iron formation (Aker Kvaerner, 2008) formed in a volcanic ark setting in an extensional or rift basin during the Archean. Algoma-type deposits are typically characterized by a lower series of volcanics followed by

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

banded iron formation and/or interlayered to pure iron oxides of variable and potentially substantial thickness, in turn overlain by volcanics and volcaniclastic sediments (Gross, 1996).

Deposit No. 1 Mineralization

Deposit No. 1 is the largest of the five iron deposits defined to date in the Mary River area, with a total strike length of 3,800 m (Aker Kvaerner, 2008). Based on magnetic surveys, the deposit may extend a further 550 m to the south and 750 m to the north of the main outcrop along Nuluujaak. The deposits are localized within the nose and along the limbs of a northeast-plunging syncline. Economic mineralization consists of a high-grade iron oxide formation containing hematite (Fe_2O_3), magnetite (Fe_3O_4), and specularite (a form of hematite) denoted the "lower zone" and interlayered iron (magnetite) formation and schists (the "middle" and "upper" zones). In Deposit No. 1, the lower zone forms a tabular body ranging from 105 to 150 m thick, bounded by a chlorite-amphibole schist hanging wall and a predominantly quartz-feldspar-biotite gneiss footwall.

Drill core samples revealed the presence of visible sulphides (including paite and parhotite) in selected samples, primarily occurring in disseminated form, or as small vein-like occurrences within some of the deposit rocks. Sulphide oxidation is the primary mechanism for formation of acidic drainage in mine wastes, thus sulphide presence in the Mary River waste rock, borrow, and stockpile materials is of interest. Within the deposit, sulphides are thought to be predominately associated with magnetite-rich oxides (Aker Kvaerner, 2008) although it is not known whether the sulphide occurrence is lithologically controlled. The extent and total distribution of the sulphides is not known but they appear discontinuous. Recent drill core observations suggest that the majority of the recovered material has zero to trace amounts of visible sulphides.

Palaeontology

Baffinland retained Dr. Natalia Rybczynski of the Canadian Museum of Nature to conduct a desktop review of potential palaeontological resources (inclusive of palaeobotanical resources) in the region (DEIS Appendix 6A). Rybczynski (2008) identified potentially fossiliferous lithologic units outcropping near the Project area include Paleozoic carbonates of the Gallery and Turner Cliffs Formations (Cambrian to Ordovician), Ship Point Formation (Ordovician) and Baillarge Formation (Ordovician to Silurian). These units have a total combined thickness on the order of 1 km in the northern Baffin Island area, and are shown on Figure 12.25. Fossils known to be present in these units in the Admiralty Inlet region (west of the Mary River Project area) include invertebrate fossils such as shells and sponge-like organisms. In the Project area, these units are typically covered by recent glacial and fluvial sediments occurring along both sides of the Milne Inlet Tote Road beginning around km 22 from Milne Inlet for the next approximately 60 km, at which point they occur on the southwestern side of the Milne Inlet Tote Road all the way to the Mine Site, and continue to occur along the southwestern side of the Railway alignment for the first approximately 30 km south of the Mine Site. As the surficial geology map shows (Figure 12.22), surface exposures of these bedrock units are uncommon.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Petrology

Two petrographic studies have been completed on suites of rock samples from Deposit No. 1, mainly to characterize specific, non-representative portions of the orebody and associated interleaved schist, to investigate specific zones with elevated amounts of substances that are considered undesirable in iron ore used for making steel. Baffinland is currently supporting an MSc thesis that will (in part) expand the petrographic and probe work to other portions of Deposit No. 1 and look at more of the associated host lithologies.

Regional Seismicity

Major regional bedrock structures include a northwest-trending fault set system and the Central Borden Fault, a crustal-scale structure which extends more than 200 km northwest from Angajurjualak Lake to Milne Inlet. This forms the southern boundary of the Mary River iron deposits. These major fault systems typically show very large displacements both vertically and horizontally.

The majority of recorded earthquakes in the Baffin Island region are concentrated along the east and northeast coastline and within the northwestern area of Baffin Bay. Most of these events are small earthquakes with magnitudes of less than 5.0. However, some moderate to large earthquakes have been recorded in this region, the largest being a Magnitude 7.3 earthquake in 1933, located over 150 km off shore in Baffin Bay. This is the largest earthquake to be recorded north of the Arctic Circle.

A seismic review was performed in support of the Railway embankment design (Knight Piésold, 2008b) using information from the seismic hazard database of Natural Resources Canada. Information obtained included determination of seismic coefficients and horizontal Peak Ground Acceleration (PGA) value. PGA values for a range of earthquake return periods ranging from 100 years to 2,500 years are summarized in Table 12-6: Preliminary Seismic Parameters for the Project Area.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-6: Preliminary Seismic Parameters for the Project Area

Return Period (Years)	Probability of Exceedance[1] (%)	Mine Site Peak Ground Acceleration (g)[2]	Steensby Port Peak Ground Acceleration (g)[2]
100	39	0.051	**0.033**
475	10	0.114	**0.067**
1000	5	0.163	**0.089**
2500	2	0.246	**0.120**

NOTE(S):
1. PROBABILITY OF EXCEEDANCE CALCULATED FOR A DESIGN LIFE OF 50 YEARS.
2. PEAK GROUND ACCELERATIONS ARE FOR "VERY DENSE SOIL AND SOFT ROCK" (SITE CLASS C), AS DEFINED BY THE NATIONAL BUILDING CODE OF CANADA.

In accordance with the National Building Code of Canada, the maximum considered earthquake ground motion has been defined as the ground motion with a 2% probability of exceedance in 50 years (return period of 2,500 years). Based on the findings of the seismicity assessment, an appropriate design earthquake for foundations and structures at the Mine Site area is the 1 in 2,500 year earthquake, with an estimated maximum bedrock acceleration of approximately 0.25g. At the Steensby Port site the estimated maximum bedrock acceleration for the design earthquake is approximately 0.12g. The peak ground acceleration for the Steensby Inlet port site is significantly lower due to a rapid decrease in the apparent seismic hazard along the western side of Baffin Island. Potential earthquakes of these magnitudes will be incorporated into facility engineering designs, in compliance with National Building Code of Canada regulations.

12.15.3 Geotechnical and Geomechanical Conditions

Geotechnical (soil mechanics) and geomechanical (rock mechanics) investigations were conducted from 2006 to 2008 to evaluate the soil, bedrock and permafrost conditions at locations where major Project infrastructure will be situated at the Mine Site, Railway and port facilities.

Air photo interpretation (API) studies were undertaken by Knight Piésold Ltd. and EBA Engineering Consultants Ltd. (EBA). The interpretations were completed for the Mine Site area, rail alignment (including the Ravn River alternative alignments) and Steensby Inlet Port Site (Knight Piésold, 2008d - 2008g). The objectives of the API were to:

- Map the surficial deposits along in areas of Project infrastructure
- Identify and map hazardous permafrost-related geomorphic processes and landforms and recent slides
- Aid in the scoping of ongoing site investigation programs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Black and white aerial photographs taken at a scale of 1:30,000 in 2005 were used in this study. The air photos were examined with a stereoscope. The mapping incorporated the delineation of surficial geology units, relief features and hazardous permafrost-related geomorphic landforms and recent landslides in the vicinity of the Railway alignment. The base maps used for mapping included the ortho-rectified images and the 5 m contours from the LIDAR survey. To supplement these results, the entire Railway alignment was walked by foot in July-August 2007 and observations of ground conditions were recorded and used to update the air photo interpretation.

In addition to the API, the methods that have been used for the Project include the following:

- Site reconnaissance and surface mapping for all areas
- Geotechnical drilling using diamond drilling techniques
- Excavation of shallow test pits by hand and mini-excavator
- Collection of soil and bedrock samples for on-site and laboratory testing
- Installation and monitoring of thermistors
- Oriented core drilling for rock mass classification
- Geophysical surveys.

The drilling, thermistor installations and test pitting completed between 2006 and 2008 by Project area are summarized as follows:

Milne Port (including docks, stockpile areas, airstrip, roads)

- Geotechnical Drilling - 13 holes

Milne Inlet Tote Road (including road alignment, rock quarries and borrow sources)

- Test Pits - 22 locations

Mine Site (including open pit, general plant infrastructure and waste rock stockpile)

- Geotechnical Drilling - 76 holes
- Geomechanical Drilling (open pit) - 15 holes
- Thermistor Installations - 6 thermistors
- Test Pits - 19 locations

Railway Alignment (including foundations, bridges, rock cuts and tunnels)

- Geotechnical Drilling - 419 holes
- Geomechanical Drilling (tunnels) - 4 holes
- Thermistor Installations - 45 thermistors
- Test Pits - 284 locations

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Steensby Port Site Area (including on-shore infrastructure and docks)

- Geotechnical Drilling (off-shore) - 32 holes
- Geotechnical Drilling (on-shore) - 53 holes
- Thermistor Installations - 3 thermistors
- Test Pits - 11 locations

Borrow and Quarry Sources

- Geotechnical Drilling - 29 holes
- Test Pits - 19 locations

The results of the geotechnical investigations were summarized in a series of reports completed between 2006 and 2010 (Knight Piésold, 2006, 2007a, 2007b, 2008a, 2008b, 2008c, 2008g, 2008h, 2010a, 2010b, 2010f; AMEC 2010a and 2010b).

The results were used for development of design recommendations and approaches for the Project infrastructure. Recommendations related to foundation design, rail routing and embankment/bridge design, waste rock storage design, and slope design for the open pit and other excavations have been provided and incorporated into the design development of the various Project components.

Geotechnical Overview

The geotechnical conditions associated with the Project areas are summarized as follows:

Milne Port

The Milne Port area consists of a series of variably dipping, dissected terraces sloping towards the waters of Milne Inlet. The surficial deposits are marine and glacial marine sediments, ranging from coarse beach sediments (gravel and sand) to finer deltaic sediments (clay, silt, sand and gravel) to even finer deep water periglacial silt veneers (silt, clay and fine sand). The soils in the area are often covered by a thin layer of organics at the ground surface. The soils were noted to typically be frozen below 2 m depth and contain ice lenses (AMEC, 2010a).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Milne Inlet Tote Road

The Milne Inlet Tote Road generally follows a glacial valley oriented northwest-southeast to the Mine Site. The surficial deposits along this alignment were reviewed in 2006 (Knight Piésold, 2006), in 2009 (EBA, 2009) and most recently in 2010 (AMEC, 2010b) and generally include the following materials:

- till deposits - veneer (up to 2 m thick) or blanket (up to 10 m thick) with drumlins and moraines (in places);
- glaciofluvial sediments - outwash gravel and sand forming braided floodplains, terraces and fans or stratified glacial drift (gravel and sand);
- limited bedrock exposure - especially nearer to the Mine Site/Deposit No. 1 area; and
- Mary River flows across the glacial valley to the southeast of the Mine Site, and several thaw lakes and thermokarst depressions are located along the valley floor.

Mine Site

The results of recent investigations completed for the Mine Site areas were summarized in a series of factual reports (Knight Piésold, 2007a, 2008b, 2010b). Deposit No. 1 is located along the top and margins of a bedrock hill on the north side of the valley, while the waste rock piles will be located along the west-facing and east-facing side slopes of the bedrock hill. Bedrock is exposed at the apex of the deposit with talus being present on the upper slopes. The mid slopes on the east side of the deposit posses up to 50 m (vertical depth) of glacial till, tapering out to near surface bedrock at the base of the slope. The till on the north and west side of deposit is shallower, in the 10 to 15 m range. The till around Deposit No. 1 is typically dominated by boulders, cobbles, gravel and trace to some organics and a moderately thick, wet organic layer is present over the majority of this upper area. The overburden materials are considered to be very ice-rich based on site investigations, observations from bulk sample road construction and general understanding of the deposit.

Other Project-related infrastructure in the Mine Site area will be located on areas of glaciofluvial terrace along the valley floor directly south and southwest of Deposit No. 1. In addition to the glaciofluvial deposits, there appears to be some direct glacial deposition in and around the south-eastern portion of Sheardown Lake. Overburden depths over the majority of the valley floor are typically noted to be in the 10 to 20 m thickness ranges. Based on the investigations and surficial features in and around these deposits, evidence of ice-rich areas and localized massive ice bodies are present. A thin organic layer is present in some areas, over the till, in depressions and at the base of some slopes.

Underlying the glaciofluvial materials southwest of the deposit in the valley floor is weak, unconsolidated sandstone; gneissic bedrock to the south, west and north of Deposit No. 1; and amphibolite schists to the east. Often, the upper horizon of the bedrock is highly fractured and often contains ice lenses and/or infilling in the joints.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Steensby Port

In general, the area was found to be primarily either exposed bedrock hills or bedrock very close to surface. Lower depressions between the hills generally have a moderate layer of wet organics at surface and drainage is poor. These lower areas have a range of materials present from colluvial/alluvial type deposits to till with significant fines present. In areas where overburden was present, this generally comprised of a thin layer of organics, underlain by moist gravely sand with some silt with some higher ice content and ice-rich materials noted. Some clay and silt materials were encountered toward the southwest side of the site. Overburden depths greater than 13.5 m were encountered; however, typically the depth of overburden ranges from 4 to 8 m in these lower areas. The underlying granitoid gneiss bedrock is generally of moderate to good quality across the footprint of the proposed rail maintenance shop.

Geomechanical Overview

Mine Site

The results of investigations completed to study the rock associated with the open pit was previously summarized in the investigation and design recommendations report for the open pit (Knight Piésold, 2010a). At the Mine Site, specifically in the area of the proposed open pit, a number of different rock masses were identified and investigated and subsequently divided into geomechanical domains for design purposes. The domains were defined along lithological boundaries and three main geomechanical domains were identified:

- Hangingwall Rocks consisting primarily of Tuffs, Amphibolites and Schists.
- Ore Body consisting primarily of High Grade Magnetite, High Grade Hematite and Mixed Ore.
- Footwall Rocks consisting primarily of a Gneissic rock mass that locally grades to Schist.

Although there are some strong local variations, each domain generally has discontinuities from three main joint-set families and will often appear blocky when exposed on the pit walls. In some cases the minor joint-set orientations will be widely spaced and in other cases a wide range of orientations will be present at the same location and local ravelling failures will be likely. In all cases, the dominant discontinuity can be expected to be parallel to the local dip of the Ore Body and its orientation will change depending on position relative to the Deposit No. 1 syncline.

Unconfined Compressive Strength (UCS) results from the field and laboratory testing suggest medium to strong intact strengths of 30 to 85 MPa for each domain. Rock mass qualities as suggested by the Rock Mass Rating (RMR89) system, vary widely but are generally in the fair to good range. The exception to this is within the Fold Axis (the point where the North and South Limbs join) where all rock mass qualities were poor to fair. The diamond drilling program encountered a relatively large number of shears and faults, which can be characterized as sheared, broken or rubble zones. These regions also have reduced rock mass qualities and were more frequently encountered in the hangingwall and the Ore Body domains. While some of these are likely to locally affect bench

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

integrity and could even affect overall wall stability at some locations, investigations from nearby drillholes suggest that a substantial proportion of these may not cross-cut lithology or be particularly persistent.

Potential Quarry Sites

The results of investigations completed for the quarry sites were recently summarized in the site investigation report for the Railway (Knight Piésold, 2010f). Potential borrow source/quarry locations visited were given an overall site suitability rating from poor to good based on a combination of estimated size, haul distance to right-of-way, material suitability and constructability. Further work will be completed on these potential material sources as the Project advances through the more detailed design phases.

In terms of the ballast testing, the results of the AMEC laboratory testing on the saw-cut suggested that only one of the eleven samples passed the Los Angeles Abrasion test, seven met the requirements for the Mill Abrasion test and all tests failed to meet the limits specified for shape factor.

12.15.4 Geochemistry

Geochemical assessments of the potential for metal leaching and acid rock drainage (ML/ARD) have been completed for the Mine Site and for prospective quarry and borrow sites along the Railway alignment and existing Milne Inlet Tote Road (to be upgraded). A summary of the work completed is provided in the following sections.

Mine Site

AMEC (2010c) has evaluated existing geochemical studies and completed additional sampling of rock materials from drill core that are expected to be representative of the waste rock produced during mining. Geochemical characterization of rock materials from this and previous studies has been completed using industry-standard ML/ARD assessment techniques. In addition, AMEC has evaluated drainage and runoff data from existing stock piles to assess the potential mine drainage quality at the site during mine operations and closure. A full report on these studies is provided in DEIS Appendix 6B-1 and summarized below.

A total of 277 drill core waste rock samples (including an additional 180 samples from current studies) were submitted for Acid-base Accounting (ABA) testing. Results of this testing has determined that approximately 86% of the waste rock samples are unlikely to generate acidic drainage in the future. The remainder of the samples were classified as potentially acid generating (PAG) materials.

Drainage quality expected at the site, based on monitoring of existing ore stock piles, is expected to be circum-neutral to mildly acidic (pH 5.5 to 6) with generally low metal concentrations.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The current mine plan includes encapsulation of the PAG rock within the core of the waste rock pile. Based on the proportion of PAG samples and the findings of the ML/ARD characterization study, this proposed approach appears to be a viable method for minimizing any ML/ARD effects on the environment. Additional geochemical studies including further kinetic testing are continuing to evaluate and refine this option. Additional testing is planned to better understand the kinetics of potential acid leaching behaviour and further refine the expected drainage quality and metal leaching behaviour from materials at the site.

Milne Inlet Tote Road

A screening level ML/ARD assessment has been completed for a number of proposed quarries and borrow pits along the existing Milne Inlet Tote Road. Full details of this investigation (AMEC, 2010d) are provided in DEIS Appendix 6B-2 and summarized below.

Drill core and unconsolidated surficial materials were collected from potential quarry and borrow pit locations along the Tote Road route during a geotechnical investigation and aggregate sourcing program recently completed by AMEC. Selected samples from this program were submitted for geochemical analyses. The objective of sample selection for ML/ARD characterization was to collect samples which are representative of the geochemical variation of the different soil and rock types expected to be used as borrow and quarry material for the Milne Inlet Tote Road upgrade.

The geology along the route includes both relatively flat lying Paleozoic sedimentary rocks and more structurally complex Precambrian rocks. Potential quarry sites sampled for this study include granitic gneiss and schist along the Precambrian portion of the route and carbonate rich sedimentary rocks in the Paleozoic section. Borrow materials sampled include sand and silty sand with variable quantities of gravel, cobbles and boulders.

Sulphide content of all samples was low (maximum of 0.04% total sulphur), and all Paleozoic rock samples analyzed were carbonate rich (mostly limestone or dolomite). Borrow materials were also carbonate rich with only a single sample that was carbonate deficient with a correspondingly low neutralization potential. The Precambrian rocks consistently exhibited a low neutralization potential with little evidence of carbonates. Diligence through adequate levels of sampling and monitoring during extraction operations will be necessary to ensure that the low concentrations of sulphide observed in this study are confirmed elsewhere, particularly for any materials identified as having low neutralization potentials.

Based on this screening level ML/ARD assessment, the currently proposed quarries and borrow pits along the Tote Road route appear to have a low potential for ML/ARD and are expected to be suitable as quarry or borrow sources. Individual quarry and borrow sites will be subjected to additional site specific ML/ARD characterization at a sampling density sufficient to address potential geological variability. Collection and analysis of material from future drilling or excavation programs related to quarry and borrow pit development is planned.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.15.5 Groundwater/Hydrogeology

Groundwater flow in the LSA consists of seepage through unconsolidated materials within the active layer, which typically ranges from 1 to 2 m (up to 3 m) below surface. This groundwater reports to local surface drainages and lakes.

The Project is located in a zone of continuous permafrost, which extends to a Projected 610 m below ground surface at Deposit No. 1. As such, no groundwater flow is anticipated to exist below the active layer. This conclusion is supported by observations at other Mine Sites in northern latitudes, including the Polaris[20] and Nanisivik underground mines, as well as the EKATI™ mine where open pits in moderately faulted granite did not generate groundwater until the pits extended below the limit of permafrost at around 350 to 400 m depth below ground surface (Kevin Jones, pers. comm.).

Based on these empirical examples, the Deposit No. 1 open pit is not expected to develop significant groundwater inflow below the active layer. This is further supported by the fact that the open pit will be developed in relatively high quality bedrock, with minimal faulting. In addition, the area has generally colder mean temperatures, is topographically higher, and has a deeper permafrost zone than the previously cited examples. In addition, site geologists have reported that ground ice is present in fractures in the rock.

12.16 Vegetation

Vegetation within the Mary River Project area is described in the Vegetation Baseline Study Report (DEIS Appendix 6C). Baseline studies were conducted during each of the summers of 2005 through 2008. A total of 833 plots were surveyed across the terrestrial RSA, focusing mainly on the PDA.

A total of 155 vascular plant species were recorded, a vegetation classification system was developed and a species list was compiled. No plant species considered to be “rare” in Canada were found to occur in the survey locations. One unusual association was found, and has been proposed for special protection. Plant species abundance data derived from the vegetation plots were used in the development of an Ecological Land Classification (ELC), described in DEIS Appendix 6D. To help develop an understanding of Inuit Qaujimajatuqangit (IQ) regarding the traditional use of plants by Inuit, studies were carried out with elders in Pond Inlet. Metals analysis of samples of surface soil and plant foliage from 56 baseline stations in the Local Study Area was conducted to establish a baseline of metal concentrations in plants and soil.

[20] The Polaris mine encountered problems with groundwater coming into the mine causing temporary closure of the mine. However, the water was due to thawing of permafrost in ice-rich rock (shale) due to the ventilation system, rather than natural groundwater inflow. The ventilation system was subsequently renovated and there were no additional problems with underground water accumulations in the mine as it was extended to a total depth of approximately 450 meters. The mine was not extended deeper due to incompetence of the shale, rather than groundwater inflow problems. (K. Jones, pers. comm.)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The Regional Study Area (RSA) was identified to ensure that the range of direct and indirect potential disturbances as a result of the Project's activities could be examined and potential effects could be spatially quantified. The RSA was chosen to represent vegetation distribution and abundance at an ecologically relevant scale and to reflect the regional vegetation. The RSA also had to be a reasonable size so that surveys and information could be gathered in an economical fashion and provide information that is directly relevant to Project monitoring and mitigation. The RSA is a 30,711 km^2 area centred on the Project's PDAs (Figure 12.26). The southern end of the study area centres on Steensby Port, the northern portion includes Milne Inlet, and the central portion includes many large lakes to the south and west of Angajurjualuk Lake - the largest lake in the RSA. The RSA for assessing the effects on vegetation is the same as that used for the baseline Ecological Land Classification (DEIS Appendix 6D).

12.17 Migratory Birds and Habitat

Baseline studies were conducted on birds in 2006–2008 and included reviews of regional literature and existing databases, discussions with federal (Environment Canada Canadian Wildlife Service, CWS) and territorial (Government of Nunavut, GN) wildlife agencies, Inuit Qaujimajatuqangit (IQ) studies, and three years of field surveys (Knight Piésold, 2010g and AMEC, 2010c; see Appendices 6E-1 and 6E-2). These studies and consultations were conducted to characterize the pre-existing conditions within the RSA and to identify any important bird issues to be examined during the environmental assessment process. Detailed descriptions of the baseline methods and results are presented in DEIS Appendix 6E-1 and 6E-2. A brief overview of the study areas and a description of bird abundance and distribution is provided below.

Results from the IQ surveys in Pond Inlet, Igloolik, Arctic Bay, Hall Beach and Clyde River indicated that the RSA and LSA contain several areas that are used seasonally by large densities of various bird species (geese, Eiders, ducks, terns, gulls and seabirds), and that some of these species are harvested on a regular basis. Community Elders indicated that most bird species in the area are migratory and typically arrive in late-April, May, and June, and start leaving in August. The IQ studies indicated that some seabirds (murres, northern fulmars), gulls and Eiders are generally the first species to arrive (in April), and that long-tailed ducks, Snow Geese, shorebirds and songbirds typically arrive in June. Fall migration occurs between early August to late October depending on the species and the sex as male birds and non-breeders for some species leave the area much earlier than adult females with young. Some birds such as Common Raven, ptarmigan, and sometimes Snowy Owl winter in the area and some seabirds, such as the Black Guillemot, also remain in the area year-round using the shore leads in the winter.

IQ surveys provided little information on migration corridors but it was noted that "lots" of geese and Eiders fly over Foxe Basin and Steensby Inlet during their spring and fall migrations and can be found nesting near all five communities.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Residents of all five communities indicated that harvesting of birds and their eggs is still important to them but much less so than in the past. The species that were most commonly harvested were Snow Goose, Common and King Eider, Arctic Tern (eggs only), and Long-tailed Duck.

Field surveys documented a number of species as present and/or breeding within the RSA (49 species present, 33 confirmed breeding). A complete list of the 49 species recorded during the 2006–2008 baseline surveys is presented in Appendices 6E-1 and 6E-2.

The diverse environments of the RSA offer an abundant supply of seemingly suitable habitat for marine birds. Three years of surveys indicate that at least 49 species use the area in relatively high densities. At least 33 species were confirmed to be nesting in the RSA. The RSA is a migration corridor for several species of birds (both marine and terrestrial) including Snow Geese, Common and King Eiders, Brant, and Long-tailed Ducks. The five most abundant species were Snow Geese, Common and King Eiders, Brant, Arctic Terns and Long-tailed Ducks. No large, conspicuous seabird nesting colonies were recorded in the Project's LSA although several are known to exist along the outside edges of the RSA, particularly on Bylot Island, in Foxe Basin, and along Hudson Strait. There are two moderately sized Glaucous Gull colonies (>100 individuals) on the cliffs in Milne Inlet, a large Snow Goose colony (>5,000 individuals) on the southwestern shores of Steensby Inlet, and a few dozen female Common Eiders, King Eiders, and Red-throated Loons raising young in the coastal marine waters of Steensby Inlet.

Species at Risk

Six species that could occur in the RSA are listed by COSEWIC (2010) or SARA (Environment Canada, SARA 2010) as Species at Risk:

- Harlequin Duck - eastern population, COSEWIC *Special Concern*; SARA: Schedule 1 *Special Concern*; CESCC: *Sensitive*
- Peregrine Falcon (*tundrius* subspecies) - COSEWIC Special Concern; SARA: Special Concern; CESCC: Secure
- Red Knot - COSEWIC Special Concern; SARA: Special Concern; CESCC: Sensitive
- Ross's Gull - COSEWIC *Threatened*; SARA: Schedule 1 *Threatened*; CESCC: *At Risk*
- Ivory Gull - COSEWIC *Endangered*; SARA: Schedule 1 *Endangered*; CESCC: *May Be At Risk*
- Short-eared Owl - COSEWIC Special Concern; SARA: Special Concern; CESCC: Sensitive.

Many Peregrine Falcon nests were recorded in each of the three years of the baseline studies and these were distributed throughout the LSA and RSA. Three Short-eared Owls were seen in both 2007 and 2008 (six total) but none were seen in 2006, and no nests were found. Harlequin Duck, Ross's Gull and Ivory Gull were observed in low numbers during the marine bird surveys (DEIS Appendix 6E-2). No Red Knot were seen in any of the three years. Details of survey effort and a description of life history characteristics relevant to each species at risk is provided in Appendices 6E-1 and 6E-2.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Waterbirds (Loons, Geese, Eiders, and other Waterfowl)

The five most abundant species of marine birds were, in descending order: Snow Goose, Eider (Common and King), Brant, Arctic Terns and Long-tailed Duck. Marine bird densities were highest in Foxe Basin (largest survey area) and Steensby Inlet (second smallest survey area), and were lowest in Hudson Strait. Seasonal densities were highest in the months of June and August due to large groups of Snow Geese migrating from Bylot Island just north of the RSA. Large groups of migrating Common and King Eider and Long-tailed Duck were also seen throughout the area in August.

There is an abundant supply of wetlands, streams, rivers, and waterbodies of various sizes, ranging from small shallow ponds up to large deep lakes within the RSA. These are used by a high density, but low diversity, of waterbirds including loons, geese, Eiders, and other waterfowl. The average percentage of lakes occupied by waterfowl species within the LSA was 66% (averaged over the three survey years).

Loons

Red-throated Loon, Pacific Loon, Yellow-billed Loon, and Common Loon (in descending order of abundance) were observed in the RSA. All four species were also found scattered throughout the LSA in close proximity to proposed Project components. IQ studies did not indicate that loons are culturally or economically important to local Inuit communities. However, a 1992 study on Igloolik Island found that 73% of all Red-throated Loon eggs laid within the 10 km^2 study site over two breeding seasons were collected by residents of Igloolik (Forbes et al., 1992).

Snow Geese

Each year tens of thousands of Snow Geese were seen using the RSA primarily as a spring and fall migratory stop-over and it is presumed that most of these birds were travelling to and from nesting grounds on Bylot Island. These stop-over locations were most heavily concentrated in the Steensby Inlet region, especially within the marine waters and low-lying tundra areas adjacent to the Steensby coastline (inland to approximately 10 km). Dozens of Snow Goose nests were also observed scattered throughout the RSA in all three years of the baseline studies (14 nests in 2006; 79 in 2007; and 171 in 2008) and a colony of more than 5,000 individuals was recorded along the southwestern shore of Steensby Inlet, just to the southwest of the RSA. Several thousand Snow Geese stopped in various lakes around Steensby Inlet in mid-late June to rest and to forage onshore before continuing their spring migrations northwards. From mid July to late August, thousands of these geese returned to rest, forage, and to moult their feathers, before continuing their fall migration south. IQ studies indicated that Snow Geese are an important harvest species for North Baffin communities as the birds, eggs and down feathers are all harvested.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Common and King Eiders

Common and King Eiders were also seen in large migratory flocks in the coastal waters of the RSA during their spring and fall migrations, and dozens of females were seen raising broods in Steensby Inlet around the proposed port facilities although no nests were found during ground surveys for songbirds and shorebirds. IQ studies indicate that Eiders are of similar community importance as Snow Geese in terms of harvesting and consuming and some Inuit still use Eider feathers in clothes, pillows, and quilts.

Waterfowl

Long-tailed Ducks were also plentiful in these areas and some Red-breasted Merganser were seen in the rivers. No Red-breasted Merganser broods were seen in 2006 although several groups of non-breeders were seen.

Raptors

Five raptor species were observed in the RSA: Cliff-nesting Peregrine Falcon, Rough-legged Hawk, and Gyrfalcon; and ground-nesting Snowy Owl and Short-eared Owl. There were two distinct concentrations of Peregrine Falcon nest sites: i) a 50 km radius area around the Mine Site (average density over the three years was 0.01 nests per km^2), and ii) south of Angajurjualuk Lake to the Steensby Port (average density over the three years also was 0.01 nests per km^2). Rough-legged Hawks were also found to be distributed throughout the RSA but at lower densities than Peregrines. Several Gyrfalcon nests were identified between the Mine Site and Steensby Port but Gyrfalcon observations between the Mine Site and Milne Port were rare.

For ground-nesting Snowy Owls, four nests were recorded in 2006, none in 2007, and 105 in 2008. Observations of Snowy Owls flying throughout the RSA also increased dramatically in 2008 probably in response to the high number of lemmings in 2008 (DEIS Appendix 6F, Dr. Gilles Gauthier, pers. comm.). Three Short-eared Owls were seen in both 2007 and 2008 (none were seen in 2006) but no nests were found. A few Short-eared Owls were observed on Bylot Island, but there have been no confirmations of these birds breeding in the area (Lepage et al. 1998; Dr. Gilles Gauthier, pers. comm.).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

A number of the occupied raptor nests recorded within the LSA will be in close proximity to Project activities during mine construction and operation (see Figures 3 to 5 in DEIS Appendix 6E-1):

- Seven active Peregrine Falcon nests and eight inactive/unidentified raptor nests were recorded 500 - 1,000 m from the Milne Inlet Tote Road
- One Peregrine Falcon nest was located within 100 m of the road at signpost 'km 84.5'
- Three Peregrine Falcon nests were recorded in the Mine Site area
- A Gyrfalcon nest was found directly within the Railway construction footprint, about 500 m south of the major bridge crossing at Cockburn Lake
- Two Peregrine Falcon nests (one nest active in 2006, the other active in 2007 and 2008), one active Rough-legged Hawk nest, and one active Common Raven nest were found at the Steensby Port site
- Two active Peregrine Falcon nests were recorded within 500 m of the proposed Steensby Port site in 2010.

Songbirds, Shorebirds, and Other Breeding Birds

Several species of songbirds and shorebirds migrate to this area annually to breed, and were predominately found in the various types of lowland habitats (river deltas, coastal plains, tundra, and near wetlands) that offer an abundant source of insects and vegetation for foraging and nesting habitat. Regardless of an abundant supply of suitable habitat in the RSA, relatively low densities of songbirds and shorebirds were recorded in comparison to studies carried out on mainland Nunavut, Northwest Territories, Yukon, and Alaska (summarized in Weider and Hobaek, 2000; Morrison et al., 2001). Eighteen species of songbirds and shorebirds were seen in the RSA, 15 of which nested in the area.

Bird densities in and around Deposit No. 1 and at nearby control sites were low, compared to the low-lying areas found along the Milne Inlet Tote Road and Railway alignment. Species that were most common around the deposits and corresponding controls were Snow Bunting, American Pipit, and Lapland Longspur. The only shorebirds seen in these areas were Baird's Sandpiper and Common Ringed Plover, but these were scarce. Surveys along the transportation routes revealed higher densities of those species as well as the Horned Lark, Common Redpoll, American Golden Plover, Black-bellied Plover, Sanderlings, Purple Sandpiper, Pectoral Sandpiper, Red-necked Phalarope, Red Phalarope, and Northern Wheatear.

Sandhill Crane was widely distributed throughout the RSA with relatively high densities occurring between Mary River and Angajurjualuk Lake, and between Cockburn Lake and Steensby Inlet. Although several dozen pairs of Sandhill Crane were observed migrating over the Mine Site in early June each year, no cranes were ever observed on the ground at the Mine Site.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.18 Terrestrial Wildlife and Habitat

Terrestrial wildlife on north Baffin Island was described in the terrestrial wildlife baseline report (DEIS Appendix 6F). Terrestrial wildlife includes caribou, wolves, foxes, arctic hares, ermine, and small mammals. Many terrestrial wildlife species, caribou in particular, are an important part of the Inuit culture and are an important component of a subsistence lifestyle. Occurrence of most wildlife species on north Baffin Island is relatively sparse. Regardless of current numbers, the proposed Project could potentially affect wildlife by removing habitat within the Project footprint, increasing the degree of sensory disturbances such as that created by noise and traffic, possibly changing movement patterns of some caribou as they perceive physical and sensory barriers to movement, and possibly reducing the health of local animals. This section of the EIS assesses the degree of those potential effects on the key terrestrial wildlife species (to both humans and within the broader ecology) — caribou.

North Baffin Island caribou currently occur at low densities and their abundance seems to be cyclical - harvest data and Inuit Qaujimajatuqangit (IQ) suggests that there is roughly a 70 year cycle of abundance. The cyclical pattern of caribou abundance is similar to patterns described on Greenland and south Baffin Island. The cause of these changes in abundance is currently unknown. The last period of caribou abundance in the RSA was approximately from 1980 to 2000. Caribou numbers are expected to gradually increase in the Project area, but may not recover to a historical “high” until the 2050s. There is evidence that, although in low density, caribou occur throughout the entire region and, therefore, use most of the area as some form of habitat. The most used habitat is in the southern and central portion of the Regional Study Area (RSA), as indicated by caribou sign (bones, antlers, tracks and trails), IQ and recent collar data. Analyses of habitat use show a greater probability of caribou occurrence for some habitats in summer and winter, but the probability of occurrence of caribou is relatively equal in many areas throughout the Project area.

Wolves and foxes are the dominant carnivores in the study area and exist at low densities. Limited information was collected on carnivores because they were so rarely observed. Carnivores are discussed as issues of note.

12.19 Freshwater Quantity Baseline Condition

12.19.1 Introduction

The Mary River Project (Project) is located in northern Baffin Island, which is one of the coldest regions in Canada. The region experiences a mean annual temperature of approximately -15°C, with mean daily temperatures below -20°C from November through April, and above 0°C during June through August. The long period of sub-zero temperatures results in a very short runoff season, typically occurring from June through September. Runoff may extend to late October in systems with large lake components. The frigid temperatures also result in very low precipitation values for northern Baffin Island, from the combined effect of the low moisture carrying capacity of cold air and

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

the scarcity of liquid water available for evaporation. According to Natural Resources Canada the region is classified as semi-arid with mean annual total precipitation ranging from 200 to 400 mm, although regional climate stations suggest that the true value is near the lower end of this range. The amount of water available for runoff is further reduced by the processes of evaporation, transpiration and sublimation. The frigid climate and subsequent lack of significant vegetative cover combine to minimize the volume of water evaporated and transpired to very low levels. Conversely sublimation, which is the process by which solid water changes phase directly to water vapour, frequently occurs during the winter months, largely as a result of blowing snow transport.

Stream flow regimes in the high Arctic are most strongly influenced by temperature. During the winter months, frigid temperatures cause all hydrologic systems to freeze solid. During these months, snow is frequently redistributed within and between watersheds by wind transport. As temperatures rise above 0 °C, stream flow resumes. The majority of annual runoff typically occurs during the nival freshet in late June through July, with runoff decreasing through the late summer before freezing up again at the onset of winter, typically sometime in October. Peak instantaneous flows typically occur during the freshet, but in smaller watersheds peak flow may occur due to rainfall events in July or August. Mean annual discharge per unit area is typically on the order of 5 - 10 l/s/km^2. Differences in elevation, aspect, glacial cover and lake cover between watersheds results in regional variability in the timing and magnitude of runoff. Typically, the onset of the spring melt is delayed in higher elevation regions, as well as in north facing watersheds. Higher elevation areas may also receive greater volumes of precipitation as a result of orographic influences. In smaller watersheds aspect may help decide whether the watershed is a net sink or source for blowing snow transport and deposition. Finally, glacial cover tends to greatly increase the volume of runoff in a watershed, while lakes act to attenuate runoff events and prolong the runoff season. The presence of permafrost, coupled with the lack of vegetative cover, also has a profound effect on regional hydrologic systems. Permafrost typically restricts water from infiltrating the ground to any great depth, while the lack of surface vegetation results in little to no impedance or loss of runoff as it flows to the river channels. Therefore, July and August rainfall events tend to produce flashy stream flow conditions.

12.19.2 Methods

Eighteen hydrologic monitoring stations were installed as part of a freshwater baseline studies program designed to assess hydrologic conditions in the Project area. These data, in addition to regional data, provide the basis for the hydrologic assessment of the Project.

During the 2006 open water season Knight Piésold Ltd. (KP) installed seven hydrologic monitoring stations in the immediate vicinity of the Mine Site, plus one station within the RSA to the north of the Mine Site and one station within the RSA to the south of the Mine Site. The Water Survey of Canada (WSC) also concurrently installed four monitoring stations on large river systems to the south of the Mine Site, two of which are within the RSA. In June 2008, a further five hydrologic monitoring stations were installed by KP along the railway alignment between the Mine Site and Steensby Port. Data collected at all eighteen stations between July 2006 and September 2008 were used to assess

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

hydrologic conditions for the Project. Long-term regional WSC data, in conjunction with the short-term Project data, were used to derive long-term mean annual discharge (MAD) estimates for select watersheds within the RSA. Mean monthly wet and dry period runoff estimates were derived for various return periods using these MAD estimates. Peak instantaneous flood estimates for various return periods were also developed using long-term historical peak flow and extreme rainfall data collected by Environment Canada. Further details on methodology can be found in the Baseline Hydrology Report (Knight Piésold, 2009).

12.19.3 Results

The key findings presented within the Baseline Hydrology Report (Knight Piésold, 2009) pertain to four main categories: hydrograph shape, runoff, variations in runoff and hydrograph shape, and long-term streamflow estimates. Hydrograph shapes for systems within the RSA were first estimated by analyzing hydrographs from regional WSC monitoring stations, and were then validated by actual onsite measurements and observations. The characteristics of hydrographs within the RSA are as follows:

- Watersheds typically begin to produce small volumes of runoff in late May to early June as temperatures first climb above 0°C. This runoff is directed down the surface of the frozen stream channels, aiding in their melt. By mid to late June, most channels are ice free. Runoff continues throughout the summer and ends in late September to late October.
- The annual hydrograph is dominated by a nival freshet which typically occurs between late June and the end of July, followed by a period of low baseflows driven by permafrost melt and shallow subsurface flow and punctuated by precipitation events through July to early September. Streamflow then diminishes as the watersheds begin to freeze up at the onset of winter.
- Intense precipitation events can occur throughout June to September. In catchments without significant lakes, these events produce large, intense runoff events. At several of the gauging stations, these events produced the largest instantaneous flows on record. Runoff increases very rapidly, as shallow permafrost, cool temperatures and lack of vegetative cover result in little of the precipitation being slowed down or lost to infiltration, evaporation or transpiration, as it makes its way into the channels. In catchments with significant lakes components, these events are attenuated, producing lower peaks and longer duration flow events.

Mean annual runoff within the RSA was originally estimated from regional analysis and then validated by onsite measurements. Initial estimates suggested that mean annual unit runoff (MAUR) in the vicinity of Mary River should be less than 10 l/s/km^2. They also suggested that mean annual peak daily unit runoff values likely range from less than 100 l/s/km^2 for watersheds with significant lake volumes, to approximately 400 l/s/km^2 for smaller watersheds without lakes. The actual measured results validate these estimates and are as follows:

- Watersheds H1-H9 operated by Knight Piésold had an average MAUR of 9 l/s/km^2 for the years of 2007 and 2008. The lowest measured annual mean unit runoff was recorded at H9 in 2007 at

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

3.3 l/s/km^2. The highest annual mean unit runoff of 19.0 l/s/km^2 was recorded in 2008 within the Isortoq River watershed, which contains significant glacial cover.

- The maximum annual peak daily unit runoff varied greatly among the monitored watersheds in the RSA. Peak flow events that occurred during the monitoring period resulted from snowmelt events, precipitation events, as well as combinations of both. The lowest maximum daily runoff was 65 l/s/km^2 recorded within the extensively lake covered BR137 catchment during 2008. The highest maximum daily unit runoff was 306 l/s/km^2 recorded during 2008 in the BR11 watershed.

As noted above, significant variation was recorded within both the annual hydrograph shape and the volume and intensity of unit runoff. Numerous factors can be attributed to this variation, but the primary factors are listed below:

- The proportion of lakes within a watershed has profound effects on both the hydrograph shape as well as daily and annual unit runoff. Lakes act to attenuate flow during rapid runoff events, as well as mute diurnal fluctuations in runoff, resulting in much lower intensity and longer lasting storm event runoff and an overall smoother hydrographs shape. This attenuation typically results in stream flow persisting later in the year downstream of larger water bodies. Lakes also allow for much larger volumes of water to evaporate from a watershed, resulting in lower mean annual unit runoffs in catchments with large lake components.
- The presence of uplands, especially lowland to upland transitions, within a watershed may act to increase the MAUR of the system. This is achieved through increases in precipitation which result from orographic uplift of moisture laden air caused by the rise in ground elevation.
- In smaller watersheds, windblown snow deposition may act to increase and/or decrease the mean annual unit runoff of a system, depending on whether the watershed experiences a net gain or net loss of snow as a result of blowing snow transport and deposition.

Finally, regional streamflow and precipitation data were used to estimate long-term mean annual runoff, as well as the coefficient of variation of mean annual runoff, for select stations within the RSA. Return period flood event magnitudes were also calculated. Results are summarized as follows:

- Long-term mean annual unit runoff at stations H1-H9 ranged from a low of 5 l/s/km^2 at H9 to a high of 12 l/s/km^2 at H3. The average long-term mean annual unit runoff was 9 l/s/km^2.
- The 10-year wet return period mean annual unit runoff varied between 7 l/s/km^2 and 16 l/s/km^2. The 10-year dry return period mean annual unit runoff varied between 4 l/s/km^2 and 9 l/s/km^2.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Equations were developed to calculate instantaneous flood flows for various return periods based upon watershed area. The equations are as follows:
- $Q_2 = 1.1 \times A^{0.79}$
- $Q_5 = 1.7 \times A^{0.77}$
- $Q_{10} = 2.0 \times A^{0.76}$
- $Q_{25} = 2.6 \times A^{0.75}$
- $Q_{100} = 3.5 \times A^{0.73}$
- Where, Q = peak instantaneous flow in m^3/s

  A = drainage area in km^2 (only applicable for watersheds between 0.5 km^2 and 1000 km^2 in size)

The baseline analysis also presented information regarding groundwater discharge and climate change. It was determined that permafrost in the region is on the order of 500 m deep, and that the active layer of the permafrost is approximately 1 m to 2 m deep. As a result, groundwater infiltration and storage is minimal, and transport is limited to shallow subsurface flow. With regards to climate change, current climate models indicate that temperature, precipitation and runoff will increase throughout the rest of the century in Northern Baffin Island. However, due to the interdependent nature of the physical processes operating within the freshwater RSA, it is extremely difficult to predict what net effects such potential changes will have on the hydrology of the region. The report recommends incorporating conservatism in hydrologic designs and impact assessments to account for possible changes due to potential future climate change effects. Further information on climate change in the region is available in Volume 5 Section 1.4, as well as in Volume 9 Section 2.2. Further details regarding the results of the hydrologic assessment can be found in the Baseline Hydrology Report (DEIS Appendix 7A).

12.19.4 Freshwater Quality Baseline Conditions

12.19.4.1 Introduction

The baseline water quality program conducted by Knight Piésold commenced in 2005 and is currently being carried out jointly by Knight Piésold and North/South Consultants Inc. The surface water quality program has included up to 74 surface water sampling sites distributed throughout the RSA and five LSAs, respectively. Three lakes, in the vicinity of the Mine Site with the potential to be impacted by Project-related components and activities, were sampled in 2006 through 2007 including Camp Lake, Sheardown Lake, and Mary Lake. In 2008, lake water sampling extended to the Steensby Inlet area, the Rail Camp area, as well as the current (eastern) railway alignment. Results from the 2005 through 2008 sampling programs were included in this EIS.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Sediment samples were collected from various lake, stream, and river locations within the five freshwater LSAs. The 2005 and 2006 sampling programs were conducted by Knight Piésold and the 2007 sampling program was conducted by North/South Consultants Inc. The complete water and sediment quality baseline data are provided in the Surface Water and Sediment Baseline Report prepared by Knight Piésold, 2010, which is included as DEIS Appendix 7B of this volume.

12.19.4.2 Sampling Locations

All surface water and sediment quality sampling sites that were sampled from 2005 through 2008 are illustrated on Figures 12.27 through and 12.33. All sampling locations were organized into sampling groups to simplify data analysis, interpretation, and reporting. Justification for the sample group locations that were selected are provided in Table 12-7: Water and Sediment Quality Sampling Group Justification.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-7: Water and Sediment Quality Sampling Group Justification

Sample Group (LSA)	Sample Type(s)	Justification
Milne Inlet Area (Milne Port and Milne Inlet Tote Road LSAs)	Surface Water	Downstream receiving environment for Project components/activities associated with Milne Port and Milne Inlet Tote Road.
Upstream of Deposits (Mine Site LSA)	Surface Water Sediment	Upstream environment for Project components/activities associated with the Mine Site and Railway Alignment.
Downstream of Deposits (Mine Site LSA)	Surface Water Sediment	Downstream receiving environment for Project components/activities associated with the Mine Site and Railway Alignment.
Drainages off Deposits (Mine Site LSA)	Surface Water	Downstream receiving environment for Project components/activities associated with the Mine Site.
Tom River Area (Mine Site LSA)	Surface Water Sediment	Upstream environment for Project components/activities associated with Milne Inlet Tote Road and Mine Site.
Tributaries of Sheardown Lake (Mine Site LSA)	Surface Water Sediment	Upstream environment for Project components/activities associated with the Mine Site and Railway Alignment.
Sheardown Lake N.W. (Mine Site LSA)	Surface Water Sediment	Downstream receiving environment for Project components/activities associated with the Mine Site and Railway Alignment.
Sheardown Lake S.E. (Mine Site LSA)	Surface Water Sediment	Downstream receiving environment for Project components/activities associated with the Mine Site and Railway Alignment.
Tributaries of Camp Lake (Mine Site LSA)	Surface Water Sediment	Upstream environment for Project components/activities associated with the Mine Site and Milne Inlet Tote Road.
Camp Lake (Mine Site LSA)	Surface Water Sediment	Downstream receiving environment for Project components/activities associated with the Mine Site and Milne Inlet Tote Road.
Background Tributary to Mary River (Mine Site LSA)	Surface Water Sediment	Upstream environment for Project components/activities associated with the Mine Site, Railway Alignment, and Milne Inlet Tote Road.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Sample Group (LSA)	Sample Type(s)	Justification
Mary Lake (Mine Site LSA)	Surface Water Sediment	Downstream receiving environment for Project components/activities associated with the Mine Site, Railway Alignment, and Milne Inlet Tote Road.
Mary River Downstream of Mary Lake (Mine Site LSA)	Surface Water Sediment	Downstream receiving environment for Project components/activities associated with the Mine Site, Railway Alignment, and Milne Inlet Tote Road.
Ravn River Upstream of Angajurjualuk Lake (Mine Site LSA)	Surface Water	Downstream receiving environment for Project components/activities associated with the Mine Site, Railway Alignment, and Milne Inlet Tote Road.
Cockburn Area (Railway Alignment LSA)	Surface Water	Downstream receiving environment for Project components/activities associated with the Mine Site, Railway Alignment, and Milne Inlet Tote Road.
Rowley River (Railway Alignment LSA)	Surface Water	Upstream environment for Project components/activities associated with the Railway Alignment.
Steensby Port Area (Steensby Port LSA)	Surface Water	Downstream receiving environment for Project components/activities associated with Steensby Port and Railway Alignment.

12.19.4.3 Sampling Methodology

Water Quality

Water quality sampling was conducted following methodologies described in the Baseline Water and Sediment Quality Summary Report (DEIS Appendix 7B). Sampling of watercourses and lakes was undertaken in spring (June), summer (mid-July to mid-August) and fall (late August to mid-September). Only lakes were sampled in late winter (May) as rivers in the Project area were frozen solid. A summary of surface water sampling areas and years of investigation are provided in Table 12-8: Surface Water Sampling Programs by Year.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-8: Surface Water Sampling Programs by Year

Year	General Sampling Areas
2005	Mine Site LSA Milne Inlet Tote Road LSA Railway Alignment LSA
2006	Mine Site LSA Milne Inlet Tote Road LSA Railway Alignment LSA
2007	Mine Site LSA Railway Alignment LSA
2008	Mine Site LSA Railway Alignment LSA Steensby Port LSA Milne Port LSA

A detailed description of surface water sampling methodology as well as specific sampling locations and timing are provided in Tables 2-1 through 2.5 of the Surface Water and Sediment Quality Baseline Report included in DEIS Appendix 7B of this volume.

Sediment

Sediment sampling was conducted following generally accepted methodologies. Ten sediment samples were collected from each river and stream sampling location in August 2005. Six sediment samples were collected in 2006 from new locations that were chosen as future monitoring sites in accordance with Canadian MMER requirements. On the Mary River, site G0-09 is located upstream of Deposit Nos. 1, 2, and 3; and, site C0-10 is located immediately downstream of the deposits and the proposed facilities. These locations are paired with reference locations on the Tom River where I0-04 is the upstream reference location and I0-01 is the downstream reference location. Two sampling locations were selected in Mary Lake to characterize the depositional habitat.

Three lake locations were sampled in May 2007 and 39 lake, river, and stream locations were sampled in August and September 2007. Several of the locations were the same locations sampled in 2005 or 2006, providing a baseline characterization of sediment quality through the seasons, over consecutive years. A summary sediment sampling areas and years of investigation are provided in Table 12-9: Sediment Sampling Programs by Year.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-9: Sediment Sampling Programs by Year

Year	Sediment Samples Collected
2005	10 (at each river/stream location in Mine Site LSA, Milne Inlet Tote Road LSA and Railway Alignment LSA)
2006	6 (at each river/stream location in Mine Site LSA, Milne Inlet Tote Road LSA and Railway Alignment LSA)
2007	3 (at each lake location - 5/07) 39 (at each lake, river/stream location in Mine Site LSA and Railway Alignment LSA)

A detailed description of sediment sampling methodologies, locations and timing is provided in Tables 2-1 through 2.5 of the Surface Water and Sediment Quality Baseline Report included in DEIS Appendix 7B of this volume.

12.19.5 Results

Water Quality

The water quality data collected between 2005 and 2008 for river/stream and lake water sampling sites are summarized in Tables 3.1 to 3.3 in DEIS Appendix 7B, respectively.

Rivers

In general, surface water quality measured in rivers and streams throughout the study area was nutrient-poor, with low conductivity and anion concentrations (Tables 3.1 and 3.2 in DEIS Appendix 7B). Turbidity was generally low, but observed to be naturally elevated in some areas based on inputs from adjacent landforms, snow-melt, and precipitation. Metal concentrations were also generally low, with the exception of total aluminum, iron, and copper concentrations, which had more concentrations greater than the respective CCME guidelines than other metals parameters. These exceedances are discussed in further detail in the following paragraphs, but in all cases the mean concentration of the analyzed metals over the course of the baseline sampling program was below the CCME guideline value.

Since 2005, total aluminum concentrations have exceeded the CCME guideline on several occasions at the Mine Site as well as in the Ravn River and Cockburn areas. Total aluminum concentrations exceeded the CCME guideline at all of the general locations listed in Table 3.3 in DEIS Appendix 7B. The measured aluminum concentrations ranged from 0.0013 to 2.97 milligrams per litre (mg/L) with the mean concentration for the Mary River Site between 2005 and 2007 being 0.0724 mg/L which, is less than the respective CCME guideline (0.1 mg/L as determined by pH),. The mean aluminum concentration for sites in the Ravn River and Cockburn areas (0.0495 mg/L) was also below the CCME guideline value.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

At the Mine Site, total copper concentrations above the CCME guideline of 0.002 - 0.004 mg/L (guideline is dependent on hardness) occurred in Mary River downstream of Mary Lake, in the tributaries of Sheardown Lake, downstream of the deposits, drainages off Deposit No. 1, and in a tributary of Camp Lake. Measured total copper concentrations between 2005 and 2007 ranged from 0.00042 to 0.00310 mg/L with a mean concentration of 0.0012 mg/L, which were all less than the CCME guideline of 0.002 mg/L. Considering the relative hardness of the water, the potential copper toxicity is likely to be reduced.

Total iron concentrations greater than the CCME guideline of 0.3 mg/L occurred in a tributary of Sheardown Lake, downstream of the deposits, drainages off Deposit No. 1, upstream of the deposits, and in Mary River downstream of Mary Lake. Between 2005 and 2007, the measured total iron concentrations ranged from <0.02 (below method detection limits) to 2.96 mg/L, with a mean concentration of 0.0871 mg/L, which was below the CCME guideline value of 0.3 mg/L.

Between 2005 and 2007 nine other parameters including lead, silver, dissolved oxygen, phenols, pH, cadmium, arsenic, selenium, and zinc have all shown a minimum of one exceedance of the respective CCME guideline values within Mary River, and for pH in the Cockburn area. These concentrations are assumed to be natural fluctuations, based on the mineralogy of the ore body (Volume 6, Sections 1.3.6 and 1.3.7.1).

To assess the general characteristics of mean surface water quality and relative sensitivity in each individual rivers/streams or group of rivers/streams, the criteria included in Table Table 12-10 were applied:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-10: Qualitative Characterization of River Systems

General Characteristic	Parameter
pH Scale	**pH**
Acidic	< 6
Neutral	6 - 8
Basic	> 8
Hardness Scale[1]	**Calcium Carbonate (mg/L)**
Very Soft	<30
Soft	31-60
Moderately Soft	61-120
Hard	121-180
Very Hard	>180
Acid Sensitivity Scale[2]	**Alkalinity (CaCO3 in mg/L)**
Acidic	<0
Highly Sensitive	0-2.5
Sensitive	2.6-10
Not Sensitive	>10
Nutrient Scale[3]	**Total Phosphorous (mg/L)**
Very Nutrient Poor (VNP)	<0.004
Nutrient Poor (NP)	0.004-0.01
Moderate Nutrients (MN)	0.01 - 0.02
High Nutrients (HN)	0.02 - 0.035
Nutrient Rich (NR)	0.035 - 0.1
Very Nutrient Rich (VNR)	>0.1

NOTE(S):
1. DERIVED FROM MCNEELY et. al. (1979).
2. DERIVED FROM BOWARD et. al. (1999).
3. DERIVED FROM ENVIRONMENT CANADA (2004).

A summary of general mean surface water characteristics (based on the criteria included in Table 12-10: Qualitative Characterization of River Systems) that are important with respect to prediction of potential Project-related impacts for each of the rivers/streams are provided in Table Table 12-11: Characterization of River Systems in the Project Area.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-11: Characterization of River Systems in the Project Area

Sample Group	Hardness	Acid Sensitivity	Nutrient Level[1]	pH
Upstream of Deposits	Soft	Not Sensitive	Nutrient Poor	Basic
Downstream of Deposits	Very Hard	Not Sensitive	Nutrient Poor	Basic
Drainages off Deposits	Hard	Not Sensitive	Nutrient Poor	Neutral
Tom River Area	Moderately Soft	Not Sensitive	Nutrient Poor	Basic
Tributaries of Sheardown Lake	Moderately Soft	Not Sensitive	Nutrient Poor	Basic
Tributaries of Camp Lake	Moderately Soft	Not Sensitive	Very Nutrient Poor	Basic
Background Tributary to Mary River	Soft	Not Sensitive	Nutrient Poor	Basic
Mary River Downstream of Mary Lake	Soft	Not Sensitive	Nutrient Poor	Basic
Ravn River Upstream of Angajurjualuk Lake	Very Soft	Not Sensitive	Nutrient Poor	Neutral
Cockburn Area	Very Soft	Highly Sensitive	Nutrient Poor	Neutral
Rowley River	Very Soft	Sensitive	Nutrient Poor	Basic

NOTE(S):
1. REFLECTS MEAN TOTAL PHOSPHOROUS CONCENTRATION DURING 2008 SAMPLING EVENTS.

Lakes

Lakes in the study area are relatively shallow (mean depths of 7.38 to 12.45 m) and experience long periods of ice cover (approximately 10 months/year). They are generally near-neutral to slightly alkaline, soft to moderately soft (hardness less than or slightly above 60 mg/L as calcium carbonate), relatively dilute (low conductivity/total dissolved solids), and relatively nutrient-poor (low phosphorus and nitrogen). Metal concentrations are relatively low in the lake waters, although some metals concentrations were greater than the CCME guidelines at some sites and times in 2007 (cadmium) and 2006 (aluminum). Details regarding the cadmium and aluminum exceedances are provided in DEIS Appendix 7B.

To assess the general characteristics of mean surface water quality and relative sensitivity in each individual lake, the criteria included in Table 12-12: Qualitative Characterization of Lake Systems were applied, with the exception of the following lake-related criteria included in Table 12-12: Qualitative Characterization of Lake Systems:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-12: Qualitative Characterization of Lake Systems

General Characteristic	Parameter
Acid Sensitivity[1]	**Alkalinity ($CaCO_3$ in mg/L)**
High	0 - 10
Moderate	10 - 20
Low	20 - 40
Least	>40
Productivity Scale[2]	**Chlorophyll α (µg/L)**
Low Productivity	<2.5
Low to Moderate Productivity	2.5 - 8
Moderate Productivity	8 - 25
Moderate to Productive	26 - 75
Highly Productive	> 75

NOTE(S):

1. DERIVED FROM SAFFRAN AND TREW (1996).
2. DERIVED FROM ENVIRONMENT CANADA (2004).

A summary of general mean surface water characteristics (based on the criteria included in Table 12-10: Qualitative Characterization of River Systems and Table 12-12: Qualitative Characterization of Lake Systems) that are important with respect to prediction of potential Project-related impacts and future monitoring for each of the lakes are provided in Table 12-13: Characterization of Lake Systems in the Project Area.

Table 12-13: Characterization of Lake Systems in the Project Area

Sample Group	Hardness	Acid Sensitivity	Nutrient Level[1]	Productivity	pH
Sheardown Lake N.W.	Soft	Least	Nutrient Poor	Low Productivity	Basic
Sheardown Lake S.E.	Soft	Least	Nutrient Poor	Low Productivity	Neutral
Camp Lake	Soft	Least	Nutrient Poor	Low Productivity	Neutral
Mary Lake	Soft	Least	Nutrient Poor	Low Productivity	Basic

NOTE(S):

1. REFLECTS MEAN TOTAL PHOSPHOROUS CONCENTRATION DURING 2008 SAMPLING EVENTS.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Sediment Quality

The results of the baseline sediment quality study are summarized in Table 3.5 in DEIS Appendix 7B. Sampling locations have been grouped according to location and summary data for each group is presented.

Sampling locations are identified by group in Figures 12.32 and 12.33. To assist in analysis of the data, parameters that were below method detection limits (not detected) were assigned the analytical detection limit applicable for that analysis. The detection limits were not always the same depending on the year and the laboratory that conducted the analysis. It should be noted that this method of data analysis is a conservative approach that overestimates analyte concentrations, which are either not present in the sample or are present in concentrations below the method detection limit.

River Sediment

Chromium concentrations (mean and/or maximum values) were greater than the CCME Interim Sediment Quality Guidelines (ISQG) downstream of the deposits, in the Mary River downstream of Mary Lake, and in the tributaries of Sheardown Lake and Camp Lake. Additionally, chromium concentrations (mean and/or maximum values) were greater than the CCME Probable Effects Limit (PEL) downstream of the deposits and in the Mary River downstream of Mary Lake. All other chromium concentrations (mean and/or maximum values) in river sediments were less than the CCME ISQG.

Cadmium and copper concentrations (maximum values) were greater than the CCME ISQG in the sediments of the tributaries of Camp Lake. All other cadmium and copper concentrations (mean and/or maximum values) in river sediments were less than the CCME ISQG.

Iron concentrations (maximum values) were greater than the Ontario LEL in the sediments upstream of the deposits, downstream of the deposits, and in the tributaries of Camp Lake. The greatest mean iron concentration was in Mary River downstream of the deposits, indicating that elevated iron concentrations are a naturally occurring phenomena downgradient of the Mary River ore bodies. All other iron concentrations (mean and/or maximum values) in river sediments were less than the Ontario LEL.

Nickel concentrations (mean and/or maximum values) were greater than the Ontario LEL downstream of the deposits, in Mary River downstream of Mary Lake, in the tributaries of Sheardown Lake, and in the tributaries of Camp Lake. All other nickel concentrations (mean and/or maximum values) in river sediments were less than the Ontario LEL.

None of the concentrations of analyzed parameters in either the Tom River or in the tributary to Mary River were greater than the applicable guidelines. Nitrite, mercury, silver, bismuth, and thallium concentrations were not detected in samples collected from any of the river sampling

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

locations and the concentrations of all other analyzed metals were less than the applicable guidelines.

In terms of nutrients, only the Total Kjeldahl Nitrogen (TKN) concentration in the tributaries to Sheardown Lake was greater than the Ontario LEL. All other TKN and total organic carbon (TOC) concentrations in river sediments were less than the applicable guidelines.

The concentrations of many parameters, including copper, iron, total phosphorous, manganese, and sodium were generally lower in river sediments than in lake sediments (see following Section regarding lake sediment quality).

Lake Sediment

The sediments of Mary Lake, Camp Lake, Sheardown Lake NW, and Sheardown Lake SE, are characterized by high concentrations of iron, chromium, copper, manganese, nickel, total phosphorus, TKN, and TOC; however, the concentrations generally appear to be lower in Sheardown Lake SE.

The majority of chromium concentrations (mean and/or maximum values) in all four lakes were greater than the CCME ISQG, and maximum chromium concentrations in Mary Lake and Sheardown Lake NW that were greater than the CCME PEL. All other chromium concentrations (mean and/or maximum values) in lake sediments were less than the CCME ISQG.

Copper concentrations (mean and/or maximum values) were greater than the CCME ISQG in Mary Lake, Camp Lake and Sheardown Lake NW. All other copper concentrations (mean and/or maximum values) in lake sediments were less than the CCME ISQG.

Iron concentrations (mean and/or maximum values) in lake sediment exceeded the Ontario LEL, and maximum iron concentrations in Mary Lake, Camp Lake, and Sheardown Lake NW were greater than the Ontario Severe Effects Level (SEL).

Manganese concentrations (mean and/or maximum values) were greater than the Ontario in sediment samples from Mary Lake and Sheardown Lake NW, while manganese concentrations in Camp Lake and Sheardown Lake SE were greater than the Ontario LEL.

The nickel concentrations (mean and/or maximum values) in all samples were greater than the Ontario LEL, the maximum concentration in Sheardown Lake NW that was greater than the Ontario SEL. Similarly, the total phosphorous concentrations in all samples were greater than the Ontario LEL, except for minimum concentrations in Mary Lake and Camp Lake where total phosphorus was not detected.

The majority of TKN concentrations (mean and/or maximum values) in sediment samples were greater than the Ontario LEL and at least one TOC concentration in sediment samples from each lake was greater than the Ontario LEL. Nitrite, mercury, silver, cadmium, antimony, and thallium concentrations were not detected in any of the lake sediment samples.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The concentrations of all other analyzed metals in lake sediments were less than the applicable guidelines.

A general observation is that the concentrations of contaminants in lake sediments are higher than in river sediment, indicating that the lake sediment is likely acting as a sink for contaminants as they move with the water and sediment through the aquatic systems.

12.20 Freshwater Aquatic Biota and Habitat Baseline Conditions

12.20.1 Introduction

The following provides a description of:

- The freshwater biota and habitat in LSAs and the RSA potentially affected by Project activities. This description provides the baseline for assessing potential impacts of the Project
- The approach and methods for the assessment of potential Project-related impacts to freshwater biota and habitat;
- The results of the impact assessment, including a description of proposed mitigation;
- A summary of residual effects; and
- An outline of the aquatic effects monitoring program.

In general, the assessment is aimed at determining the nature and magnitude of potential impacts to freshwater biota and habitat and ultimately, identifying the significance of anticipated impacts to these resources. The assessment incorporates results of the impact assessments for environmental components that affect freshwater biota and habitat, including the water quantity and water and sediment quality assessments presented in Sections 2.0 and 3.0, respectively.

12.20.2 Baseline Summary

Information sources for describing the existing freshwater biota and habitat in the LSAs and RSA included baseline studies conducted in support of the Project, information collected under the Inuit Qaujimajatuqangit (IQ) study, and literature review. Freshwater biota and habitat field studies were initiated in 2005 and continued through 2010.

The following provides an overview of the methods and results of freshwater aquatic biota and habitat studies conducted during the baseline studies for the Project, as well as information collected from the IQ studies and scientific literature. The methods and years of study differed by study area and are presented according to the following LSAs:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Milne Port
- Milne Inlet Tote Road
- Mine Site
- Railway
- Steensby Port.

12.20.2.1 Background

Freshwater aquatic baseline studies were conducted initially by Knight Piésold Ltd. (Knight Piésold) and then by North/South Consultants Inc. (NSC) from 2005-2010. Baseline study programs for describing freshwater aquatic biota and habitat included collection of information on:

- Aquatic habitat (streams and lakes)
- Primary producers (phytoplankton, periphyton, and aquatic plants)
- Secondary producers (zooplankton, invertebrate drift, and benthic invertebrates)
- Fish communities and populations
- Fish condition
- Fish movements
- Metals in Arctic char (Salvelinus alpinus) tissues.

A review of COSEWIC (2010) and SARA (2010) species lists was conducted to determine if any rare, threatened, at risk, or endangered freshwater aquatic species are present in the LSAs. No species identified in COSEWIC or SARA lists were found in the Project LSAs.

12.20.2.2 Methods

DEIS Appendix 7C provides a detailed description of sampling and analysis methods employed during the conduct of the baseline studies for the Project. The following provides a general overview of the field program sampling methods employed over the course of the studies.

Aquatic habitat was assessed in streams and lakes in the LSAs through aerial surveys and ground based sampling techniques. Assessment protocols used for streams were adapted from the Department of Fisheries and Oceans (DFO) and British Columbia Ministry of the Environment (1989) and NSC (2006). Surveyed habitat was classified by quality (Important, Marginal, Not Fish-bearing) based on observed characteristics and fish presence/absence (Present, Probable, Not Present). Selected lakes were surveyed for bathymetry and substrate using side-scanning sonar or more detailed Geographic Information System (GIS)-based techniques. Mapping of the euphotic zone and distribution of macrophytes were also used to characterize available lacustrine habitat.

Primary producers were sampled in streams (periphyton and phytoplankton chlorophyll a) and lakes (phytoplankton chlorophyll a and community composition). Periphyton was sampled from

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

representative cobble at selected sites and analysed for ash free dry weight (AFDW) and chlorophyll a. Phytoplankton chlorophyll a in streams was measured in surface grab samples collected in conjunction with the water quality sampling program, as described in Section 3.2.3.1. Phytoplankton species composition and biomass in lakes were examined in samples collected across the euphotic zone in conjunction with the water quality sampling program. Lake chlorophyll a samples were analysed from samples of water collected 1 m from the surface and 1 m from the sediments.

Studies of secondary producers included invertebrate drift in selected streams, zooplankton in lakes, and benthic macroinvertebrates in lakes and streams. Invertebrate drift was sampled seasonally and at regular daily intervals with drift traps set at the outlets of selected streams. Wisconsin nets lifted vertically through the water column collected seasonal samples of lacustrine zooplankton. Benthic macroinvertebrates in lakes and streams were sampled with dredges and Surber samplers, respectively. All invertebrate samples were identified to the lowest taxonomic Level possible by qualified taxonomists.

Fish population studies varied across the five LSAs, being most extensive and intensive in the Mine LSA. Studies in the other four LSAs focussed primarily on fish habitat and fish presence/absence. Studies in the Mine LSA included determination of fish presence/absence, juvenile and adult fish distribution (spatial and temporal), fish movements, fish population characteristics, fish condition, and anadromy. Fish capture techniques in all LSAs utilized of a variety of sampling gear including hoop nets, gill nets, backpack electrofishing, minnow traps and angling. Fish movements within and between waterbodies were monitored primarily in the Mine LSA and used mark-recapture techniques (Floy® and acoustic tagging) and analysis of strontium concentrations in otoliths. Identification and description of barriers were also used to determine potential fish movements across the five LSAs. Arctic char were captured from the Mine LSA and liver and muscle samples were analysed for metals.

All programs were subject to rigorous quality assurance/quality control (QA/QC) procedures including adherence to sampling protocols, use of Canadian Association for Laboratory Accreditation Inc. (CALA) analytical laboratories, standard measures to prevent sample contamination (where applicable), and taxonomic verifications (where applicable).

12.20.2.3 Milne Port LSA

The Milne Port LSA includes a major coastal watershed (Phillips Creek), several small, coastal streams that drain directly into Milne Inlet, small, shallow headwater ponds near the coast, and deeper headwater lakes in the highlands to the southeast (Figure 12.34). Coastal areas within the footprint of existing and proposed port infrastructure are of relatively low relief with most streams having direct connections to Milne Inlet. Baseline studies focused primarily on aquatic habitat and fish presence/absence in streams and lakes throughout the area in 2009 and 2010.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

IQ information suggests that there is little harvesting occurring with regard to freshwater environments in the immediate vicinity of the Milne Port site. The presence of Arctic char was noted for some inland lakes, some of which were indicated to be land-locked (Figure 12.35).

A total of 18 lake and 33 stream sites within the Milne Port Area were surveyed for fish habitat and fish presence/absence from 2009-2010 (Figure 12.36). Phillips Creek (M03-1) and streams M11-1, M13-1, M18-1, and M02-1 are the largest of the LSA streams flowing into Milne Inlet. All five have sufficient depths and flows to maintain open water connections to Milne Inlet with habitat consisting primarily of riffle/pool over cobble/gravel substrata. All remaining watercourses in the coastal area are small, ephemeral, spring runoff streams that drain snowmelt from the highlands to the south, providing no fish habitat. Coastal lacustrine (e.g. ML-01 to ML-13) habitat consists entirely of small, shallow ponds with no overwintering potential and intermittent connections to nearby streams, providing no fish habitat. Surveyed headwater lakes (ML-015, ML-016, ML-018, ML-019, ML-020) are located at relatively high elevation to the south of the Port Site (Figure 12.36). The nearshore areas of most of these lakes are largely comprised of fines with overlying cobble and gravel and maximum lake depths are likely suitable for overwintering. However, waterfall barriers exist between the coastal reaches of all Milne Port Area streams (including Phillips Creek) and any potential upstream overwintering habitat. The presence of these barriers prevents movement of fish between Milne Inlet and the headwater lakes and restricts fish use of the lower reaches to summer foraging by anadromous Arctic char.

Only Arctic char were captured during fish surveys conducted in the Milne Port Area. Of the five headwater lakes surveyed, Arctic char were captured only in ML-20 (Figure 12.36). Small numbers of Arctic char were captured in the coastal reaches of M13-1 and M18-1. The colouration of these fish differs from those captured in streams supporting known or probable land-locked populations. This difference, combined with a lack of access to upstream overwintering sites, suggests that Arctic char in the coastal reaches are likely entering the streams from Milne Inlet. Adult Arctic char have been captured in Milne Inlet (Volume 8, DEIS Appendix 8A1; Stewart and MacDonald 1981) and known anadromous populations have been identified in the nearby Robertson (Stewart and MacDonald 1981) and Tugaat (Read 2004) rivers. These two rivers are the probable sources of anadromous Arctic char using the lower reaches of Milne Port Area streams for summer foraging.

Although fish were not captured, Phillips Creek, and streams M11-1 and M02-1 all provide habitat similar to streams M13-1 and M18-1 and could also potentially support limited summer foraging use by anadromous juvenile and/or adult Arctic char from Milne Inlet. Phillips Creek, in particular, provides an abundance of suitable habitat. Although not captured during current surveys, ninespine stickleback were observed in a small stream in the nearby Robertson River catchment (Stewart and MacDonald 1981).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.20.2.4 Milne Inlet Tote Road LSA

The Milne Inlet Tote Road runs approximately 105 km from the Milne Port Area to the Mine Area (Figure 12.37). Designated as public use, the road was upgraded by Baffinland in 2007 to facilitate haul road travel as part of a Bulk Sampling Program Twenty-five habitat alteration, disruption, or destruction (HADD) sites that would be created as a result of the upgrade were identified.

The purposes of the Milne Inlet Tote Road environmental baseline studies (2006-2010) were to identify and describe fish habitat in watercourses crossed by the Milne Inlet Tote Road and determine the extent of fish use of available habitat upstream and downstream of the crossings. Monitoring studies were conducted following completion of road upgrades and the Bulk Sampling Program to enhance, and compare to, information collected during baseline studies.

Little IQ information was provided with regard to freshwater environments in waterbodies in the vicinity of the Milne Inlet Tote Road. The presence of Arctic char was noted in Muriel and McQuat lakes (Figure 12.35). In addition, there does not appear to be any previous scientific survey data for this area.

A total of 248 watercourse crossings were identified along the Milne Inlet Tote Road during the initial surveys, prior to road upgrades (Figure 12.38). Streams within the first 15 km from the Milne Inlet terminus typically flow directly into Milne Inlet or into the reach of Phillips Creek downstream of an impassable set of falls. These streams often lack persistent flows, contain an abundance of barriers separating them from potential overwintering habitat, and are largely non fish-bearing.

Streams crossed from km 15 to km 61 (Phillips Creek catchment upstream of the falls) have fewer barriers, are accessible from overwintering lakes (Figure 12.38), and are typically characterized by smaller substrate sizes with riffle/pool habitat. Fish habitat is more abundant in this zone. Two lakes surveyed in this region (at km 27 and km 32) provide suitable overwintering and nearshore juvenile Arctic char habitat. The zone between km 61 and km 75 is part of the upper Ravn River catchment and, like streams in the first 15 km of the Milne Inlet Tote Road, consists largely of intermittent or ephemeral drainages that are not fish-bearing with abundant barriers. The area between km 75 and km 83 is a relatively broad, flat terrain characterized by largely sandy watercourses that flow into or out of Muriel Lake (Figure 12.38), providing relatively abundant fish habitat.

Watercourses crossed by the remaining 20 km of the Milne Inlet Tote Road are mainly part of the Mary River sub-catchment. This region includes many spring run-off drainages providing no fish habitat, but also several large streams in close proximity to Arctic char overwintering lakes (e.g., Mary Lake, Camp Lake), providing abundant fish habitat (Figure 12.38). Cobble/sand substrata and riffle/pool habitat dominates with water velocities occasionally exceeding 1.0 m/s. Few downstream barriers are present.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Ninespine stickleback is relatively uncommon in the LSA (captured at only 11 of 248 crossings). No streams along the Milne Inlet Tote Road have sufficient depth for survival of incubating Arctic char eggs over winter and are, therefore, used only as open-water rearing/foraging habitat and movement corridors by Arctic char. Within the first 15 km from Milne Inlet, Arctic char were captured or suspected to occur only in two streams that flow directly into Milne Inlet (total catch = 5 fish). These Arctic char are thought to be anadromous fish from Milne Inlet using the streams for foraging during summer. Juvenile Arctic char were captured at a total of 18 crossings (11 of Important quality) between km 15 and km 61 along the Tote Road. Both of the surveyed lakes in this Section of the Tote Road support Arctic char populations with the presence of young-of-the-year (YOY) suggesting the occurrence of spawning. Only two streams present in the zone between km 61 and km 75 support Arctic char use near the crossings. Three crossings between km 75 and km 83 were classified as Marginal and two as Important. Twelve watercourses along the remainder of the Milne Inlet Tote Road provide fish habitat (nine were Important). Several of these streams are tributaries to large lakes and appear to support large numbers of rearing YOY and juvenile Arctic char.

12.20.2.5 Mine LSA

The majority of the baseline studies undertaken for the Project were conducted in the Mine LSA (2005-2010). Programs included collection of information on:

- Aquatic habitat (streams and lakes)
- Primary producers (phytoplankton, periphyton, and aquatic plants)
- Secondary producers (zooplankton, invertebrate drift, and benthic invertebrates)
- Fish communities and populations
- Fish condition
- Fish movements
- Metals in Arctic char tissues.

The baseline field programs involved characterization of the biological communities and their habitat in waterbodies in the Mine LSA and surrounding area including five lakes (Sheardown Lake NW and SE, Camp Lake, Mary Lake, Angajurjualuk Lake, and the Candidate Reference Lake), small tributary streams, and the Mary and Tom rivers (Figure 12.35).

Aquatic Habitat

The lakes investigated in the Mine LSA are relatively shallow (mean water depth ranges from 4.0 to 13.0 m), clear (high Secchi Disk depth and corresponding maximum depth of light penetration estimated to be 12 m), with substrate dominated by sand interspersed with patches of cobble/ boulder. Macrophytes, which rarely occur and are sparsely distributed, in the Mine LSA lakes appear to be predominantly macroalgae (e.g., Chara spp.) with the exception of Mary Lake where water crowfoot (Ranunculus sp.) and aquatic moss are observed.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The Mine LSA includes persistent perennial, intermittent and ephemeral streams, but all LSA streams freeze to the bottom in winter. Persistent perennial streams generally consist of riffle habitat, with occasional pools. Substrate is often dominated by cobble, with sand, gravel and boulders present in varying amounts. Streams are generally shallow (<0.5 m deep) with, particularly during lower flow periods, extremely shallow (<0.1 m deep) Sections that limit connectivity between upstream and downstream reaches. Intermittent and ephemeral streams provide marginal to no habitat for fish. In general, stream width and depth decreased substantially between high and low flow periods. Riparian vegetation is limited, and generally consists of moss and grass and, in some locations, willows.

The majority of Camp Lake inflows are small, ephemeral streams providing limited or no aquatic habitat. Five inflows were identified as providing important aquatic habitat. Several larger perennial and intermittent streams provide habitat for fish, but the presence of barriers within the first 5 km upstream of Camp Lake limits the availability habitat. Fish-bearing streams are generally shallow; with predominantly riffle/pool morphology, cobble substrates, and relatively limited cover.

Perennial and intermittent streams are similarly uncommon among Sheardown Lake inflows. Only four support multiple trophic levels of aquatic biota and only one of these (Tributary 1) is of substantial size. Tributary 1 is the primary open-water rearing habitat for juvenile Arctic char from Sheardown Lake and it provides a relatively large amount of habitat for other aquatic biota. Much of the available Sheardown Lake inflow habitat is shallow riffle or cascade/pool habitat over a predominantly cobble substrate. Barriers limit the extent of upstream access for fish in Sheardown Lake inflows. Numerous, small, intermittent and ephemeral tributaries are also present, none of which provide sufficient aquatic habitat to support fish populations and provide very limited habitat for other biota.

Mary Lake has two large inflows: the Tom River entering the north basin and the Mary River entering the south basin (Figure 12.39). Five additional tributaries, two in the north basin and three in the south, provide sufficient aquatic habitat for multiple trophic levels. However, the composition of available habitat differs from other surveyed lake systems, with sand and gravel, macrophytes, and areas of standing water more abundant in the lower reaches of Mary Lake tributaries. As with the other lakes in the LSA, the majority of the remaining inflows are small and provide limited aquatic habitat and, even in fish-bearing streams, available habitat is generally limited to the lower 4-5 km due to upstream barriers.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The Mary and Tom are the largest LSA streams, both originating north of the Mine Site and flowing south west into Mary Lake (Figure 12.39); the Mary River then continues into Angajurjualuk Lake. Waterfall barriers in the Mary and Tom rivers limit fish access to approximately the lower 15 and 6 km, respectively. The lower reaches (approximately 1 km) of both streams are depositional environments dominated by sand and run/flat habitat with no cover. These areas provide limited aquatic habitat for local biota. Upstream reaches of the Mary and Tom rivers have more diverse habitat with a combination of riffle/run/pool habitat over cobble boulder/gravel substrata and more abundant cover.

Of the two potential candidate reference streams that were surveyed for habitat, Candidate Reference Stream 2 is most similar to the Mary River with primarily shallow depths, cobble substrates, and riffle habitat characteristics.

Primary Producers

Lakes in the Mine LSA (Camp, Sheardown, Mary and Candidate Reference lakes) are characterized by low primary productivity (i.e., low chlorophyll a concentrations and phytoplankton biomass) as is typical in Arctic aquatic ecosystems. Lake-wide mean concentrations of chlorophyll a measured in the open-water season indicate a trophic status of ultra-oligotrophic to oligotrophic. Means of chlorophyll a and biomass for the 2007-2008 period were very similar between lakes ranging between 0.2 and 0.7 µg/L and 122 and 204 mg/m^3, respectively. A total of 82 species of phytoplankton were recorded in the Mine LSA lakes in 2007 and 2008. Phytoplankton biomass was dominated by diatoms (Bacillariophyceae) at most sites and times; Cyclotella and Melosira were ubiquitous and relatively abundant across the lakes.

Like lakes, streams in the Mine LSA are characterized by low phytoplankton productivity (i.e., low chlorophyll a concentrations) with mean concentrations of chlorophyll a ranging from $<$0.2 µg/L to 4.5 µg/L across sites. Overall, means for the Mary and Tom rivers, and tributaries to Sheardown Lake were less than 1 µg/L and similar to means observed in lakes. Applying the stream trophic classification scheme of Dodds et al. (1998) streams in the Mine LSA are oligotrophic on the basis of phytoplankton chlorophyll a.

Periphyton densities were highest in the tributaries to Sheardown and Camp lakes and lowest in the Mary and Tom rivers. Most individual measurements and all site means of periphyton chlorophyll a were $<$100 mg/m^2. Application of the trophic categorization scheme proposed by Dodds et al. (1998) for streams indicates that some streams or areas of streams in the Mine LSA would be considered oligotrophic while others mesotrophic on the basis of benthic chlorophyll a.

Secondary Producers

A total of nine crustacean zooplankton taxa were identified in the Mine LSA lakes during the open-water seasons of 2007 and 2008. Overall mean total zooplankton density (seasons and years combined) is highest in Sheardown Lake NW (15,922 individuals/m^3), followed by Sheardown Lake

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

SE (11,852 individuals/m^3), Camp Lake (11,125 individuals/m^3), and Mary Lake (3,939 individuals/m^3). Copepoda, particularly Cyclopoida, comprise the majority of the zooplankton collected from Mine LSA lakes with Cyclops scutifer and Diaptomus minutus being the predominant species identified.

Macroinvertebrate density for the 2006-2008 period varies among lakes in the Mine LSA and is highest in Sheardown Lake SE (8,229 individuals/m^2), followed by Mary Lake (3,270 individuals/m^2), Sheardown Lake NW (2,488 individuals/m^2), and Camp Lake (2,122 individuals/m^2). Within all but Camp Lake (where euphotic/littoral zone was not sampled), the highest mean density occurred in areas falling within the euphotic/littoral zone. The higher densities of macroinvertebrates in the littoral zone generally reflect higher productivity (via photosynthetic and detrital foodweb pathways). A total of 45 macroinvertebrate taxa were identified at the genus level. All lakes are considered moderately diverse, with a variety of insect genera represented. Overall, macroinvertebrate density in lakes is dominated by Chironominae larvae (mainly Micropsectra and Stictochironomus). The benthic communities of the Mine LSA lakes are comparable in many respects to the communities of other small lakes in the Canadian Arctic and subarctic, and are typical of oligotrophic Arctic lakes.

Drifting macroinvertebrate density varied among Mine LSA tributaries and among sampling times within a tributary for the 2007-2008 period. Overall mean total drifting macroinvertebrate density (seasons and years combined) is highest in tributaries to Sheardown Lake (87 individuals/m^3), followed by tributaries to Camp (67 individuals/m^3) and Mary (10 individuals/m^3) lakes. Overall, drift density is dominated by Orthocladiinae larvae in tributaries to Camp (67%), Sheardown (91%), and Mary lakes (34%); 21 macroinvertebrate families were identified in drift traps deployed at the mouths of tributaries. Drifting invertebrate densities in Mine LSA streams are similar to those observed in streams in northern Alaskan Arctic and subarctic streams (Miller and Stout 1989). Chironomids typically dominate the community of Arctic and subarctic streams.

Macroinvertebrate density for the 2006-2008 period varies among Mine LSA streams and is highest in Sheardown Lake tributaries (1,422 individuals/m^2), followed by Camp Lake tributaries (515 individuals/m^2), the Tom River (346 individuals/m^2), and the Mary River (341 individuals/m^2). A total of 62 macroinvertebrate genera were recorded. The Mary and Tom rivers are considered moderately diverse, whereas the Camp Lake and Sheardown Lake tributaries are relatively more diverse, each with a variety of insect genera represented. Overall, macroinvertebrate density is dominated by Orthocladiinae larvae (mainly Cricotopus, Tokunagaia, and Orthocladius [Euorthocladius]) at all sites. According to the classification of Beaufort Sea drainage streams by Craig and McCart (1975), the densities of macroinvertebrates in Mine LSA streams are low to moderate (i.e., in the range of approximately 100 to 1,000 individuals/m^2). The composition of the benthic macroinvertebrate community in Mine LSA streams is typical of tundra streams found in other parts of the Arctic (Oswood 1989).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Fish Populations and Movements

IQ collected as part of the Project indicated that Mine LSA waterbodies contain land-locked Arctic char, with sea-run (i.e., anadromous) populations being restricted to waterbodies further downstream in the Ravn River system. It was generally felt that land-locked Arctic char within the Mine Area overwinter in lakes. Mary Lake was stated to have an Arctic char population; however, no specific IQ was indicated with respect to Arctic char populations within Camp and Sheardown lakes.

Arctic char and ninespine stickleback are the only fish species found in waterbodies within the Mine LSA and surrounding area. Arctic char were the dominant species, accounting for at least 98.6% of the overall catch from all surveyed Mine Area lakes. The results of surveys in tributaries to the surveyed lakes indicated that Arctic char are also typically the dominant riverine species.

Arctic char were found to be widely distributed in Mine Area lakes and streams (Figure 12.40). Overall gillnet catch-per-unit-effort (CPUE) was highest in the north arm of Mary Lake, followed by Sheardown Lake SE, Angajurjualuk Lake, Mary Lake S, Sheardown Lake NW, and Camp Lake (Figure 12.41). Electrofishing catches of juveniles varied, but overall CPUE was highest in Sheardown Lake NW, followed by Sheardown Lake SE, Angajurjualuk, Camp Lake, Mary Lake north, and Mary Lake south (Figure 12.42).

Arctic char were captured in all four surveyed Camp Lake tributaries, both Sheardown Lake NW tributaries, both Sheardown Lake SE tributaries, three of the four tributaries to Mary Lake N, and two of the three tributaries to Mary Lake S. Arctic char were captured in six of the eight Mary River reaches sampled and between Mary Lake and Tom River Falls in the Tom River. No Arctic char were captured upstream of the falls in the Mary or Tom rivers (Figure 12.40).

The youngest captured Arctic char from lakes in the Mine Area ranged from five to eight years with maximum age ranging from 17 to 25 years. The overall ratio of male to female gillnet-caught Arctic char was 0.96:1. The proportion of fish that were maturing to spawn in the current year ranged from 12.7% in summer, 2007 to 93.9% in fall, 2008. Diet of Arctic char captured in Mine Area lakes was primarily chironomids with other invertebrates and small Arctic char consumed at lower frequencies.

As in most high Arctic populations, Arctic char in the Mine Area are believed to restrict their spawning to lakes where depths are sufficient for overwinter egg incubation. Information collected during field studies suggested that Arctic char spawn in Sheardown and Camp lakes and may spawn in Mary and Angajurjualuk lakes.

Data indicate that Arctic char use all the major lakes, many of the tributaries to these lakes, and the Mary and Tom rivers for rearing and foraging during the open-water period. Among the lakes, catches of adults and larger juveniles were highest in the southeast basin of Sheardown Lake and lowest in Camp Lake (Figure 12.41). Catches of smaller juveniles and YOY were highest in Sheardown Lake NW and lowest in the south basin of Mary Lake (Figure 12.42).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Juvenile, YOY and, to a lesser extent, adult Arctic char move upstream into the smaller tributaries to access rearing and foraging habitat in spring, remaining throughout the open-water season. Stream habitat where Arctic char were captured in surveyed streams is illustrated in Figure 12.40. Some of the more productive tributaries in terms of rearing and foraging habitat for Arctic char included Camp Lake Tributary 1, Camp Lake Tributary 2, Sheardown Lake Tributary 1, Sheardown Lake Tributary 7, Mary Lake North Tributary 1, Mary River, and Tom River. In most of these tributaries, Arctic char use the entire reach between the lake into which the tributary flows and the first impassable barrier and are found primarily in cobble and boulder habitat where cover is available.

Overwintering habitat within the Mine Area appears to be restricted to the four main surveyed lakes. None of the streams or rivers in the Mine Area are considered to provide overwintering habitat for Arctic char, as all freeze solid (see Volume 7, DEIS Appendix 7A). Overwintering habitat is abundant in the four surveyed lakes, with the possible exception of the generally shallower Mary Lake North. Winter sampling in Camp and Sheardown lakes confirmed the presence of overwintering adults.

In general, movement data collected from Mine Area lakes and streams suggest that Arctic char larger than approximately 250 mm do not move large distances, preferring to spend the majority of their life within a particular lake, although some movement of Arctic char between lakes via larger rivers during summer has been documented. Juvenile Arctic char overwinter in lakes and move either to the nearshore zones of lakes or into the smaller tributaries during spring and move back into the lakes during summer or fall. Arctic char within the Mine Area may be classified as non-anadromous freshwater residents

Metals in Fish

A total of 102 Arctic char ranging from 5 to 25 years of age and 165 to 751 mm in length were captured and analysed for metals in liver and/or muscle tissues from 2006-2007. Thirty juvenile Arctic char ranging from 2-5 years and from 63-150 mm in length were captured from the Mary River and analysed for metals in liver and muscle in 2008.

In general, results were similar across lakes and the Mary River in terms of metals consistently detected or consistently not detected in liver and muscle samples. With one exception (mercury), metals consistently detected in muscle and liver were essential elements, such as calcium, potassium, and zinc. In addition, several metals were detected in all liver samples of fish captured from lakes (cadmium, cobalt, molybdenum, selenium, sodium, and thallium) but not in juvenile fish captured from the Mary River.

All concentrations of lead and arsenic measured in Arctic char muscle were below the Canadian Food Inspection Agency (CFIA) guidelines (0.5 µg/g w.w. for lead; 3.5 µg/g w.w. for arsenic) in the Mine Area. As mercury bioaccumulates and biomagnifies, it is generally highest in larger, older fish and in species that occupy a higher trophic position (i.e., top predators). Mercury concentrations in muscle and liver of Arctic char (excluding juvenile fish) were positively correlated to fish fork length and age.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Arithmetic and length-standardized mean concentrations of mercury in Arctic char muscle were relatively similar across lakes, but both values were highest in Angajurjualuk Lake. Concentrations of mercury in juvenile Arctic char muscle were notably lower than in larger fish captured from the lakes. Collectively, of the fish captured in lakes (age range of 5 to 25 years),14% of Arctic char muscle samples exceeded the Health Canada (2007) guideline for the commercial sale of fish (0.5 µg/g w.w.) and 29% of samples exceeded the Health Canada (Wheatley 1984) subsistence guideline (0.2 µg/g w.w.). Mercury concentrations are commonly higher in land-locked Arctic char relative to anadromous populations (Lockhart et al. 2005) and frequently above the Health Canada subsistence guideline of 0.2 µg/g (w.w.) in Arctic fish (e.g., Gantner et al. 2010). Concentrations of mercury in muscle of Arctic char collected in the Mine Area fall within the ranges observed in 27 populations of land-locked Arctic char sampled across remote lakes of the Canadian Arctic (Gantner et al. 2010) and from land-locked Arctic char collected from six lakes in the Canadian Arctic archipelago (Muir et al. 2005). The arithmetic mean concentrations of mercury in muscle of Arctic char from the Mine Area lakes was lower than the mean reported by Gantner et al. (2010) for Radar Lake, Baffin Island, despite similarity in mean fork lengths between these populations.

12.20.2.6 Railway LSA

The railway is 149 km in length and will connect the Mine Site to Steensby Port (Figure 12.43). The railway corridor, which will include a construction access road, several spur roads to access rock quarries and four construction camps, will traverse three major watersheds. From the Mine Site to approximately km 69 the line will traverse numerous watercourses that drain generally westward as part of the Ravn River watershed. From km 69 to approximately km 127 the line will pass through the Cockburn River watershed that flows southward to Steensby Inlet. The remainder of the line will lie within the Ikpikitturjuaq River watershed that drains southwestward and empties into Ikpikitturjuaq Bay, north of the Steensby Port site.

The access road will run adjacent to the railway for most of its length, with several minor deviations and two major deviations, one at Cockburn Lake and one to the north of the Ravn River crossing (Figure 12.43). Construction camps will be located north of the Ravn River crossing (Ravn River Camp), at Mid-Rail Camp Lake (Mid-Rail Camp), on the east side of the middle basin of Cockburn Lake (Cockburn Tunnels Camp), and near the southern end of Cockburn Lake (Cockburn South Camp) (Figure 12.43).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Railway/Access Road Stream Crossings

A total of 224 sites were surveyed at potential railway crossings, or where the railway and construction access road crossings will be adjacent (Figure 12.44). These included 65 sites (29%) that were confirmed or suspected to be Arctic char habitat. Ninespine stickleback habitat was confirmed or suspected at 60 streams (27%). A total of 49 streams (22%) were assessed as fish habitat for both species, and 149 streams (67%) were designated as having no fish habitat. Excluding the Mary and Ravn river crossings, Arctic char habitat was limited to summer rearing and feeding habitat YOY and juveniles. Forty-seven sites (21%) were assessed as Important, most of them in the Ravn and Cockburn river watersheds. Eighteen sites (8%) were

A total of 93 potential access road crossing sites were surveyed along the access road alignment, excluding sites where the access road and railway crossings will be adjacent. These included 19 (20%) that were confirmed or suspected to be Arctic char habitat. Ninespine stickleback habitat was confirmed or suspected at 22 streams (24%). A total of 19 streams (20%) were assessed as fish habitat for both species, and 70 streams (75%) were designated as having no fish habitat. Excluding the Mary and Ravn river crossings, Arctic char habitat was limited to summer rearing and feeding habitat for YOY and juveniles. Twelve sites (13%) were assessed as Important, most of them in the Ravn River watershed. Seven sites (8%) were considered to provide Marginal habitat for Arctic char, most in the Ravn River watershed.

Cockburn Lake

Cockburn Lake is a narrow lake, approximately 37 km long, confined within a steep-sided valley. It comprises three basins separated by two narrow and relatively shallow channels (Figure 12.44). The middle basin is by far the largest (approximately 18.6 km long and 394.4 km^2), while the south basin (approximately 7.8 km long and 11.1 km^2) and north basin (approximately 5.7 km long and 9.5 km^2) are substantially smaller. The north basin has maximum and mean depths of 192 m and 29.8 m, respectively. The middle has a maximum depth of 195 m and a mean depth of 34.7 m. The south basin has maximum and mean depths of 61.4 m and 21.5 m, respectively, for the portion of the basin that was surveyed.

Acoustic depth and substrate data collection was focused along shorelines adjacent to the proposed railway and access road alignments. Six discrete substrate types were identified. Boulder and cobble substrates with clay or pebble matrices comprised about 94% of the nearshore habitat mapped in the north and middle basins. Areas mapped in the south basin were dominated by fines (i.e., sand, silt, and clay), with coarser rock substrates (i.e., boulder, cobble, gravel) generally confined to nearshore areas. Nearshore substrate composed of boulder and cobble would provide cover and feeding habitat for juvenile Arctic char and possibly ninespine stickleback.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Gillnetting was conducted in the fall of 2008, at five sites located in the vicinity of the Cockburn Lake railway crossing. CPUE was highest, 85-86 fish/100 m/24 hrs, at two nearshore sites (4-5 m depths), while average CPUE at three deeper sites was less than 10 fish/100 m/24 hrs.

Railway/Access Road Lake Encroachments

A total of 45 potential encroachment sites were surveyed between 2007 and 2010, including 19 (42%) that were confirmed or suspected to be Arctic char habitat. Ninespine stickleback habitat was confirmed or suspected at 25 sites (56%). A total of 17 sites (38%) were confirmed or suspected to provide habitat for both species, and 18 sites (40%) were designated as having no fish habitat. Encroachment sites identified as Arctic char habitat generally are shallow nearshore sites with habitat that is suitable for Arctic char feeding and rearing. No sites were identified as potential spawning or overwintering sites, and no sites were identified where this type of habitat is limited in a given waterbody (i.e., critical).

Quarry Locations

A total of three potential quarry sites were surveyed. A total of one site (33%) was confirmed or suspected to provide habitat for both species, and two sites (67%) were designated as having no fish habitat. Potential quarry sites identified as Arctic char habitat generally are shallow nearshore sites with habitat that is suitable for Arctic char feeding and rearing. No sites were identified as potential spawning or overwintering sites, and no sites were identified where this type of habitat is limited in a given waterbody (i.e., critical).

Construction Camps

Ravn Camp Lake has a surface area of 1.9 km^2 and at the time of the 2010 survey had a maximum and mean depth of 50.0 m and 14.5 m, respectively. The lake Volume was calculated to be 27.5 million m^3. The east basin, which includes any potential water withdrawal sites, is both the largest and the deepest. The lake substrate is dominated by sand and silt/clay/sand and no potential Arctic char spawning areas were identified.

Mid-Rail Camp is located near the railway alignment, approximately 60 km from the Mine Site and 20 km south of the Ravn River Camp site (Figure 12.44). Mid-Rail Camp Lake has a surface area of 1.8 km^2 and a maximum and mean depth of 14.4 m and 4.2 m, respectively, for the portion of the lake that was surveyed. The lake Volume was estimated to be 7.6 million m^3. The Mid-Rail Camp area is relatively flat and local surface water flow patterns are complex and in places indefinite.

A total of four Arctic char were captured in a gill net set in Mid-Rail Camp Lake in 2008. Juvenile Arctic char were observed in nearshore areas of this lake, but were generally absent from the shallow lakes to the south of Mid-Rail Camp Lake. Mid-Rail Camp Lake and several other lakes in the area also support ninespine stickleback.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The Cockburn Tunnels Camp is located on the east side of Cockburn Lake, approximately midway down the middle basin (Figure 12.44). Bathymetry and substrate mapping surveys were conducted along the east shore of Cockburn Lake in 2007, including the area adjacent to the Cockburn Tunnels Camp. A single access road crossing (AR-037b) that lies within the camp's footprint was assessed and determined to be non fish-bearing.

The Cockburn South Camp is located on the east side of Cockburn Lake, near the south end of the lake and approximately 20 km from the Steensby Port site (Figure 12.44). Substrates in the south basin of Cockburn Lake are dominated by fines (i.e., sand, silt, and clay), with coarser rock substrates (i.e., boulder, cobble, gravel) generally confined to nearshore areas at depths less than 3 m. No potential Arctic char spawning areas were located in the vicinity of Cockburn South Camp, although nearshore habitats composed of boulder and cobble would provide cover and feeding habitat for juvenile Arctic char and possibly ninespine stickleback.

Though not directly associated with the camp, two access road crossings within the camp footprint (AR-021 and AR-021a) were assessed. These were classified as Marginal and No Fish Habitat for Arctic char for AR-021 and AR-021a, respectively.

12.20.2.7 Steensby Port LSA

The Steensby Port LSA consists of numerous lakes and streams in small, coastal watersheds and various components of larger catchments such as the watersheds of the Cockburn and Ikpikitturjuaq Rivers (Figure 12.43). Most of the freshwater in this region lies in areas of relatively low relief with perennial or intermittent outflows to the sea. Aquatic biota and habitat baseline studies at the Steensby Port LSA were largely conducted from 2007-2010. Studies included surveys to determine fish presence/absence and distribution, fish barriers, and habitat use. Information on primary production (i.e., phytoplankton) was obtained in 2008 at selected lakes in conjunction with water quality sampling.

Information from the IQ study indicated the presence of Arctic char in three lakes including Ikpikitturjuaq Lake (ST-347), its largest upstream lake (ST-176) and Lake ST-352 (Figure 12.45). Arctic char were identified as being abundant in Ikpikitturjuaq Lake during summer with anadromy via the Ikpikitturjuaq River. Both Ikpikitturjuaq Lake and Lake ST-352 were identified as important for fish and as drinking water sources by five Igloolik IQ study participants. Although not surveyed as part of this Project, test fisheries conducted on nearby rivers in the Steensby Inlet area, including the Ravn, Cockburn and Ikpikitturjuaq Rivers,

Generally, the majority of available fish habitat in the Steensby Port LSA is lacustrine and is found exclusively on the mainland; freshwater ponds on the island are not fish-bearing. There are relatively few large streams, in particular those with a predominance of cobble/riffle habitat, relative to other LSAs. In addition, most of the available fish habitat in the surveyed area can be found in only four catchments (ST-02, 04, 05, and 06). Nearshore substrates in a large number of the lakes in the surveyed area are predominantly gravel or smaller in size. Most catchments on the mainland contain

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

a minimum of one lake with apparently sufficient depth to provide overwintering habitat for both fish species.

A large proportion of surveyed streams were identified as non fish-bearing based on a lack of sufficient flows and/or connectivity with probable suitable overwintering locations. Of the remaining streams with suitable fish habitat, most are characterized by fine substrates. Barriers to fish movements are present in most catchments, but are more common in smaller drainages along the coast (Figure 12.45). In addition, with the exception of the Ikpikitturjuaq River, there appears to be a general lack of connectivity with the marine environment and, therefore, little anadromy. Primary production of Steensby Port LSA lakes is low. Chlorophyll a concentrations measured in 2008 ranged from <0.2 µg/L to 5.5 near the water surface and indicate a trophic status ranging from ultra-oligotrophic to borderline oligotrophic/mesotrophic.

Both freshwater fish species were observed throughout the Steensby Port LSA. However, in contrast to other LSAs, ninespine stickleback were more widespread and abundant than Arctic char in many catchments. Three entire watersheds (ST-03, 18, and 19) were found to support only ninespine stickleback. Both species were captured or observed more commonly in lakes than in streams and were generally absent from small, coastal, mainland and island catchments despite the presence of apparently suitable spawning, overwintering, and/or rearing habitat in many waterbodies.

The broader distribution of ninespine stickleback relative to Arctic char in many Steensby watersheds may be related to the predominance of fine substrates and low flow/lack of connectivity. Many of these areas are suitable for multiple life history stages of ninespine stickleback, but may limit movements of and use by Arctic char, which prefer larger substrate sizes.

12.21 Marine Environmental Baseline Conditions

12.21.1 Regional Setting

The following sections are based on information from several sources, including DEIS Appendix 8A-1, Appendix 8A-2, Enfotec (2010), Mallory and Fontaine (2004), and unpublished ship traffic data.

12.21.1.1 Shipping Routes

In general, shipping-related effects to sea ice and marine mammals are discussed on a large spatial scale that encompasses all of Milne Inlet and Eclipse Sound to the north and, to the south, all of Steensby Inlet, Foxe Basin and parts of Hudson Strait that lie within Nunavut territorial waters. Ship access to Milne Inlet is primarily from the North Atlantic through Davis Strait and Baffin Bay.

The timing of ice formation in Baffin Bay and Davis Strait is variable, but generally begins in September. Ice begins to ablate during June in the vicinity of the Northwater Polynya, (located at the northern end of Baffin Bay), and open water extends southward across the entrance to Lancaster Sound. On average, clearing of ice occurs by September. All of the waters within Milne Inlet, Eclipse

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Sound and Navy Board and Pond Inlets are covered by fast ice from about mid-October until early or mid-July. Most shipping activity in the region occurs from July through October and is comprised mainly of merchant vessels supplying communities in the region, cruise ships, and Canadian Coast Guard vessels. Smaller numbers of commercial fishing vessels also occur.

Regionally, western Baffin Bay and eastern Lancaster Sound are among the most biologically productive areas in the Canadian Arctic, supporting high diversity and abundance of marine mammals, seabirds and other marine biota. Large numbers of marine mammals overwinter in Baffin Bay and use Lancaster Sound as a migration corridor to summering areas in the central Canadian Arctic.

Ship access to Steensby Inlet will be through northern Hudson Strait and Foxe Basin. Throughout Hudson Strait, open water leads develop from May through June, though the area may not clear until early fall. Freeze-up begins in the western portion of Hudson Strait during November, and proceeds east until the entire area is covered in ice (generally by mid-December). The Strait is characterized by strong currents and winds and, consequently, pack ice in central areas is constantly in motion. Shore lead systems frequently form along the southern coast of Baffin Island, while ice tends to accumulate along the southern shore of Hudson Strait and Ungava Bay. Ice melt in Foxe Basin begins in June, and leads open along shores throughout July. Rather than drifting extensively as in southern Hudson Bay, pack ice tends to move less in the central part of Foxe Basin and disintegrates in place throughout August. Ice formation begins in mid-October in the northern and western portions of the basin, spreading southward to cover the basin by early November. Steensby Inlet is covered by fast ice from mid-October to mid- or late July. Landfast ice in Steensby Inlet generally breaks up during late July, and reforms in mid-October. Most shipping activity in the region occurs from July through November and is comprised mainly of merchant vessels supplying communities in Hudson Strait, Foxe Basin and Hudson Bay, bulk carriers exporting grain from Churchill, Manitoba, cruise ships, and Canadian Coast Guard vessels. Very little winter ship traffic occurs in the region, and is comprised of Canadian Coast Guard ice breakers and periodic ice breaking ore carriers accessing the Raglan Mine at Deception Bay in Nunavik.

Hudson Strait and northern Foxe Basin are biologically productive areas that support large numbers of seabirds and marine mammals, seasonally and annually. These areas provide important staging and breeding areas for seabirds, and represent an important migration corridor for many marine mammals moving between wintering areas in Hudson Strait or the Labrador Sea and summering areas in Hudson Bay and Foxe Basin. Northern Foxe Basin provides year-round habitat for several species of marine mammals, including walrus, ringed and bearded seals, and polar bears.

12.21.1.2 Port Sites

Milne Inlet is a narrow fjord originating to the south of Eclipse Sound (Figure 12.46), and is characterized by deep waters (generally >100 m) and steep surrounding head lands. The Inlet system includes two minor arms; Tremblay Sound to the west (depths to 260 m) and Eskimo Inlet to

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

the east (depths to 285 m) adjacent to the main portion of Milne Inlet. The proposed port is located at the southern tip of Milne Inlet on a fjord-head delta. Shorelines within Milne Inlet include a mix of rock cliffs, alluvial fans and raised beach ridges. Like many peri-glacial shorelines, coastal sediments are coarse boulders, cobbles and sand. The Inlet is ice-covered most of the year, with a short three-month open-water season. Icebergs are common and often become grounded in shallow, nearshore areas. During the open-water season, anadromous Arctic char, as well as a variety of bird and marine mammal species use Eclipse Sound and Milne Inlet extensively for summer feeding and rearing. On average, approximately 20,000 narwhal summer in Milne Inlet, Eclipse Sound, and other adjoining Inlets.

Steensby Inlet is a wide bay, characterized by shallow waters (<100 m) and gentle terrestrial relief around most of its perimeter. Shorelines include wide tidal flats along the west cost of the Inlet, lagoon complexes to the north, and a mix of bedrock and coarse alluvial shorelines along the east coast. The tidal range within the Inlet is over 4 m and tidal currents dominate water circulation. Steensby Inlet is covered by landfast ice from late October to late July/August. The proposed port is located on the eastern shore, about 50 km into the Inlet (Figure 12.46).

Steensby Inlet provides year-round habitat for ringed seals and polar bears, and is used during open-water periods by beluga, bearded seal and walrus. Bird species such as Arctic tern, brant, Canada geese, common eiders, glaucous gulls, king eiders, Pacific loons, red-breasted mergansers, red-throated loons, jaegers, and snow geese use Steensby Inlet as a nesting and staging area. Nearshore habitat in Steensby Inlet provides feeding habitat for anadromous Arctic char populations from several watersheds, including the Ikpikitturjuaq, Cockburn, and Rowley rivers.

12.22 Sea Ice

For PDW shipping to Milne Port and Steensby will only occur only during open water periods and, therefore, no shipping-related effects to sea ice are anticipated along that route.

12.23 Water And Sediment Quality

Water quality is an important component of the aquatic environment as it forms a significant facet of the environment for aquatic life and wildlife. Sediment quality is also important to the health of aquatic biota that live in or on sediments, or that are part of the food chain that includes sediments and/or benthic communities.

The following sections provide a description of the existing water and sediment quality conditions in Milne and Steensby Inlets, a description of the approach and methodology used in assessing potential effects on the environment, an assessment of the predicted effects of the Project on this VEC, a summary of residual effects, and proposed environmental monitoring and follow-up.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.23.1 Study Areas

LSA selection was based on guidance from NIRB and is described in Volume 2. It is defined as the area where there exists reasonable potential for direct interaction due to Project activities, ongoing normal activities, or possible upset conditions, such as a fuel spill. Various Project activities could affect water and sediment quality in the vicinity of the proposed port sites and were considered in the development of the LSA, including the following:

- Discharge of ballast water from supply vessels and ore carriers;
- Airborne dispersion of dust from ore stockpiles;
- Discharge of treated wastewater; and
- The modelled 95% probability distribution of diesel spills.

Note that although the areal extent of a potential diesel spill was included in the development of the LSA for water and sediment quality, the assessment of fuel spills will not be considered within this volume. Rather, all assessments of spills and emergency procedures are discussed in Volume 9 (Accidents and Malfunctions, Section 1.0).

Milne Inlet

The Milne Inlet LSA for water quality and sediment quality extends northeast from the proposed port site (at the south end of the Inlet) for a total of 4 km, and spans the whole width of the Inlet (Figure 12.48). The southwest boundary of the LSA ends at the confluence of the Inlet with Phillips Creek. Milne Inlet and Eclipse Sound are the water and sediment quality RSA.

Steensby Inlet

The Steensby Inlet LSA contains all of the marine waters within an 8 km radius of the proposed port site (Figure 12.49). This area spans approximately two-thirds the width of Steensby Inlet, and includes the Steensby Port Island and a large part of Ikpikitturjuaq Bay. The water and sediment quality RSA is Steensby Inlet.

12.23.2 Baseline Summary

While water and sediment quality are interrelated, for clarity they have been presented separately in Sections 3.2.1 and 3.2.2, respectively. Additional details and results are presented in DEIS Appendix 8A-1.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.23.2.1 Water Quality

Surveys of Milne and Steensby Inlets were conducted during the open-water (i.e., August or September) and ice-cover (i.e., May or June) seasons of 2007 and 2008 (Steensby Inlet), and 2008 and 2010 (Milne Inlet). Surface and deep-water (i.e., 1 m above the bottom or to a maximum of 30 m) samples were collected from sites located at various depths and distances from shore to characterize the overall conditions within each Inlet (Figure 12.50 and Figure 12.51). Analyses were carried out at accredited laboratories (EXOVA Laboratories, Ottawa, ON; ALS Laboratories, Vancouver, BC). Results were compared to the Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of marine aquatic life (PMAL) (CCME, 1999; updated to 2010). A guideline is a recommended upper limit for protection, but is not a legally binding value. Guidelines for marine environments exist for pH, nitrate, arsenic, cadmium, chromium, and mercury. The CCME (1999; updated to 2010) has also issued guidelines for total suspended solids (TSS), turbidity and salinity but the guidelines refer to a departure from background conditions. Where detection limits exceed the guidelines, the results are conservatively assumed to be at or above the guideline.

Milne Inlet

The surface waters of Milne Inlet were near neutral (pH: 7.33 to 7.98), brackish (23 psu to 30 psu), hard (total hardness: 1620 mg/L to 5990 mg/L) and clear (turbidity: 0.3 NTU to 0.6 NTU) with moderate amounts of nutrients (0.3 to 3.1 mg/L, and 0.011 mg/L to 0.54 mg/L for total nitrogen [TN] and total phosphorus [TP], respectively; Table 12.20). Similar to trends noted in the literature (LGL Limited, 1983; Mose Jensen et al., 1999; Michel et al., 2006), nutrient concentrations measured during the open-water season tended to be higher in deep waters compared to the surface. Nutrients in the Inlet were also generally higher during the ice-cover season than during the open-water season. Overall, nutrient concentrations in Milne Inlet were generally within range of those found by previous studies conducted in nearby arctic waters (Table 12.21). Results for all sites, seasons, and depths were within the CCME guidelines for the protection of marine aquatic life for pH (7.0 to 8.7) and nitrate (3.6 mg N/L).

The predominant elements (i.e., major ions and metals) in water samples collected from Milne Inlet were those that typically dominate marine waters (e.g., chloride, sodium, sulphate, and magnesium; Figure 12.52). Total and dissolved metal concentrations were mostly similar, illustrating that metals were present in the water column in the dissolved form and were not typically associated with particulates. Several metals (including arsenic, cadmium, iron and mercury) were generally below the analytical limits of detection. However, concentrations of most metals detected in samples from Milne Inlet were higher at depth than they were near the surface, particularly during the open-water season (Figure 12.52). Most metals that were detected were also present at higher concentrations during the ice-cover season than during the open-water season. Mercury concentrations exceeded the CCME guideline for the protection of marine aquatic life in two samples collected from Milne Inlet in June 2008. No other exceedances were observed; however, the CCME guideline was

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

regularly less than the detection limit (DL) for cadmium, chromium, arsenic, and occasionally mercury; therefore, comparison to these guidelines (0.00012 mg/L; 0.056 mg/L [Cr III] and 0.0015 mg/L [Cr VI]; 0.0125 mg/L; and, 0.000016 mg/L, respectively) is not possible.

Steensby Inlet

The water quality of Steensby Inlet was near-neutral (pH: 7.54 to 7.96), brackish (25 psu to 32 psu), hard (total hardness: 3760 mg/L to 6680 mg/L), and clear (turbidity: 0.1 NTU to 1.3 NTU), with moderate concentrations of nutrients (0.1 mg/L to 4.56 mg/L, and <0.2 mg/L to 0.63 mg/L for TN and TP, respectively; Table 12.22). During both the open-water and ice-cover seasons, most routine parameters were fairly consistent across depth indicating that the Inlet is generally well-mixed within the upper 30 m. The exceptions to this trend were conductivity, alkalinity, and ammonia measured during the open-water season, which were generally higher at depth (to a maximum of 30 m) than at the surface (Table 12.22). Alkalinity, TP, reactive silica, total dissolved solids, and conductivity in Steensby Inlet were also generally higher during the ice-cover season than during the open-water season; whereas, turbidity was slightly lower during the ice-cover season. Generally, nutrient concentrations in Steensby Inlet were within the range of results from previous studies conducted in nearby arctic waters (Table 12.21). Results for all sites, seasons, and depths were within the CCME guidelines for the protection of marine aquatic life for pH and nitrate.

The major elements in water samples collected from Steensby Inlet were those that would be expected to occur in marine waters (e.g., chloride, sodium, sulphate, and magnesium; Figure 12.53). Total and dissolved metal concentrations were often similar, illustrating that metals were present in the water column in the dissolved form and were not typically associated with particulates. Several metals (including arsenic, cadmium, iron, and mercury) were present in such low concentrations that they were generally below the analytical limits of detection. For the most part, metal concentrations at depth were similar to those near the surface; however, a few metals were higher in deep waters than in surface waters during the open-water season.

Most metals (that were detected), were present at higher concentrations during the ice-cover season compared to the open-water season. Mercury concentrations were within the CCME guideline for protection of marine aquatic life (0.000016 mg/L) during the ice-cover and open-water seasons of 2008. The DL exceeded the CCME guidelines for the protection of marine aquatic life for: mercury in September 2007; and all sampling periods for arsenic (0.0125 mg/L), cadmium (0.00012 mg/L), and chromium (0.056 mg/L [Cr III] and 0.0015 mg/L [Cr VI]); therefore, no comparison could be made with respect to these guidelines.

12.23.2.2 Sediment Quality

Sediment quality in Milne Inlet was examined during the open-water seasons of 2008 and 2010. Studies in Steensby Inlet were conducted during the open-water seasons of 2007, 2008, and 2010. Samples were collected from nearshore (i.e., within the inter-tidal zone, water depths from 0 m to 4 m) and offshore (i.e., sites with depths > 10 m) areas within each Inlet in order to characterize the

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

overall conditions of the Inlet while also examining specific sites with historic and potential future interactions (Figure 12.54 and Figure 12.55). Sample analyses were conducted by an accredited laboratory (EXOVA Laboratories, Ottawa, ON). Results were compared to the CCME probable effects level (PEL; the guideline above which severe biological effects can result) and the interim sediment quality guidelines (ISQG; a conservative guideline below which biological effects are rarely seen) (CCME, 1999; updated to 2010). Guidelines for marine sediments exist for arsenic, cadmium, chromium, copper, lead, mercury, zinc, and polycyclic aromatic hydrocarbons (PAHs).

Milne Inlet

Sediments in Milne Inlet are dominated by either sand or sand and silt (Table 12.23). Nutrient concentrations were low, generally comprising less than one percent of the total amount of sediment. Throughout Milne Inlet, some metals (including cadmium and mercury) were present at concentrations below the analytical limits of detection. When detected, metal concentrations were higher in areas where the sediments had a higher proportion of fines (p-values for linear regressions ranged from 0.070 to <0.001, see DEIS Appendix 8A-1 for details).

Since shipping has occurred periodically in Milne Inlet over the past 45 years, sediments from three sites (two near the port and one reference) were tested for the presence of hydrocarbons. No hydrocarbons were detected in the sediments of the reference site; however, some were detected within the port area, including: oil and grease; naphthalene; hydrocarbons C10-16 and C16-C34; and, toluene (Table 12.24). Naphthalene was the only PAH detected. Petroleum compounds measured in another study conducted in the region were also low (Levy, 1986).

Sediment concentrations were consistently within the CCME guidelines for protection of marine aquatic life for arsenic, cadmium, chromium, copper, lead, zinc, and PAHs (Table 12.23 and Table 12.24; CCME, 1999; updated to 2010).

Steensby Inlet

Consistent with the literature, sediments in nearshore areas of Steensby Inlet tended to have a higher proportion of coarse material and lower concentrations of nutrients and metals than those in offshore areas (Thomson, 1982; Kuzyk et al., 2010; Table 12.25). Overall, sediments throughout the Inlet are composed predominantly of sand and have low concentrations of nutrients. Metals and major ions adsorb to silt and clay more readily than to sand. As a result, offshore sediments had a higher concentration of most metals than the nearshore sediments; however, regardless of location, some metals were always near or below the DL throughout Steensby Inlet. Concentrations of metals were lower than the CCME PELs at all sites. Concentrations of cadmium, copper, lead, and zinc were also consistently below the CCME ISQGs (CCME, 1999; updated to 2010; Table 12.25). However, arsenic, chromium and mercury each exceeded their respective ISQG in at least one sample collected from Steensby Inlet.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.24 Marine Habitat and Biota

12.24.1 Introduction

The following provides a description of:

- The aquatic biota and habitat in local study areas (LSAs) potentially affected by Project activities. This description provides the baseline for assessing potential environmental effects of the Project;
- The approach and methods for the assessment of potential Project-related effects on marine biota and habitat;
- The results of the effects assessment, including a description of proposed mitigation; and
- A summary of residual effects.

Detailed methods and results of marine baseline studies conducted in support of this Project are provided in DEIS Appendix 8A-1.

12.24.1.1 Study Areas

LSA selection was based on guidance from NIRB and is described in Volume 2. It is defined as the area where there exists reasonable potential for direct interaction due to Project activities, ongoing normal activities, or possible upset conditions, such as a fuel spill. Various Project activities that could affect marine fish habitat and Arctic char in the vicinity of the proposed port sites and were considered in the development of the LSAs, including the following:

- Discharge of ballast water from supply vessels and ore carriers;
- Airborne dispersion of dust from ore stockpiles;
- Discharge of treated wastewater; and
- The modelled 95% probability distribution of diesel spills.

Note that although the areal extent of a potential diesel spill was included in the development of the LSA for marine fish habitat and Arctic char, the assessment of fuel spills will not be considered within this volume. Rather, all assessments of spills and emergency procedures are discussed in Volume 9, Section 3.0.

Milne Inlet

The Milne Inlet LSA for marine fish habitat and Arctic char extends northeast from the proposed port site (at the south end of the Inlet) for a total of 4 km, and spans the whole width of the Inlet (Figure 12.56). The southwest boundary of the LSA ends at the confluence of the Inlet with Phillips Creek. The southern portion of Milne Inlet extending northward to Eclipse Sound is the marine fish habitat and Arctic char RSA.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Steensby Inlet

The Steensby Inlet LSA contains all of the marine waters within an 8 km radius of the proposed port site (Figure 12.57). This area spans approximately two-thirds the width of Steensby Inlet, and includes the Steensby Port Island and a large part of Ikpikitturjuaq Bay. The marine fish habitat and Arctic char RSA is Steensby Inlet.

12.24.2 Baseline Summary

Information sources for describing the existing marine habitat and organisms in Milne and Steensby Inlet included baseline studies conducted in support of the Project, Inuit traditional knowledge collected during the Inuit Qaujimajatuqangit (IQ) study, and a review of available literature. Field investigations were conducted from 2007-2010 and included the collection of information on:

- Seabed and coastal habitat;
- Primary producers (phytoplankton and attached algae);
- Secondary producers (zooplankton, benthic invertebrates);
- Fish communities and populations;
- Fish condition; and
- Metals in arctic char.

Baseline conditions are briefly summarized in the following sections. Methodology and additional description of results of the field programs are provided in DEIS Appendix 8A-1.

12.24.2.1 Milne Inlet LSA

Seabed Habitat

Observations made with underwater video imagery formed the basis of the nearshore seabed habitat mapping at the Milne Inlet Port Site. Substrates are gravelly sands which become finer with depth. Vegetative cover was the dominant biotic feature in nearly all observations, with bladed kelps and filamentous red algae being the dominant flora. Associated fauna at Milne Inlet is depth stratified, generally sparse, and was most often observed in places where algal cover was low. Brittle stars, sea urchins, and bivalve siphons were commonly observed in Milne Inlet. The seabed was classified into three habitat categories based upon substrate size, water, depth, and biotic assemblages (Table 12-14: Seabed Habitat Classification in Milne and Steensby Inlets).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Coastal Habitat

Surveys conducted in 2007 revealed that the coastal habitats of Milne Inlet are typical of periglacial coastal environments where most of the shoreline is dominated by either rock or coarse sediment beaches comprising poorly sorted boulder, cobble, pebble, and sand. Limited open-water seasons and the coarse nature of the shorelines result in complex, poorly organized shoreline morphology. In some locations, glacial rebound has created prominent raised beach complexes. The presence of sea ice limits the development of intertidal biota, although rockweed was commonly observed (45-55% of the shoreline). Milne Inlet displays considerable evidence of human use, with hundreds of tent rings, dozens of active hunting camps, and several large and abandoned construction camps; human debris is common along the shoreline.

Primary Producers

Overall, concentrations of chlorophyll *a* at Milne Inlet were within the range of concentrations previously reported for Arctic marine waters (Table 12-15: Photosynthetic Pigment Concentrations, Milne and Steensby Inlets). The observed trend of higher chlorophyll *a* in deep water (<0.2-1.9 mg/m^3) in Milne Inlet is consistent with the literature and indicates that maximum concentrations typically occur near the bottom of the mixing zone. Contrary to the literature, chlorophyll *a* was higher during the ice-cover season than during the open-water season. However, chlorophyll *a* in the water column is known to increase as the ice begins to melt and ice-associated algae are released. This phenomenon may explain the higher chlorophyll *a* concentrations that were observed under ice-cover (<0.2-1.7 mg/m^3), as sampling occurred near the end of the ice-cover season (i.e., May and June) when melting would have been underway.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-14: Seabed Habitat Classification in Milne and Steensby Inlets

Location	Habitat Class	Description[1]	Depth Range (m)	Habitat Quality[2]
Milne Inlet	1	**Intertidal/Upper Subtidal:** Gravelly sand with filamentous brown algae and few fauna	< 3	Low
	2	**Shallow Subtidal:** Gravelly sand with bladed kelps, algae, and diverse fauna	3-15	High
	3	**Subtidal:** Muddy, sandy gravel with filamentous red algae, kelps, and brittle stars and urchins	> 15	Moderate
Steensby Inlet	1	**Intertidal/Upper Subtidal:** Sandy gravel with rockweed and brown algae, and few fauna	< 3	Low
	2	**Shallow Subtidal:** Muddy, sandy boulder-cobble with bladed kelps and algae, anemones main part of diverse fauna	3-15	High
	3	**Subtidal:** Muddy, sandy gravel with red algae, kelps, and anemones main part of relatively diverse fauna	15-25	High
	4	**Intertidal/Upper Subtidal:** Muddy, sandy gravel with red algae, anemones, and crinoids dominant	> 25	Moderate

NOTE(S):
1. HABITAT DESCRIPTION BASED ON DOMINANT SUBSTRATE, VEGETATION, AND FAUNA.
2. HABITAT QUALITY ASSIGNED ON THE BASIS OF ESTIMATED PRODUCTIVE CAPACITY.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-15: Photosynthetic Pigment Concentrations, Milne and Steensby Inlets

Location	Parameter	Season	DL [1]	Surface							Bottom						
				Mean	SD [2]	Min	Max	Median	n	% > DL	Mean	SD [2]	Min	Max	Median	n	% > DL
Milne Inlet	**Chlorophyll a (mg/m^3)**	Open	0.2	0.5	0.63	<0.2	1.7	<0.2	14	43	0.5	0.73	<0.2	2	<0.2	14	21
		Ice	0.2	0.8	0.77	<0.2	2.1	0.6	6	67	2.9	1.55	1.1	5.2	2.9	6	100
	Pheophytin a (mg/m^3)	Open	0.2	0.2	0.26	<0.2	0.9	<0.2	14	14	2.1	7.4	<0.2	27.8	<0.2	14	14
		Ice	0.2	1	1.72	<0.2	4.4	<0.2	6	17	<0.2	-	<0.2	<0.2	<0.2	6	0
Steensby Inlet	**Chlorophyll a (mg/m^3)**	Open	0.2	0.7	0.85	0.1	2.7	0.1	20	45	0.7	0.67	<0.2	1.9	0.3	19	68
		Ice	0.2	1.1	2	<0.2	7.3	<0.2	25	37	0.5	1.05	<0.2	4.9	<0.2	25	26
	Pheophytin a (mg/m^3)	Open	0.2	0.8	1.61	<0.2	7	<0.2	25	16	1.1	1.44	<0.2	6.5	0.6	25	47
		Ice	0.2	0.8	1.61	<0.2	7	<0.2	25	16	1.1	1.44	<0.2	6.5	0.6	25	47

NOTE(S):

1. ANALYTICAL DETECTION LIMIT.
2. STANDARD DEVIATION.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Abundances of nearshore algae were estimated from analysis of the georeferenced underwater video imagery collected at Milne Inlet (Table 12-16: Zooplankton Summary Statistics, Milne and Steensby Inlets). The shallowest depth category (< 3 m) had the lowest average algal cover in Milne Inlet. The 3 m to 15 m depth category had the highest algal cover, which primarily consisted of benthic bladed kelps (BKS; 38% mean coverage). Foliose red algae averaged 4% cover, while the filamentous red algae were only observed as trace amounts. Vegetative cover decreased in depths over 15 m, although community composition remained similar to that of the 3 m to 15 m depth range.

Secondary Producers

Twenty-three invertebrate taxa were collected from vertical zooplankton tows conducted in Milne Inlet during 2008 and 2010. The cyclopoid copepod *Oithona similis* dominated the Milne Inlet zooplankton community in both years, followed by *Calanus finmarchicus/glacialis* in 2008 and calanoid copepodites in 2010 (Table 12-17: Benthic Infauna Summary Statistics, Milne and Steensby Inlets 2010). *Calanus finmarchicus*, *Pseudocalanus. minutus*, *O. similis*, Harpacticoida, *Parasagitta elegans*, and *Fritillaria. borealis* occurred in 100% of samples in 2008 and 2010. Average densities and dominant species in Milne Inlet were similar to those reported from Lancaster Sound.

Drop camera videography conducted from the shoreline to a depth of 25 m provided information on benthic epifauna (living on the seabed surface) within Milne Inlet; clams (Bivalvia), brittle stars, and sea urchins were most frequently observed. Brittle stars collected in benthic infauna samples suggest that the density of these echinoderms increases with depth.

Benthic infauna (living within the surface layers of the seabed) sampling in Milne Inlet was conducted in 2010, with samples using benthic grabs collected along transects from shallow subtidal (<3 m) to deep-water (> 60 m) sites. A total of 146 benthic infauna species were identified from Milne Inlet. Polychaetes and ostracods were the most abundant taxa in Milne Inlet, although copepods, amphipods, and several species of bivalves were also common (Table 12.29). As reported in previous studies of the Canadian Arctic, the abundance and community composition of benthic infauna in Milne Inlet varies with depth. Copepods were more prevalent at shallow sites and clams dominated at deeper sites. The highest density of organisms occurred between 15 m and 25 m, and there was a small decrease in density with increasing depth beyond 25 m depth (Table 12.26).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-16: Zooplankton Summary Statistics, Milne and Steensby Inlets

Location	Year	Total Density[1]						Dominant Class			Dominant Species	
		Mean	SE[2]	Min	Max	Median	n	Taxon #1	Taxon #2	Taxon #3	Taxon #1	Taxon #2
Milne Inlet	2008	1612	307	1041	2095	1700	3	Cyclopoida	calanoida	harpaticoida	*Oithona similis*	*Calanus finmarchicus/glacialis*
	2010	548	51	293	742	587	10	Cyclopoida	calanoida	harpaticoida	*Oithona similis*	Unidentified Calanoida spp.
Steensby Inlet	2008	1861	306	1066	3693	1676	8	Calanoida	larvacea	thoracica	*Pseudocalanus minutus*	*Fritillaria borealis*
	2010	1904	510	693	5245	1599	8	thoracica	calanoida	larvacea	*Balanus* spp.[3]	*P. minutus*

NOTE(S):
1. # OF INDIVIDUALS/m^3.
2. STANDARD ERROR.
n = NUMBER OF SITES SAMPLED.
3. INCLUDES NAUPLII AND CYPRIS LIFE HISTORY STAGES.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-17: Benthic Infauna Summary Statistics, Milne and Steensby Inlets 2010

Common Name	Scientific Name	Milne Inlet					Steensby Inlet				
		Mean	SE[1]	Min	Max	Median	Mean	SE[1]	Min	Max	Median
Hydroids/Anemones/Medusae	*P. Cnidaria*	0	-	-	-	-	5	5	0	43	0
Unsegmented Worms	*P. Nemertea*	18	8	0	58	0	118	24	0	231	130
	P. Sipuncula	0	-	-	-	-	3	3	0	26	0
	P. Priapulida	3	3	0	29	0	6	6	0	58	0
Worms	*Cl. Oligochaeta*	0	-	-	-	-	5	5	0	43	0
Bristle Worms	*Cl. Polychaeta (Errantia)*	1265	434	244	4628	897	1722	408	14	4043	1261
	Cl. Polychaeta (Sedentaria)	695	149	205	1449	513	2186	618	101	4768	1754
Insects	*Cl. Insecta*	17	17	0	154	0	2	2	0	14	0
Mites	*Cl. Arachnida*	252	225	0	2051	0	0	-	-	-	-
Sea Spiders	*Cl. Pycnogonida*	3	3	0	26	0	0	-	-	-	-
Copepods	*Cl. Copepoda*	185	98	0	821	13	133	51	0	478	77
Seed Shrimps	*Cl. Ostracoda*	1355	238	410	2769	1167	635	164	0	1159	826
Barnacles	*Cl. Cirripedia*	0	-	-	-	-	24	19	0	174	0
Water Scuds, Cumaceans, Isopods, Crabs, and Shrimp	*Cl. Malacostraca*	994	279	147	2885	769	1042	312	58	2269	848
Snails	*Cl. Gastropoda*	46	22	0	154	6	58	24	0	217	43
Clams	*Cl. Bivalvia*	1428	257	558	3058	1500	155	35	0	283	159
Chitons	*Cl. Polyplacophora*	0	-	-	-	-	3	2	0	14	0
Sea Urchins	*Cl. Echinodea*	1	1	0	10	0	0	-	-	-	-

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Common Name	Scientific Name	Milne Inlet					Steensby Inlet				
		Mean	SE[1]	Min	Max	Median	Mean	SE[1]	Min	Max	Median
Sea Cucumbers	*Cl. Holothuroidea*	0	-	-	-	-	2	2	0	14	0
Brittle Stars	*Cl. Ophiuroidea*	28	16	0	135	0	23	9	0	87	14
Sea Stars	*Cl. Stelleroidea*	0	-	-	-	-	2	2	0	22	0
Total		6290	788	2641	10333	6510	6124	1262	188	10452	6754

NOTE(S):
1. NINE QUANTITATIVE BENTHIC INVERTEBRATE SAMPLES WERE COLLECTED FROM EACH OF MILNE AND STEENSBY INLETS.
2. SE = STANDARD ERROR.

© Hatch 2011/09

Nearshore Fish Community

The nearshore marine fish community of Milne Port is characterized by low species diversity and abundance. Small numbers of anadromous Arctic char, fourhorn sculpin (*Myoxocephalus quadricornis*), shorthorn sculpin (*M. scorpius*), Arctic staghorn sculpin (*Gymnocanthus tricuspis*), and Greenland cod (*Gadus ogac*) were captured during baseline studies, with sculpin species accounting for 80% of the catch (Table 12-18: Number of Fish Captured and Mean Catch Per Unit Effort (CPUE), Milne and Steensby Inlets). Arctic char are distributed throughout coastal areas in the Milne Inlet LSA, but no rivers supporting anadromous char populations drain into the LSA. The two nearest rivers known to support anadromous Arctic char are the Tuggat and Robertson rivers, both of which drain into the RSA 10-15 km from the port site (Figure 12.58). It is assumed that most anadromous char occurring at the Milne port site originate from one of those rivers.

Metals in Fish

Summary statistics for muscle mercury and total metals concentrations in muscle and liver from Arctic char captured at Milne Inlet in 2010 are presented in Table 12-19: Mean Concentration of Select Trace Elements in Arctic Char Muscle and Liver Tissue, Steensby (2007 and 2010) and Milne (2010) Inlets(results for individual fish are provided in NSC 2010b). Mercury concentrations were above the detection limit in all Arctic char muscle and liver samples (n = 11 fish). Concentrations in muscle tissue ranged from 0.0254 to 0.105 µg/g [wet weight- ww] with a mean concentration of 0.050 µg/g [ww] and an average length-standardized muscle mercury concentration of 0.0326 µg/g [ww]. None of the fish sampled at Milne Inlet had muscle mercury concentrations that exceeded the Health Canada commercial export limit of 0.5 µg/g [ww] (Health Canada, 2007; NSC, 2010b).

Arsenic, calcium, chromium, copper, iron, magnesium, manganese, phosphorus, potassium, selenium, sodium, strontium and zinc were detected in all muscle and liver samples. In addition, all liver samples contained detectable levels of cadmium, cobalt, molybdenum and thallium. In general, trace element concentrations were lower in muscle than in liver tissue. Only calcium, magnesium, and potassium were present in greater concentrations in muscle than in liver. Twelve metals in muscle and ten metals in liver were rarely (< 10% of sampled fish) or never present at concentrations above the minimum detection limit.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-18: Number of Fish Captured and Mean Catch Per Unit Effort (CPUE), Milne and Steensby Inlets

Gill Net Type	Fish Species	Milne Inlet		Steensby Inlet	
		Catch	Mean CPUE	Catch	Mean CPUE
Standard Index	Arctic char	11	4.54	270	24.05
	Arctic staghorn sculpin	3	1.24	0	-
	Atlantic spiny lumpsucker	0	-	1	0.09
	Fourhorn sculpin	7	2.89	14	1.25
	Greenland cod	4	1.65	0	-
	Shorthorn sculpin	50	20.63	5	1.25
Small Mesh	Arctic char	N/A	-	9	84.36

NOTE(S):
1. NINE QUANTITATIVE BENTHIC INVERTEBRATE SAMPLES WERE COLLECTED FROM EACH OF MILNE AND STEENSBY INLETS.
2. # FISH/100 m NET/ 24 hrs.

Table 12-19: Mean Concentration of Select Trace Elements in Arctic Char Muscle and Liver Tissue, Steensby (2007 and 2010) and Milne (2010) Inlets

Location	Tissue	Sample Size	Length Range (mm)	Trace Element Mean Concentration (µg/g [ww])							
				As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Milne Inlet	Muscle	11	287-746	0.816	0.0057	0.59	0.848	< 0.020	0.0497	0.30	6.2
	Liver	11	287-746	1.369	0.3079	0.91	18.719	< 0.020	0.0485	0.48	31.6
Steensby Inlet	Muscle	59	203-840	1.131	0.0052	0.52	0.654	< 0.020	0.0451	0.31	6.2
	Liver	47	203-703	1.208	0.3084	0.36	25.399	< 0.020	0.0638	0.18	33.5

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.24.2.1 Steensby Inlet LSA

Seabed Habitat

Four depth-stratified seabed habitat classes were described from bathymetry and geo-referenced underwater digital videography collected in nearshore areas in the Steensby Port area (Table 12-14: Seabed Habitat Classification in Milne and Steensby Inlets). Each class is defined by the dominant substrate and assemblage of benthic algae and epifauna. High resolution bathymetry and side-scan sonar images were combined with the mapped habitat classes to extrapolate areas of habitat classes across the nearshore. Ice scour ridges, troughs and wallow depressions were commonly observed, in particular at depths less than 9 m. Substrates are generally coarse sediment in the nearshore, tending towards muddy gravelly sands in the deeper areas. Vegetative cover is the dominant biotic feature in nearly all observations, with bladed kelps and foliose red algae being the most abundant flora. Associated fauna are depth stratified, generally sparse, and most often observed in places where algal cover was low.

Coastal Habitat

Shoreline surveys conducted in 2007 revealed that the coastal habitats of Steensby Inlet are typical of periglacial coastal environments where most of the shoreline is dominated by either rock or coarse sediment beaches comprised of poorly sorted boulder, cobble, pebble, and sand. Limited open-water seasons and the coarse nature of the shorelines result in complex, poorly organized shoreline morphology. In some locations, glacial rebound has created prominent raised beach complexes, and although ice ride-up features occur, they are less common than in Milne Inlet. The presence of sea ice limits the development of an epibiotic community in shallow areas, although rockweed was commonly observed (45% to 55% of the shoreline), and salt marshes are found along about 13% of the coast in Steensby Inlet. Kelps are rare in the intertidal zone, but occur throughout the Inlet and are very common offshore in water depths greater than 10 m. The shoreline of Steensby Inlet has little evidence of anthropogenic disturbances – a few active camps were noted and a number of older archaeological sites were observed.

Primary Producers

Overall, concentrations of chlorophyll *a* at Steensby Inlet were within the range of concentrations previously reported for Arctic marine waters (Table 12-15: Photosynthetic Pigment Concentrations, Milne and Steensby Inlets). As in Milne Inlet, chlorophyll *a* was higher during the ice-cover season (<0.2-7.3 mg/m^3) than during the open-water season (0.1-2.7 mg/m^3).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Algal community information was collected using underwater videography in Steensby Inlet in 2007 and 2008. Sample collection in Steensby Inlet in 2008 was used to supplement the videography data (Table 12-15: Photosynthetic Pigment Concentrations, Milne and Steensby Inlets). The shallowest depth category (< 3 m) has the lowest average algal cover. The 3 m to 15 m depth category has the highest algal cover and primarily consists of BKS, which averaged 34% cover. Foliose red algae averaged 8% cover and filamentous red algae averaged 14% cover. Vegetation cover decreases at depths greater than 15 m, although community composition remains similar to that of the 3 m to 15 m depth range.

Secondary Producers

Thirty invertebrate taxa were identified from vertical zooplankton tows conducted in Steensby Inlet in the fall of 2008 and fall 2010. Calanoida had the highest average density in 2008, followed by the Larvacea and Thoracica (Table 12-17: Benthic Infauna Summary Statistics, Milne and Steensby Inlets 2010). In 2010, Thoracica had the highest average density followed by Calanoida and Larvacea. Species dominance and richness were similar between the two years. The species *P. minutus* and *Balanus sp*. (nauplius or cypris) were present in 100% of samples in both years, while *F. borealis, C. finmarchicus*, and unidentified polychaete larvae were each only absent from one sample. In 2010, Harpaticoida and unidentified calanoid copepodites were also present in 100% of samples. The dominance of copepods within Steensby Inlet samples appears to be typical for the region, as reported in the literature.

In 2007 and 2008, distribution and abundance of epifauna were classified from underwater towed videography. Samples were collected opportunistically during Steensby Inlet algal sampling in the same years. Like the infauna samples (see below), epifauna species are stratified by depth. Although barnacles and bacterial mats are common at shallow depths and feather stars are common in deeper waters, anemones are the most abundant taxa at all depths (Table 12-17: Benthic Infauna Summary Statistics, Milne and Steensby Inlets 2010).

Benthic infauna sampling in Steensby Inlet was conducted along transects from shallow subtidal (<3 m) to deep-water (> 60 m) sites. Polychaetes, usually followed by either Malacostraca or Ostracoda, were the most abundant taxa of the 202 benthic infauna species identified from the Steensby Inlet samples (Table 12-17: Benthic Infauna Summary Statistics, Milne and Steensby Inlets 2010). Benthic invertebrate community composition and densities changed with depth. The highest benthic infauna densities occurred between 10 m and 45 m and the lowest occurred at 3 m (likely due to disruption of habitat from ice scour).

Marine and Anadromous Fish

In general, the marine fish community near the Steensby Port is characterized by low species diversity and abundance. Arctic char, fourhorn sculpin, shorthorn sculpin, and Atlantic spiny lumpsucker (*Eumicrotremus spinosus*) were captured during experimental gillnetting programs (Table 12-18: Number of Fish Captured and Mean Catch Per Unit Effort (CPUE), Milne and Steensby Inlets).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Arctic cod (*Boreogadus saida*) and larval sculpin (most likely ribbed sculpin, *Triglops pingeli*) are also present as indicated by Arctic char stomach contents. Arctic char were the most common species observed, comprising 90.6% of the total catch between 2007 and 2010. The average concentration of mercury within muscle tissue samples collected from the Arctic char catch was within the Health Canada commercial export limit of 0.5 ug/g (Table 12-19: Mean Concentration of Select Trace Elements in Arctic Char Muscle and Liver Tissue, Steensby (2007 and 2010) and Milne (2010) Inlets).

Arctic char are distributed throughout coastal areas in the vicinity of the port site (Figure 12.59), but were captured in much greater abundance in Ikpikitturjuaq Bay (a large bay just to the north of the Steensby Port site). The Ikpikitturjuaq River enters into Ikpikitturjuaq Bay and has long been known to support a population of anadromous Arctic char that was sufficient in size to support a commercial fishery. Scientific literature and IQ contend that most anadromous char display strong fidelity to their natal stream, remaining in close proximity to the outlet. Thus, it is likely that most of the char captured in the vicinity of the Steensby Port were members of the Ikpikitturjuaq River population. Numerous other rivers within Steensby Inlet support anadromous populations of Arctic char. Some, such as the Cockburn River or the Rowley River, are in close proximity (10-15 km) to the Steensby Port.

12.25 Marine Mammals Baseline Summary

An environmental baseline report on marine mammals has been prepared in support of the EIS for Baffinland's Mary River Project by LGL Limited and North South Consultants (DEIS Appendix 8A-2). The baseline report includes a review of scientific information of marine mammal species that occur within the Project RSA and those species that occur along the shipping routes outside of the RSA. In addition, traditional knowledge collected during Project-specific IQ studies and other sources of IQ is provided. Aerial surveys were conducted in support of the Project periodically during 2006, 2007, and 2008 to document the distribution and abundance of marine mammals in the vicinity of the Milne Inlet and Steensby Inlet port sites and along potential shipping routes. The results of these surveys are presented in detail in DEIS Appendix 8A-2 and are summarized below.

Twenty-two marine mammal species are known or expected to occur in the RSA and along the proposed shipping routes in Baffin Bay and Davis Strait (Table 12-20: The Status and Regional Distribution of Marine Mammal Species in the RSA and in Baffin Bay and Davis Strait). Species accounts are provided for all species in DEIS Appendix 8A-2. Only one mysticete or baleen whale species, the bowhead whale (*Balaena mysticetus*), occurs regularly in the RSA. Narwhals (*Monodon monoceros*) and belugas (*Delphinapterus leucas*) are abundant in the RSA; other odontocetes that occur (albeit in low numbers) in the RSA include the killer whale (*Orcinus orca*) and northern bottlenose whale (*Hyperoodon ampullatus*). Pinniped species that occur regularly in the RSA include the ringed seal (*Pusa hispida*), bearded seal (*Erignathus barbatus*), harp seal (*Pagophilus groenlandicus*), and walrus (*Odobenus rosmarus*). The polar bear (*Ursus maritimus*) also occurs throughout the RSA. The summary provided below focuses on the marine mammal species that have

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

been selected as indicator species in the EIS: ringed seal, walrus, beluga whale, narwhal, bowhead whale, and polar bear.

12.25.1 Ringed Seal

The ringed seal is an important component of the Arctic marine system, both as main prey of polar bears, and as a major consumer of marine fish and invertebrates (Lowry et al. 1980; Smith 1987). Ringed seals occur year-round along both proposed shipping routes and in the vicinity of both proposed port sites, and are a major traditional food source for the Inuit.

Ringed seals establish a series of breathing holes and subnivean (under snow) lairs on the sea ice, with many of these structures created shortly after freeze up and maintained through the winter and spring. Birth lairs are constructed on the landfast ice in mid March (Smith et al., 1991) and pups are born in April. Pups are nursed for 38–44 days (Smith et al., 1991) and rely on their white fur, high metabolic rates, and the birth lair for protection from the cold while building an adequate layer of blubber. Landfast ice is preferred for breeding rather than pack ice (McLaren, 1958; Kelly, 1988). IQ also suggests that ringed seal dens will not be constructed on moving pack ice in areas of strong ocean currents but there is a large breeding population on the offshore pack ice in Baffin Bay (Finley et al., 1983).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 12-20: The Status and Regional Distribution of Marine Mammal Species in the RSA and in Baffin Bay and Davis Strait

Species	**Status**			Region		
	***SARA*[1]**	**COSEWIC[2]**	**IUCN[3]**	**Eclipse Sound, Navy Board Inlet, Pond Inlet**	**Baffin Bay, Davis Strait**	Foxe Basin, Hudson Strait
BALEEN WHALES (MYSTICETES)						
Bowhead whale	UC	SC	LC	present	present	**present**
Humpback whale	NS	NAR	LC	absent	present	**absent**
Minke whale	NS	NAR	LC	absent	present	**present**
Sei whale	NS	DD	EN	absent	uncommon	**absent**
Fin whale	Sc1:SC	SC	EN	absent	common	**absent**
Blue whale	Sc1:EN	EN	EN	absent	uncommon	**absent**
TOOTHED WHALES (ODONTOCETES)						
Sperm whale	NS	NAR/CWS: 3	VU	absent	common	**absent**
Northern bottlenose whale	NS	NAR	DD	absent	present	**present**
Beluga	UC	EN,SC [4]	NT	abundant	abundant	**abundant**
Narwhal	UC	SC	NT	abundant	abundant	**abundant**
White-beaked dolphin	NS	NAR	LC	absent	present	**absent**
Atlantic white-sided dolphin	NS	NAR	LC	absent	uncommon	**absent**
Killer whale	NS	SC	DD	uncommon	uncommon	**uncommon**
Long-finned pilot whale	NS	NAR	DD	absent	present	**absent**

© Hatch 2011/09

Species	Status			Region		
	***SARA*[1]**	**COSEWIC[2]**	**IUCN[3]**	**Eclipse Sound, Navy Board Inlet, Pond Inlet**	**Baffin Bay, Davis Strait**	Foxe Basin, Hudson Strait
Harbour porpoise	UC	SC	LC	absent	present	**absent**
SEALS AND WALRUS (PINNIPEDS)						
Walrus	UC	SC/CWS: 1	DD	common	present	**common**
Bearded seal	NS	DD	LC	abundant	abundant	**abundant**
Harbour seal	NS	NAR	LC	uncommon	present	**uncommon**
Ringed seal	NS	NAR/CWS: 2	LC	abundant	abundant	**abundant**
Harp seal	NS	CWS: 3	LC	abundant	abundant	**common**
Hooded seal	NS	NAR/CWS: 3	VU	absent	present	**absent**
BEARS (URSIDS)						
Polar bear	NS	SC	VU	present	present	**present**

NOTE(S):

1. *SPECIES AT RISK ACT*: NS = NO STATUS (GOC, 2009); UC = Under Consideration; Sc = Special Concern; T = Threatened; En = Endangered; Sc1 = Schedule 1.

2. COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA (COSEWIC, 2010): NAR = Not at Risk; DD = Data Deficient; SC = Special Concern; T = Threatened; EN = Endangered; NL = Not Listed; CWS = Candidate Wildlife Species Priority List for Assessment: 1 = HIGH PRIORITY, 2 = MID-PRIORITY, 3 = LOW PRIORITY.

3. INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN, 2010): EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient. CLASSIFICATIONS ARE FROM THE 2010 IUCN RED LIST OF THREATENED SPECIES.

4. EN: Ungava Bay and Eastern Hudson Bay Populations, SC: Western Hudson Bay And Eastern High Arctic-Baffin Bay Populations.

© Hatch 2011/09

The population of ringed seals in the Canadian Arctic is estimated to be at least a few million (Reeves, 1998), but no reliable quantitative estimates are available. Canadian populations are not listed under SARA and are listed as Not at Risk by COSEWIC.

Milne Port and Shipping Route

Ringed seals are common throughout Baffin Bay (McLaren and Davis, 1982) as well as along the length of West Greenland (Vibe, 1950; McLaren and Davis, 1982). During winter and spring, ringed seals concentrate on stable landfast ice, although in areas where fast ice is limited, as in Baffin Bay, increased numbers may occupy offshore pack ice (Finley et al., 1983). As ice breaks up during summer, they disperse as solitary animals or small groups throughout open-water areas (Moulton and Lawson, 2002) or to coastal areas (MacLaren, 1958; Smith, 1973; 1987; MacLaren and Davis, 1982; Harwood and Stirling, 1992). Although ringed seals were originally thought to remain in the same general region throughout the year (MacLaren, 1958), recent evidence suggests that some members of the population, particularly juveniles, may undertake extensive seasonal movements (Smith, 1987; Heide-Jørgenson et al., 1992; Teilmann et al. 1999; Harwood and Smith 2003). IQ indicates some seasonal movements, mostly in response to changes in distribution of sea ice. A general pattern of movement into Inlets and bays as landfast ice forms in the fall has been observed. In the spring, ringed seals often follow the ice into offshore areas as it breaks up, returning again in the fall to bays and Inlets as new ice forms.

Ringed seals are abundant along the proposed northern shipping route, occurring throughout Baffin Bay and Davis Strait, Eclipse Sound, Koluktoo Bay, and Navy Board and Pond Inlets. IQ indicates that large concentrations of ringed seals haul out on the ice in many areas of Eclipse Sound. During aerial surveys for the Project in June 2006, observed densities for ringed seals in Eclipse Sound, Koluktoo Bay, Milne Inlet, and Navy Board Inlet were 41.4, 25.6, 37.6, and 39.2/100 km^2, respectively. In June 2007, densities for Milne Inlet and Koluktoo Bay were 29.9 and 18/100 km^2, respectively, and in June 2008, densities were 127.1 and 216.1/100 km^2, respectively.

12.25.1.1.1 Steensby Port and Shipping Route

Ringed seals are abundant along the proposed southern shipping route, occurring throughout Foxe Basin, including the landfast ice of Steensby Inlet, and Hudson Strait. Southern Steensby Inlet, Igloolik, Hall Beach, Murray Maxwell Bay, and Rowley Island into Fury and Hecla Strait have been mentioned as important hunting and/or pupping areas. IQ suggests that most ringed seal denning in northern Foxe Basin occurs in fast ice, but that some denning and pupping may occur in moving pack ice in southern Foxe Basin and in the western part of Fury and Hecla Strait.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Ringed seals were present in all areas of Foxe Basin and Hudson Strait where aerial surveys for the Project were conducted from April to October, and most sightings occurred during June and to a lesser extent August, when they were easily observed basking on pack ice. Aerial surveys in 2006, 2007, and 2008 indicated that the densities of seals basking on sea ice in Steensby Inlet were 20, 157, and 71/100 km^2, respectively. The densities of ringed seals in Murray Maxwell Bay and on the fast ice between Igloolik and Hall Beach in June 2008 were 126/100 km^2 and 51/100 km^2, respectively.

12.25.2 Walrus

The walrus has a discontinuous circumpolar distribution and is migratory, moving south as the ice advances in fall and north as it recedes in spring (Fay, 1981b). It winters in the offshore pack ice of Davis Strait and along the west coast of Greenland, the North Water Polynya and polynyas off western Devon Island and northern Labrador (Loughrey, 1959; Davis et al., 1978; Boles et al. 1980), and in Foxe Basin from the floe edge along the north side of Rowley Island south to the Melville Peninsula (COSEWIC, 2006b).

Little information is available with respect to walrus breeding and calving in Canadian waters. In northwest Greenland, pups are born from early April to mid July, with peak whelping in late May and early June (Born, 1990; COSEWIC, 2006). Lactation generally lasts 25–27 months (Fisher and Stewart, 1997). Calves are able to nurse in the water, and they accompany females into the water when they forage (Loughrey, 1959; Miller and Boness 1983; Kovacs and Lavigne 1992). IQ suggests that walruses are highly territorial and will aggressively defend their territories against any perceived threat; they have been observed to challenge ships passing into their territory. Walruses are primarily benthic feeders on bivalve molluscs and other invertebrates, and are generally confined to shallow coastal waters up to 100 m deep (Vibe, 1950; Outridge et al. 2003; NAMMCO 2005b; 2006).

Four extant stocks occur within Canadian waters; however, these stocks may be further subdivided based on genetic, isotopic, body size, and distributional differences (Stewart, 2002). Three of the four identified stocks occur within the confines of the RSA; the Baffin Bay (High Arctic) population, the Foxe Basin population, and the North Hudson Bay-Davis Strait population (COSEWIC, 2006). IQ suggests that different populations can be distinguished based on physical differences such as coloration, tusk size, firmness of liver, taste, skin toughness, and smell. These differences are believed to be associated with differences in diet.

The Canadian walrus population has no status under SARA but is listed as Special Concern by COSEWIC (2006b). Population numbers or trends are not well known, but shifts in walrus distribution, abandonment of main haul-out sites, and increased areas over which hunters must now travel to access walruses suggest that some stocks may be declining (Stewart 2002).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.25.2.1.1Milne Port and Shipping Route

The Baffin Bay walrus population is estimated to be between 1,700 and 3,000 (Born et al., 1995; DFO, 2002), with summering populations in Kane Basin, Buchanan and Princess Marie bays, Jones Sound, eastern Ellesmere Island, and the Lancaster Sound-Barrow Strait area (Born et al., 1995).

Walruses along the northern shipping route winter in the North Water and other polynyas among the Canadian Arctic islands, inhabiting northwest Baffin Bay north from Pond Inlet to Kane Basin, Lancaster Sound, Barrow Strait, and Jones Sound. They are also distributed along the west coast of Greenland. Walruses move westward along the southern coast of Devon Island during spring to summering areas in the Canadian Arctic islands. Only a few individuals are now observed among the Inlets and fjords south of Bylot Island. IQ indicates that calving locations have existed in Admiralty Inlet, near the outlet of Navy Board Inlet, and off the north coast of Bylot Island.

It is thought that timing and route of the fall return migration is primarily driven by ice conditions, and likely follows the same route used during the spring migrations. Aerial surveys for the Project in the vicinity of Eclipse Sound in 2007 and 2008 recorded only two walruses; one in Eclipse Sound and one in Milne Inlet.

12.25.2.1.2 Steensby Port and Shipping Route

Walruses are considerably more abundant along the southern shipping route. They are year-round residents in northern Foxe Basin, overwintering in small polynyas and shore lead systems near the outlet of Fury and Hecla Strait, to the east of Hall Beach, and among the islands (Rowley, Koch, and the Spicer islands) located farther to the east of Hall Beach and south of Steensby Inlet. Their distribution appears to be driven by ice and open-water conditions during winter. During the summer open-water period, they haul out onto beaches and coasts among the islands south of Steensby Inlet and onto drifting pans of ice. Walruses have been observed well within Steensby Inlet during late summer, but the degree to which they use the Inlet, or whether they haul out anywhere within the Inlet, is not known. Foxe Basin and along the landfast ice edge at the entrance to Steensby Inlet accommodates the largest concentration of walruses in Canada (Stephenson and Hartwig, 2010). IQ indicates that the main calving area in Foxe Basin is in waters in the north-western portion of the basin. A decade and a half ago, the Foxe Basin walrus population was estimated, albeit with low certainty, to number ~5,500 (Born et al., 1995).

Walruses were abundant within the northern Foxe Basin portion of the Project aerial survey route in 2006. They were observed in pack ice and open water. The highest densities were 15/100 km^2 in northwest Foxe Basin in June and 4.3/100 km^2 in Steensby Inlet in September. This trend was also observed in 2008; on average, walrus densities in northwest Foxe Basin were about seven times higher than those observed in northeast Foxe Basin or southern Foxe Basin. During the aerial surveys, two terrestrial walrus haul-out sites were observed, one at Manning Islands (mid way between Hall Beach and Spicer Islands) and the other at Bushnan Rock (a small sandy islet west of the gap between Rowley and Koch Islands). Walrus densities in Hudson Strait (0.1/100 km^2) were

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

lower than any observed in Foxe Basin. The low abundance of walruses in the area between northern Hudson Bay and southern Foxe Basin appears to be primarily attributable to a lack of islands that can be used as haul-outs (Stephenson and Hartwig, 2010). IQ indicates that walruses occur along the north coast of Hudson Strait and concentrate in the vicinity of Cape Dorset. Hudson Strait is an important overwintering area for many marine mammals including walrus; it is considered a highly productive area and the ice edge through the strait is likely an important habitat for walruses and other species (Stephenson and Hartwig, 2010).

12.25.3 Beluga Whale

The beluga whale has a circumpolar distribution and occurs seasonally along both shipping routes. It is an opportunistic feeder, consuming a wide array of fish and invertebrates. Mating is thought to peak prior to mid April; however, little is known about mating behaviour. Many calves have already been born when the whales begin to arrive at summering areas, suggesting that calving occurs in offshore areas during late spring migration (COSEWIC, 2004a). Calving has also been observed in July and early August in the High Arctic (Finley et al., 1974; Finley 1976). IQ cites observations of newborn calves along the floe edge in June, July, August, and September (Stewart, 2001). Calving is believed to occur within bays, Inlets, and the mouths of rivers (Stewart, 2001) but has also been detected offshore.

Beluga whales occupy different habitats seasonally. During early spring, they concentrate along ice edges as the fast ice breaks up, following leads into still ice-covered areas near their summering locations (Stirling, 1980). During summer, they are typically found along coastlines in shallow waters, often frequenting and concentrating in river estuaries or glacier fronts (Sergeant, 1973; Michaud et al., 1990; Smith and Martin, 1994; Lydersen et al., 2001). Beginning in mid August, belugas move away from nearshore habitats into deep-water areas where they spend several weeks feeding on arctic cod and diving to the seafloor, presumably to feed on deep-water fish (Finley, 1976; Smith and Martin, 1994; Richard et al., 2001b). Throughout winter, they tend to be found in areas of loose pack ice or polynyas.

Of the seven recognized populations in Canada, four occur in the RSA: the Eastern High Arctic-Baffin Bay, Western Hudson Bay, Eastern Hudson Bay, and Ungava Bay populations. The Eastern High Arctic-Baffin Bay and Western Hudson Bay populations are listed as Special Concern, and the Eastern Hudson Bay and Ungava Bay populations are listed as Endangered by COSEWIC (COSEWIC, 2010). All four subpopulations are under consideration for listing under SARA. The most recent abundance estimate for the Eastern High Arctic-Baffin Bay population summering in the Canadian High Arctic is 21,213 (Innes et al., 2002). The most recent population estimate for the Western Hudson Bay population is 57,300 (Richard, 2005). The Eastern Hudson Bay population has declined from 3,849 in 1985 to 2,453 in 2001 (Bourdages et al., 2002).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Some IQ suggests that although the current size of beluga populations may vary from year to year, numbers generally remain the same. However, IQ from other sources suggests that current beluga populations are substantially smaller than they were five decades ago.

12.25.3.1.1 Milne Port and Shipping Route

The Eastern High Arctic-Baffin Bay population summers in the Canadian Arctic archipelago and winters in the loose pack ice of two distinct areas: in Davis Strait or southern Baffin Bay off the west coast of Greenland and in the North Water Polynya in northern Baffin Bay. It has been suggested that these represent two distinct populations, although considerable uncertainty exists with regard to abundance, distribution, and summering habitat (Thomsen, 1993; de March et al., 2002; Heide-Jørgenson et al., 2003a; COSEWIC, 2004a). A limited amount of harvest occurs in the Pond Inlet area, but considerable hunting takes place along the west coast of Greenland during winter.

Belugas from the smaller population wintering in the North Water enter Lancaster Sound from the north in late April or early May (Finley and Renaud 1980). The belugas that winter off west Greenland move north along the Greenland coast in May and June, cross over northern Baffin Bay, and Lancaster Sound from the north in June and July (Koski and Davis, 1979). In most years, the large numbers from the Eastern High Arctic-Baffin Bay population migrate past Bylot Island during spring on their way to summering areas concentrated near Somerset Island. In some years, when fast ice in Lancaster Sound delays westward migration, belugas congregate along the ice edge across Lancaster Sound, primarily near Devon Island but also near Bylot Island. IQ indicates that small numbers of belugas are common in waters near Pond Inlet in spring, summer, and fall (Remnant and Thomas, 1992). Belugas have been observed mating in May and July at the Admiralty Inlet floe edge, and breeding near Pond Inlet may take place in August when floating ice is present. IQ indicates that Koluktoo Bay and the southern portion of Milne and Navy Board Inlets may be calving areas. Other mating and calving areas that have been identified include along the floe edge at Pond Inlet and Navy Board Inlet, offshore areas in Lancaster Sound and Baffin Bay, and Eclipse Sound.

Eastward fall migrations begin in September, and are concentrated almost exclusively along the southern coast of Devon Island. Small numbers of belugas were observed in Eclipse Sound and White Bay during aerial surveys. In August and September 2007, belugas were observed in Eclipse Sound and White Bay during aerial surveys for the Project, with density estimates of 0.1 and 0.3/100 km^2, respectively. In August and September 2008, belugas were observed in Eclipse Sound, Eskimo Inlet, Koluktoo Bay, Milne Inlet, and White Bay with density estimates ranging from 0.1 to 8.3/100 km^2 depending on location and day. The highest densities were observed in White Bay.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.25.3.1.2Steensby Port and Shipping Route

All four populations of belugas in the RSA are known or expected to occur along or in the vicinity of the southern shipping route.

The Western Hudson Bay and Eastern Hudson Bay populations occur near the southern shipping route waters from late October through April when the whales are on their wintering grounds, and during fall migrations from summering areas in late September and October. Beluga whales from both populations occur in the vicinity of Igloolik, Hall Beach, and likely Steensby Inlet during July–early September.

IQ indicates that belugas are not expected in Igloolik until late August or early September, and sometimes as late as December. Some Igloolik elders believe that belugas have been arriving in the area much later than usual in recent years, suggesting that northern migrations may have become delayed.

The summer distribution of the Western Hudson Bay beluga population centers along the Manitoba coastline, with large aggregations occurring in the Seal, Churchill, and Nelson river estuaries. The wintering location of this population has not been confirmed, but it is thought to be in Hudson Strait and off the coast of Labrador (Richard et al., 1990; Richard, 1993; Richard and Orr 2003, 2005). Spring migration to summering areas occurs during late April–May (Sergeant, 1973). Most animals likely follow the eastern coast of Hudson Bay south to the Belcher Islands, and then proceed westwards to the Manitoba coast in late May and early June (Figure 7 *in* COSEWIC, 2004a). A segment of the population move westwards toward Southampton Island. Belugas generally remain within estuaries along the coast, and in September begin a northward migration towards Southampton Island (Sergeant, 1973).

The very small (possibly extirpated) Ungava Bay beluga population possibly occurs year-round within the RSA. It is unclear if the few whales that have been seen in the summer in southern Ungava Bay are remnants of the Ungava Bay beluga population or if they belong to another population.

Based on Project aerial survey results, beluga whales were widespread in Foxe Basin and Hudson Strait during the months with survey effort (April to October), with abundance varying with location and month. In Hudson Strait, observed densities in 2008 decreased from 3.0/100 km^2 in April to none in October. In northwest Foxe Basin, beluga densities were low in April and June, increased in August, and reached the highest observed density in September (1.0/100 km^2). In Steensby Inlet, belugas were observed most frequently in September (1.0/100 km^2), with no sightings in April, June, and August, and one sighting in October. With the exception of August, belugas were consistently observed in small numbers during spring and fall in northeast Foxe Basin. In southern Foxe Basin, they were observed in low numbers in spring and summer.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.25.4 Narwhal

The narwhal inhabits deep arctic waters of Baffin Bay, the eastern Canadian Arctic, and the Greenland Sea (Reeves et al., 2002). It is seldom found south of 61°N (COSEWIC, 2004). The diet of narwhals consists primarily of small cod, flatfish such as Greenland halibut, squid, and other small fish and invertebrates. Although little information is available about reproduction, gestation is thought to be 14–15 months (COSEWIC, 2004b). Calving generally occurs in July and August, although it can take place as early as late May (Mansfield et al., 1975; Cosens and Dueck, 1990; Gonzalez, 2001). Some hunters believe that narwhals mate at any time of the year, whereas others believe it to occur only in spring, summer, or fall (Remnant and Thomas, 1992; Stewart et al., 1995; Stewart, 2001).

Narwhals tend to prefer coastal areas that provide deep water and protection from the wind during summer (Kingsley et al., 1994; Koski and Davis, 1994; Richard et al., 1994). In general, narwhals winter in the offshore heavy pack ice of Baffin Bay and northern Davis Strait (Koski, 1980). Narwhals are highly social animals and usually travel in small groups (Strong, 1988). They have been observed in groups of hundreds or thousands during migration, and concentrations usually occur along fast ice edges (Strong, 1988).

Based largely on summer distributions, two tentative populations of narwhals occur in Canadian waters; the Hudson Bay population (Richard, 1991) and the Baffin Bay population (Koski and Davis, 1994; Dietz et al. 2001; Heide-Jørgenson et al. 2003a; Laidre and Heide-Jørgenson 2005; Richard et al. 2010;). Many Inuit believe that at least two different narwhal stocks exist in the Arctic. However, narwhals are currently assessed as a single population in the eastern Arctic (COSEWIC, 2004b). This population is under consideration for listing under SARA and is listed as Special Concern by COSEWIC (2010). Narwhal abundance summering in the Canadian High Arctic is estimated at >63,000 animals (NAMMCO, 2010).

12.25.4.1.1 Milne Port and Shipping Route

Narwhals occur throughout the area of the northern shipping route year round but are found in the RSA primarily during the open-water period. Those that winter in Baffin Bay typically summer in the eastern Canadian Arctic. IQ indicates that within the Project RSA narwhals concentrate in Admiralty Inlet, Milne Inlet, Eclipse Sound, Koluktoo Bay, Tremblay Sound, Tay Sound, Creswell Bay, Pond Inlet, Navy Board Inlet, and Admiralty Inlet in the summer. The Lancaster Sound complex, including Navy Board and Pond Inlets, has been identified as one of the most productive in the Arctic (Stephenson and Hartwig, 2010).

Recent estimates indicate that 20,211 narwhals summer in the Eclipse Sound area (NAMMCO, 2010). Survey results from the late 1980s and early 1990s indicated that the summer distribution of narwhals within Eclipse Sound, Milne Inlet, Koluktoo Bay, and Tremblay Sound is driven by the presence and distribution of ice and the presence of killer whales (Kingsley et al., 1994).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Narwhals begin to migrate out of their summering areas in groups of a few hundred to several thousand just before freeze-up begins in late September (Koski and Davis, 1994). Those summering near Somerset Island enter Baffin Bay north of Bylot Island in mid to late October (Heide-Jørgenson et al., 2003b), whereas the population summering in Pond Inlet begins migrating down the east coast of Baffin Island in late September (Dietz et al., 2001). Narwhals generally arrive in their wintering areas in November (Heide-Jørgenson et al., 2003b). The Baffin Bay narwhal population winters at two areas with most in the pack ice in Baffin Bay (Koski and Davis, 1979, 1994; Heide-Jørgenson et al., 1993; Heide-Jørgenson et al. 2002a; Laidre et al. 2004), and small number in polynyas at the north end of Baffin Bay (Richard et al., 1998a).

Considerable aerial survey effort was focused on Eclipse Sound and Milne Inlet and nearby bays and Inlets during the open-water periods of 2006, 2007, and 2008 as part of the Project's baseline data collection program. Narwhals were present in Eclipse Sound, Milne Inlet, and Koluktoo Bay throughout the survey periods in 2007 and 2008 (~late July to mid September). Numbers of narwhals observed during a typical survey often were in the thousands. Maximum densities were recorded in Koluktoo Bay (176/100 km^2) in the first half of August 2007 and in Milne Inlet during the later part of August 2007 (305/100 km^2). Narwhals were also frequently seen in Tremblay Sound and White Bay in high densities, reaching a maximum of 760/100 km^2 in White Bay in August 2008. Aerial surveys documented fine-scale movements of large groups of narwhals between various areas of Eclipse Sound and surrounding fjords. Narwhal densities increased from August through September in Eclipse Sound with corresponding decreases in density in Milne Inlet and surrounding bays and Inlets.

12.25.4.1.2 Steensby Port and Shipping Route

A much smaller number of narwhals inhabit waters along the southern shipping route. The Hudson Bay population was estimated to be 1,780 in 2000 (COSEWIC, 2004b), although it may be as many as 3,500 during summer (COSEWIC, 2004b).

The timing and routes of migration used by the Hudson Bay narwhal population are less well understood than those of the Baffin Bay population. This population is thought to winter in eastern Hudson Strait (Richard, 1991; Koski and Davis, 1994) and move towards summering areas located primarily in the Repulse Bay area north of Southampton Island during late June (Gonzalez, 2001). Small numbers may move north towards Fury and Hecla Strait, in the vicinity of Igloolik (Stewart et al., 1995). IQ indicates that narwhals from the Gulf of Boothia and from Hudson Strait arrive in the Igloolik area at different times, and that narwhal abundance in northern Foxe Basin is irregular; the whales may be observed one year, but not the next. Fall migrations to Hudson Strait begin in late August or early September, depending on ice conditions. A small number of narwhals that winter in Baffin Bay are thought to move through Fury and Hecla Strait into northern Foxe Basin during spring migration in April and May (Brody, 1976; Stewart et al., 1995).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

During aerial surveys for the Project in April–October 2008, narwhals were present in Hudson Strait in moderate numbers but infrequently encountered in Foxe Basin. In Foxe Basin, there was one sighting of seven narwhals in April, three sightings of five narwhals in June, and no sightings during August, September, or October. In Hudson Strait, the highest densities were in April and June—0.63/100 km^2 (22 sightings) and 0.84/100 km^2 (29), respectively. Narwhals were absent in August, were observed in moderate densities (0.55/100 km^2) in September, and were absent in October.

12.25.5 Bowhead Whale

The bowhead whale is one of only three whales that spend their entire lives in the Arctic. They occur seasonally along both shipping routes and are typically found singly or in small groups. Bowheads are adapted to living in areas of heavy unconsolidated ice cover during winter, can navigate extensive distances under ice, and are capable of breaking up to 20 cm of ice in order to breathe (George et al., 1989). During open-water periods bowhead distribution is likely driven by the distribution of prey species (Thomas, 1999). Bowheads are baleen whales (filter feeders), eating pelagic crustaceans (primarily copepods and euphausiids) and epibenthic invertebrates (Lowry, 1993). Because invertebrate distributions are often subject to changing physical and chemical conditions, characteristics such as water temperature, salinity, nutrient availability, ocean currents, and marine water upwelling can indirectly affect bowhead distribution (Mackas et al., 1985). Traditionally, bowheads have been observed feeding along the floe edge, and their presence is often dependent on the tides.

Bowheads are highly vocal animals, although call type and regularity may vary appreciably with season (Tervo et al., 2009). Mating can occur throughout the year, although most conceptions occur during late winter or early spring (Koski et al., 1993). Gestation lasts 12–16 months, and single calves are born during spring migration (Nerini et al., 1984; Koski et al., 1993).

There are four recognized bowhead stocks, one of which (the Eastern Canada-West Greenland stock) occurs within the RSA. This stock ranges throughout the eastern and central northern Arctic and from northern Baffin Bay to Hudson Strait (Heide-Jørgensen et al., 2006). Bowhead whales in Davis Strait and Baffin Bay were commercially overexploited in the early 1900s, reduced from an estimated 11,800 whales to perhaps as low as 1,000 (Woodby and Botkin, 1993). However, this stock has shown major recovery in recent decades (Heide-Jørgensen et al., 2006). The current estimate, which is likely negatively biased, of the Eastern Canada-West Greenland stock is 6,344 whales (CI 3,199-12,906; IWC 2009). The Eastern Canada-West Greenland stock is listed as Special Concern by COSEWIC (2010) and is under consideration for listing under SARA.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

12.25.5.1.1Milne Port and Shipping Route

Bowheads occur along the proposed northern shipping route during summer and fall. Bowhead whales may summer along the east coast of Baffin Island, or move westward through Lancaster Sound during June and July to feed and nurse calves in Inlets and sounds within the Canadian arctic archipelago. Milne Inlet, Eclipse Sound, and to a lesser extent Koluktoo Bay are used by bowhead whales during the open-water season. Mothers and calves tend to arrive later in the season. IQ suggests that the number of bowheads using Eclipse Sound appears to be increasing in recent years. Moderate numbers of bowhead whales were sighted in Eclipse Sound during August–September aerial surveys for the Project in 2007 and 2008; overall bowhead whale densities ranged from 0.02 to 0.29/100 km^2. Fall migration to wintering grounds begins in September and occur over the next few months. It is thought that fall migrants wintering in Davis Strait follow the east coast of Baffin Island south to wintering areas, whereas whales that winter along the west coast of Greenland may cross north Baffin Bay and then move south.

12.25.5.1.2 Steensby Port and Shipping Route

Bowheads congregate to feed and nurse calves in spring and summer around Southampton Island, along the western Hudson Bay coast, and in a relatively small area in northern Foxe Basin between Igloolik and Fury and Hecla Strait. Bowhead whales north of Igloolik in summer are primarily juveniles and females with newborn calves, suggesting that this location is a nursing area (Cosens and Blouw, 1999). The area has been identified as potentially the only bowhead nursery area in the Canadian Arctic (Stephenson and Hartwig, 2010), and it is considered a potential Area of Interest for a Marine Protected Area.

IQ indicates that bowheads observed near Hall Beach in spring migrate there from southern Foxe Basin. Migrations are not well documented, although most movement is thought to take place through the western and central portion of Foxe Basin, and may be influenced by ice cover. During summer, the bowhead tends to select areas of high ice cover (Ferguson et al., 2010), presumably to reduce the risk of predation by killer whales. Northern Hudson Bay and Foxe Basin have been identified as summering areas, with whales moving farther into Inlets and bays as the ice breaks up.

During aerial surveys for the Project, small numbers of bowheads were observed in north-western Foxe Basin in fall 2006, with density estimates of 0.4–0.5/100 km^2. Bowheads were also observed in northwest Foxe Basin in September and October of 2008, with density estimates of 0.4/100 km^2 and 0.1/100 km^2, respectively. Bowheads were not observed in Steensby Inlet during aerial surveys in 2006 or 2008.

Hudson Strait has been identified as a primary wintering area (late December to late March) for bowhead whales (Koski et al., 2006; COSEWIC, 2009; Ferguson et al., 2010). IQ suggests that they are not particularly numerous in Hudson Strait, although it is thought that the corridor is used extensively for migration. Bowheads begin winter migration in October as the sea ice begins to form, heading south toward northeastern Hudson Bay and Hudson Strait. In 1981, ~1,349 bowheads were

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

estimated to occur in Hudson Strait (Koski et al., 2006). During the 2008 aerial surveys for the Project, bowheads were observed in Hudson Strait in both April and August, with density estimates of 0.1/100 km^2 in both months.

12.25.6 Polar Bear

The polar bear has a circumpolar distribution and occurs in relatively low densities throughout most of the ice-covered areas in the RSA. It tends to be more abundant along shore lead systems and polynyas during winter, where less consolidated ice cover provides habitat for prey species (Stirling and McEwan, 1975; Stirling and Smith, 1975; Smith 1980; Stirling et al., 1993). Non-pregnant females, juveniles, and adult males remain active on the pack ice throughout the year, often moving considerable distances with the ice (Garner et al., 1994; Amstrup et al., 2000). Polar bear distribution and population size are likely regulated by the extent of sea ice and the distribution and numbers of their primary prey, the ringed seal (Stirling and Øritsland, 1995). IQ indicates that polar bears also prey on walruses and whales.

Female polar bears give birth to 1–3 cubs every 3–4 years (Stirling et al., 1975; Lentfer et al., 1980; Jefferson et al., 1993). Mating occurs from April to June, and females give birth the following December or January (Harington, 1968; Jefferson et al., 1993) in maternity dens, which are excavated in accumulations of snow on stable parts of landfast ice, offshore pack ice, and most often on land within ~ 50 km of the coast (Harington, 1968; Stirling et al., 1984; Ramsay and Stirling, 1990; Stirling and Andriashek, 1992; Amstrup and Gardner, 1994). Maternity dens are created in the fall and mothers and cubs leave their dens in April. Cubs remain with their mothers for 1.4–3.4 years (Stirling et al., 1975; Ramsay and Stirling, 1988a; Derocher et al., 1993).

The global polar bear population is estimated at 22,000–25,000, of which at least 15,500 occur in Canada or in subpopulations shared with Canada (COSEWIC, 2008). Three subpopulations of polar bears occur within the RSA: the Foxe Basin, Baffin Bay, and Davis Strait subpopulations. Between 1994 and 1997, the Baffin Bay polar bear subpopulation was estimated at 2,074 (Taylor et al., 2005). The Davis Strait subpopulation was estimated at 2,100 (Peacock et al., 2006 in COSEWIC 2008). In 1996, the Foxe Basin population was estimated at 2,119; however, that estimate is outdated and current IQ suggests that numbers may be increasing (COSEWIC, 2008). The polar bear has no status under SARA and is listed as Special Concern by COSEWIC (2008).

12.25.6.1.1 Milne Port and Shipping Route

Along the northern shipping route, polar bears are distributed on the ice and along coastal areas throughout Baffin Bay and Lancaster Sound. Polar bears from the Baffin Bay subpopulation occupy drifting pack ice and landfast ice between Baffin Island and west Greenland during winter, and can concentrate along the Lancaster Sound fast ice edge (Koski, 1980; Ferguson et al., 2000; Ferguson et al., 2001). Bears are also concentrated along landfast ice edges across Pond and Navy Board Inlets during spring. Bylot Island and coastal Baffin Island are used as summer retreats when sea ice melts, and they also provide denning habitat for pregnant females. The Davis Strait subpopulation occurs in

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and an undetermined portion of southwest Greenland (Stirling and Kiliaam, 1980; Stirling et al., 1980; Taylor and Lee, 1995). Polar bears are harvested domestically as well as during a commercial sport hunt based out of Pond Inlet in spring. COSEWIC (2008) suggests the current hunting level will continue to deplete the population.

During aerial surveys for the Project in 2007 and 2008, small numbers of polar bears (six in total) were observed during the open-water season in Milne Inlet, Eclipse Sound, and Eskimo Inlet. Polar bears were also observed in low numbers on landfast ice in Milne Inlet, Koluktoo Bay, and Navy Board Inlet in June 2006.

12.25.6.1.2 Steensby Port and Shipping Route

Polar bears from the Foxe Basin subpopulation range over Foxe Basin, northern Hudson Bay, and western Hudson Strait during winter (COSEWIC, 2008). They return to shore during the open-water period, concentrating on Southampton Island and along Wager Bay and other coasts in Foxe Basin (COSEWIC, 2008). The southern limit of the subpopulation's distribution varies annually depending on the distribution of the seasonal pack ice during winter (Stirling, 1988a). IQ indicates that polar bears are concentrated in northern Foxe Basin and through Fury and Hecla Strait into the Gulf of Boothia. Information regarding the location of denning areas has not been published, but Hall Beach elders indicated that the southeastern portion of Steensby Inlet provides good den habitat. Polar bears are hunted by the communities of Hall Beach and Igloolik.

During aerial surveys for the Project, small numbers of polar bears were observed on landfast ice and pack ice, in terrestrial areas, and in open-water areas, primarily in northern Foxe Basin but also in Hudson Strait. Polar bears were most frequently observed in September and October along the shorelines of Steensby Inlet and Foxe Basin including Koch, Rowley, and Bray islands. During the aerial surveys with ice cover, highest polar bear densities were observed in northwestern Foxe Basin (0.5/100 km^2).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

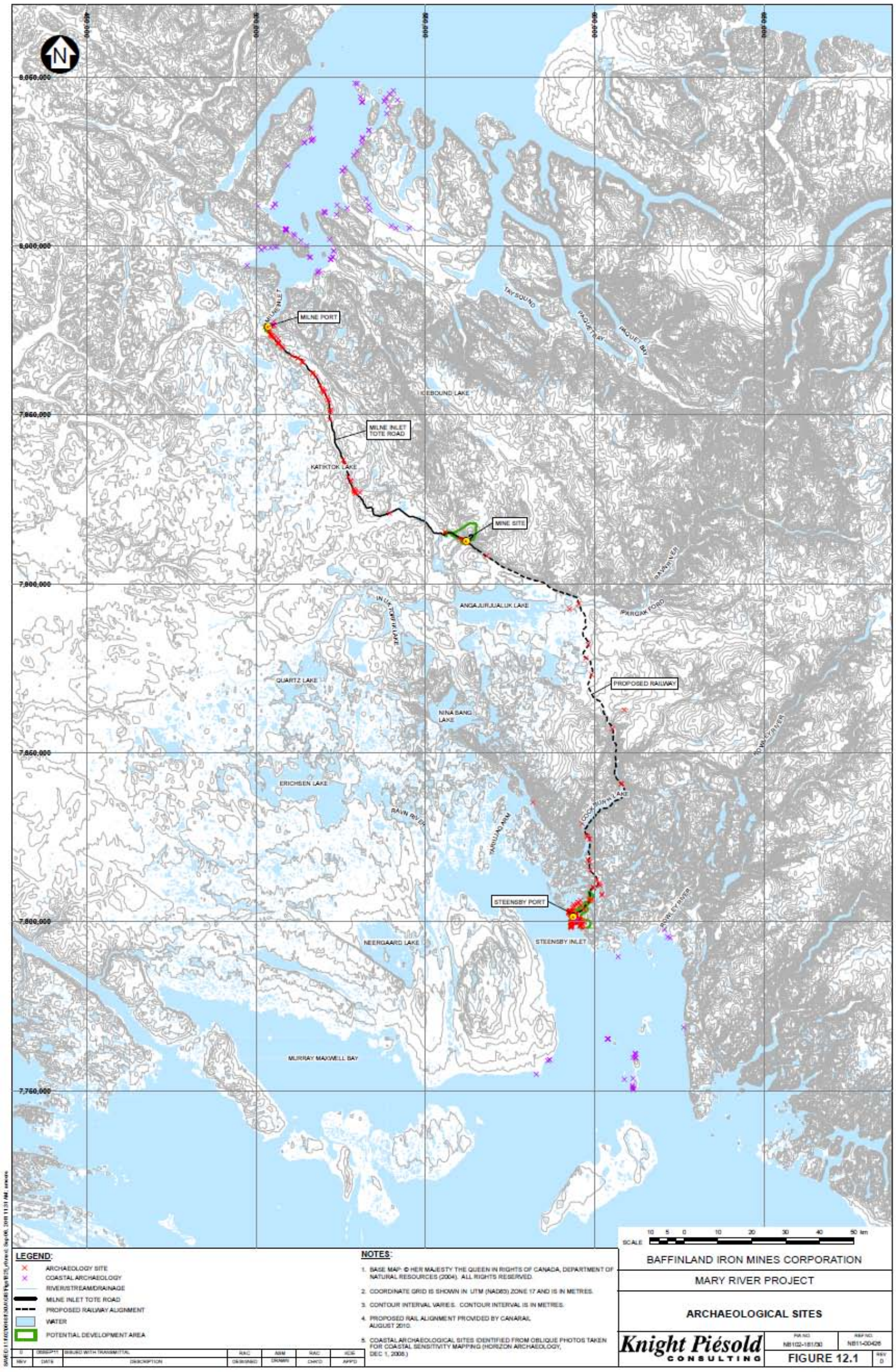


Figure 12-1: Archaeolgical Sites

© Hatch 2011/09

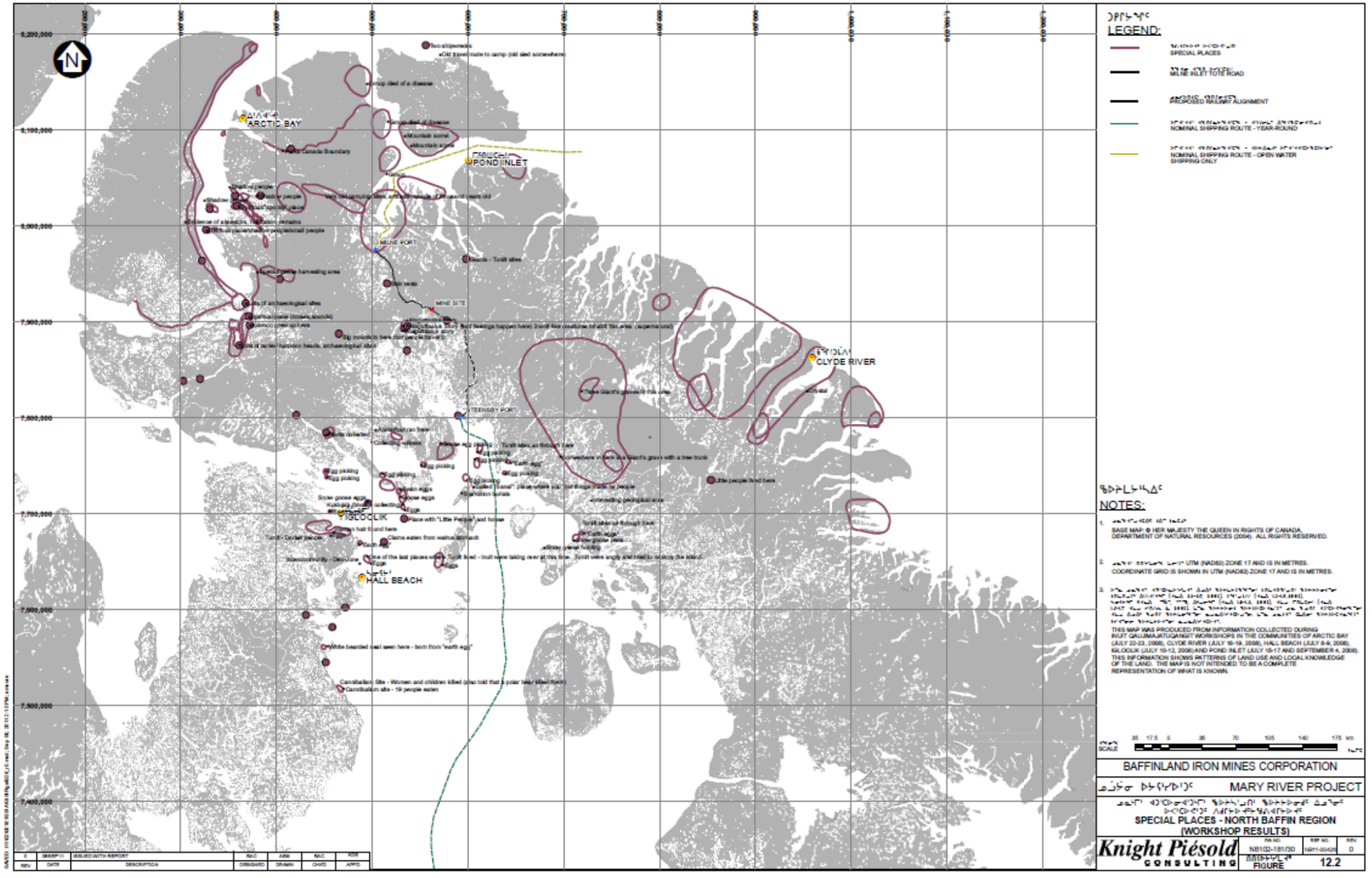


Figure 12-2: Special Places – North Baffin Region (Workshop Results)

© Hatch 2011/09

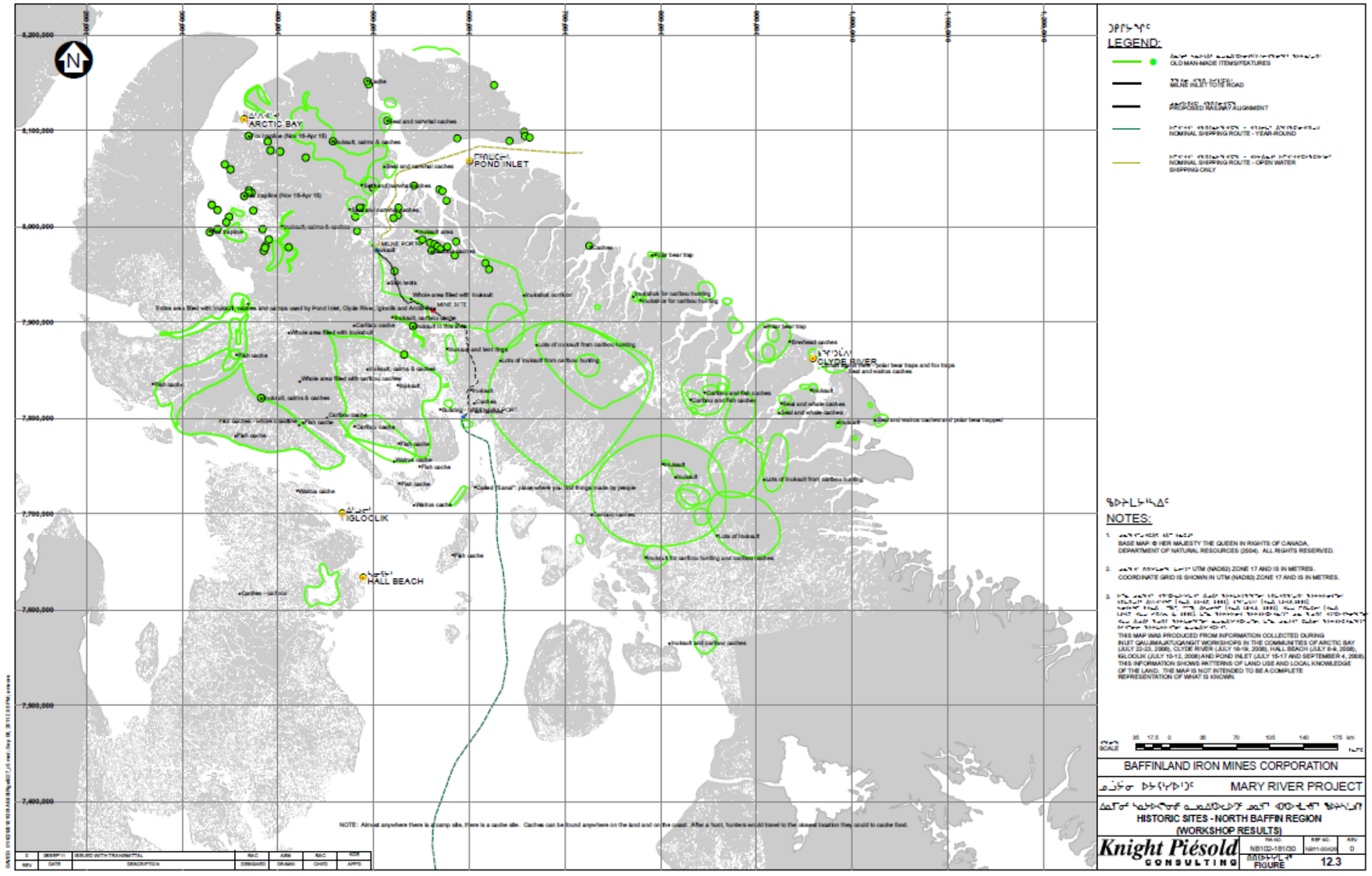


Figure 12-3: Histroic Sites – North Baffin Region (Workshop Results)

© Hatch 2011/09

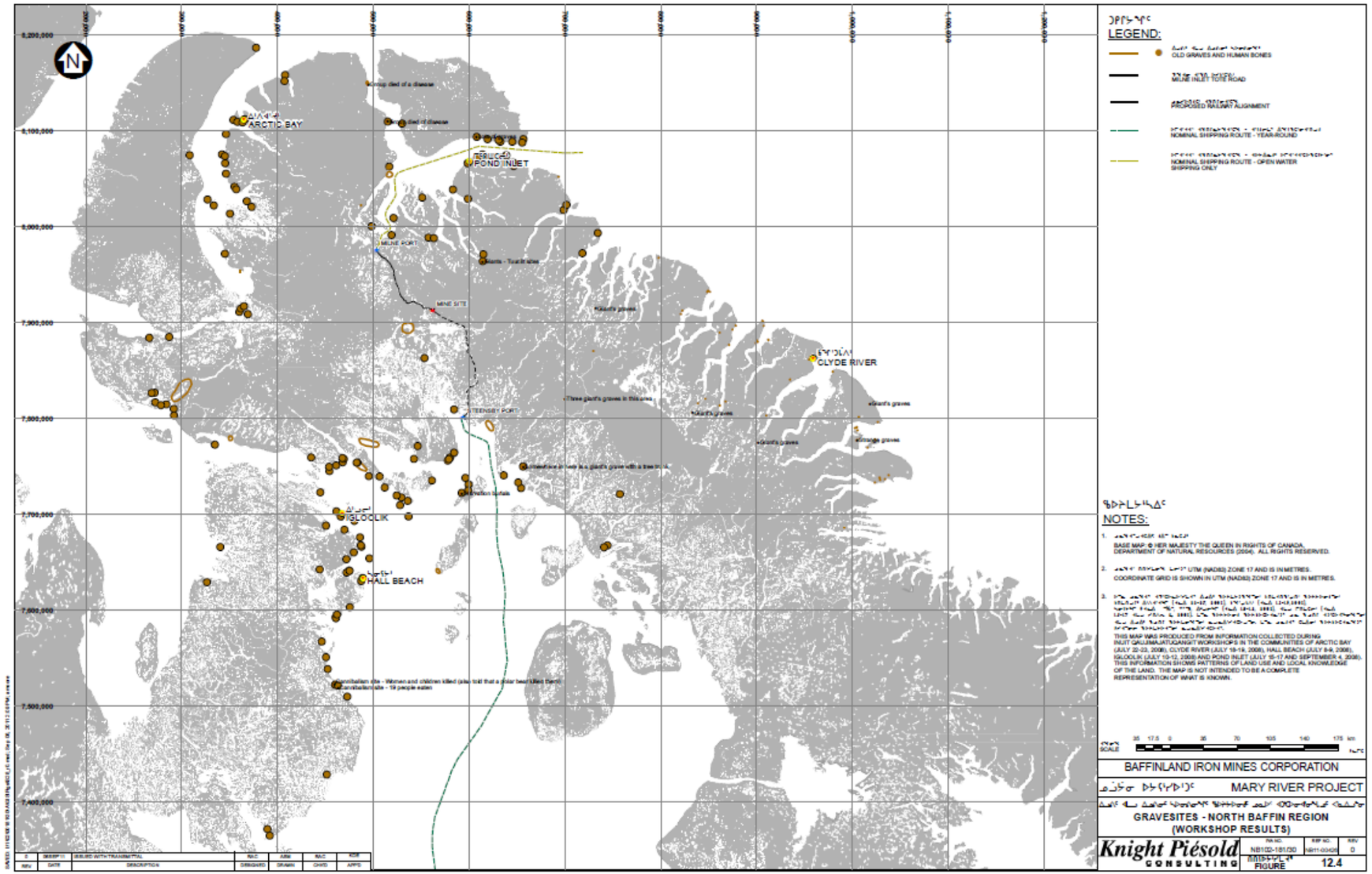


Figure 12-4: Gravel Sites – North Baffin Region (Workshop Results)

© Hatch 2011/09

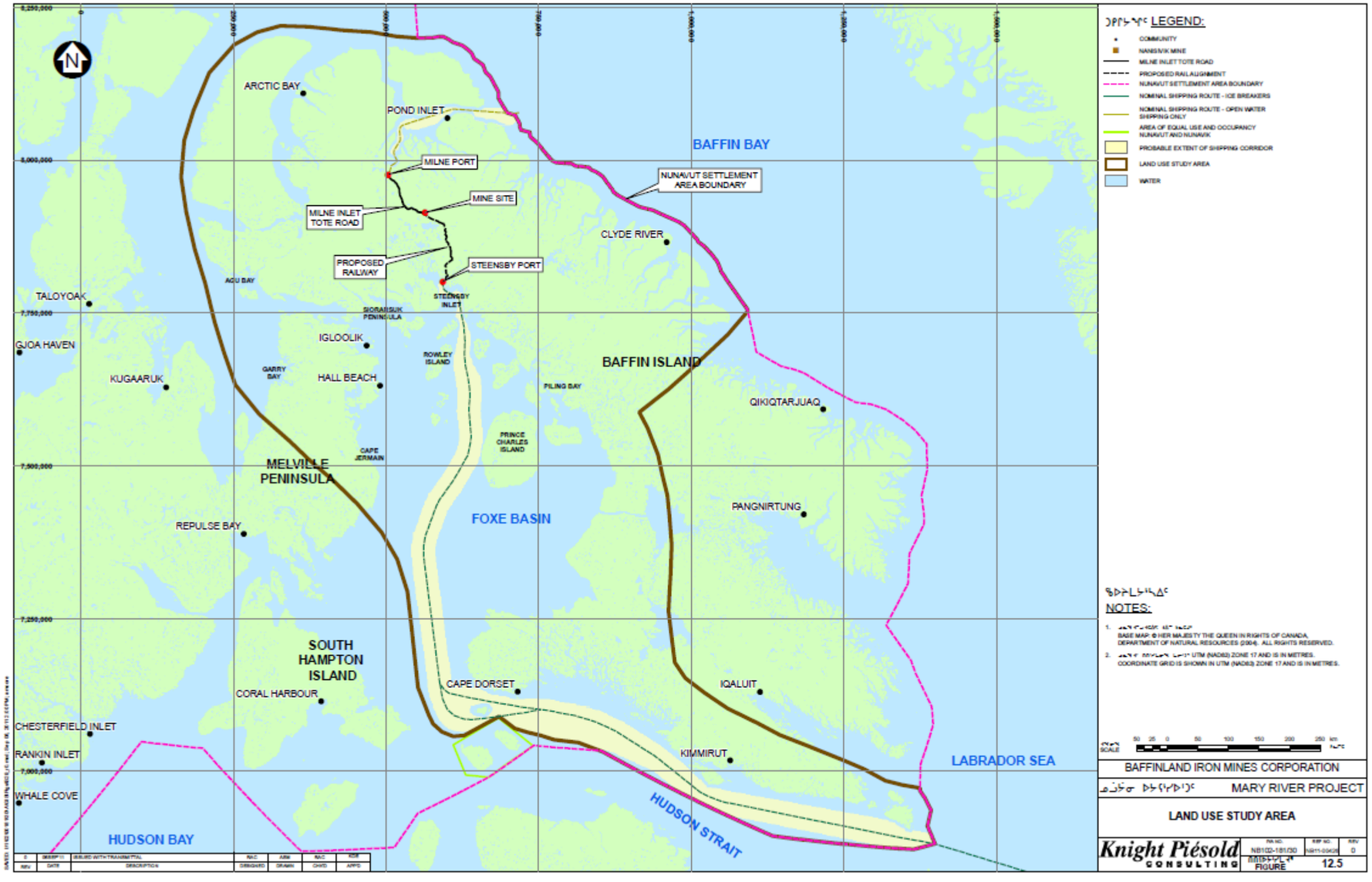


Figure 12-5: Land Use Study Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

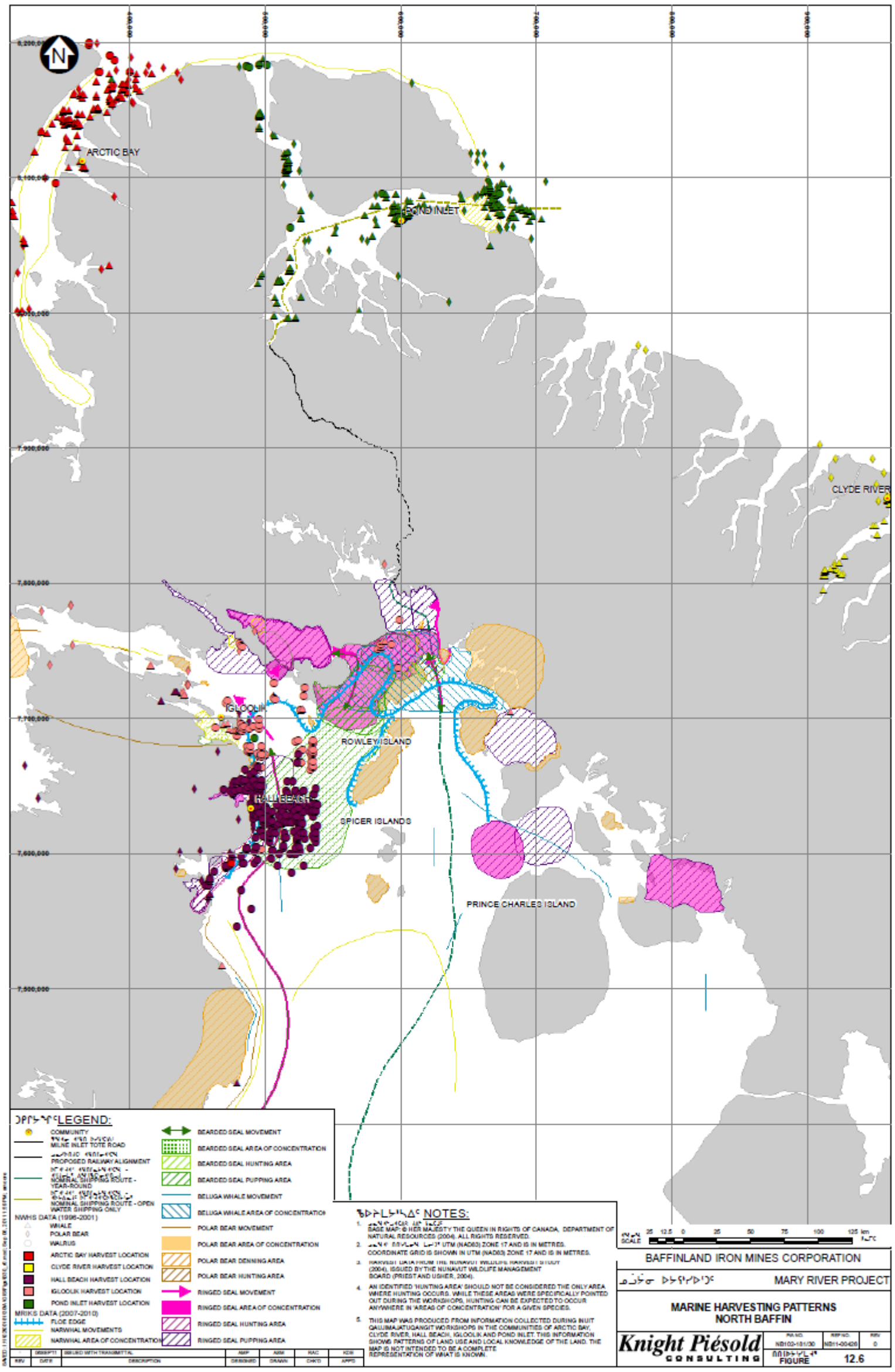


Figure 12-6: Marine Harvesting Patterns North Baffin

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

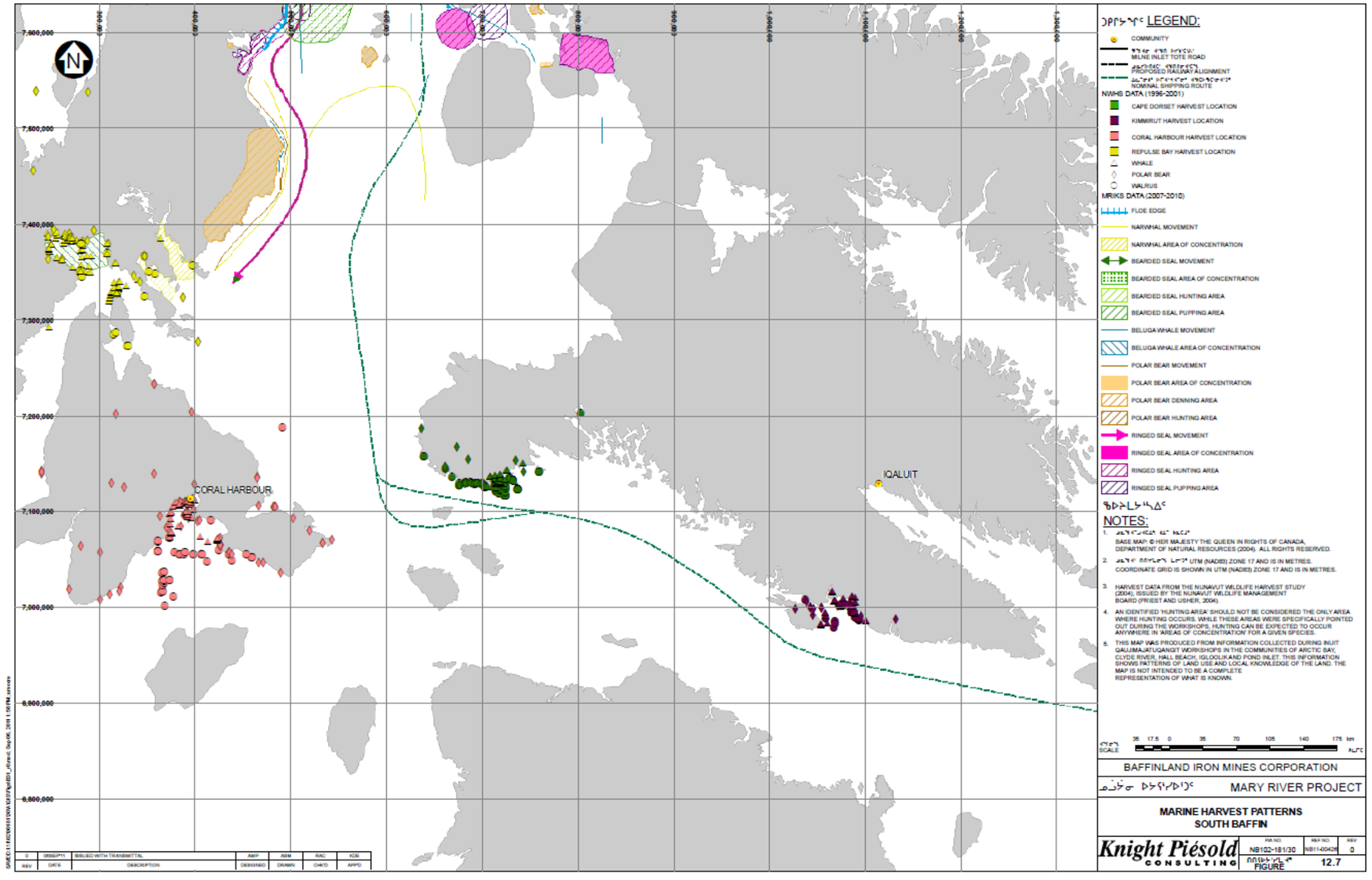


Figure 12-7: Marine Harvest Patterns South Baffin

© Hatch 2011/09

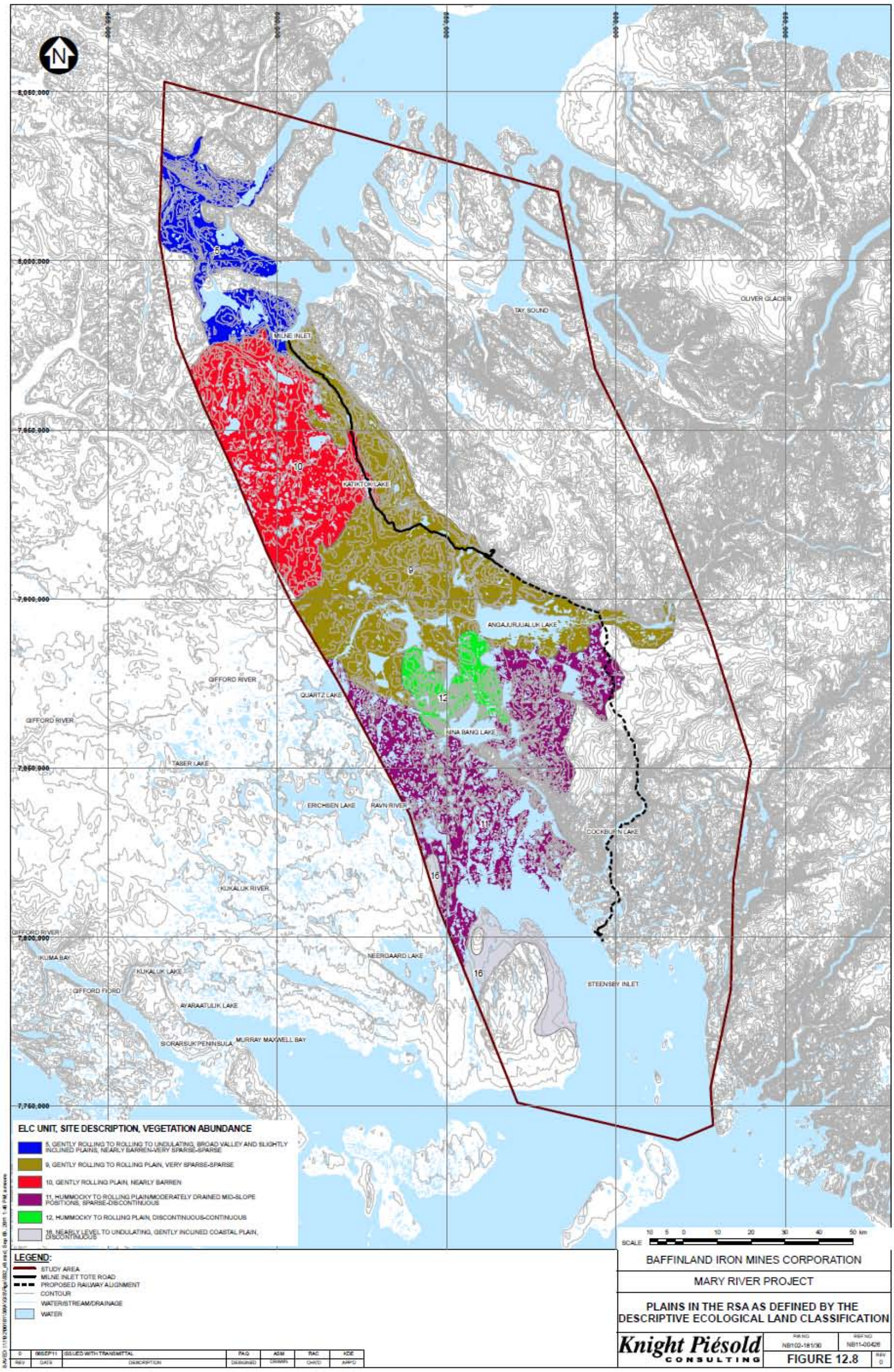


Figure 12-8: Plains in the RSA as Defined by the Descriptive Ecological Land Classification

© Hatch 2011/09

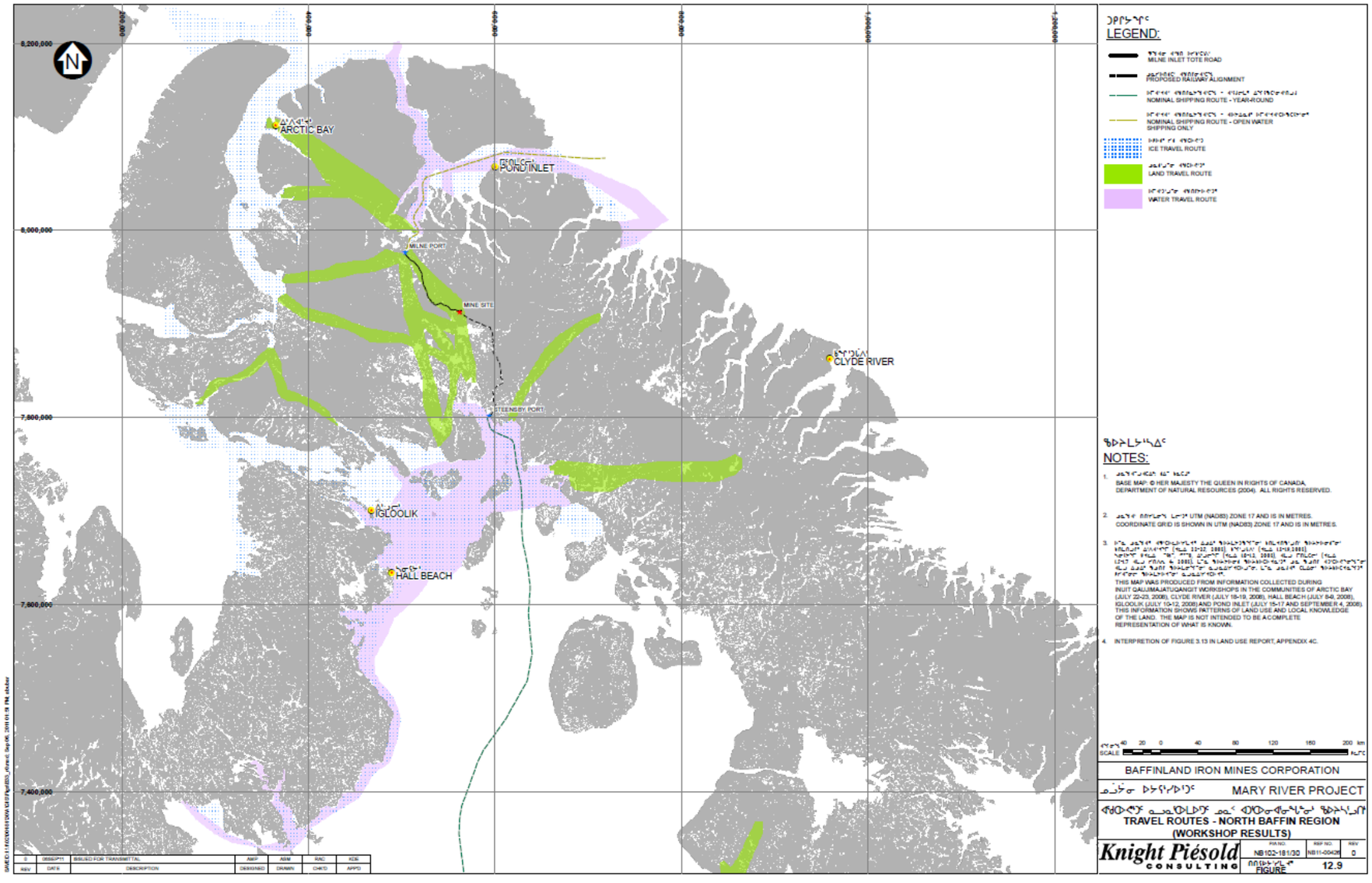


Figure 12-9: Travel Routes – North Baffin Region (Workshop Results)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

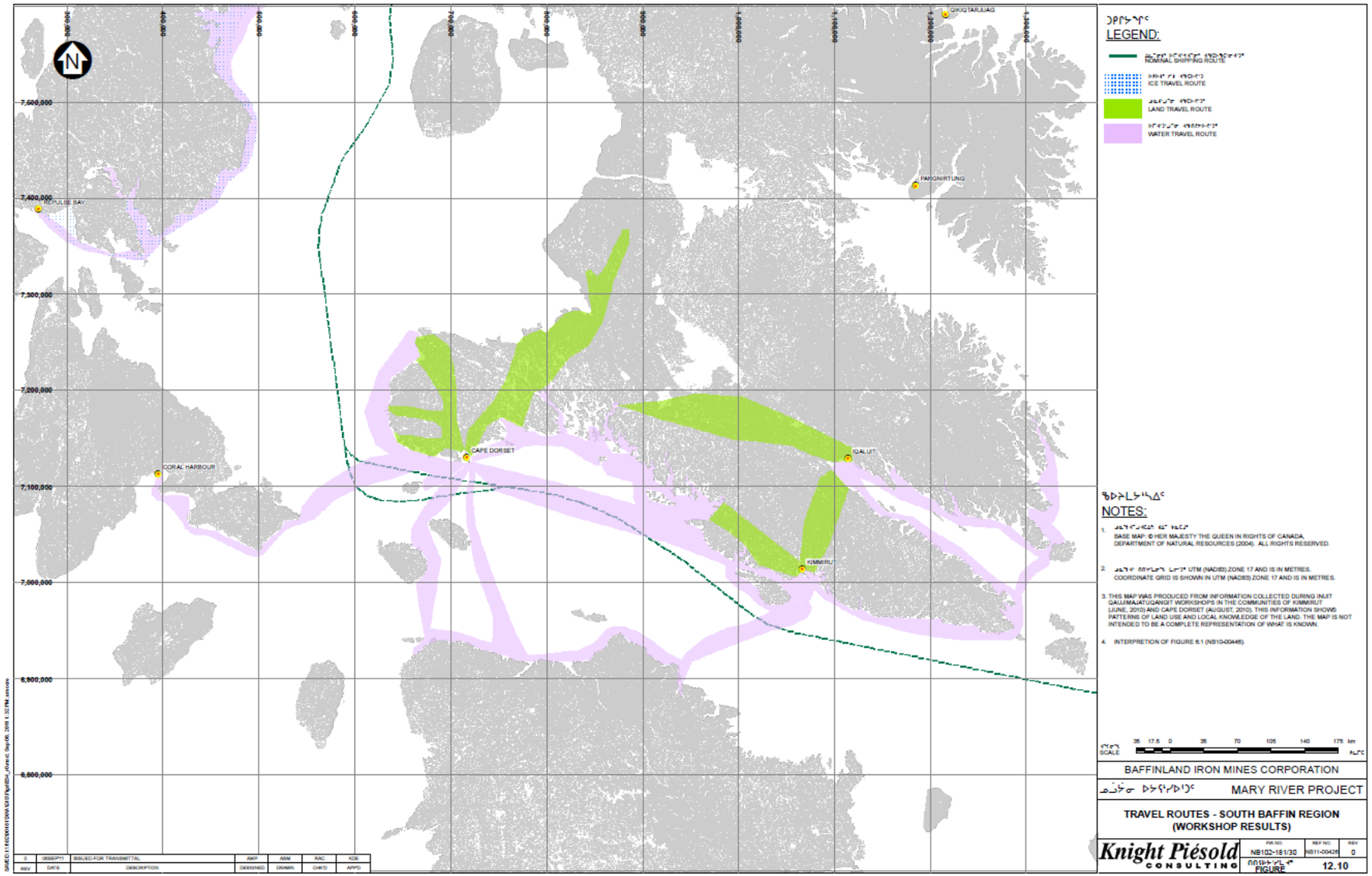


Figure 12-10: Travel Routes – South Baffin (Workshop Results)

© Hatch 2011/09

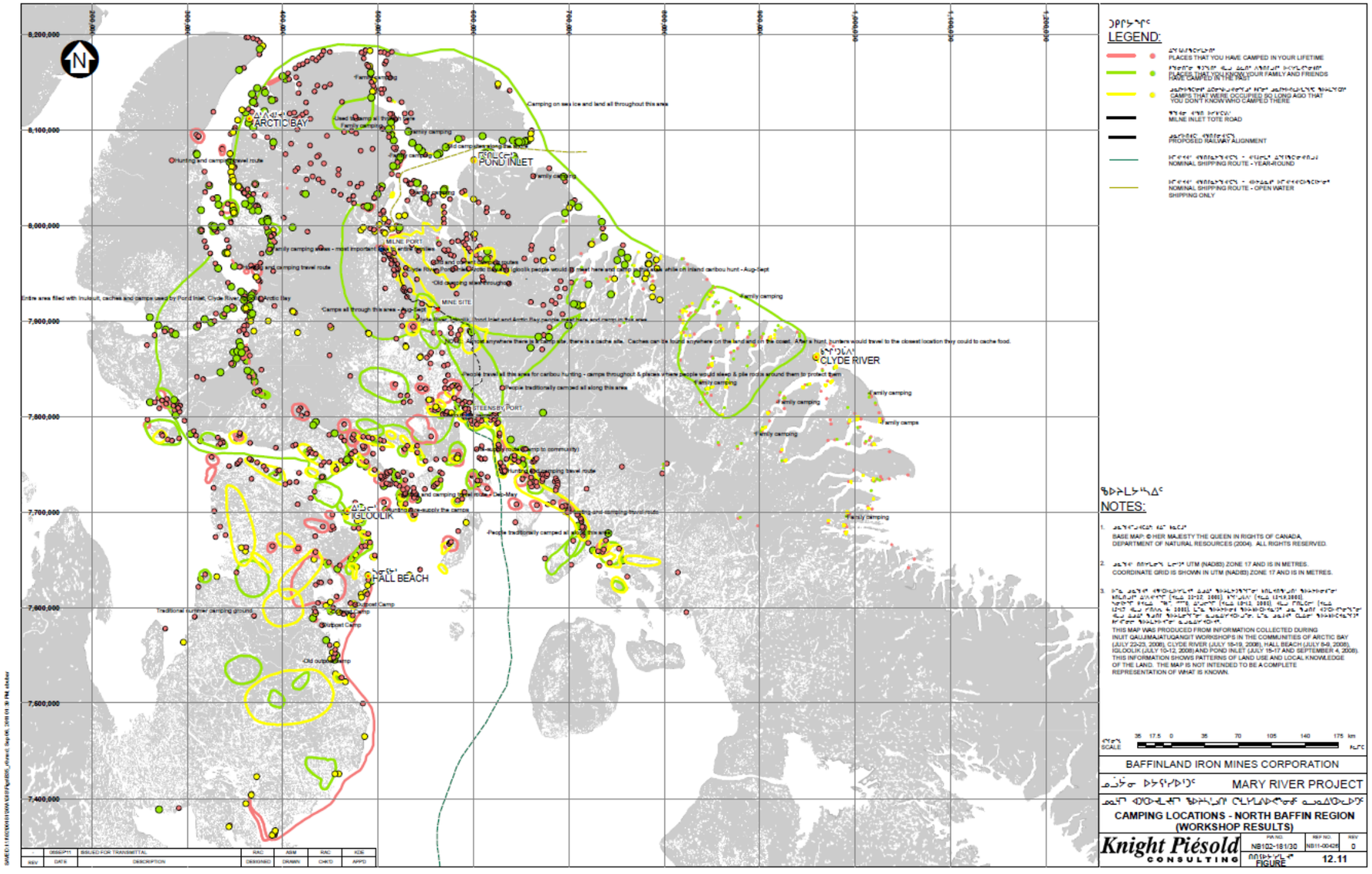


Figure 12-11: Camping Locations – North Baffin Region (Workshop Results)

© Hatch 2011/09

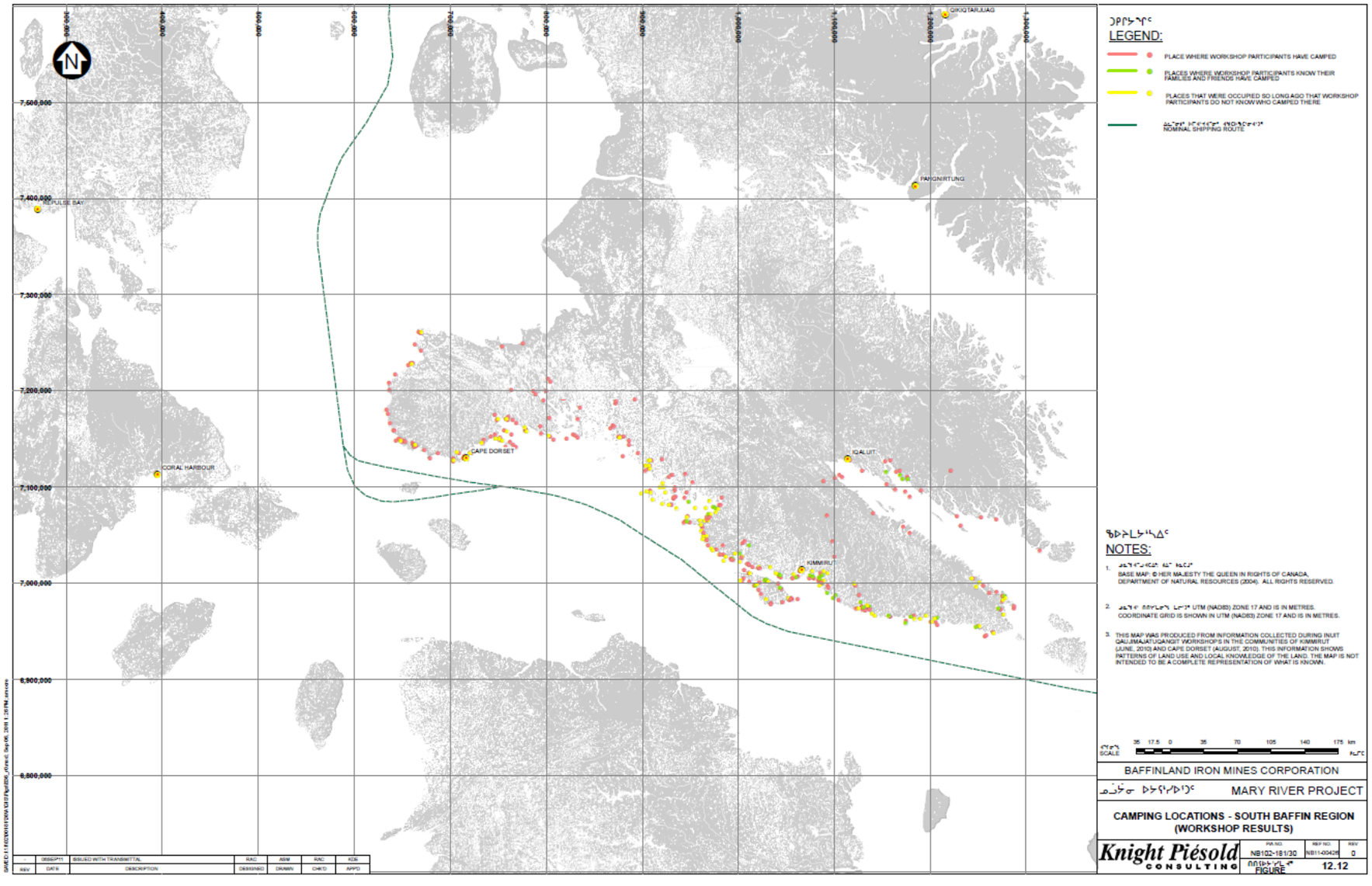


Figure 12-12: Camping Locations – South Baffin Region (Workshop Results)

© Hatch 2011/09

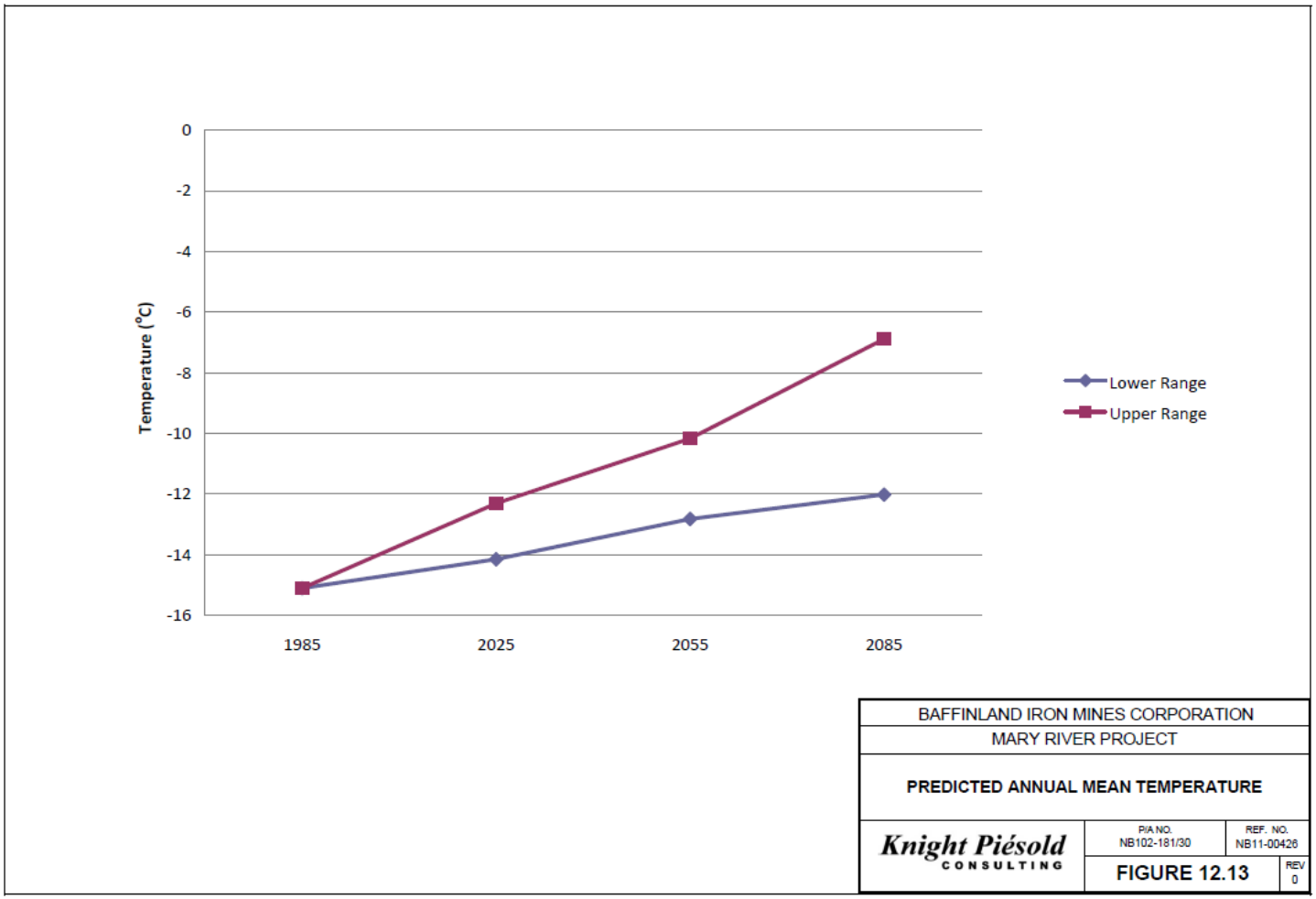


Figure 12-13: Predicted Annual Mean Temperature

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

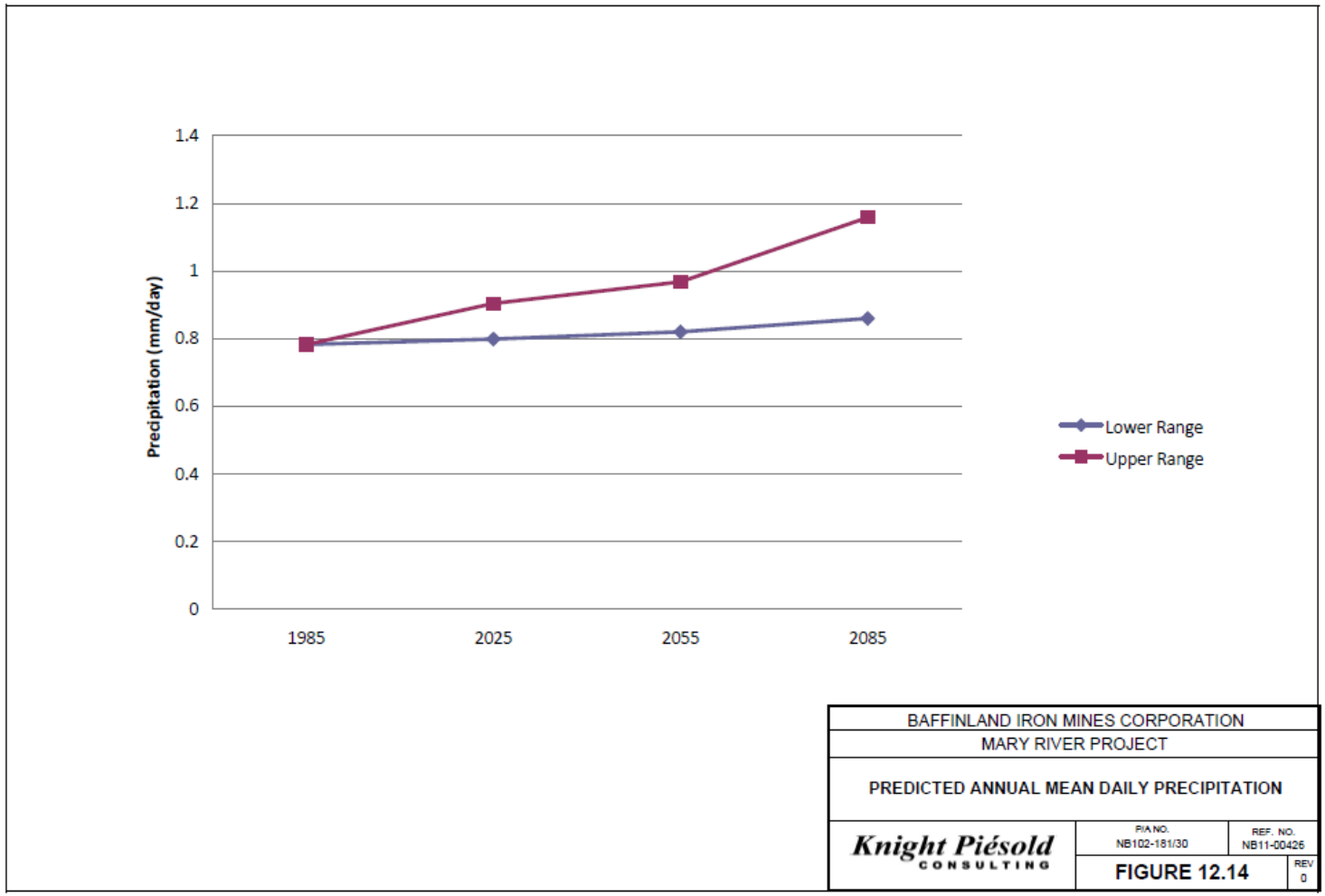


Figure 12-14: Predicted Annual Mean Daily Precipitation

© Hatch 2011/09

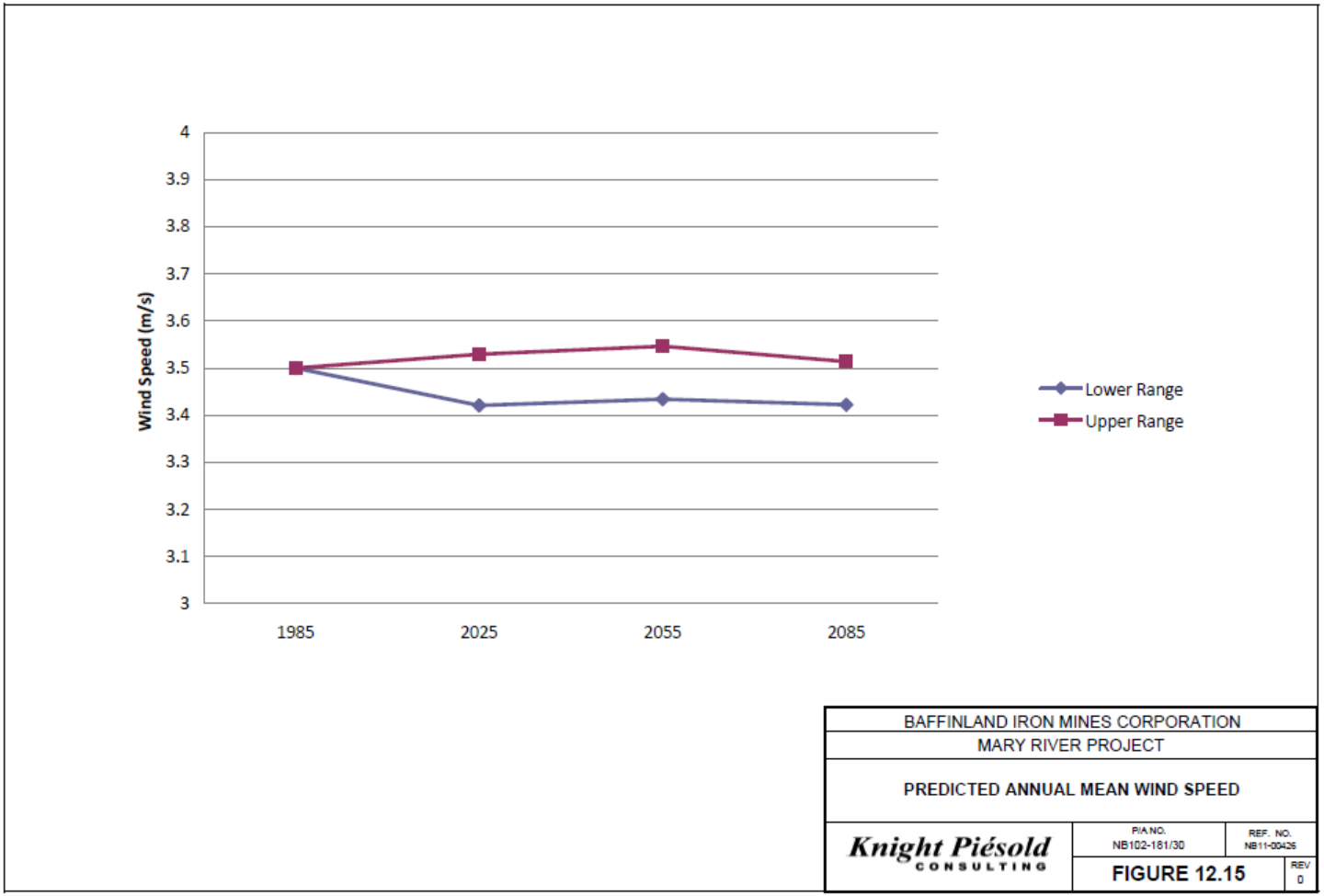


Figure 12-15: Predicted Annual Mean Wind Speed

© Hatch 2011/09

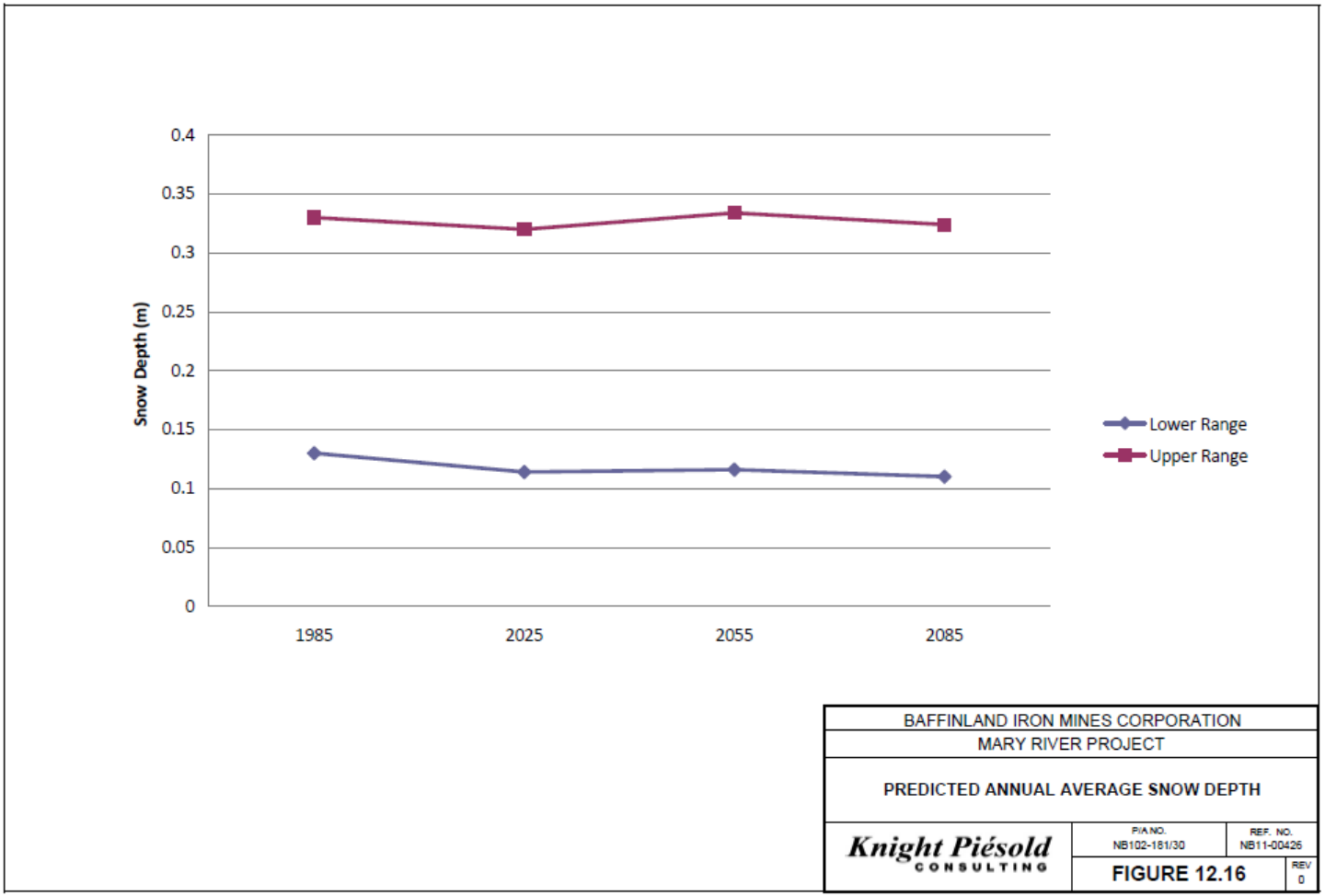


Figure 12-16: Predicted Annual Average Snow Depth

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

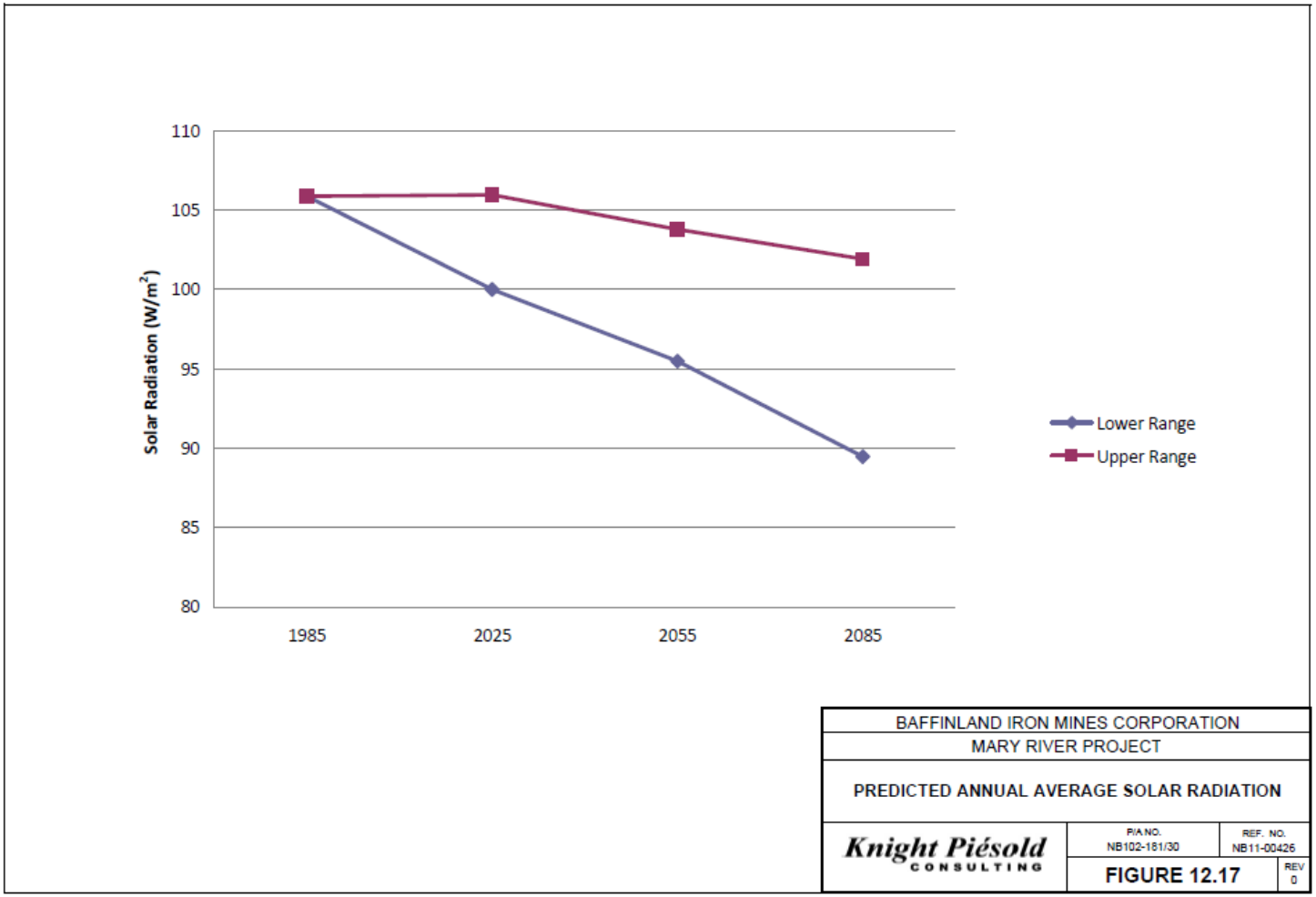


Figure 12-17: Predicted Annual Average Solar Radiation

© Hatch 2011/09

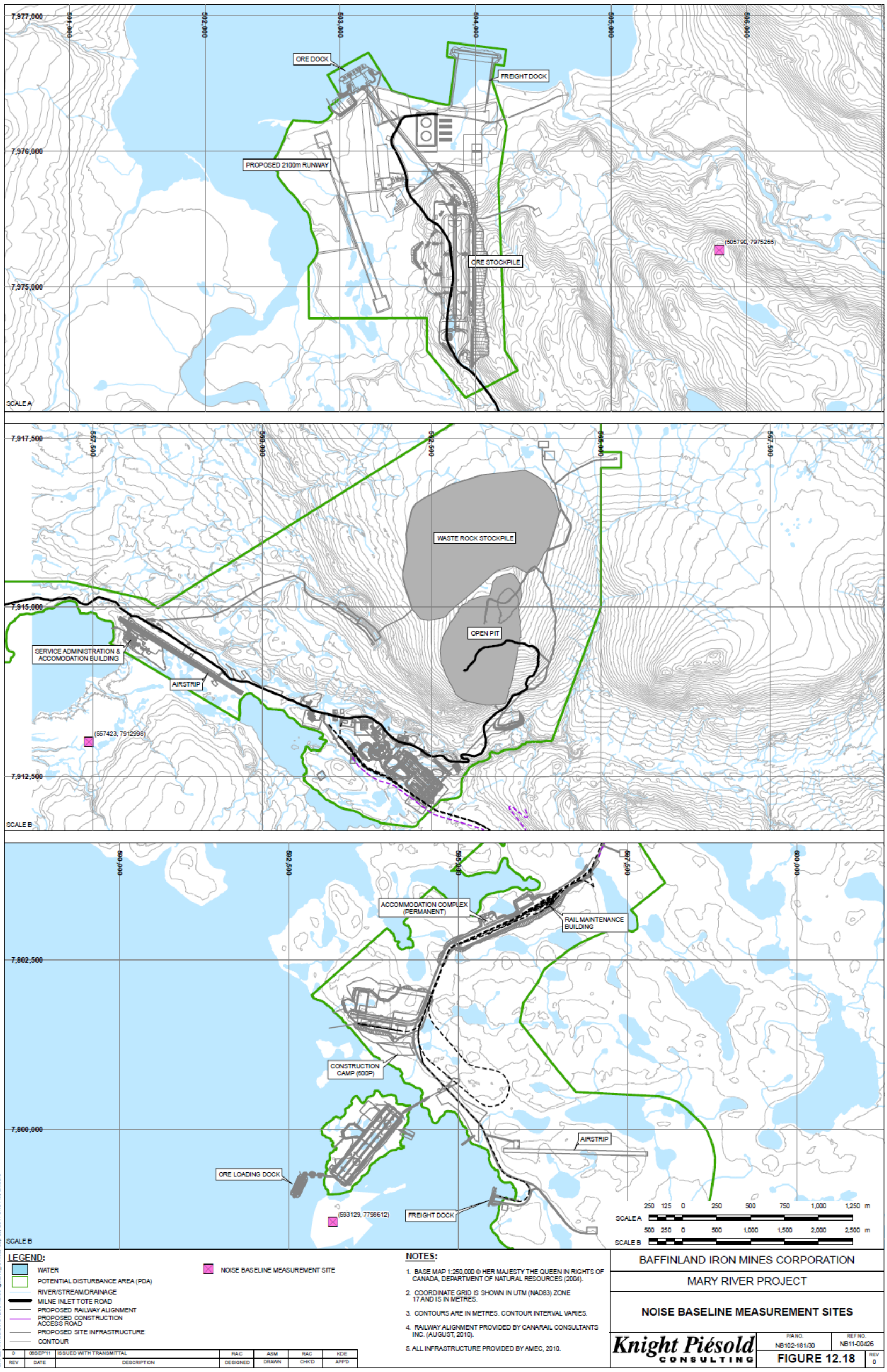


Figure 12-18: Noise Baseline Measurement Sites

© Hatch 2011/09

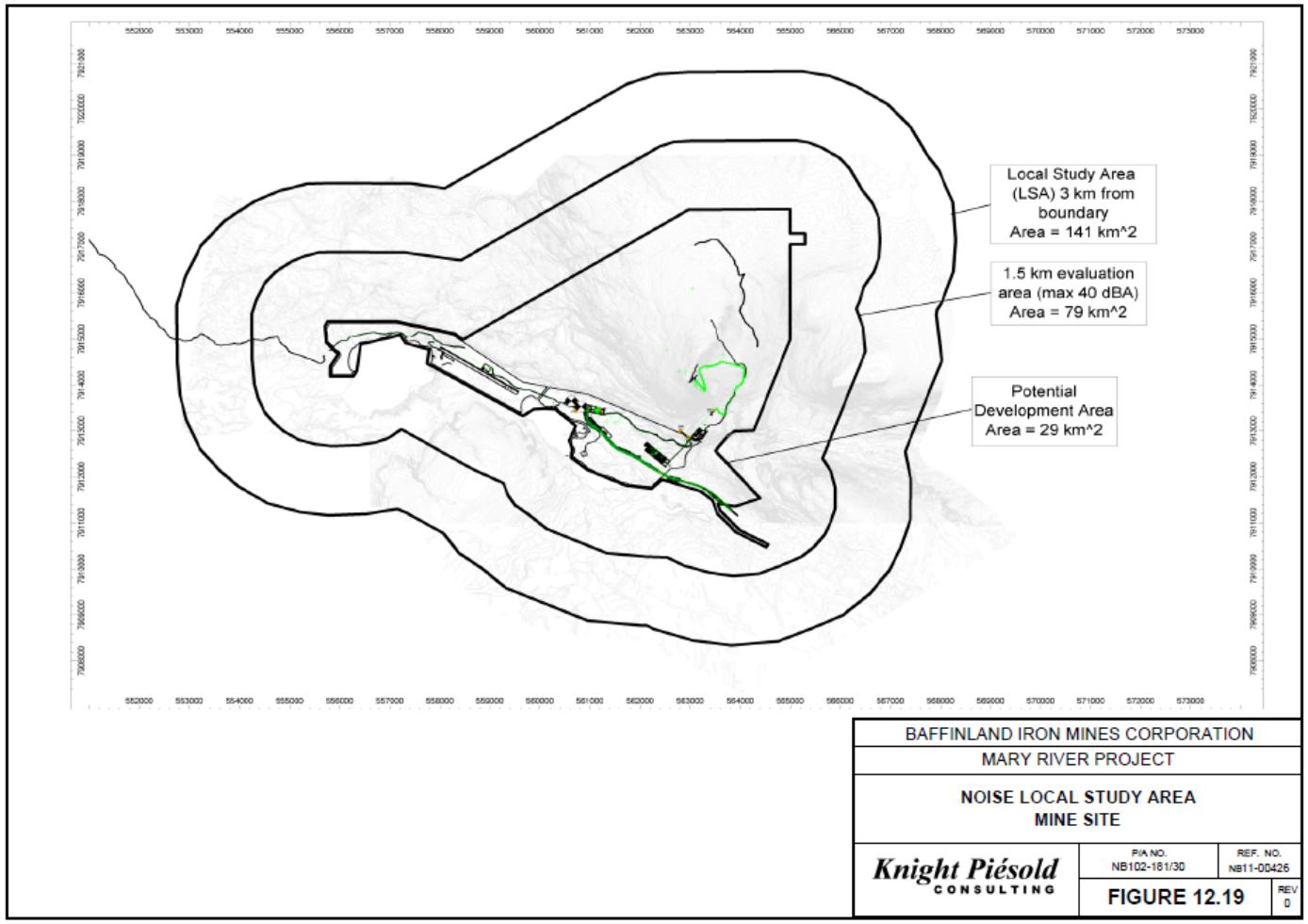


Figure 12-19: Noise Local Study Area Mine Site

© Hatch 2011/09

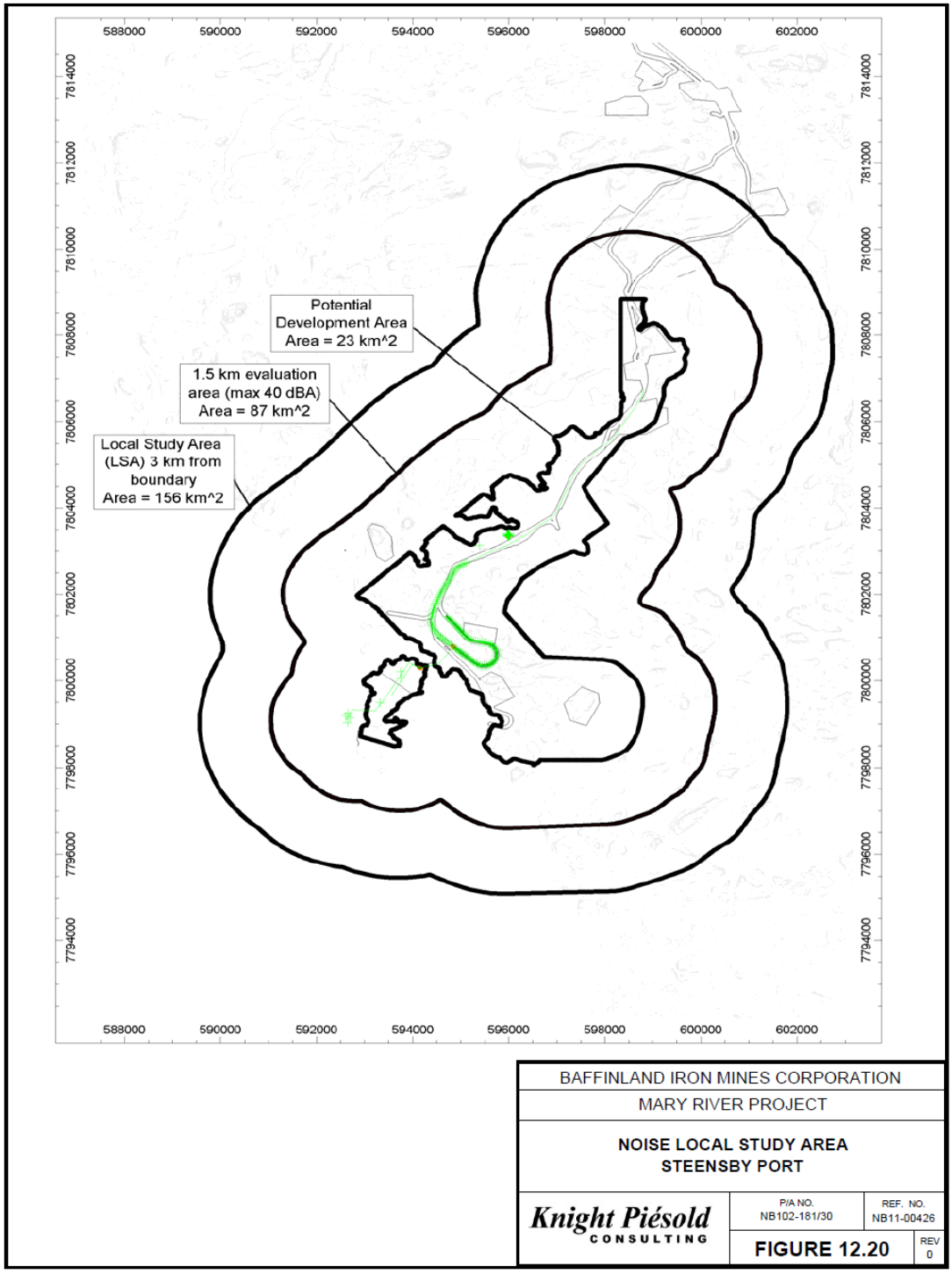


Figure 12-20: Noise Local Study Area Steensby Port

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

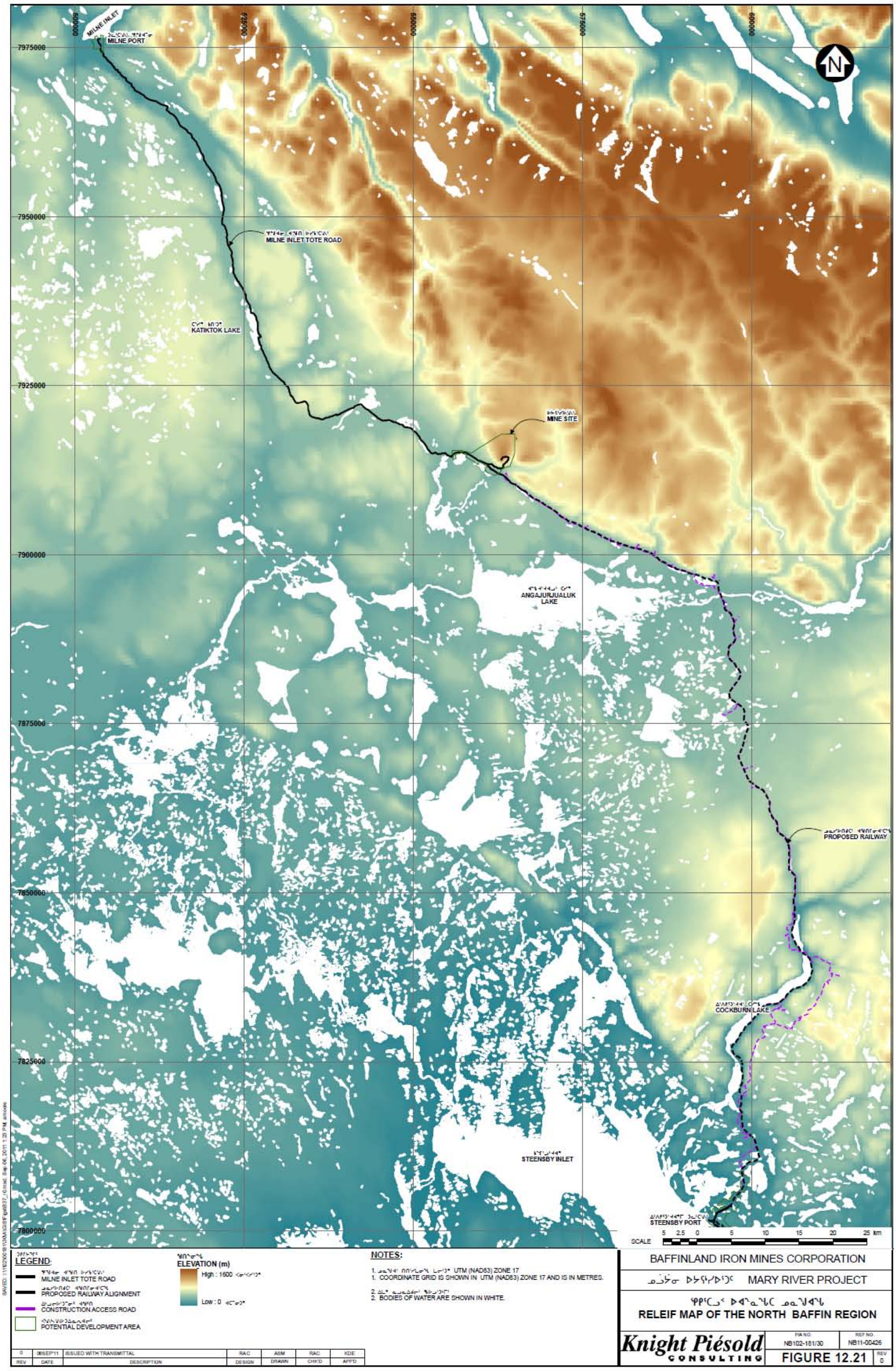


Figure 12-21: Releif Map of the North Baffin Regaion

© Hatch 2011/09

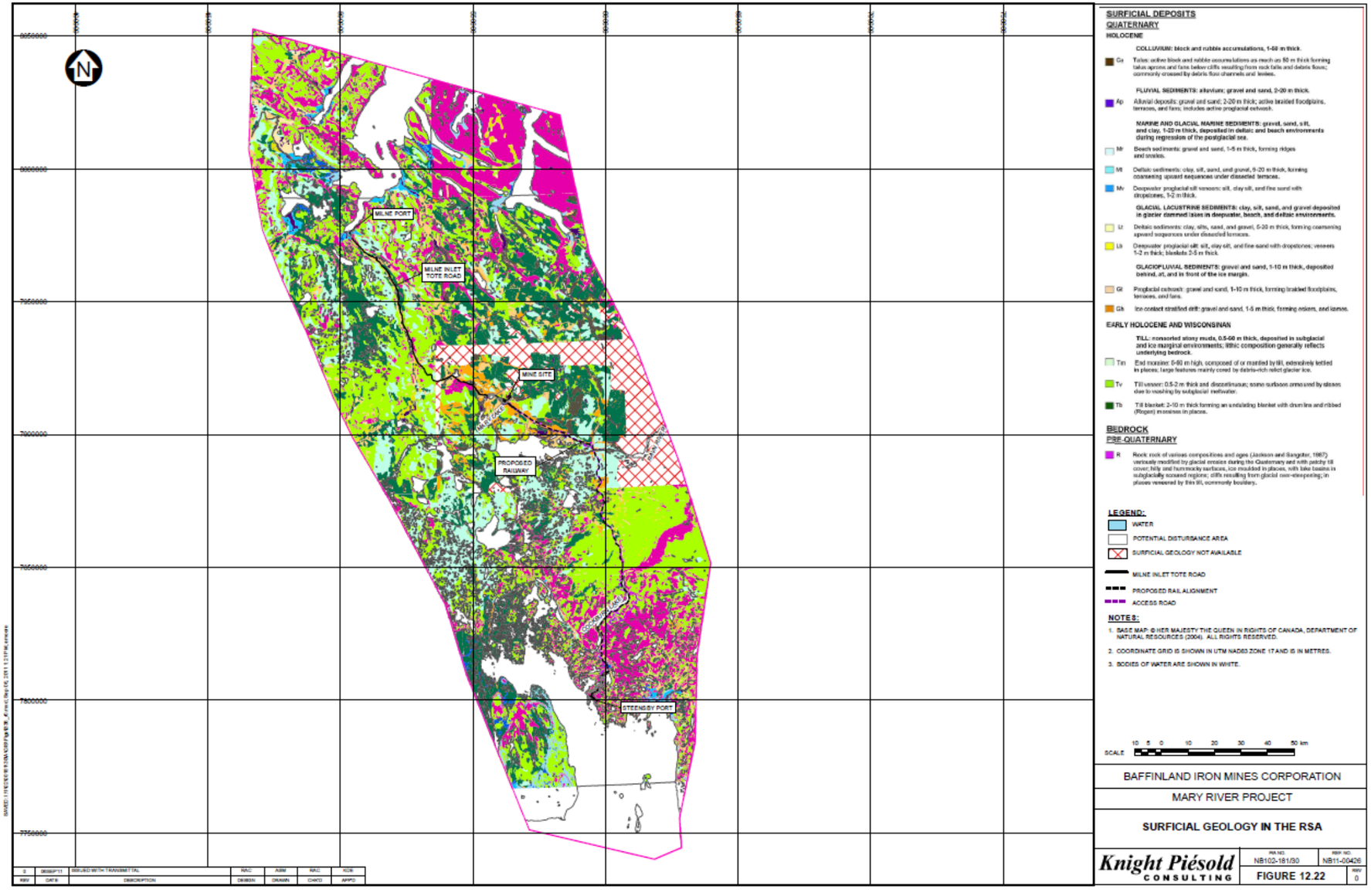


Figure 12-22: Surficial Geology in the RSA

© Hatch 2011/09

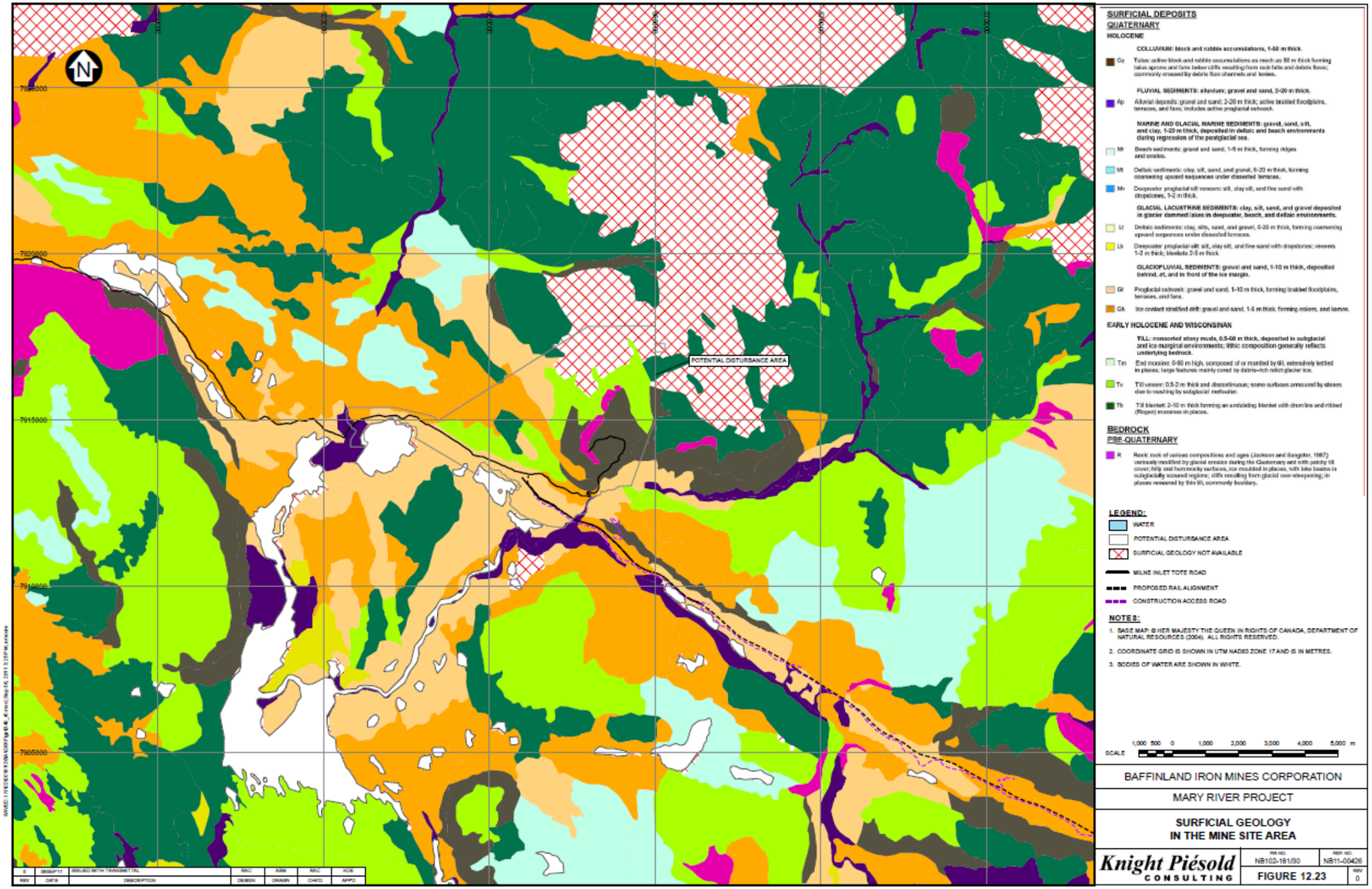


Figure 12-23: Surficial Geology in the Mine Site Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

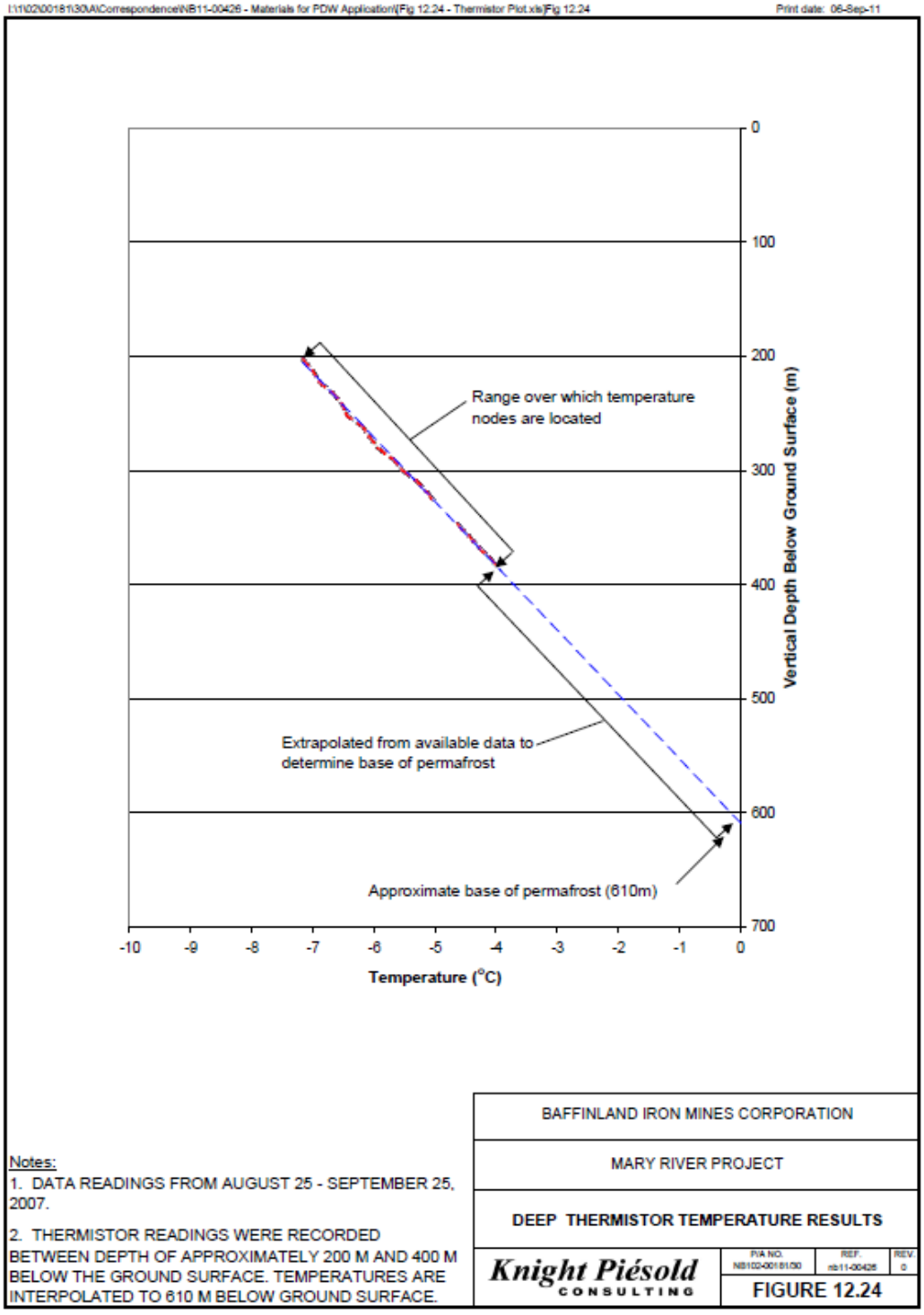


Figure 12-24: Deep Thermistor Temperature Results

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

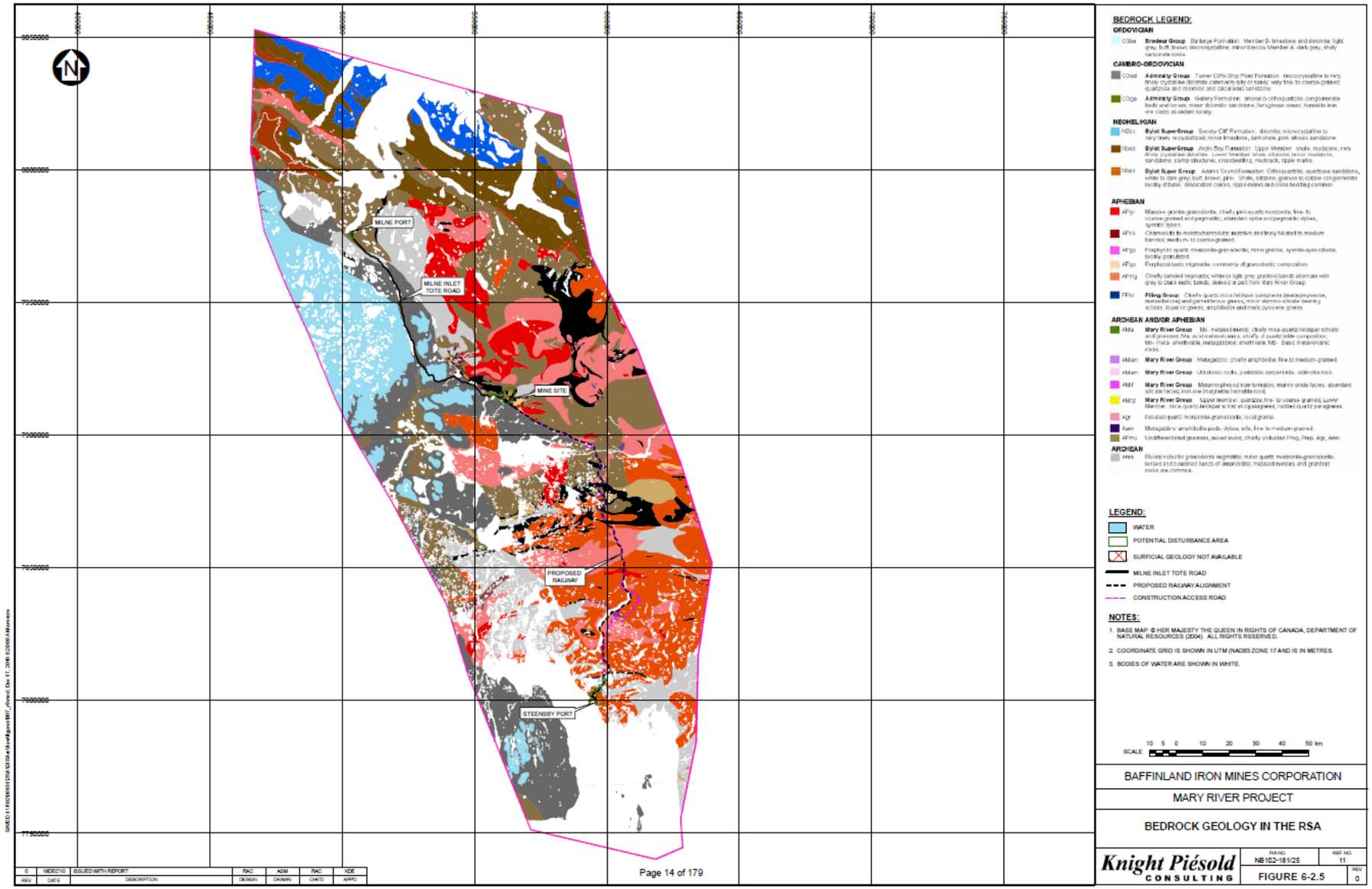


Figure 12-25: Bedrock Geology in the RSA (KP Figure 6-2.5

© Hatch 2011/09

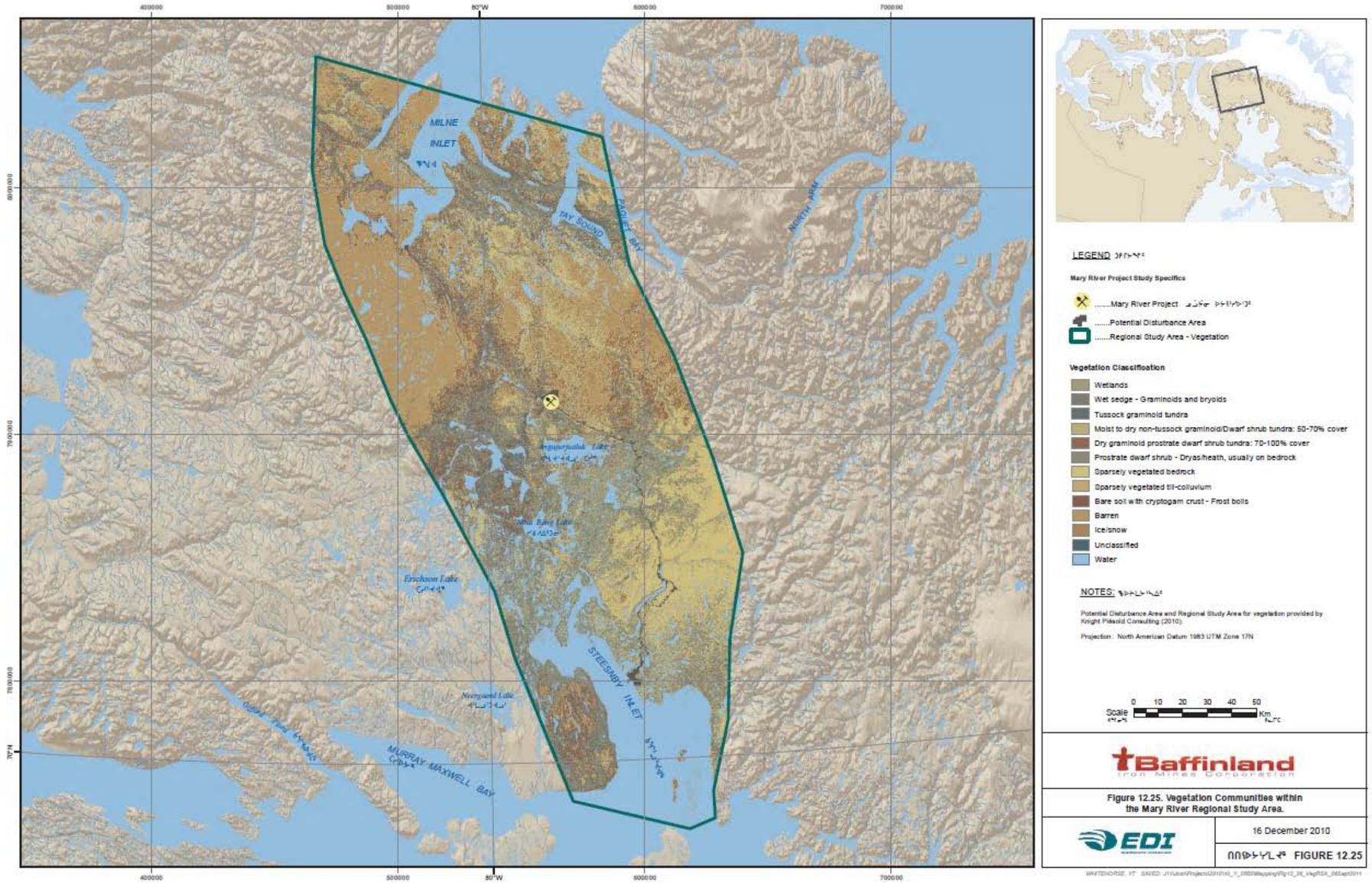


Figure 12-26: Vegetation Communities within the Mary River Regional Study Area (KP Figure 12.25)

© Hatch 2011/09

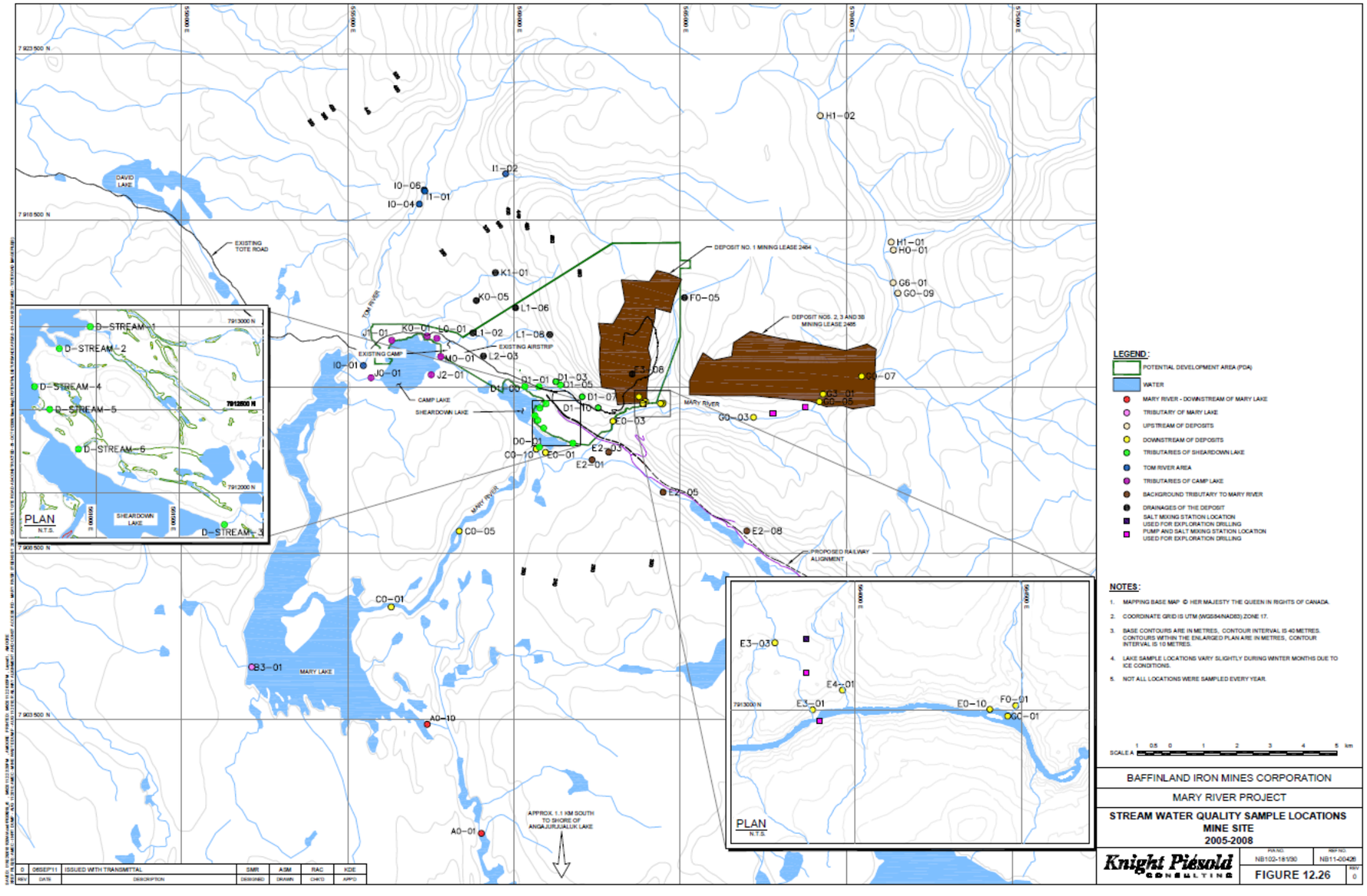


Figure 12-27: Stream Water Quality Sample Locations Mine Site 2005-2008 (KP Figure 12.26)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

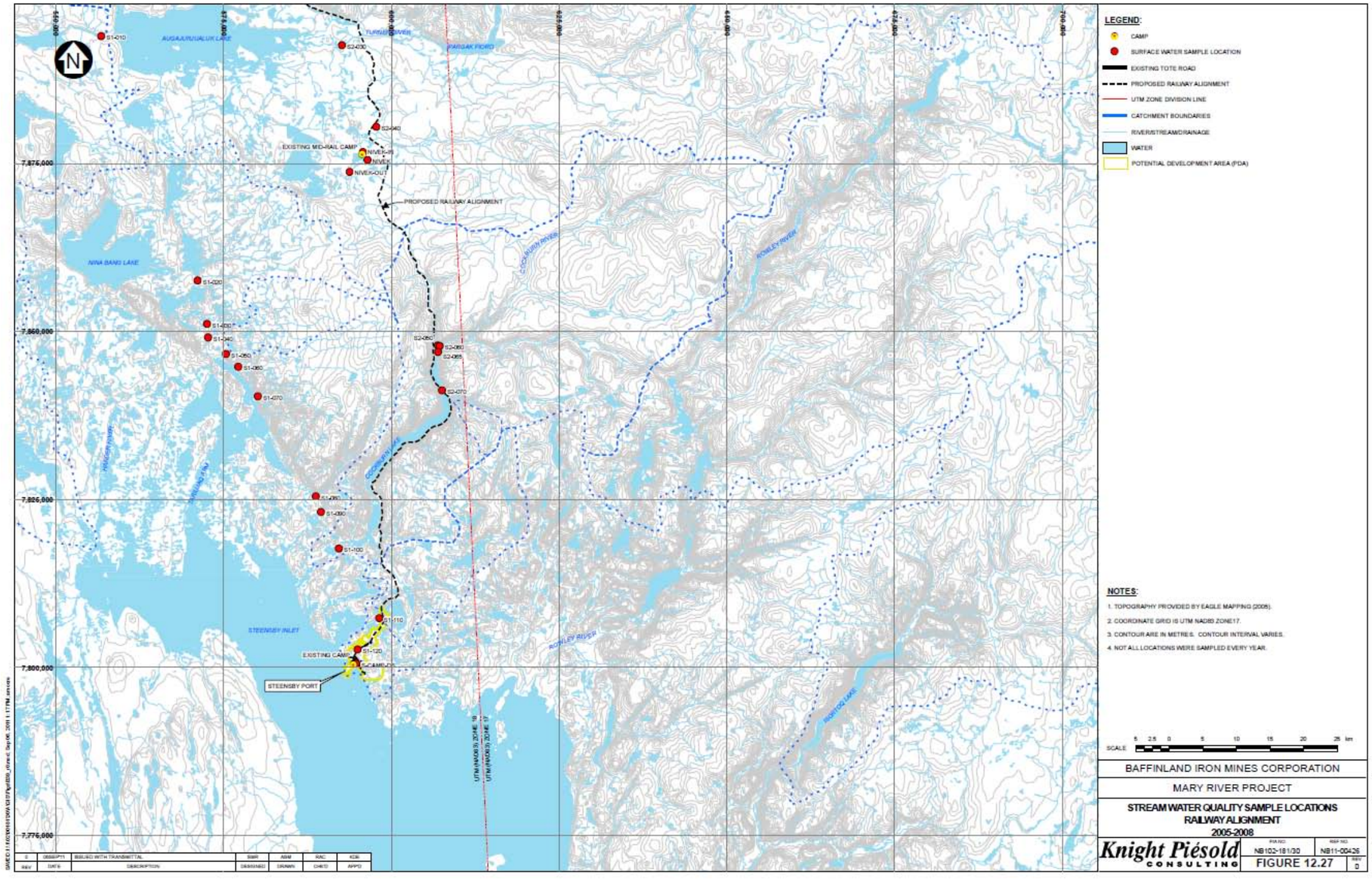


Figure 12-28: Stream Water Quality Sample Locatinos Railway Alignment 2005-2008 (KP Figure 12.27)

© Hatch 2011/09

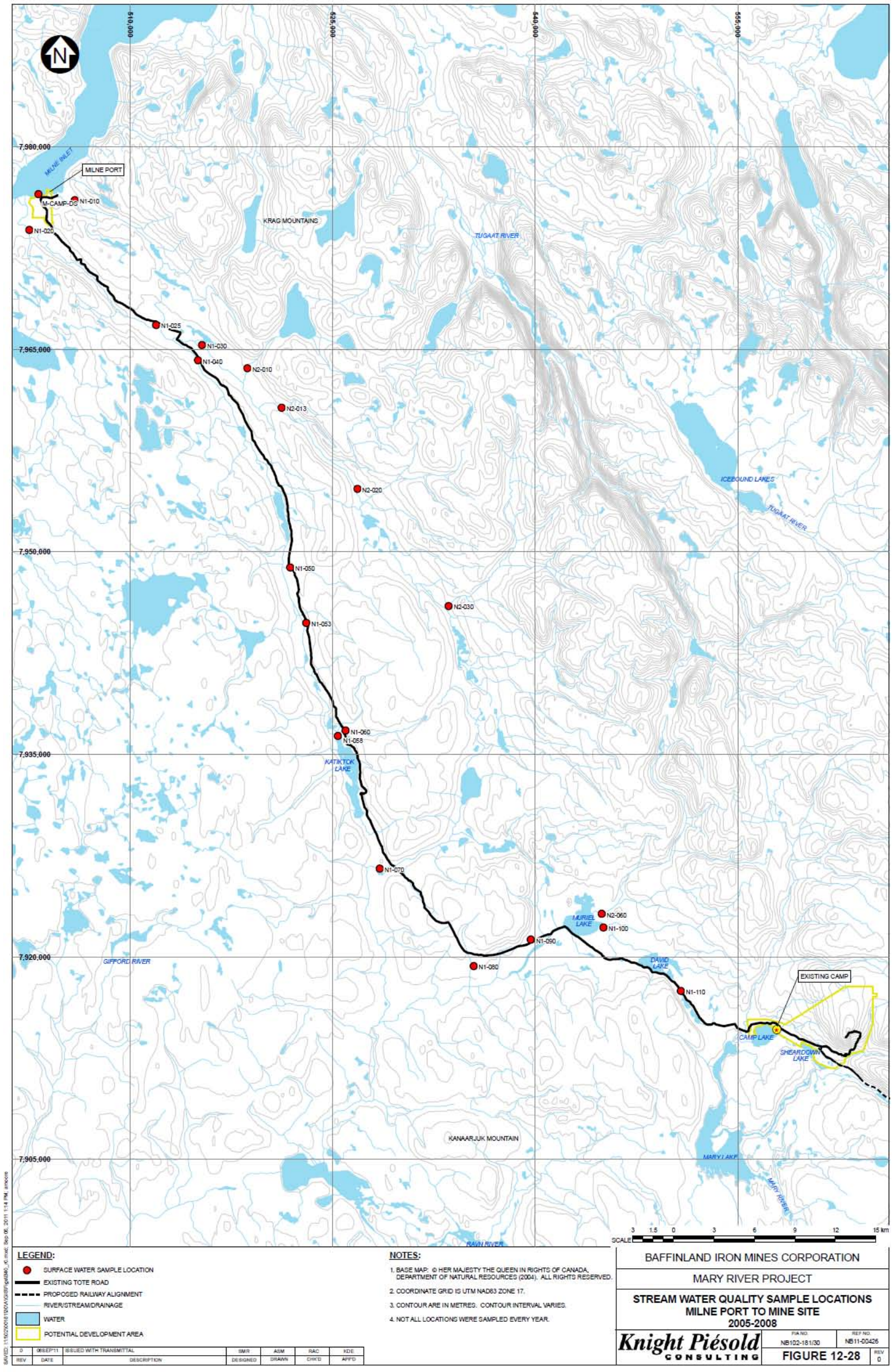


Figure 12-29: Streatm Water Quality Sample Locations Milne Port to Mine Site 2005-2008 (KP Figure 12.28)

© Hatch 2011/09

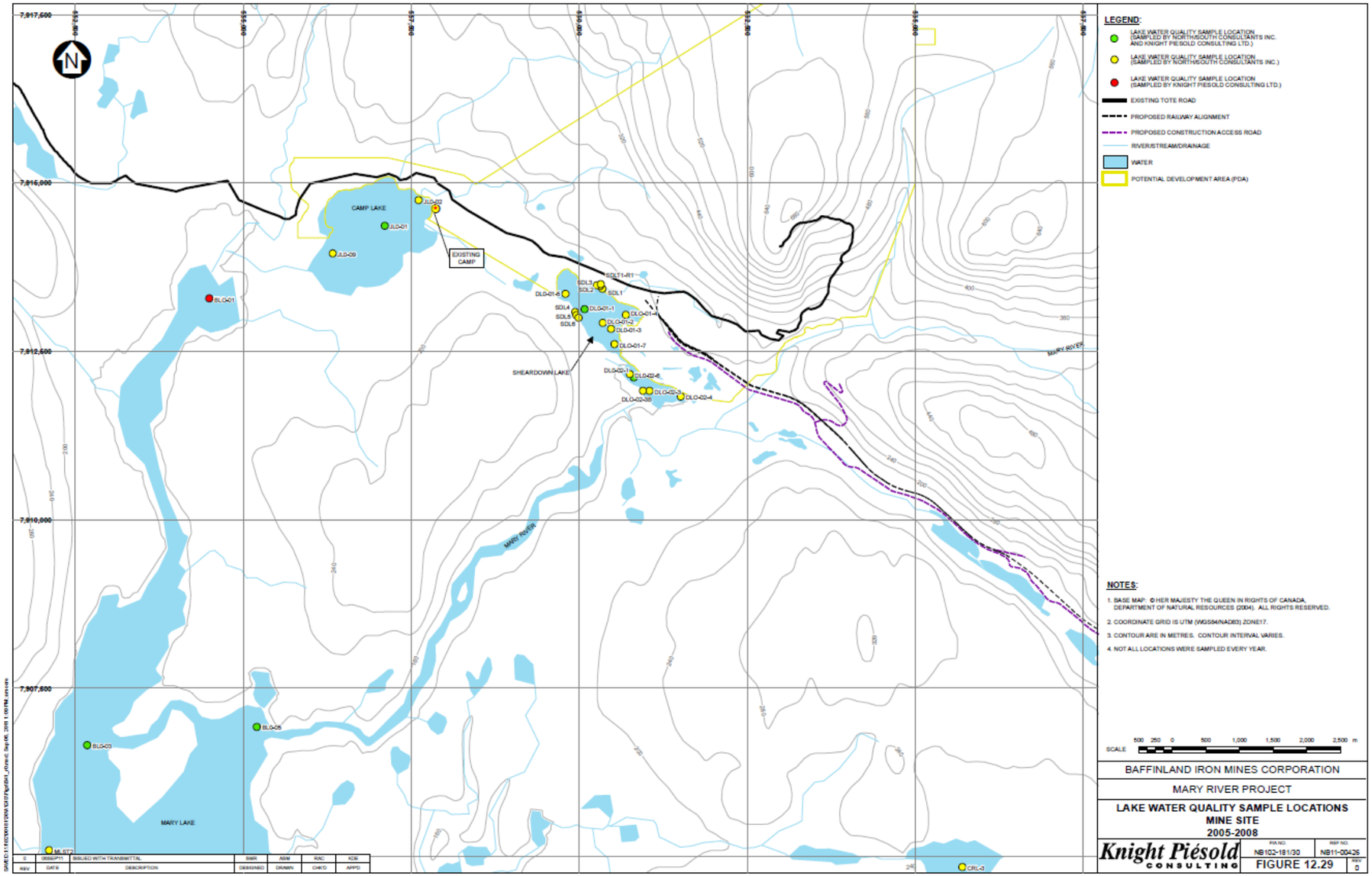


Figure 12-30: Lake Water Quality Sample Locations Mine Site 2005-2008 (KP Figure 12.29)

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

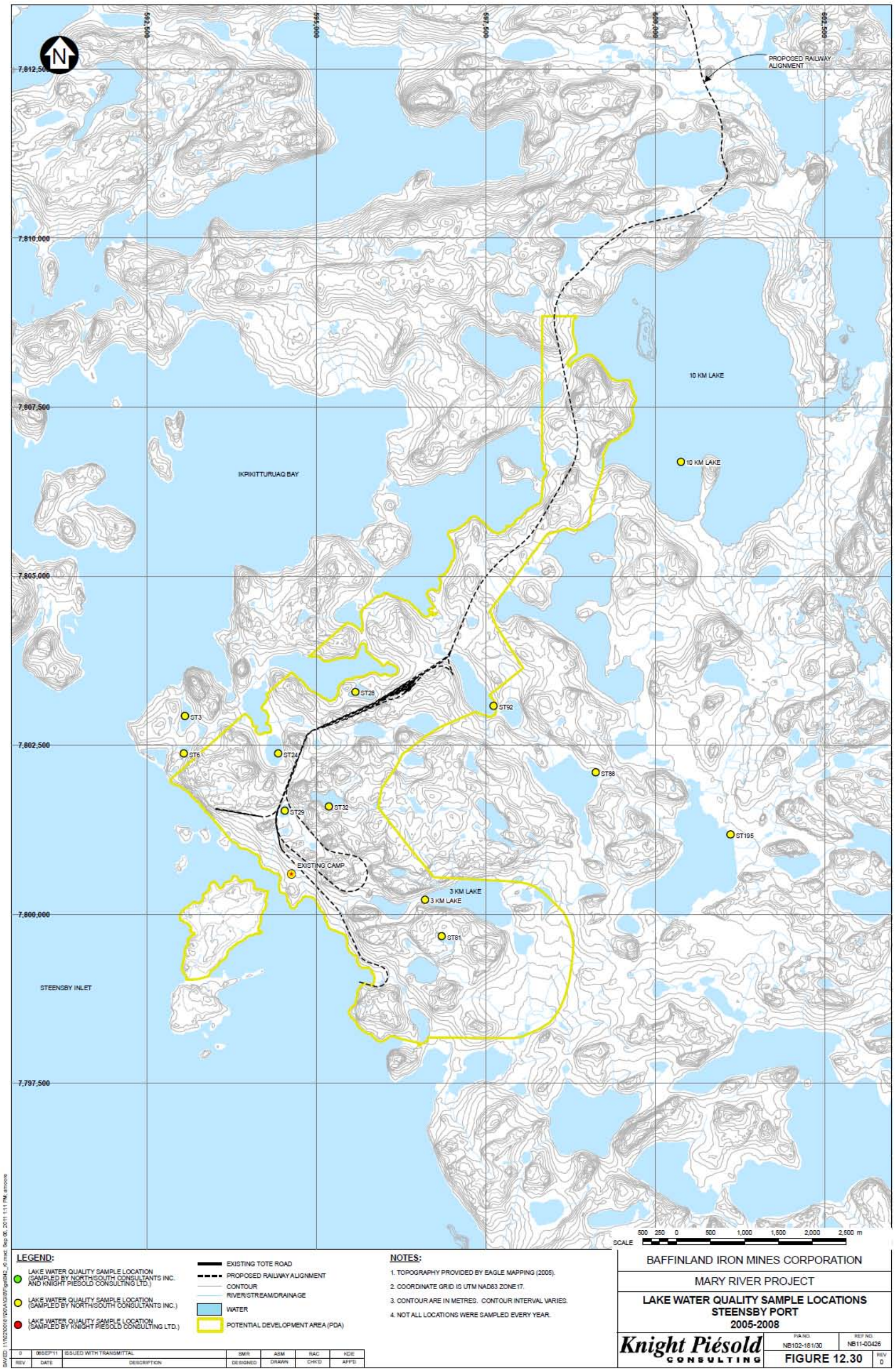


Figure 12-31: Lake Water Quality Sample Locations Steensby Port 2005-2008 (KP Figure 12.30)

© Hatch 2011/09

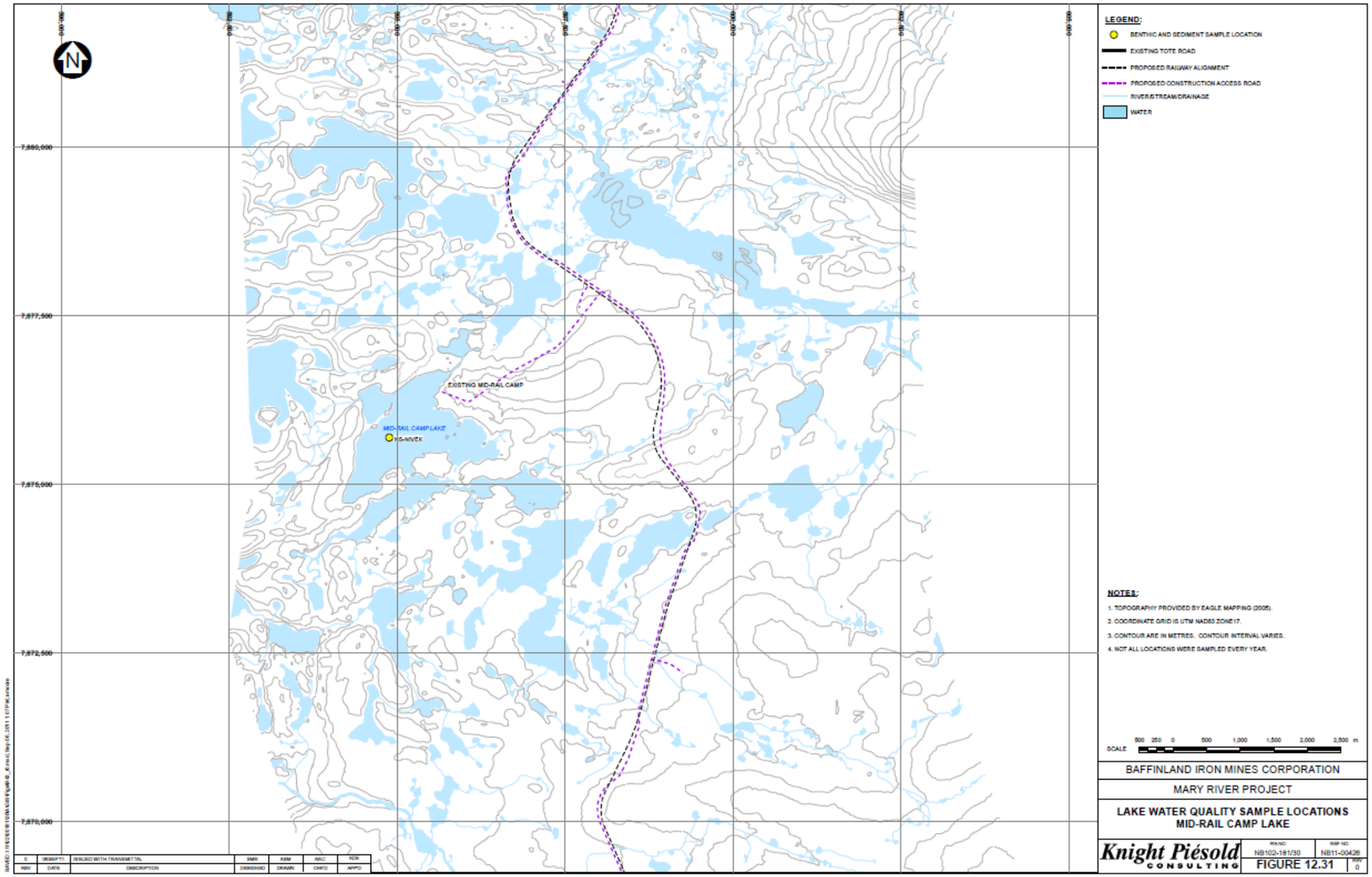


Figure 12-32: Lake Water Quality Sample Locations Mid-Rail Camp Lake (KP Figure 12.31)

© Hatch 2011/09

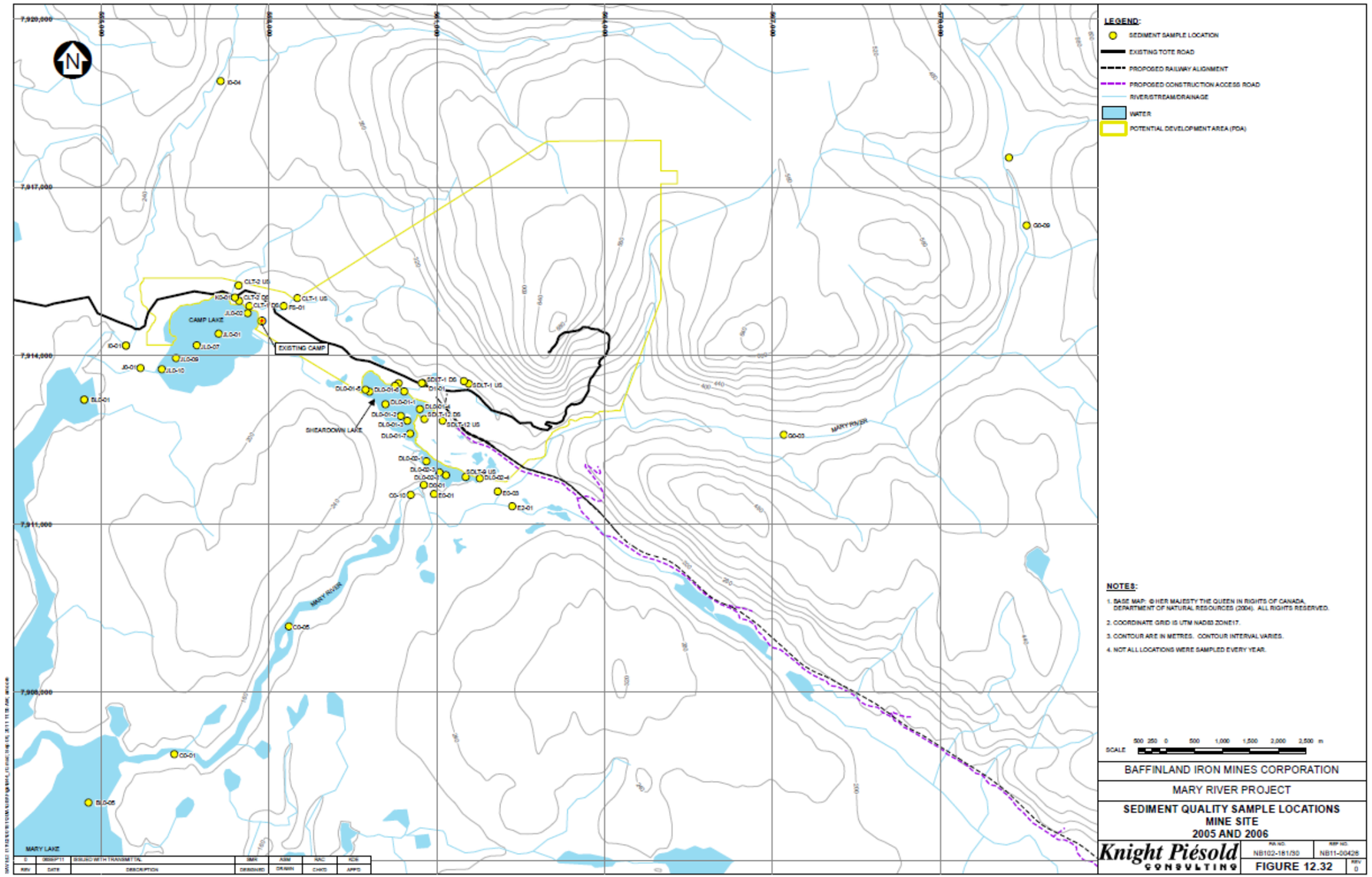


Figure 12-33: Sediment Quality Sample Locations Mine Site 2005 and 2006 (KP Figure 12.32)

© Hatch 2011/09

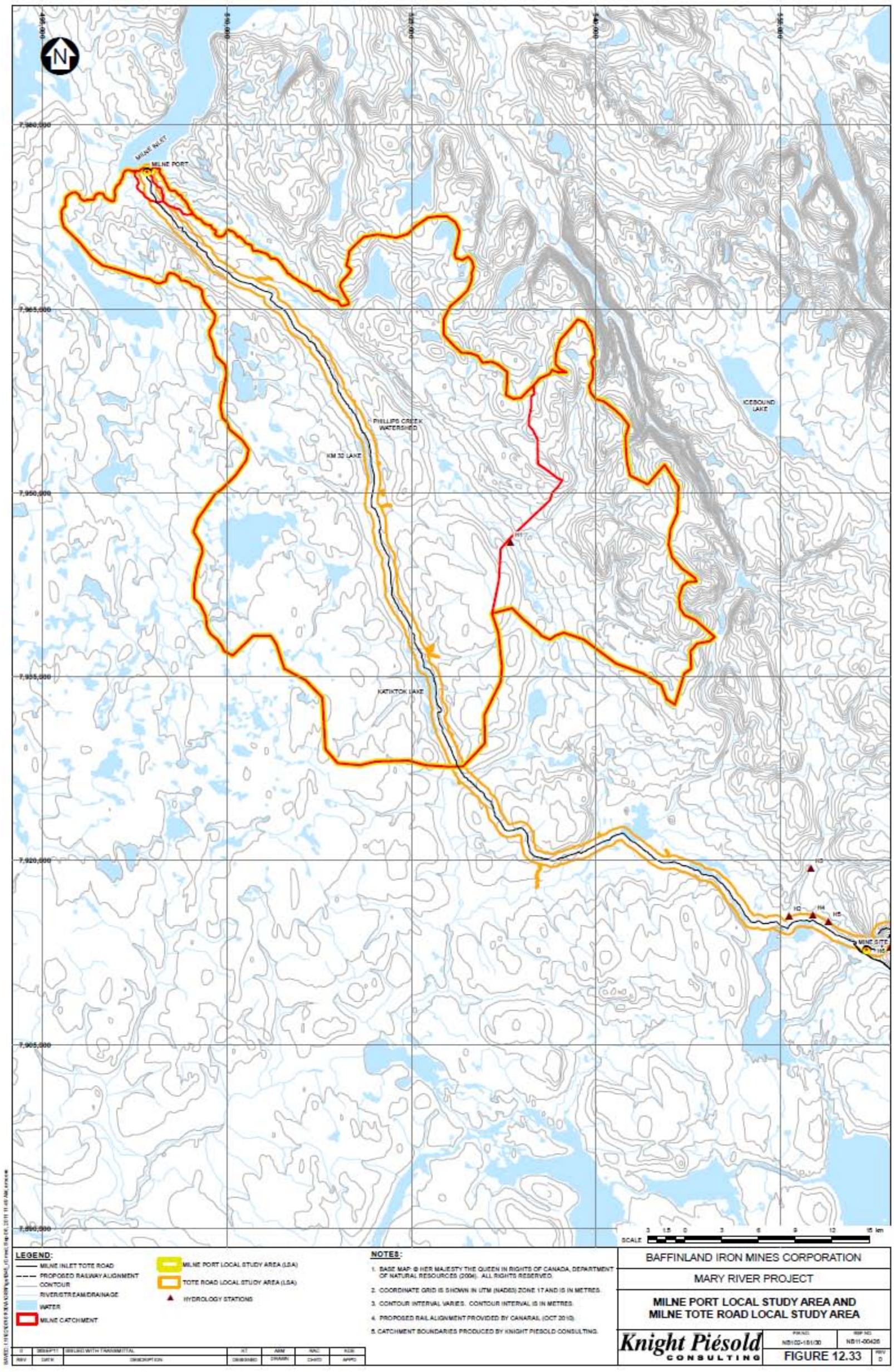


Figure 12-34: Milne Port Local Study Area and Milne Tote Road Local Study Area (KP Figure 12.33)

© Hatch 2011/09

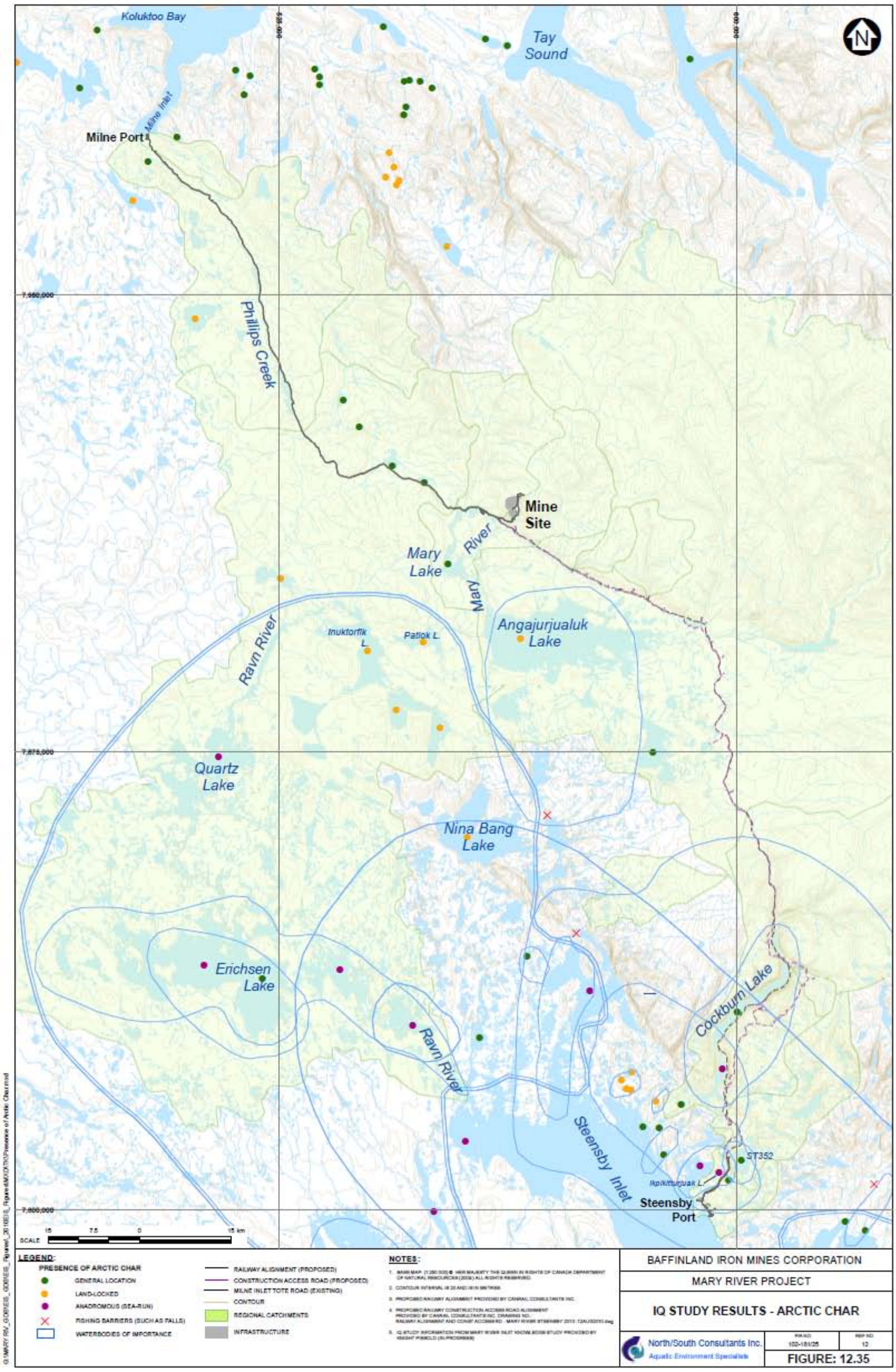


Figure 12-35: IQ Study Results – Arctic Char (KP Figure 12.35)

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

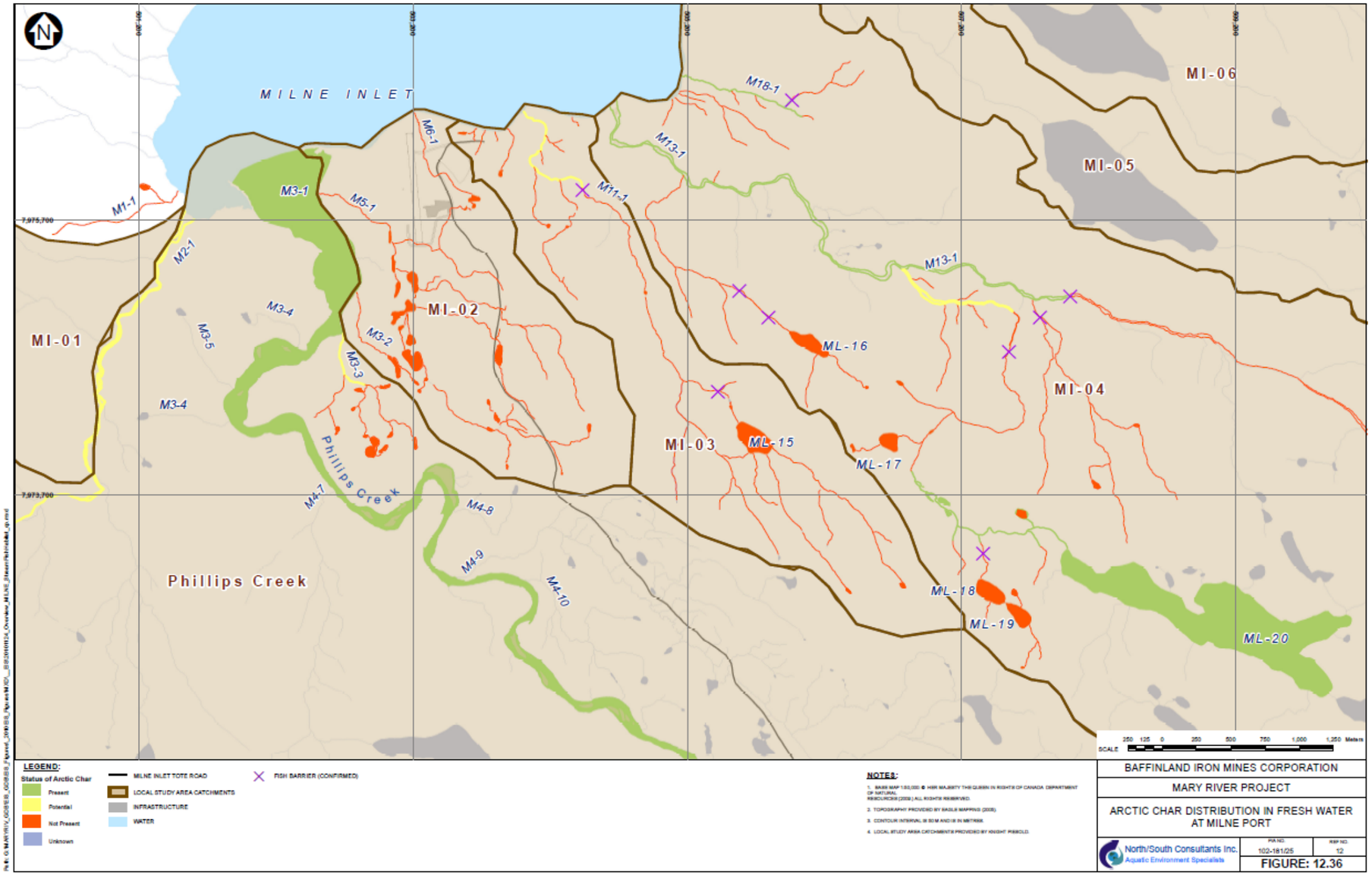


Figure 12-36: Arctice Char Distribution in Fresh Water at Milne Port (KP Figure 12.36)

© Hatch 2011/09

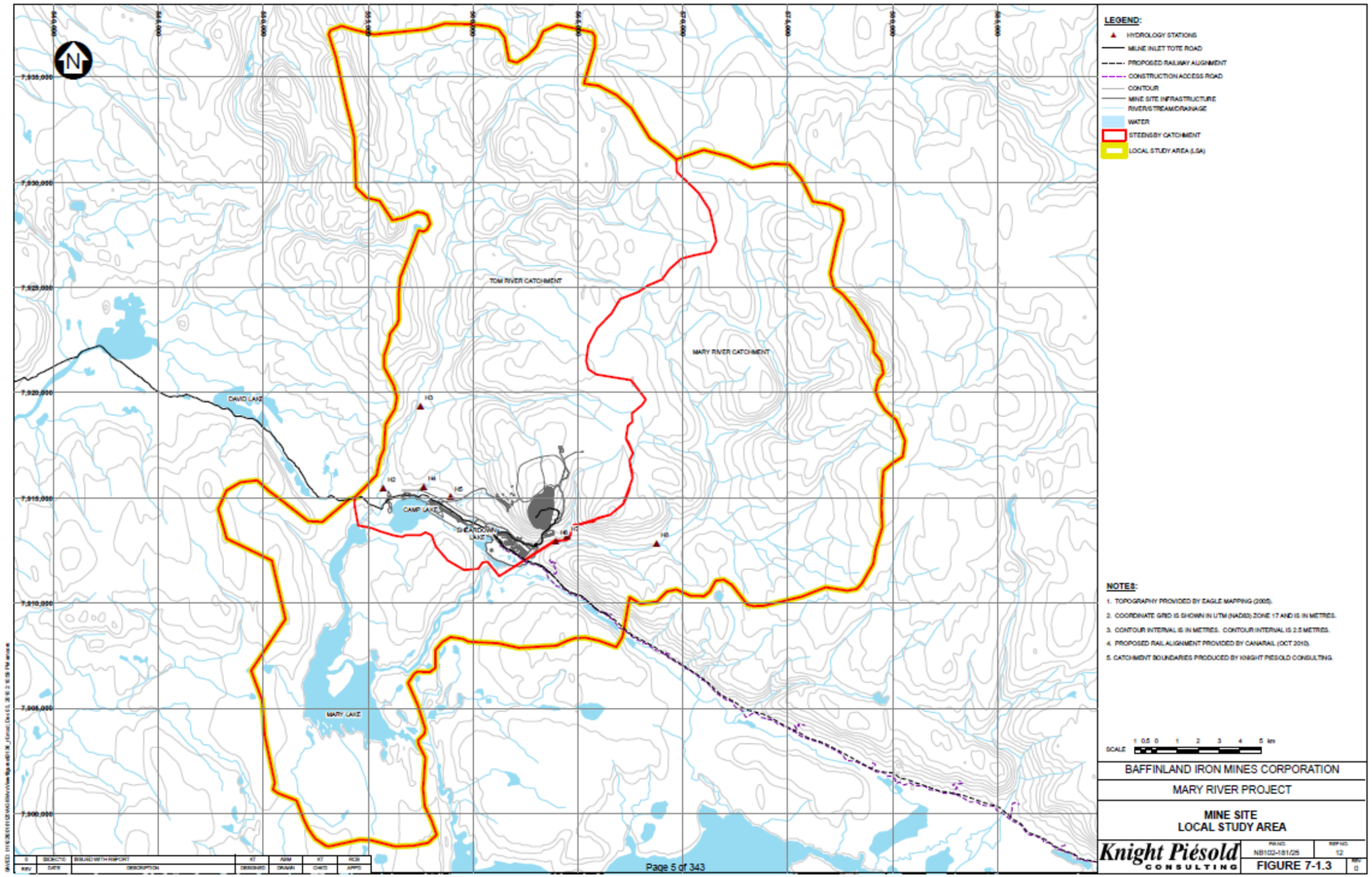


Figure 12-37: Mine Site Local Study Area (KP Figure 7-1.3)

© Hatch 2011/09

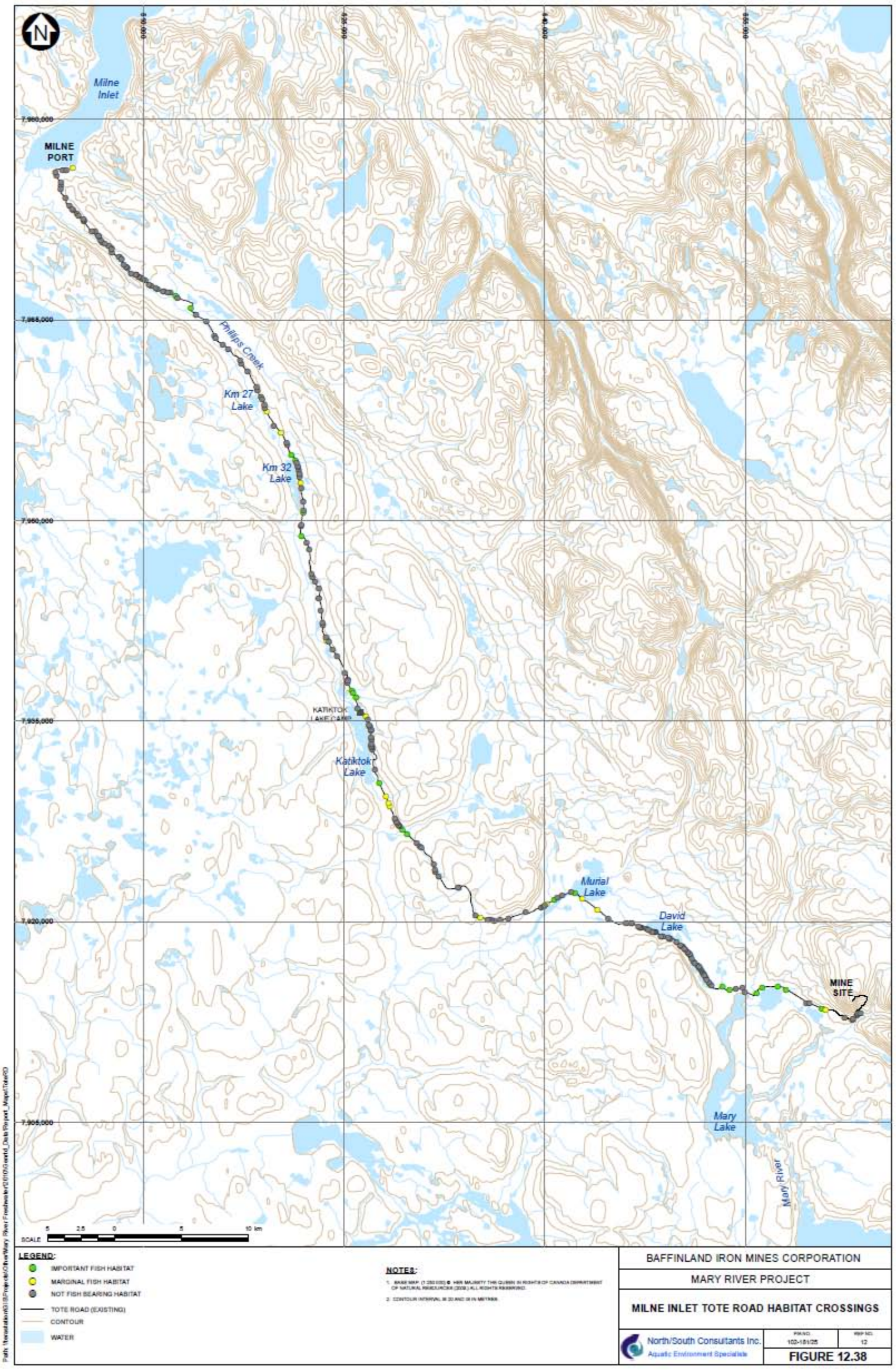


Figure 12-38: Milne Inlet Tote Road Habitat Crossings

© Hatch 2011/09

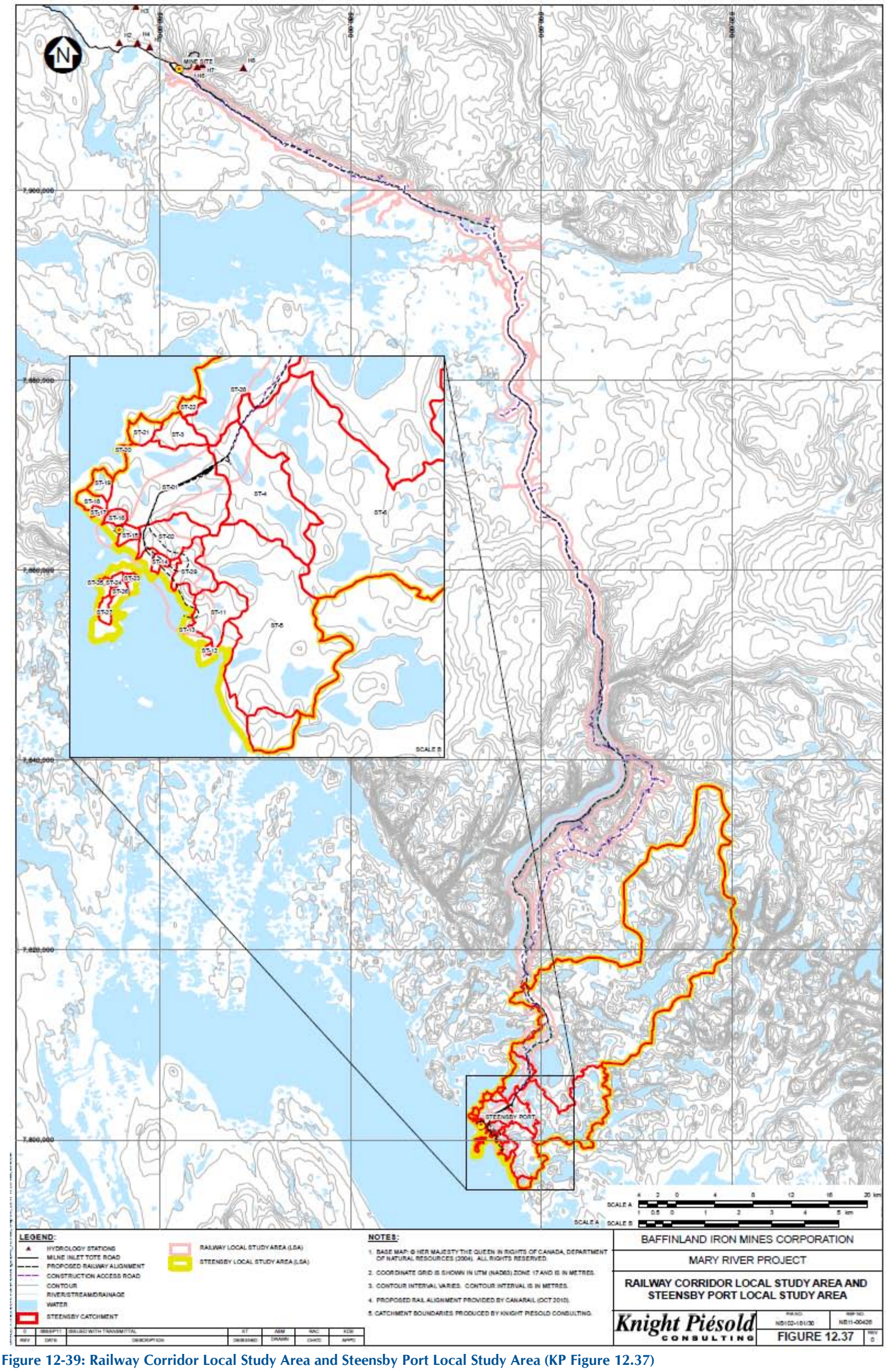


Figure 12-39: Railway Corridor Local Study Area and Steensby Port Local Study Area (KP Figure 12.37)

© Hatch 2011/09

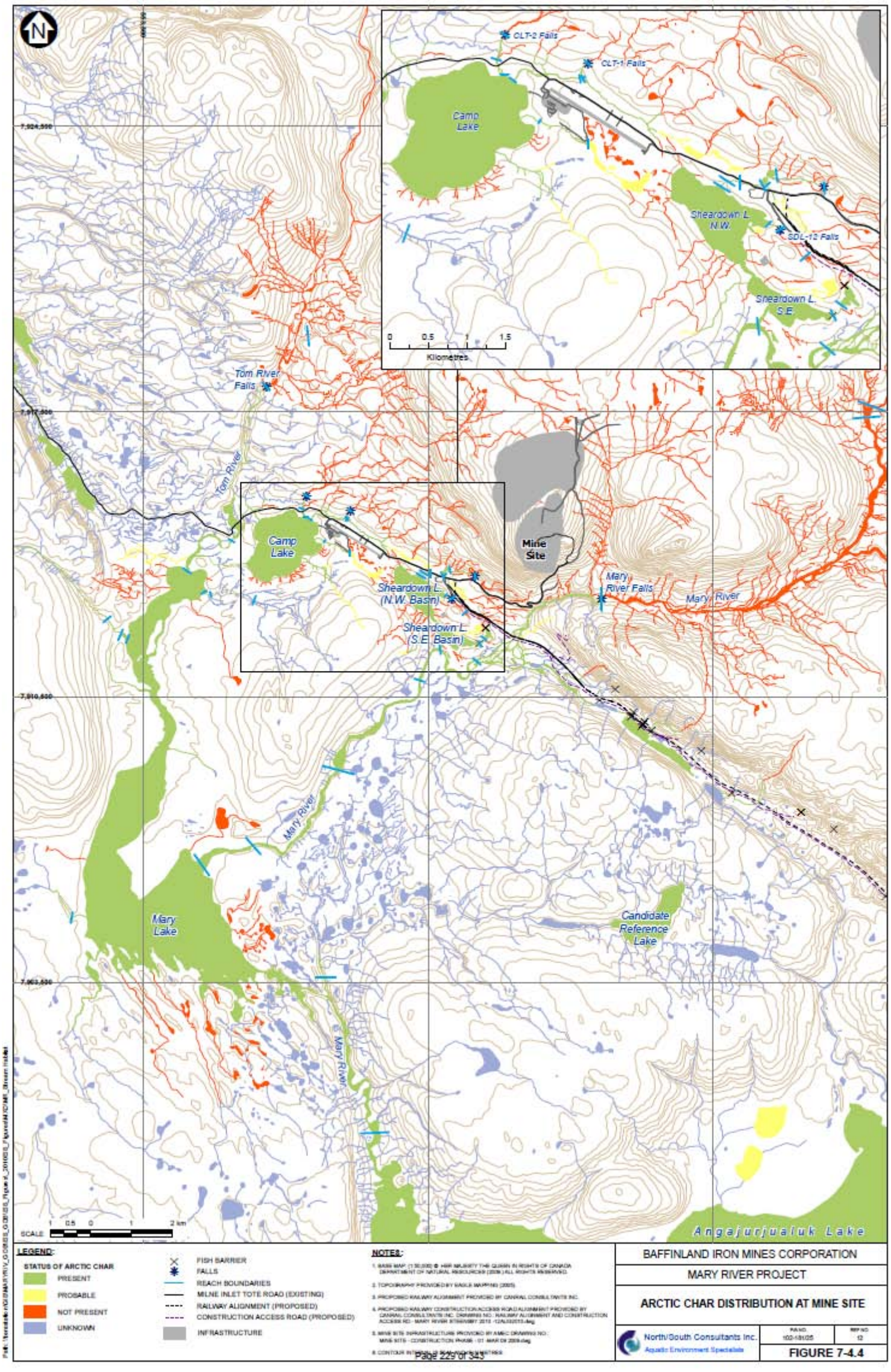


Figure 12-40: Arctic Char Distribution at Mine Site (KP Figure 7-4.4)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

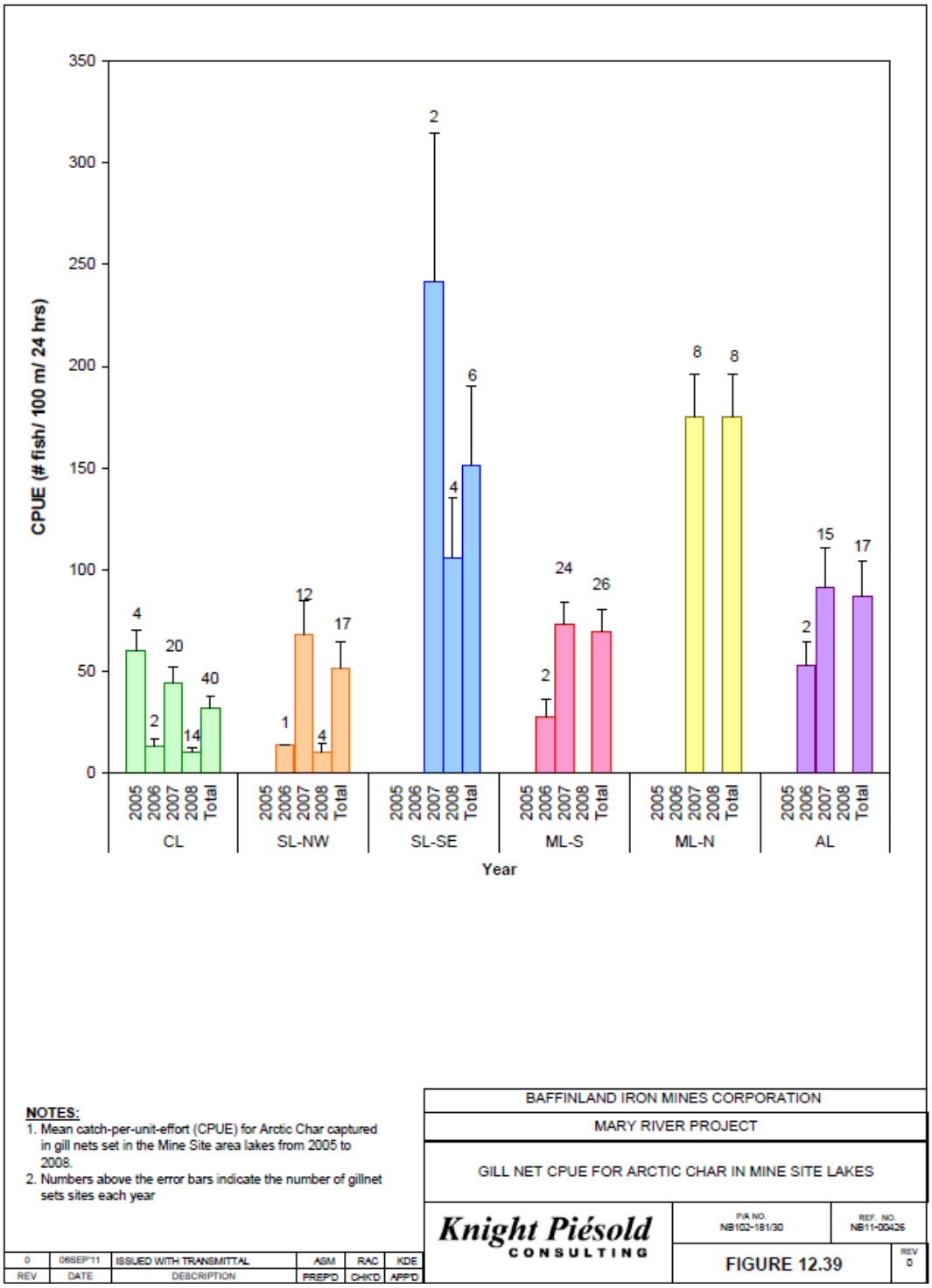


Figure 12-41: Gill Net CPUE for Arctic Char in Mine Site Lakes

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

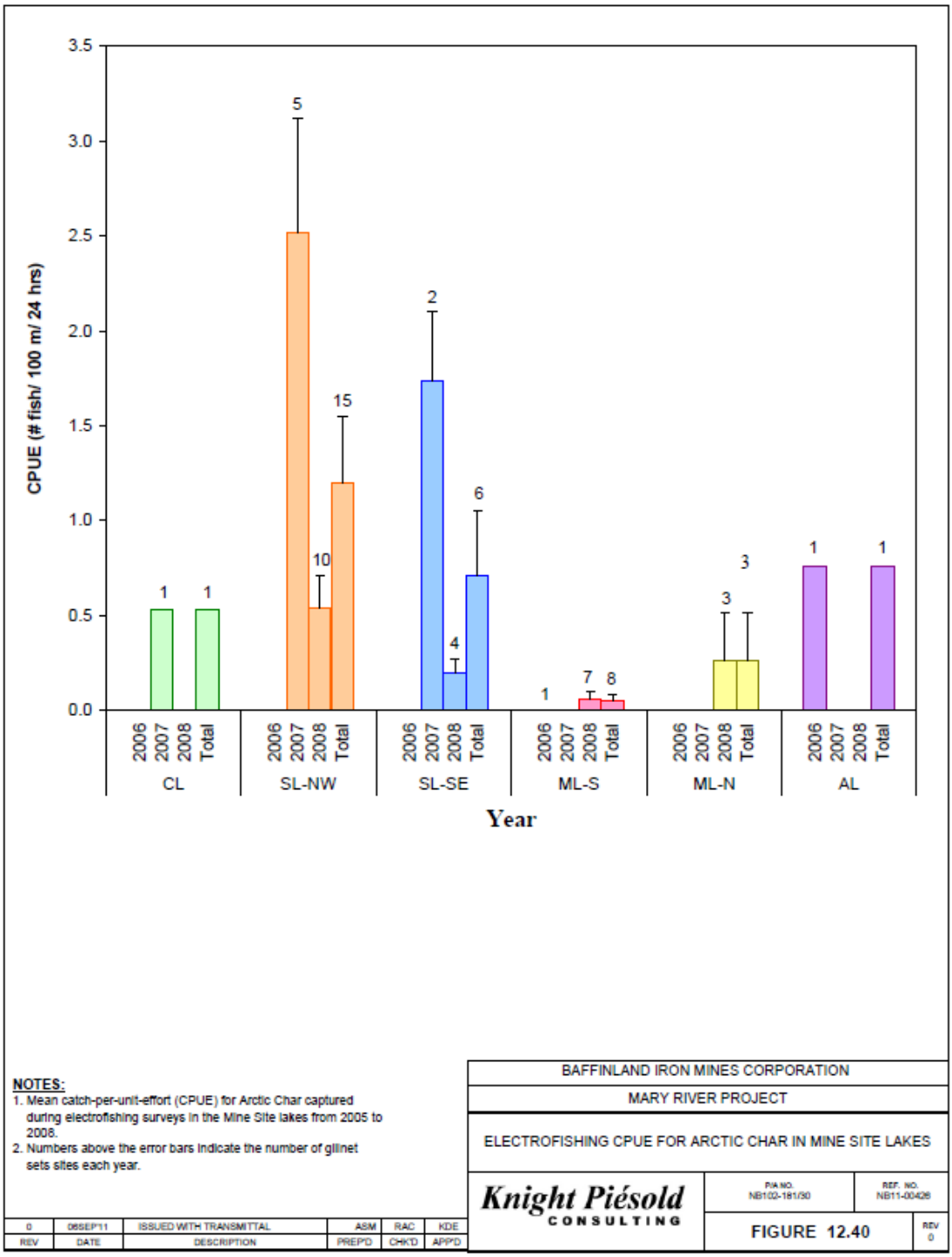
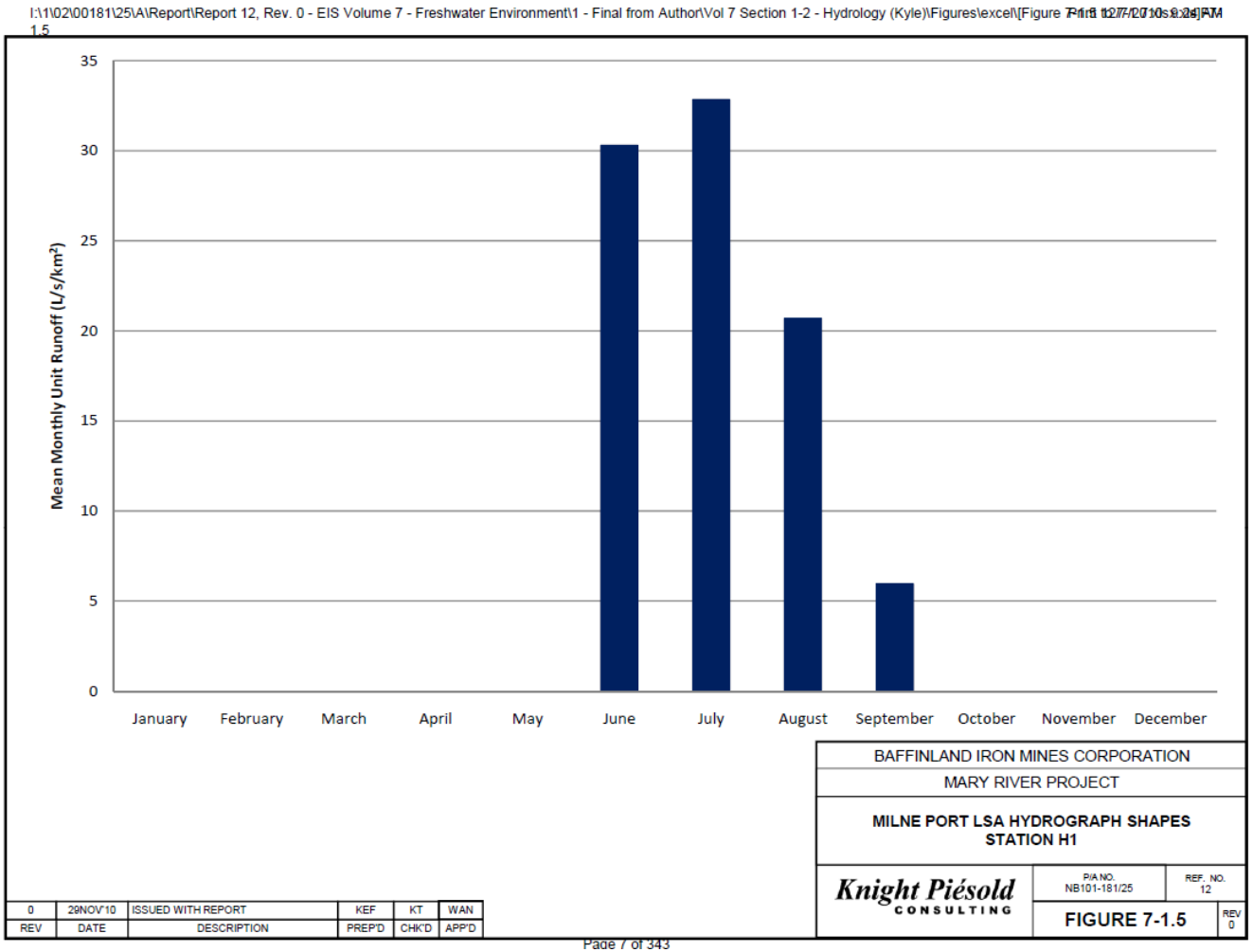


Figure 12-42: Electrofishing CPUE for Arctic Char in Mine Site Lakes

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation



Page 7 of 343

Figure 12-43: Milne Port LSA Hydrograph Shapes Station H1 (KP Figure 7-1.5)

© Hatch 2011/09

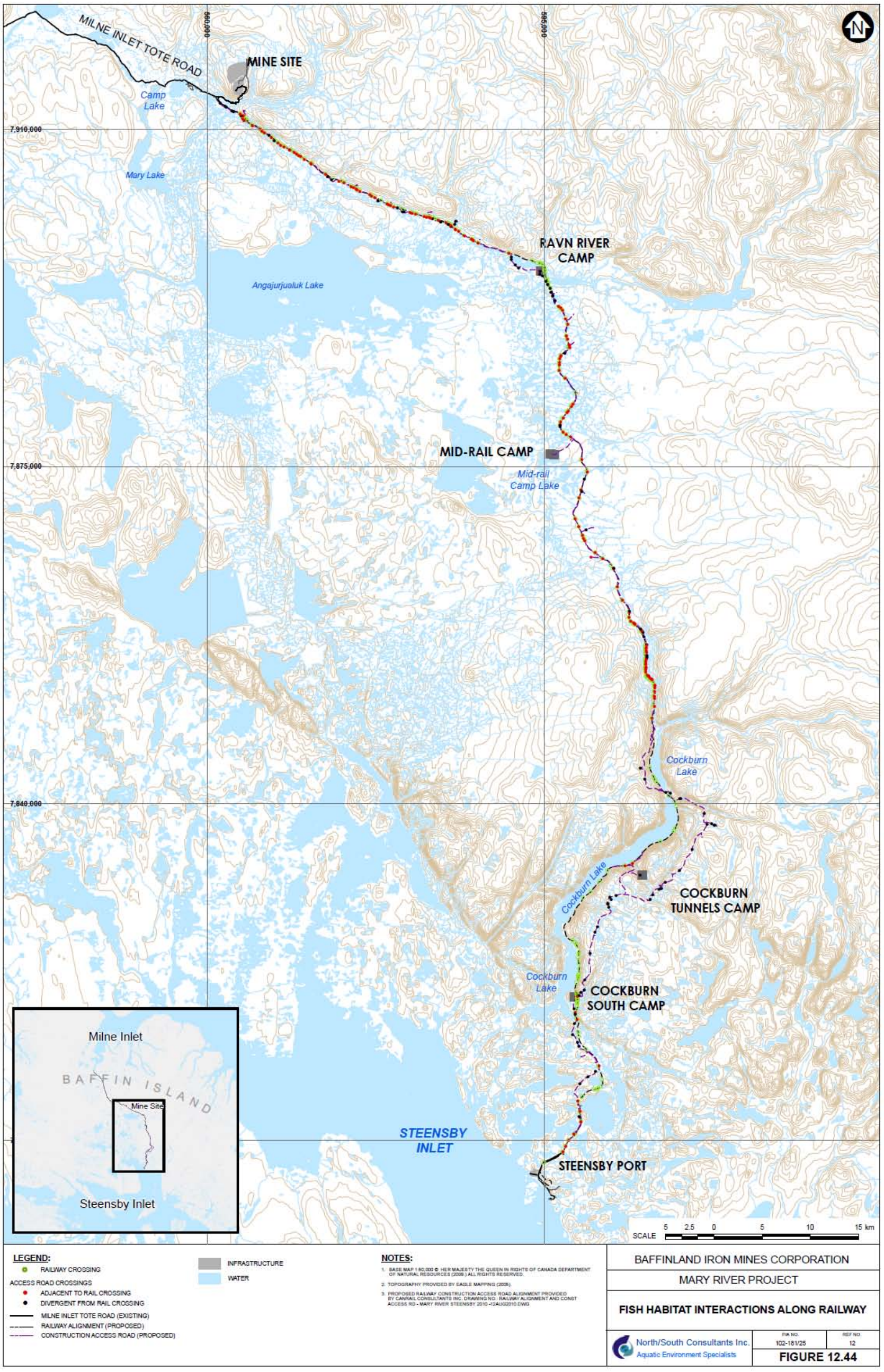


Figure 12-44: Fish Habitat Interactions Along Railway

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

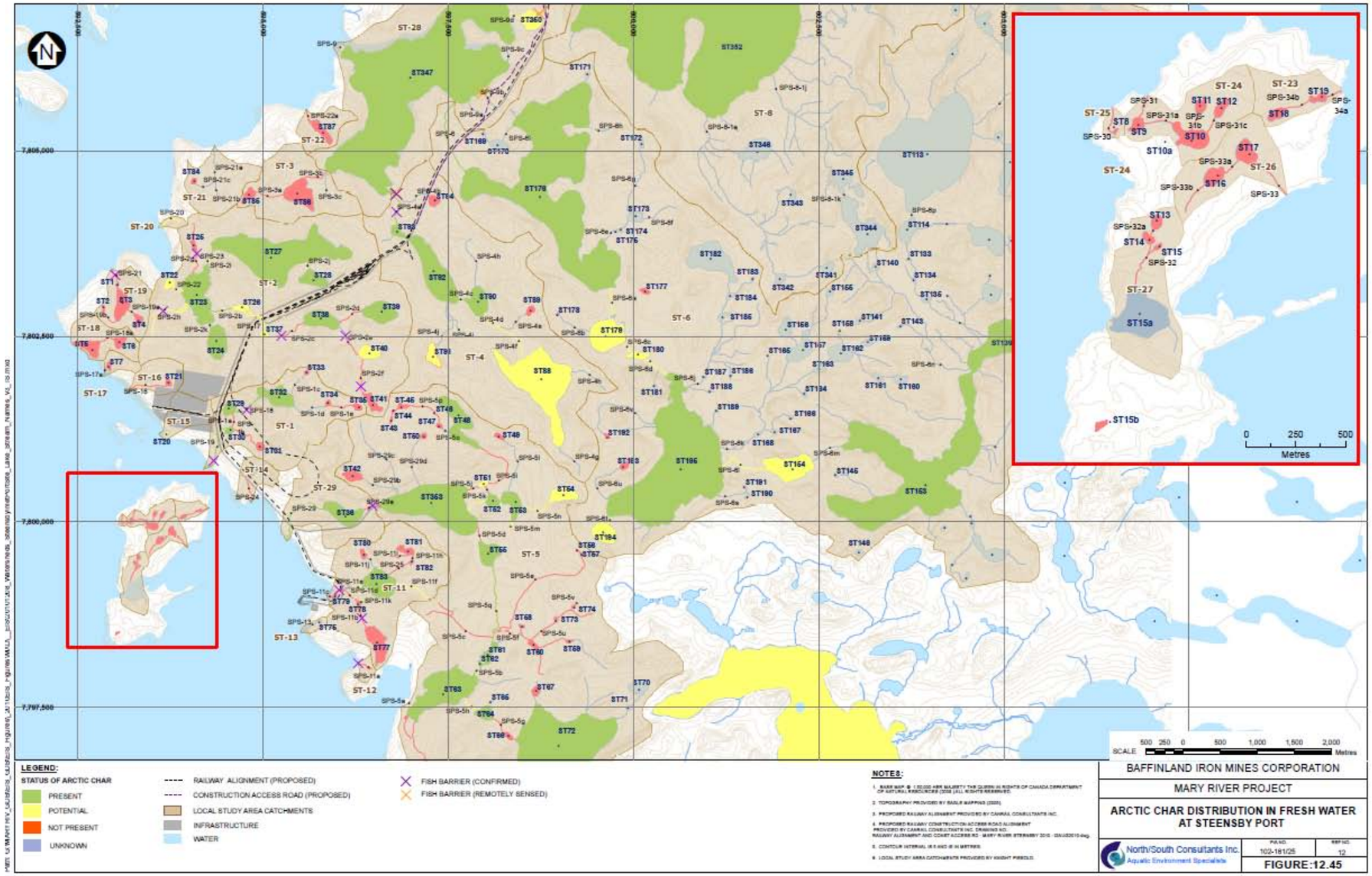


Figure 12-45: Arctic Char Distribution in Freshwater at Steensby Port

© Hatch 2011/09

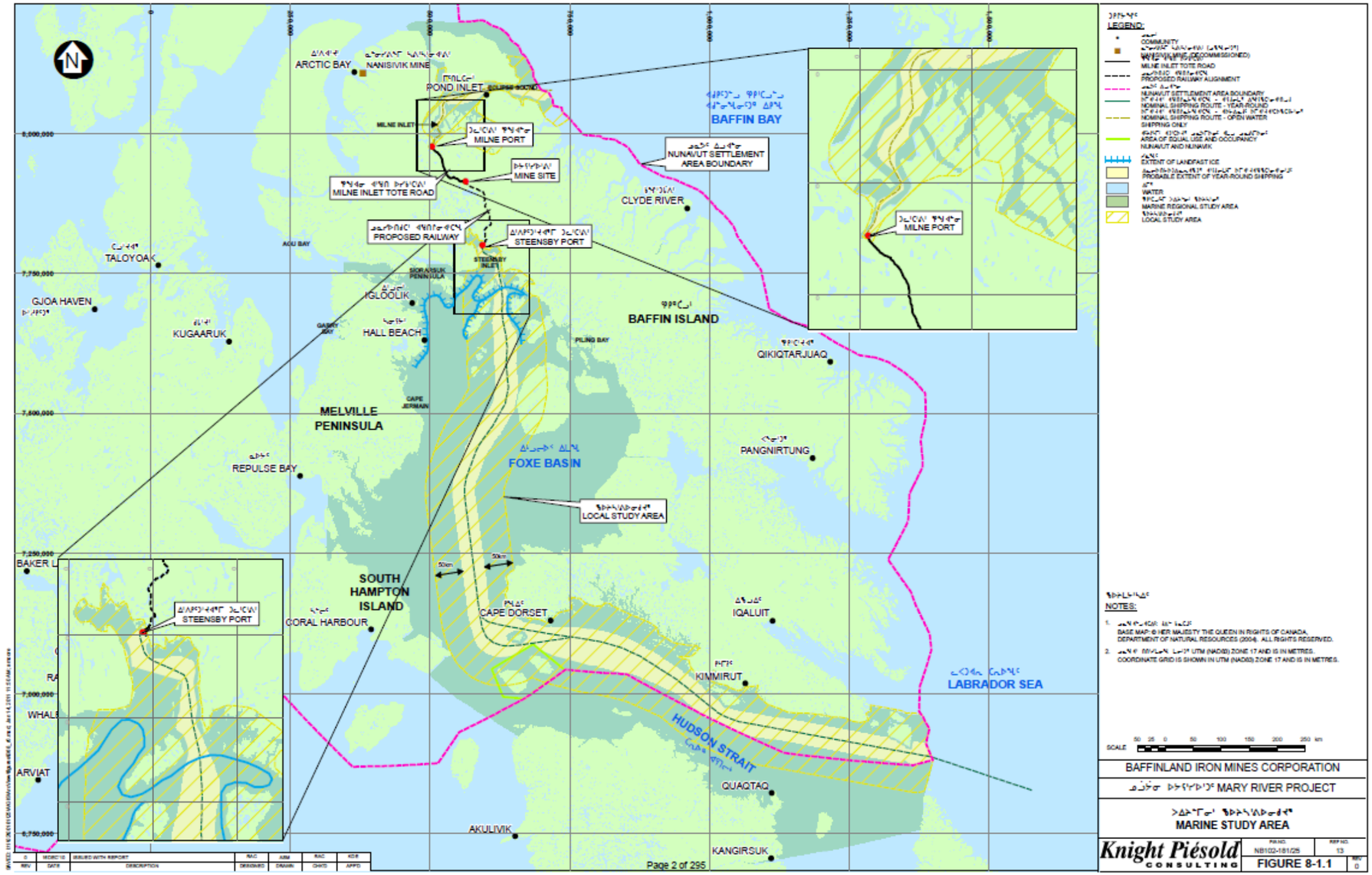


Figure 12-46: Marine Study Area (KP Figure 8-1.1)

© Hatch 2011/09

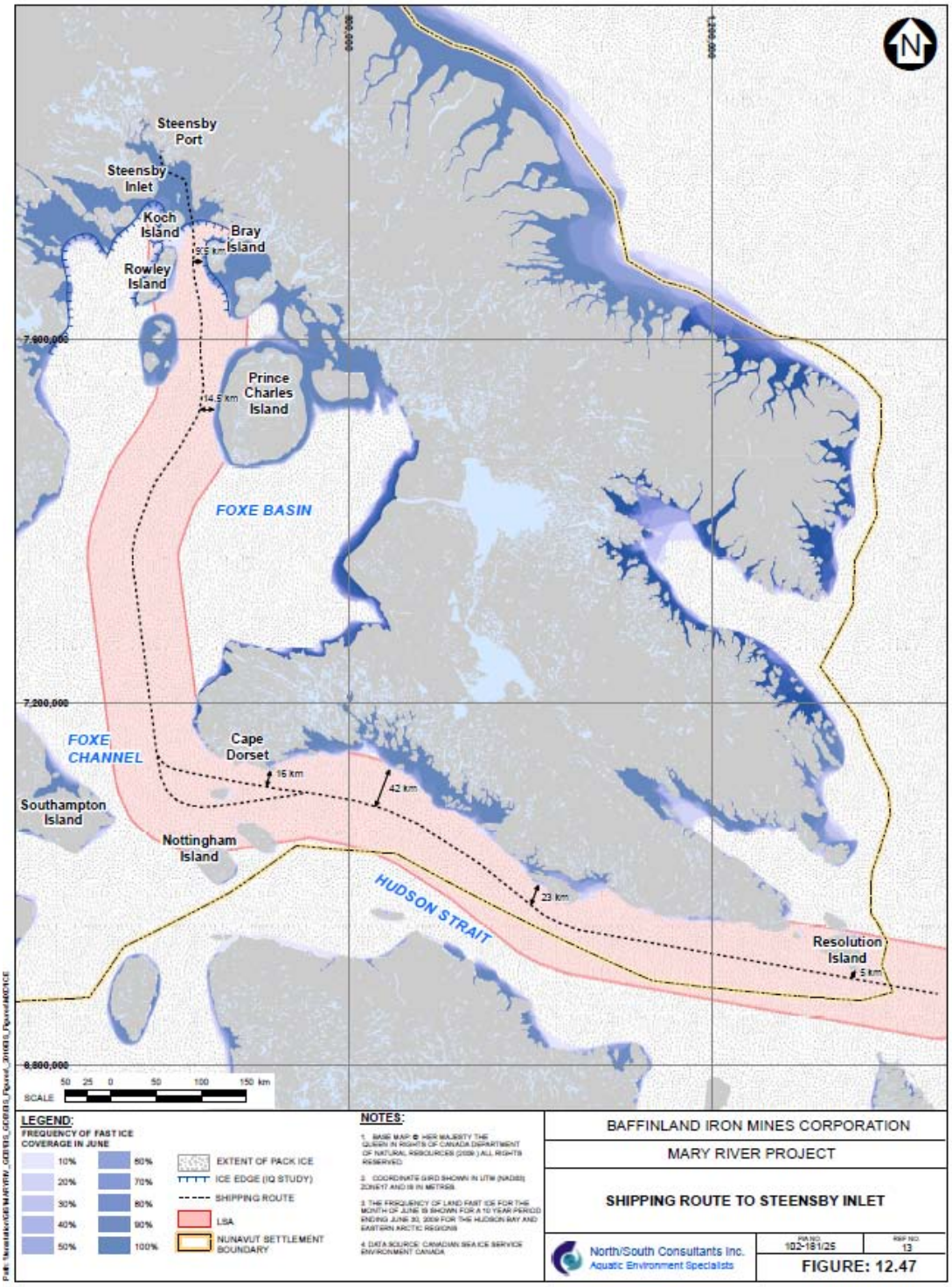


Figure 12-47: Shipping Route to Steensby Inlet

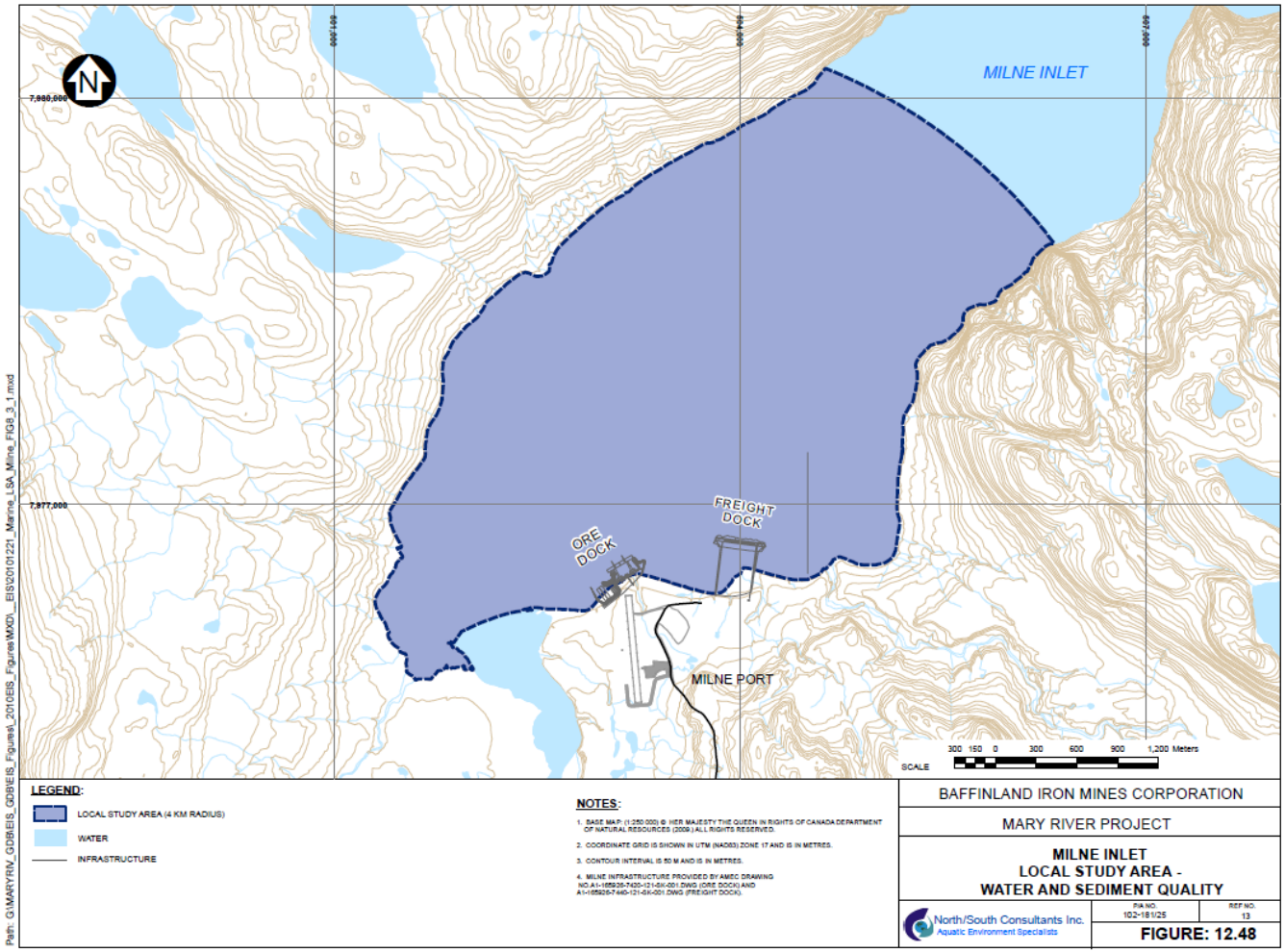


Figure 12-48: Milne Inlet Local Study Area – Water and Sediment Quality

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

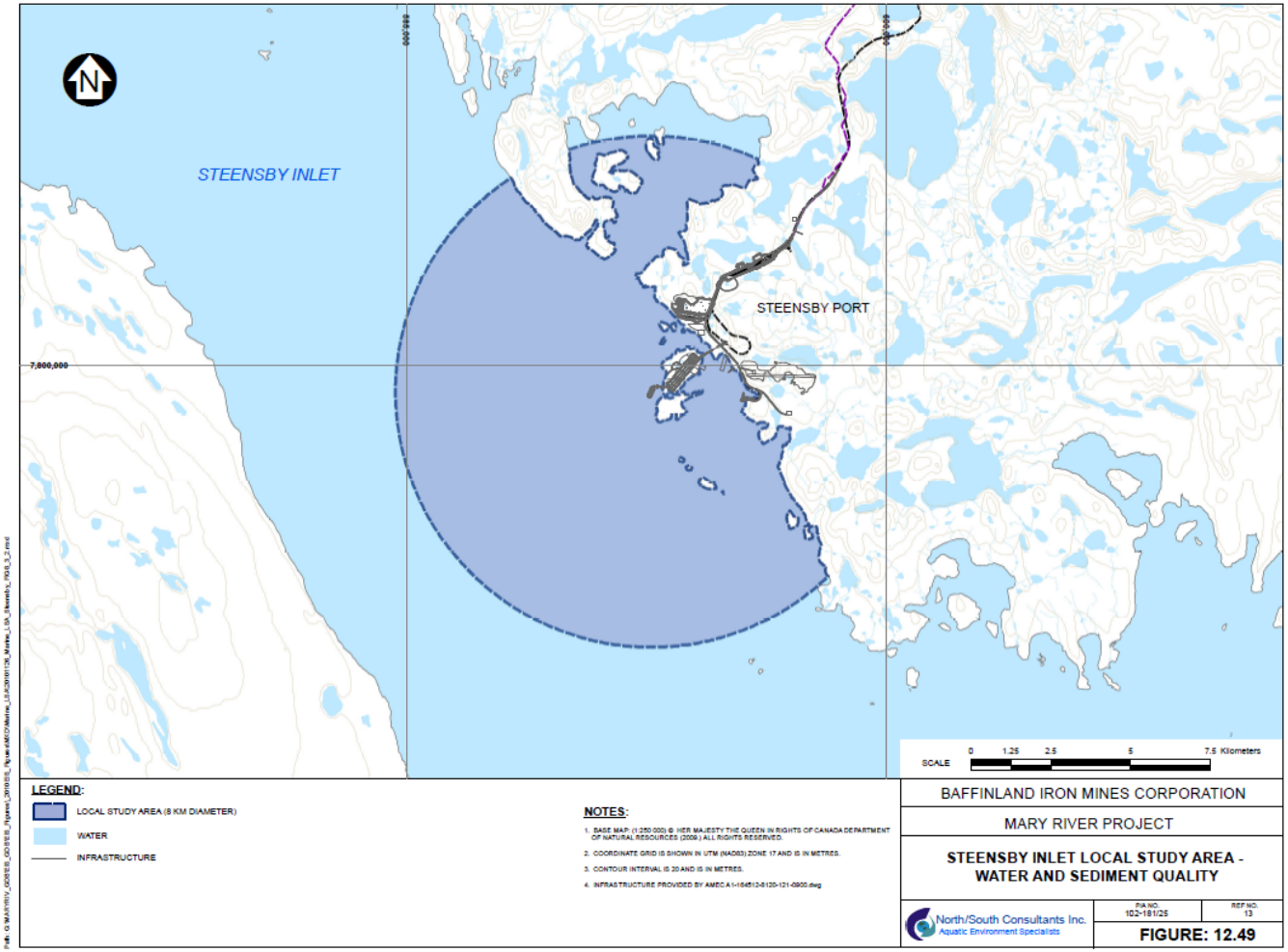


Figure 12-49: Steensby Inlet Local Study Area – Water and Sediment Quality

© Hatch 2011/09

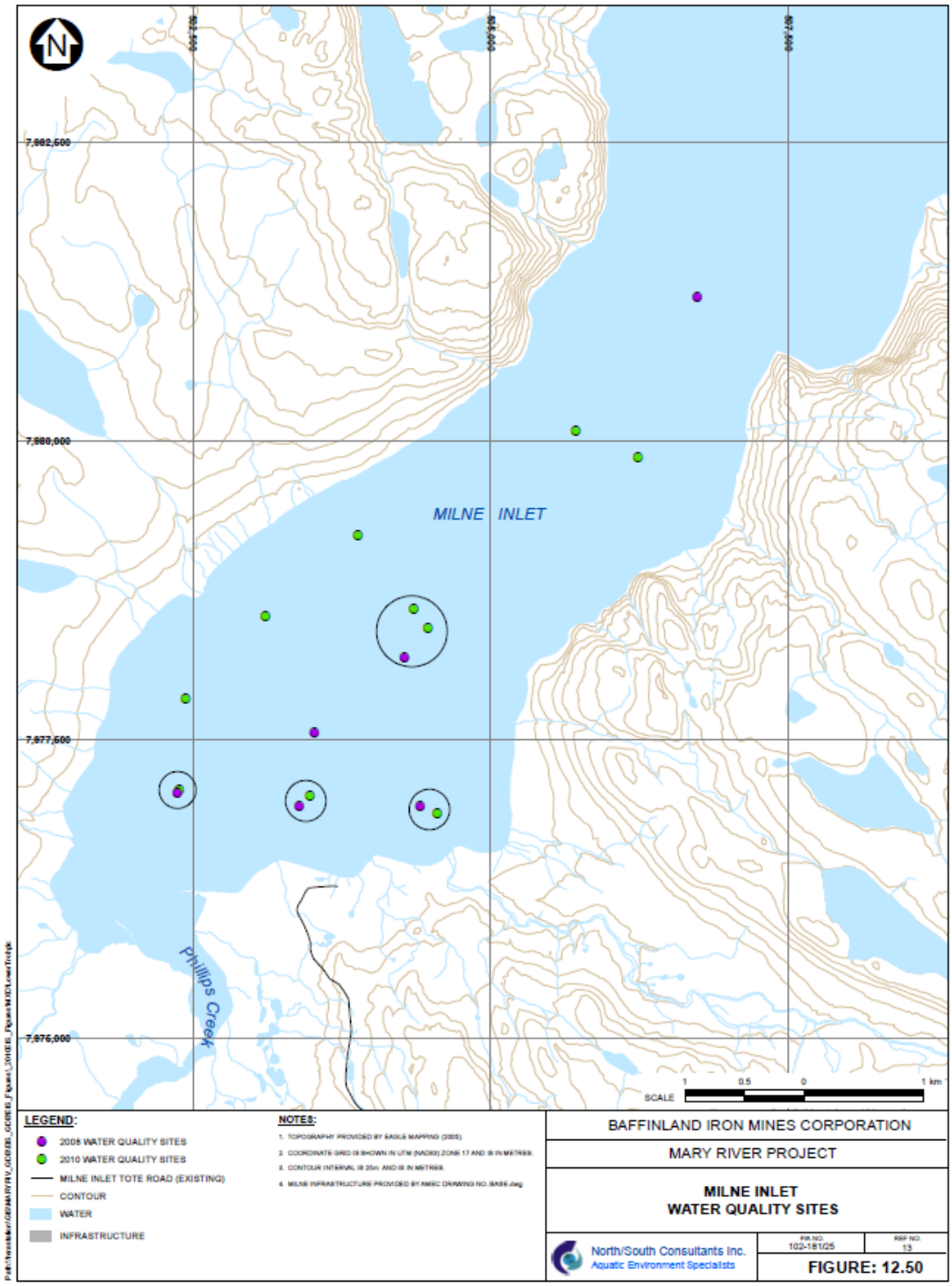


Figure 12-50: Milne Inlet Water Quality Sites

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

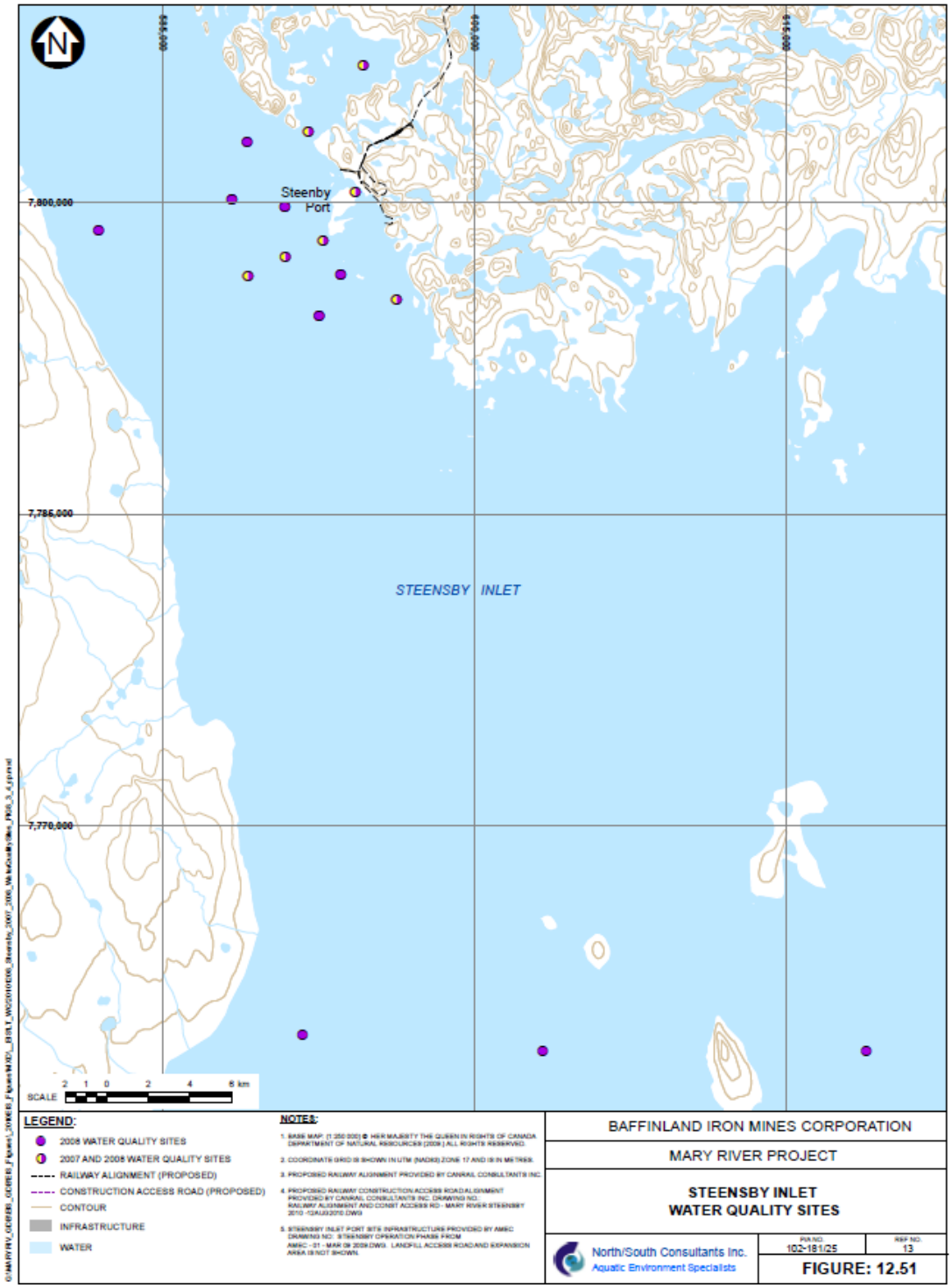


Figure 12-51: Steensby Inlet Water Quality Sites

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

I:\1\02\00181\29\A\Report\Report 13, Rev. 0 - EIS Volume 8 - Marine Environment\4 - Editorial Review Complete\Finalized Documents from Warren Jan 10 2011\[V8_Sec3_Tables_Figures_07Jan.xls]Figure 8-3.5 Print 17/01/2011 9:2

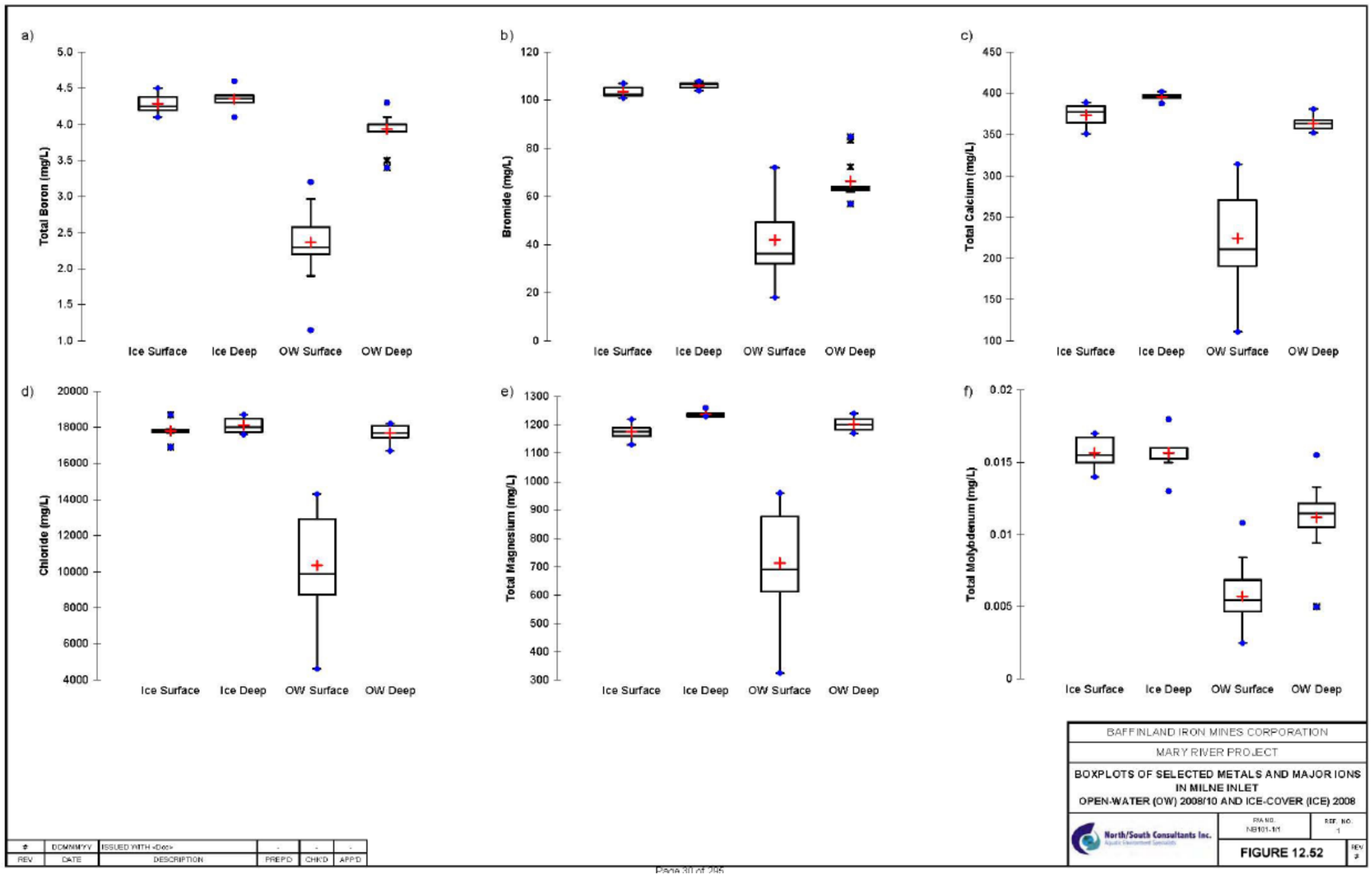


Figure 12-52: Boxplots of Selected Metals and Major Ions in Milne Inlet Open Water (OW) 2008/10 and Ice Cover (ICE) 2008

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

I:\1\02\00181\25\A\Report\Report 13, Rev. 0 - EIS Volume 8 - Marine Environment\4 - Editorial Review Complete\Finalized Documents from Warren Jan 10 2011\[V8_Sec3_Tables_Figures_07Jan.xls.xls]Figure 8-3.6

Print 17/01/2011 9:26

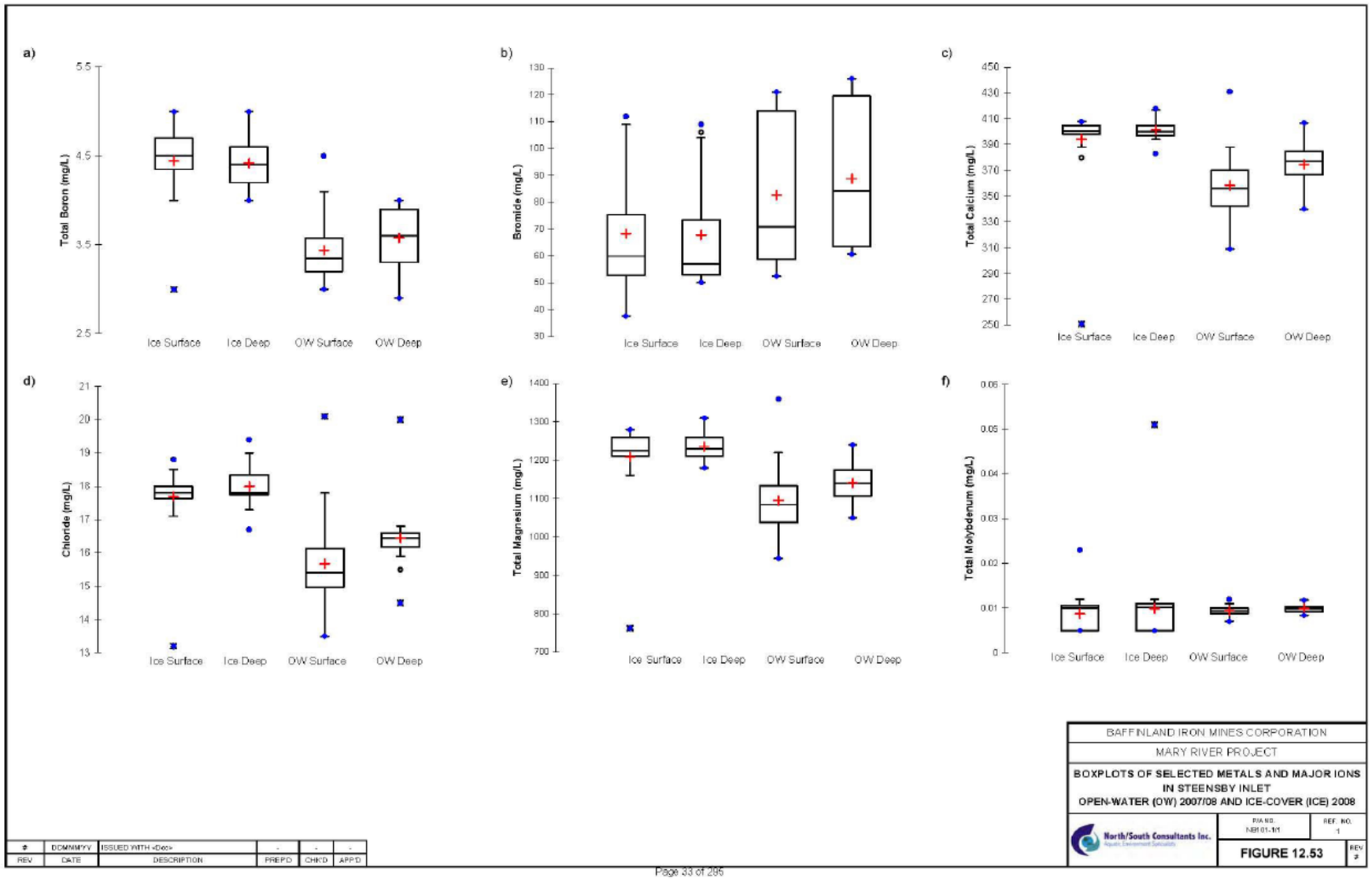


Figure 12-53: Boxplots of Selected Metals and Major Ions in Steensby Inlet Open Water (OW) 2007/08 and Ice Cover (ICE) 2008

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

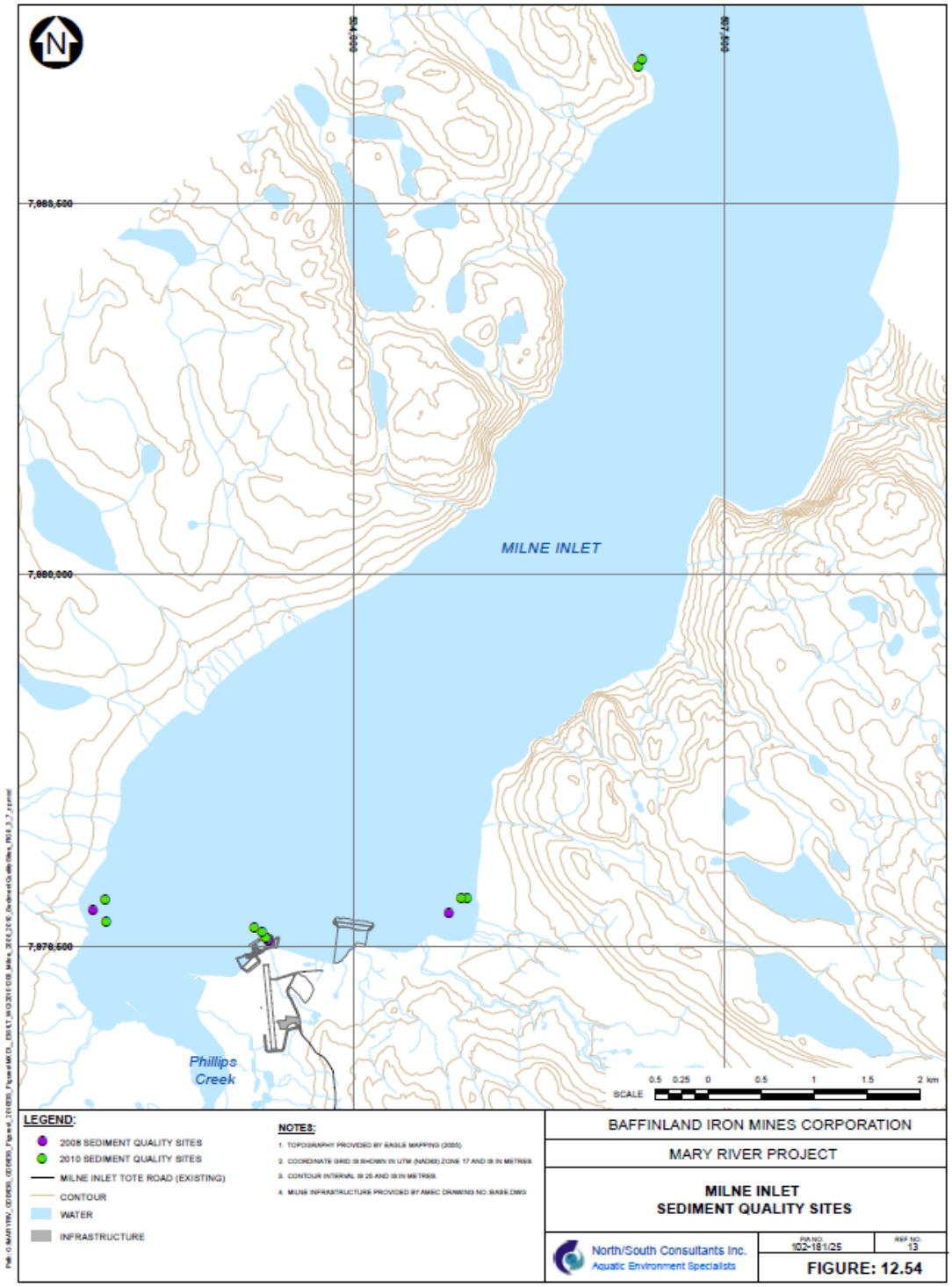


Figure 12-54: Milne Inlet Sediment Quality Sites

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

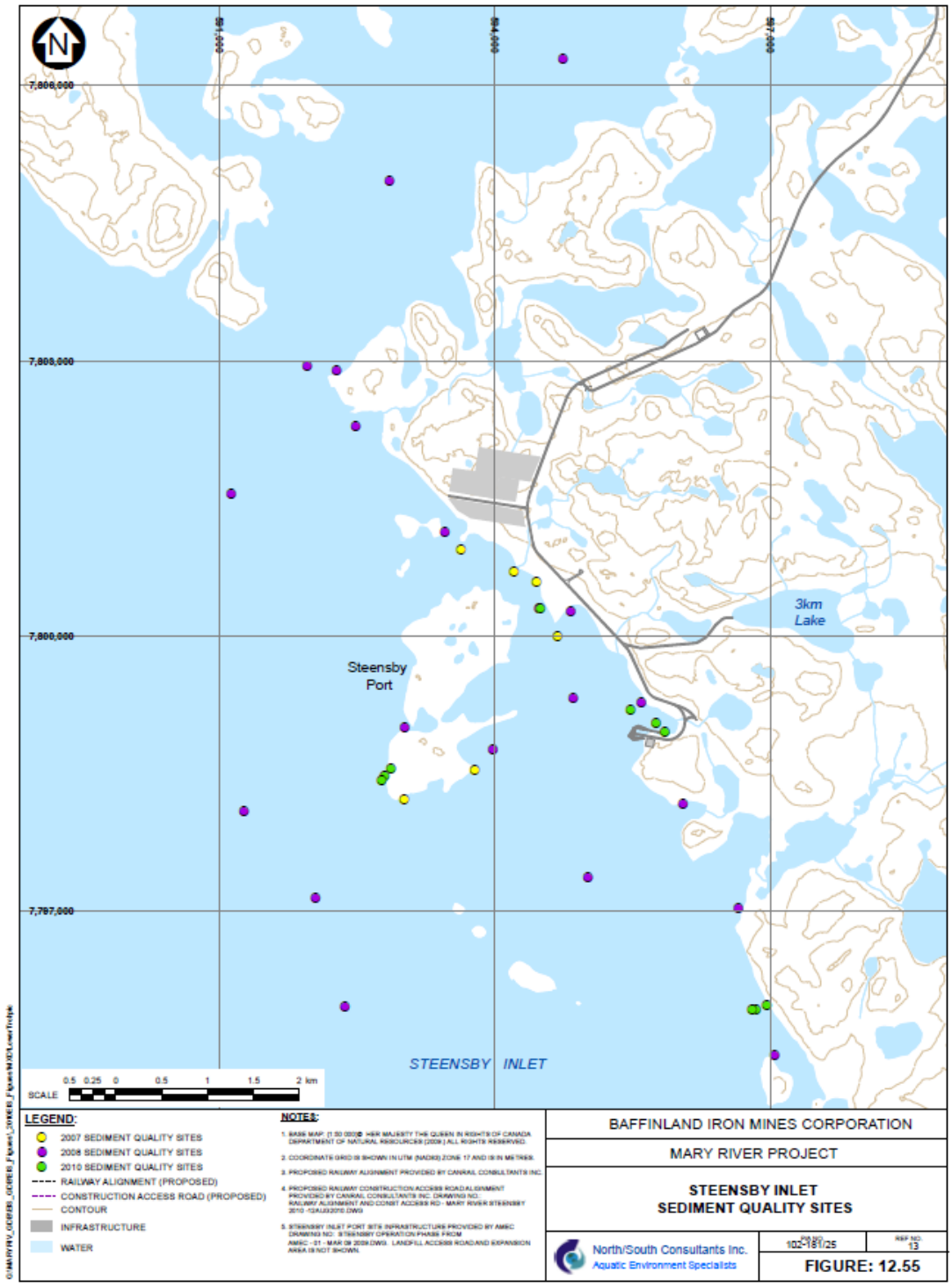


Figure 12-55: Steensby Inlet Sediment Quality Sites

© Hatch 2011/09

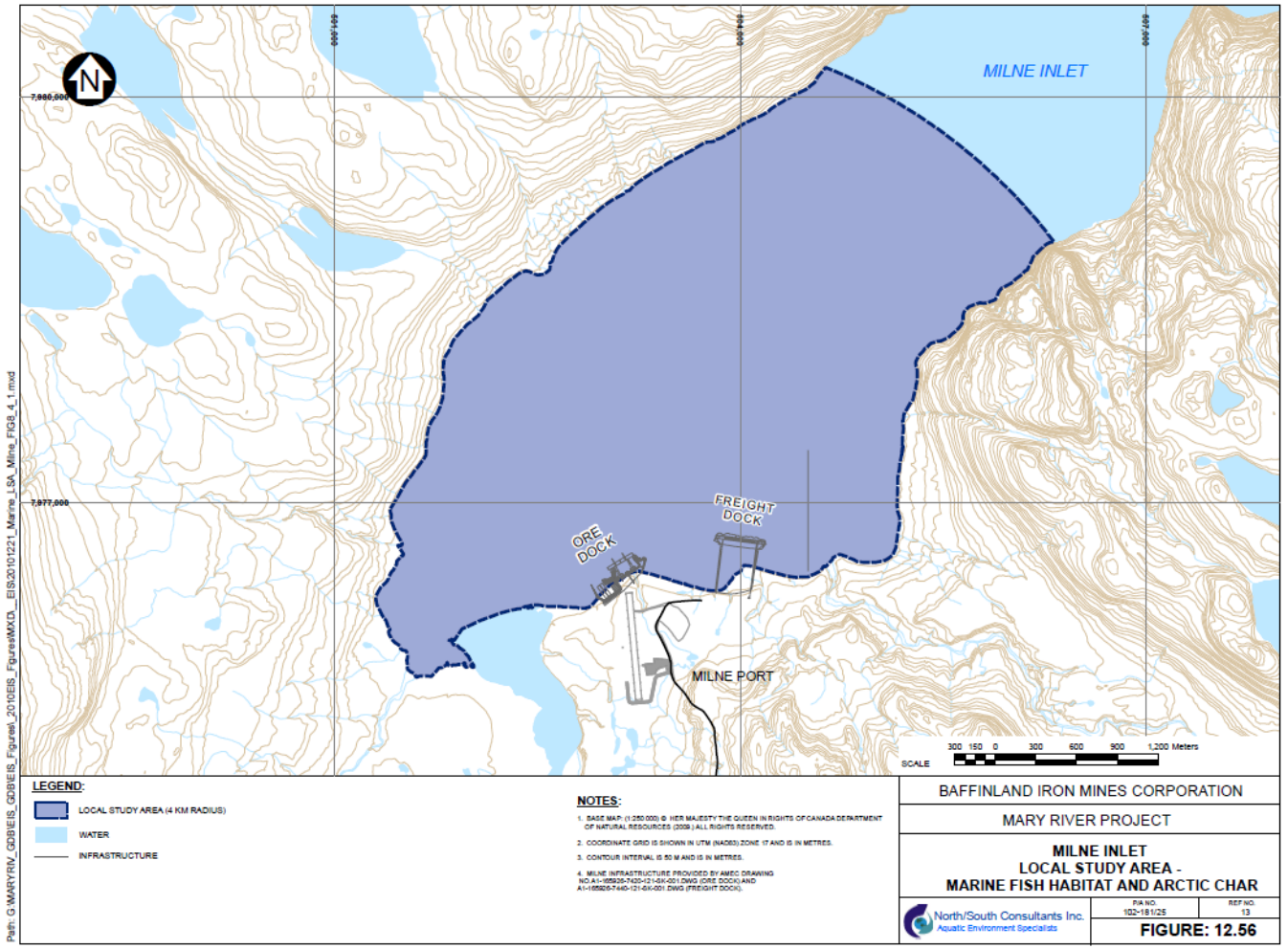


Figure 12-56: Milne Inlet Local Study Area – Marine Fish Habitat and Arctic Char

© Hatch 2011/09

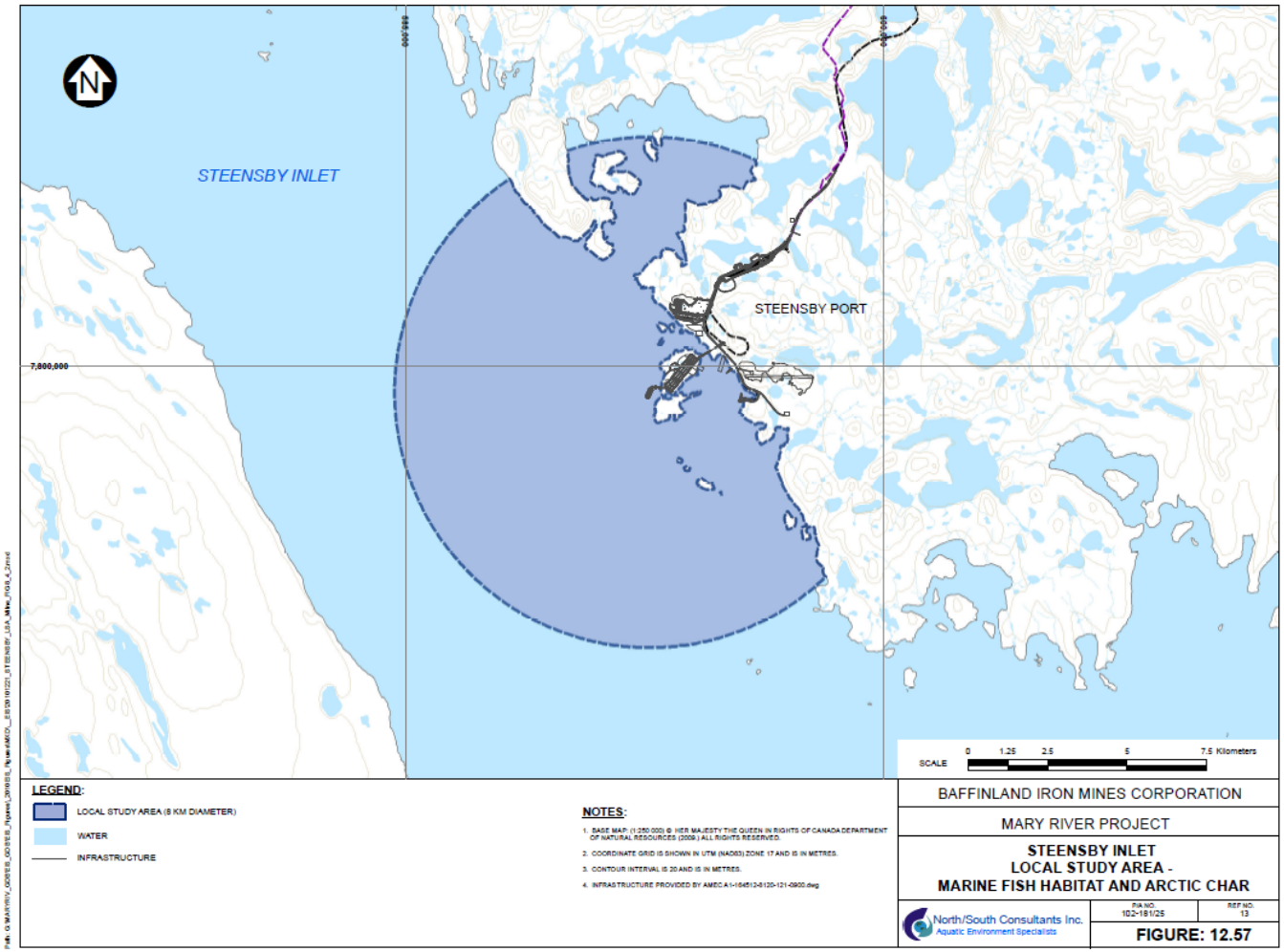


Figure 12-57: Steensby Inlet Local Study Area – Marine Fish Habitat and Arctic Char

© Hatch 2011/09

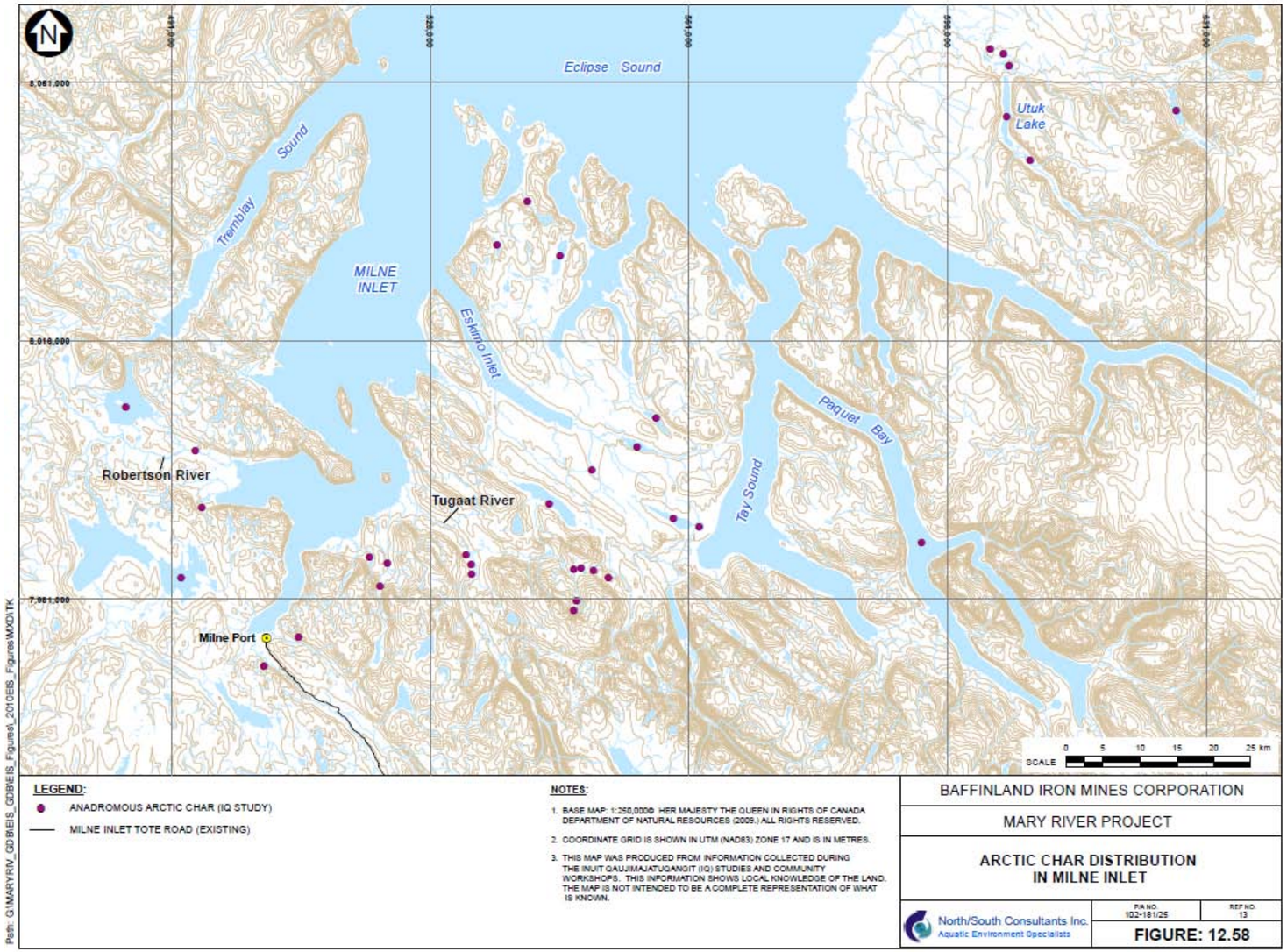


Figure 12-58: Arctic Char Distribution in Milne Inlet

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

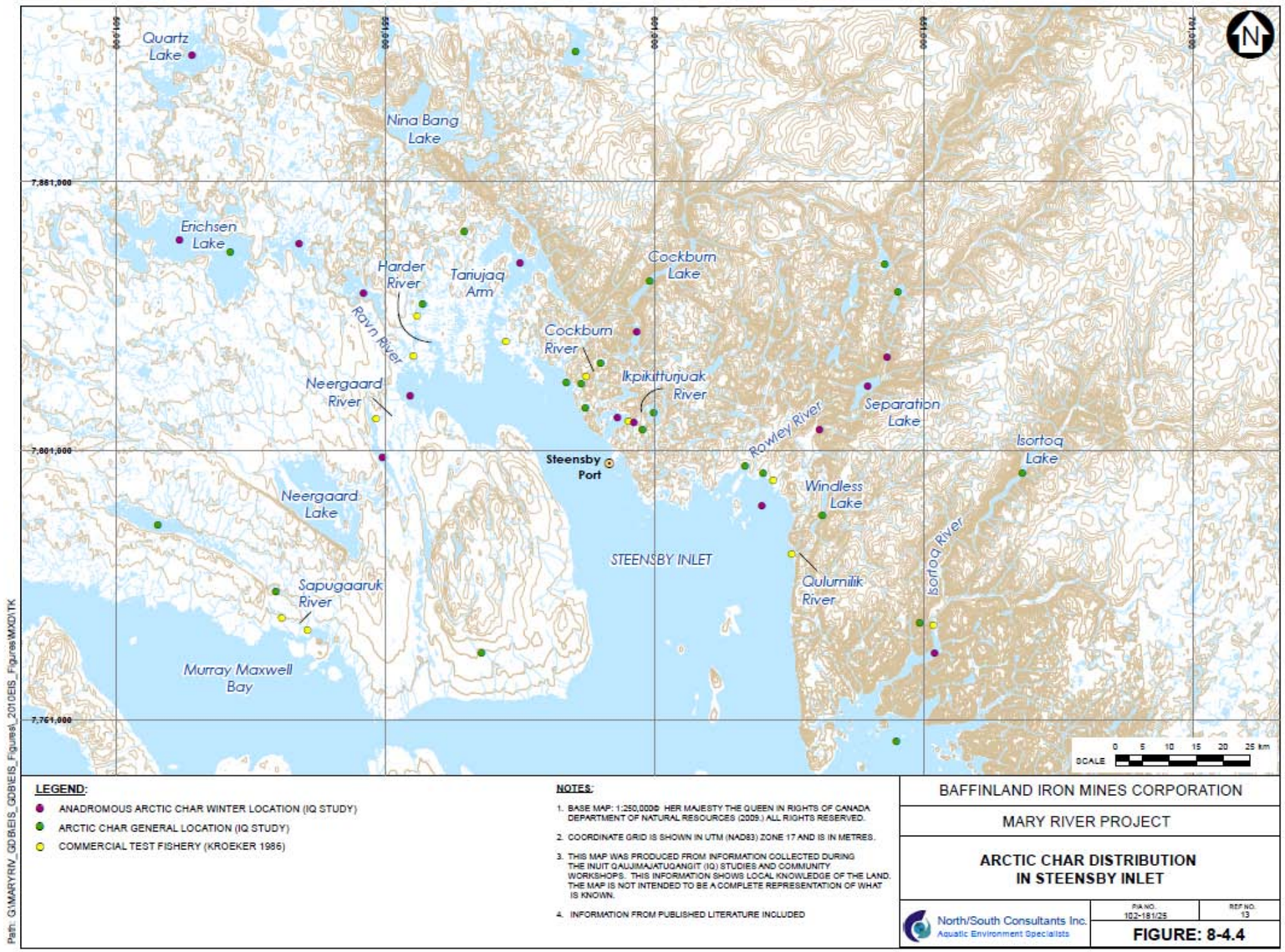


Figure 12-59: Arctic Char Distribution in Steensby Inlet

© Hatch 2011/09

13. Human Environment

13.1 Introduction

13.1.1 Socio-Economic Zone Of Influence and Study Area Determination

The socio-economic study area encompasses the communities and regions of Nunavut that will be directly or indirectly affected by the Project. These are illustrated in Figure 13-1, "*Communities in the Vicinity of the Mary River Project*" (DEIS Figure 4-1.1). Three levels of interaction have been considered. First, the Project will have effects on the entire territory of Nunavut, the Regional Study Area (RSA), through its contributions to the revenues of government and Inuit organizations, as well as through the contracting opportunities it creates for business.

Other interactions between the Project and the socio-economic environment will take place on a more localized scale. In particular, employment at the Project will be the underlying interaction that leads to a wide range of socio-economic effects. This interaction will occur primarily at the level of the point of hire communities. These include the five North Baffin points of hire communities—Hall Beach, Igloolik, Arctic Bay, Pond Inlet and Clyde River—and the City of Iqaluit. Together, these communities comprise the Local Study Area (LSA) for the purpose of socio-economic impact assessment. A description of the affected communities is provided in the DEIS Volume 4 (2011).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

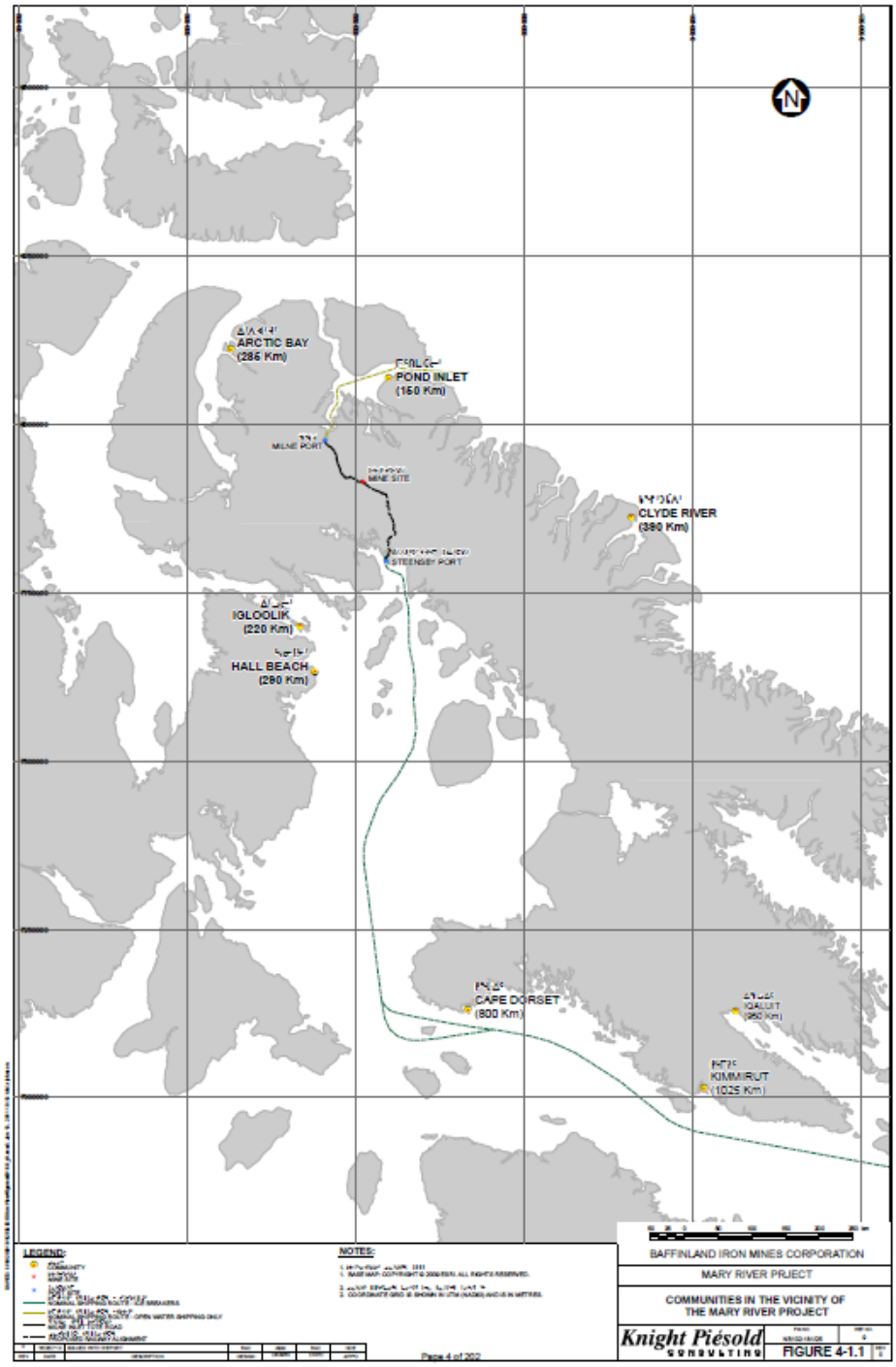


Figure 13-1: Communities in the Vicinity of the Mary River Project

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.1.2 Issues Scoping and VSEC Determination

For the purpose of PDW assessment the issues identified during socio-economic scoping carried out between 2006 and 2010, described in DEIS Appendix 2B (2011) have been utilized. Those issues of particular relevance to PDW are presented within the context of the VSECs where they apply.

The same VSECs used for the DEIS have been adopted for the PDW assessment. These are:

- Population Demographics
- Education and Training
- Livelihood and Employment
- Economic Development and Self-Reliance
- Human Health and Well-being
- Community Infrastructure and Public Services
- Contracting and Business Opportunities
- Culture, Resources and Land Use
- Benefits, Royalty and Taxation
- Governance and Leadership

13.1.3 Key Indicators

For the assessment of the Mary River Project, a total of 15 Key Indicators were identified. Given the duration and nature of PDW, many of these are not applicable to this assessment, or are addressed as Subjects Of Note rather than as Key Indicators. Based on consideration of the community research combined with a consideration of PDW design details a total of 3 Key Indicators (KI) are identified and specifically assessed:

- Wage Employment (KI of Livelihood and Employment)
- Substance Abuse (KI of Human Health and Well-Being)
- Recruitment and Retention of Hamlet Workers (KI of Community Infrastructure and Public Services)

13.1.4 Subjects of Note

In addition to the key indicators, a number of additional issues and interactions were raised during the community research or during NIRB scoping that are considered relevant to understanding how PDW may interact with VSECs. These are areas that are not believed to interact with PDW in a way that will have any substantial effects on the VSECs, but which are of adequate concern to the public that they merit consideration. These are addressed as “subjects of note.”

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.2 Population Demographics

The Population Demographics VSEC considers how PDW might affect population mobility and family living arrangements. Given the short duration of these activities, combined with the fly-in/fly-out nature of PDW, these interactions are considered to be unlikely to occur over the timeframe of PDW. For this reason, effects of PDW on this VSEC are addressed as a subject of note.

13.2.1 Subjects of Note

The potential for changes to the demographic stability and composition of local study area (LSA) communities to occur has been considered in the context of PDW. Three interactions could affect this VSEC, and could be considered to have some negative dimensions were they to occur to a substantial degree. These are:

- In-migration of non-Inuit from the South
- In-migration of Inuit into the North Baffin from other regions
- Out-migration of Inuit residents from North Baffin

None of these potential interactions are considered to be likely to occur to any substantial degree during PDW. This is due mainly to the short, thirteen-month duration of PDW.

Individuals from the south are not likely to move north for the prospect of a few months employment. Further, few opportunities to enter into long-term relationships that might lead some to choose to relocate to LSA communities will arise during such a short period of activity. The presence of a southern point of hire will serve to minimize this interaction.

Inuit migration arising from PDW-specific interactions is also considered to be minimal over this period of time. The availability of six existing LSA points of hire will enable many interested in PDW jobs to access these without the need to relocate. Some LSA residents may find that their mobility options are increased due to the transportation options presented by PDW. However given the short duration of this opportunity, the magnitude of any effects arising from this interaction will be low.

13.2.2 Impact Statement

PDW are expected to have only negligible effects on the Population Demographics VSEC, due to the short duration of these activities. As a result, PDW will have no significant impact on this VSEC.

Potential for Cumulative Effects

Negative residual effects on population dynamics arising from PDW are expected to be negligible. Therefore no residual effects are carried over to the cumulative effects assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.3 Education and Training

The Experience and Education VSEC considers the interactions between the PDW and the lifeskills, education and training opportunities available within the LSA.

The short duration and pre-IIBA nature of PDW means that many of the measures envisioned to support lifeskills development, educational advancement, and training that are described in the DEIS HRMP (DEIS Appendix 10F-3) for implementation at the Mary River Project may not be operational during the PDW. That said, Baffinland does intend to implement some training activities during PDW in order to improve the capacity of the labour force. These have been outlined in Section 9.2, above.

For this reason, combined with the short duration of the PDW phase itself, PDW interactions on this VSEC are expected to be modest. However, PDW interactions may have some importance in establishing values and approaches to education and training that will be relevant to future developments in the LSA. For these reasons, PDW interactions with the Education and Training VSEC are addressed as subjects of note.

13.3.1 Subjects of Note

Major issues related to education and training include access to training and apprenticeship opportunities; the tangible value (such as access to jobs or higher incomes) that education delivers to those who are able to attain it—an issue that is tied to economic diversity and economic opportunity; and the lifeskills individuals have that enable them to succeed in attaining and then benefiting from the employement opportunities that arise from their educational and training achievements. These issues are described in detail in the DEIS Volume 4 (2011), Section 3.2.

PDW may be expected to interact with both lifeskills and training opportunities. Community scoping activities also identified inadequate access to child care as a challenge for some students seeking to complete high school since they may have additional domestic responsibilities arising through PDW interactions. These issues are considered below.

Given the short duration of PDW, there is not expected to be a substantial effect on the “value of education” as perceived by residents of the LSA. There could be a modest positive effect that might be carried forward to future developments in the region, such as the credible development scenario of the Mary River Project. This beneficial effect is simply noted here, but not further assessed.

Lifeskills

PDW will provide opportunities to LSA residents to build life-skills through employment at a remote work site. With mitigation in place to avoid access by workers to drugs and alcohol, no negative effects on lifeskills will be generated by PDW activities.

Positive effects on lifeskills can be promoted in two ways, actively and passively. During PDW, active support for lifeskills development is expected to be modest. It may include orientation, pre-

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

employment "job readiness" components in training initiatives, and supportive on-the-job supervision.

The value of PDW in supporting lifeskills development may arise more from the passive value inherent in gaining employment. Individuals will be challenged by the rigors of remote fly-in/fly-out work. Some will use these opportunities to begin to build the personal skills they need to succeed.

Combined with active on-the-job supervision, it is expected that PDW, even though it will be of short duration, will provide benefits to some individuals seeking to improve their lifeskills. This should have a modest but beneficial effect on the Education and Training VSEC.

Availability of Training Opportunities

Baffinland has planned a modest training program to support Inuit employment within the context of PDW. This plan is described in Section 9.2, above, and is envisioned to begin in late Q1/early Q2 of 2012. The plan is to combine PDW-specific skills training with broad adult education components in order to assist people to improve their foundations for future advancement. Inclusion of "lifeskills" components is envisioned.

Balancing School Attendance with Domestic Responsibilities

Under baseline conditions, domestic responsibilities are said to present a barrier to regular school attendance for some high-school aged youth. These responsibilities include parental responsibilities such as child care, as well as care for other family members. The effect of these responsibilities on school outcomes can be compounded by limited access to adequate service alternatives such as day care options.

To the extent that PDW recruits workers from the LSA who have shared in care-giving responsibilities, their absence during the work rotation may lead to increased responsibilities for those who remain at home. For some, this may serve as a barrier to school attendance. The frequency of these situations during PDW is expected to be very low and of short duration.

13.3.2 Impact Statement

Considering the effects on lifeskills, training opportunities, and domestic responsibilities of students, PDW are expected to have a positive effect on education and training. However, given the short duration of these effects, this is not expected to be a significant overall effect. These "non-significant" effects are, however, recognized to have importance in terms of positioning individuals from the LSA to benefit from further opportunities if and when the Mary River Project were to proceed.

Potential for Cumulative Effects

No negative effects are assessed to arise from PDW in relation to the Education and Training VSEC. Therefore no residual effects are carried over to the cumulative effects assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.4 Livelihood and Employment

The Livelihood and Employment VSEC addresses the creation of new job opportunities, as well as the recruitment of people into these new jobs.

Local demand for employment is high. This has been expressed in the context of community research and demonstrated through the tremendous application response for work during the bulk sample activities carried out in 2008 (Section 4.4.3, DEIS Appendix 4A 2011).

Access to jobs is limited for many Nunavummiut. Barriers to income-earning opportunities arise from a combination of a narrow economy where the public sector dominates the labour market, and a miss-match between the skills available in the labour force and those called for by specialized positions. The result is a broadly-held understanding that the promise of mine employment will not be achieved passively, simply by creating employment opportunities in the region.

Given the importance of job creation and local employment to residents of the LSA, and since PDW will create jobs in this region, wage employment is assessed as a key indicator.

Other issues that arise in relation to employment relate to the employment of youth and women, job promotion and career advancement, and the effects that "boom and bust" cycles have on individuals, households and communities. These will be briefly discussed in the context of PDW as subjects of note.

13.4.1 Wage Employment

For residents of the LSA, a key element of PDW is its potential to provide substantial new employment opportunities. The assessment question related to this indicator is:

- Will the number of residents of the LSA who gain employment in the PDW be significant relative to the current labour market?

Assessment Methods

Two parameters are used to assess the effect of PDW on wage employment:

- labour demand created by PDW (i.e. "jobs creation"); and
- labour supplied by residents of the LSA (i.e. "local employment").

A focus on "hours of labour" demanded and supplied allows for analysis to be carried out independently from the work patterns of those hired. Conversion between hours of labour and full-time jobs is accomplished by applying a factor of 2,700 hours of labour per position identified in Section 9.[21] Since Nunavut residents are expected to work even rotations[22], the number of "jobs" created will be based on 2080 hours per "job."

[21] A worker at PDW will work this number of hours over a full year, in a four-week in/two-week out rotation.
[22] Such as such as 1 week-in/1 week-out or 2-in/2-out, or 3-in/3-out.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Parameters for rating the magnitude of both job creation and local employment are:

Low < 2.5% change in baseline labour

Medium 2.5% to 5% change in baseline labour

High 5%+ change in baseline labour

The rationale for these thresholds is rooted in consideration of baseline employment levels. In North Baffin, for example, where the wage economy has generated an estimated two million hours of labour demand (DEIS Appendix 4A 2011, Section 4.3.1), a medium magnitude change will correspond to an additional 25 full time, year-round jobs. The addition of 50 additional full time, year-round jobs would be assessed as a high magnitude change.

During the period of territorial division, between 1996 and 2004 the average annual rate of job creation for males in the North Baffin was 1.5% and for both genders was 3.1%.[23] These magnitude ratings are therefore considered conservative relative to these baseline levels.

Project Effects and Proposed Mitigation

PDW will affect wage employment through these closely related effects:

- creation of jobs;
- direct employment of residents of the LSA; and
- employment in indirect jobs (subject of note).

Creation of Jobs in the LSA

A monthly summary of the number of workers during PDW is provided in Section 9, above. These positions are equivalent to an estimated total labour demand of 700,000 hours of labour over a period of eleven months in 2012, and an additional 250,000 hours of labour during the first three months of 2013.

Demand for labour will vary month-by-month, from a starting point of 25,000 hours per month in the late winter of 2012, to a peak of 130,000 hours per month in the fall of 2012. The "total" labour demand curve for PDW is presented in Figure 13.2, "*PDW Labour Demand, By Skills Category*."

The National Occupational Classification (NOC) matrix (HRSDC, 2006) has been used to assign PDW labour demand to skill levels. The five NOC levels have been condensed into three levels for the purpose of this assessment: level B or higher (designated as "B+"), level C, and level D:

- Level B and higher occupations are jobs that usually require apprenticeship training, or college/university education. This level includes jobs such as, for example, industrial trades, train

[23] Refer to DEIS Appendix 4A (2011), Table 14, "Growth of Jobs Relative to Growth of the Inuit Working-Aged Population."

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

crew operating, drillers and blasters, supervisors, administrative occupations, technical occupations, managers, professional occupations.

- Level C occupations usually require secondary school and/or occupation-specific training. This level includes jobs such as heavy equipment operators, administrative support, scheduling jobs, and occupations in food and beverage services.
- Level D jobs are those where on-the-job training is usually provided. These may include site services, kitchen helpers, cleaners, security guards, trades helpers, and labourers.

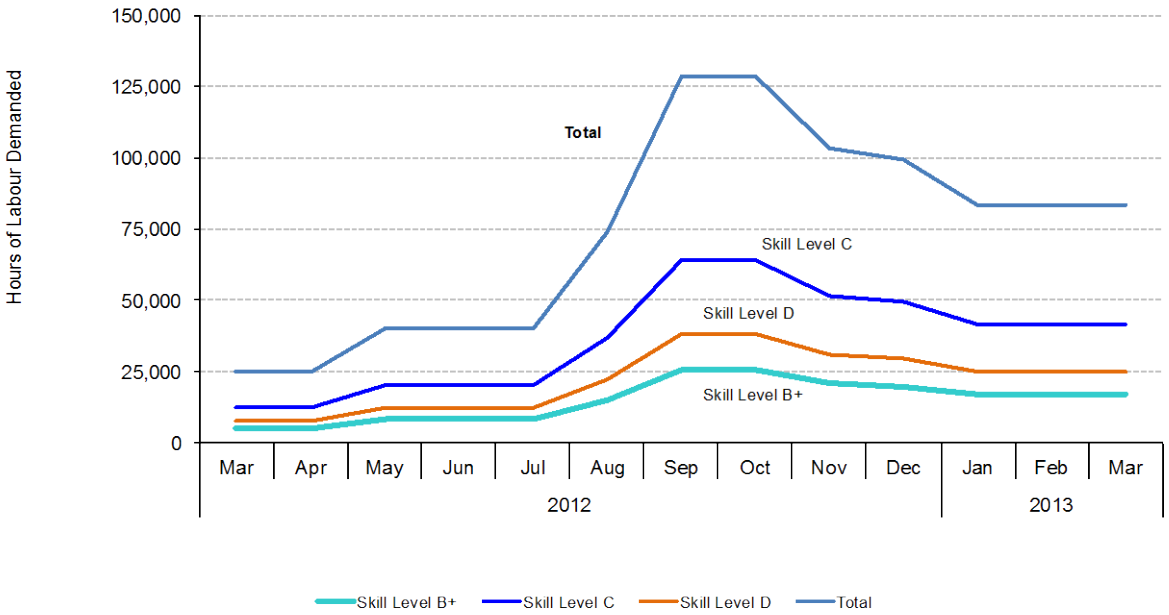


Figure 13-2: PDW Labour Demand, By Skills Category (hours of labour per month)

Note(s):

1. Monthly pdw labour demand is obtained by multiplying the number of payroll positions by 2,700 hours per position.
2. Estimated breakout of total labour demand into skill levels relate to the national occupational classification (noc) skill levels assigned to manpower estimates.
3. The scale of labour demand for PDW is comparable to that of the Mary River bulk sample activities that took place during 2008 and which are familiar to residents of the LSA. That work involved a peak labour demand of 100,000 hours of labour per month, during the months of September and October of 2008 (DEIS Appendix 4A 2011, Figure 37).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Employment of LSA Residents

During the PDW, efforts to employ residents of the LSA will be made outside of the IIBA framework. This is similar to the context under which the bulk sample was carried out.

PDW labour demand will be met by hiring qualified workers from six point-of-hire communities in the Baffin—Iqaluit, Hall Beach, Igloolik, Arctic Bay, Pond Inlet, and Clyde River—and from the south. At the peak of PDW activities, roughly 230 individuals working even rotations (such as 2 weeks in, 2 weeks out) will be needed to deliver Skill Level "D" labour requirements. Another 380 individuals will be needed to deliver Skill Level "C" labour, and 150 individuals to deliver Skill Level "B" and higher labour requirements.

An estimation of the potential labour supply available from the LSA can be arrived at by applying the peak monthly labour supply provided from the LSA during the bulk sample work to PDW activities. During bulk sample activities, North Baffin communities provided a maximum of 14,500 hours and Iqaluit a maximum of 22,800 hours in August 2008. This suggests that it is reasonable to anticipate recruiting up to roughly 15,000 hours of labour per month from the five North Baffin point-of-hire communities and 20,000 hours of labour per month from Iqaluit. This is equivalent to approximately 90 individuals from North Baffin and 120 individuals from Iqaluit working even rotations.

For the purpose of this assessment, it is assumed that three-quarters of LSA labour will be in entry level labour positions (Skill Level "D"), with one-quarter in Skill Level "C" or higher jobs. This means that the LSA can supply up to approximately 10,000 hours of Skill Level "C+" labour and 25,000 hours of Skill Level "D" labour per month. Comparing these maximum LSA labour supply capacities with PDW labour demand suggests that the PDW may generate local employment as represented in Figure 13-3, "*PDW Labour Demand and LSA Supply, by Skill Level*." This will total 130,000 hours of Level "C+" and 250,000 hours of Level D employment over the thirteen month duration of PDW.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

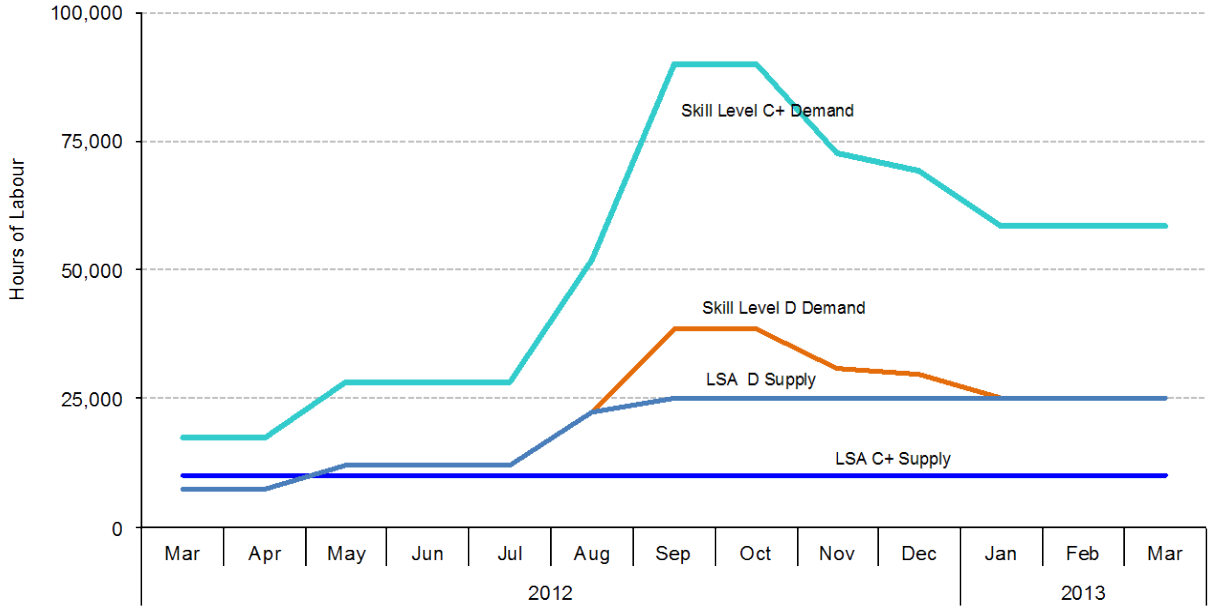


Figure 13-3: PDW Labour Demand and LSA Supply, by Skill Level (hours of labour per month)

Note(s):

1. These are rough estimates based on bulk sample experience in 2008.
2. These "hours of labour" estimates can be used to estimate that some 300 individuals from the LSA will gain employment over the course of PDW.[24]
3. These employment expectations are recognized to be approximations. For the purpose of other aspects of this assessment, however, they will be used as the best available assumptions related to the magnitude of direct employment of residents of the LSA.

Proposed Mitigation

Barriers to engagement in PDW range from individual employability and "readiness to work," to the inherent demands of fly-in/fly-out industrial shift work, to the specific skills that are required by PDW. Baffinland intends to implement a modest training program to begin preparing residents of the LSA to participate in these opportunities. In addition, Baffinland managers "on-the-ground" have gained familiarity with the local labour force over the past five years and are committed to supporting and engaging local workers.

[24] This is based on an assumption that one full-year worker on an even rotation (such as 1-in/1-out or 2-in/2-out, or 3-in/3-out) will work 2080 hours and an expectation (derived from the bulk sample experience) that, on average, LSA employee turnover will lead to 1.8 workers per full year position.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Assessment of Residual Effects

The creation of jobs and employment of LSA residents are assessed separately, as job creation does not lead automatically to employment of LSA residents. It is noted that the effect of PDW on indirect job creation is discussed as a subject of note.

Component Assessment: Creation of Jobs in the LSA

Ratings for significance criteria for the effect of PDW on creation of jobs are presented in Table 13-1, "*Effects Assessment Summary - Wage Employment*." During the thirteen-month duration of PDW, a total of 950,000 hours of labour will be demanded. This is equivalent to roughly 880,000 hours of labour demand per year.

Under baseline conditions, the labour market of the North Baffin LSA is estimated to generate a labour demand of 2.0 million hours per year, while the Iqaluit labour market generates an estimated demand of 4.7 million hours of labour per year (DEIS Appendix 4A 2011). Thus, PDW will increase the labour market of the LSA by 13%. The level of job creation is therefore assessed to be of high magnitude.

Job creation is a positive effect that will be experienced across the study area by way of the six point-of-hire communities. Expansion of labour demand, combined with some normal worker turnover, will mean that new job opportunities will be continuously available during the first eight months of PDW. As PDW gear down, it is expected that fewer positions will be open for new recruits. Overall, therefore, the frequency of job creation is considered to be "intermittent." When PDW ends, direct PDW-generated labour demand will end spontaneously.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 13-1: Effects Assessment Summary – Wage Employment

Key Indicator: Wage Employment		
VSEC: Livelihood and Employment		
Effect	**Creation of Jobs in the LSA**	**Employment of LSA Residents**
Design / Mitigation Measure(s)	LSA points-of-hire	Training program Management commitment
Direction	Positive	Positive
Geographic Extent	Point of hire communities	Point of hire communities
Social Extent	Community	Family
Equity	Engaged individuals	Engaged individuals
Magnitude	High	High
Frequency	Intermittent	Intermittent
Duration	Short-term	Short-term
Reversibility	Spontaneous	Spontaneous
Significance of Adverse Residual Effects	No adverse residual effects	No adverse residual effects
Significance of Beneficial Residual Effects	Not significant	Not significant
Probability of effect occurring	High	High

Significance Determination

Although the magnitude of job creation will be high, with intermittent frequency, the short duration of this effect—a period of just thirteen months—means that the positive effect of PDW on wage employment in the LSA is assessed to be "not significant." This reflects the fact that PDW is unlikely to leave a lasting impression on LSA wage employment if it does not lead to a longer-term project. Confidence in this prediction is high, based on the magnitude of the effect.

Component Assessment: Employment of LSA Residents

Ratings for the significance criteria for employment of LSA residents are presented in Table 13-1, "*Effects Assessment Summary - Wage Employment*." Based on the best available understanding of baseline labour force conditions, including the employment experience during exploration and bulk sample activities, an estimated 300 individuals are expected to be engaged in PDW, supplying some 380,000 hours of labour over thirteen months.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

This employment is a positive effect that may be experienced across the study area by way of the six point-of-hire communities. The effect may be experienced across the labour force, though some demographic groups are more likely than others to be attracted to fly-in/fly-out work. Individuals engaged in PDW, along with their families, will be the primary beneficiaries of this employment.

On an annual basis, employment creation in the LSA generated by PDW is estimated at 350,000 hours. This will occur in a baseline environment where an estimated 6.7 million hours of labour are delivered (DEIS Appendix 4A 2011). This is equivalent to a 5% increase over the baseline—a high magnitude effect.

Employment at PDW is anticipated to be gained by residents across the LSA, although some communities may experience higher magnitude of employment than others. The frequency of employment will be intermittent throughout the duration PDW, with more opportunities during the ramp-up period leading to peak demand. At completion of PDW activities, the jobs will spontaneously end. However the experience of having worked at a major fly-in/fly-out operation will be long-lasting and is, therefore, essentially non-reversible.

Significance Determination

The beneficial residual effects of PDW on wage employment of LSA residents is assessed to be not significant. In spite of a high magnitude of LSA employment arising from PDW, for many of these workers the beneficial effects of this employment will continue to be experienced by engaged individuals.

Confidence in this determination is moderate, since the finding is premised on on-going benefits to individuals lingering beyond the duration of PDW. This may not be the case if turnover rates are high, since that would suggest that employment skills have not been adequately gained to be carried over to future opportunities.

Follow-up

Tracking of the actual hours of labour deployed across PDW, by skill category, will be included as part of the socio-economic monitoring. Monitoring of employment will be carried out for all employees of PDW, including those of contractors working at PDW.

13.4.2 Subjects of Note

Job Progression and Career Advancement

Given the short duration of PDW, the opportunities for job progression and career advancement will be limited. That said, some individuals may be able to prove themselves and progress from entry-level to higher positions. There could be a modest positive effect that might be carried forward to future developments in the region, such as the credible development scenario of the Mary River Project.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Livelihood Options – Traditional Harvesting

A combination of fly-in/fly-out rotations and income earned from employment should be compatible with maintenance of traditional harvesting activities amongst those individuals who choose to participate in these as a component of their livelihood.

Due to the short duration of PDW, longer-term effects that might influence traditional harvesting are considered to be negligible and are not considered in this assessment.

Indirect Job Creation

Given the short duration of PDW, the opportunity for jobs to be generated as a result of increased local wealth will be limited. Indirect job creation is therefore not expected to arise from PDW.

13.4.3 Impact Statement

PDW is assessed to have no significant adverse residual effects on the Livelihood and Employment VSEC. PDW will have a positive effect on wage employment in the North Baffin by introducing new job opportunities and assisting local residents to access these jobs. However, given their short duration, these effects are not considered to be "significant" relative to the overall state of Livelihood and Employment in the LSA.

Potential for Cumulative Effects

No negative effects are assessed to arise from PDW in relation to the Livelihood and Employment VSEC and therefore no cumulative effects are expected.

13.5 Economic Development and Self-Reliance

The Economic Development and Self-Reliance VSEC addresses how the PDW are expected to interact with and effect the achievement of Nunavut's strategic development objectives. These are addressed as subjects of note.

13.5.1 Subjects of Note

A summary of the thirteen strategic priorities identified in the Nunavut Economic Development Strategy (SEDS 2003), along with the anticipated contributions that the Mary River Project will have to these priorities is provided in DEIS Volume 4 (2011).

PDW interactions with this VSEC will be positive—training, employment, and payment of taxes. However, the direct effects on this VSEC are defined by their short duration. Since processes of economic development are long-term, it is not felt that PDW will, on its own, lead to any substantial effects on this VSEC. The most substantial contribution that PDW will make to Nunavut economic development and achievement of self-reliance will be to advance commencement of the Mary River Project by a full year. This is an important strategic contribution.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.5.2 Impact Statement

The direction of the effects of PDW on the Economic Development and Self-Reliance VSEC are assessed, with a high level of confidence, to be positive, but of short duration. The more important contribution of PDW to territorial economic development and self-reliance is that it will advance implementation of the Mary River Project. For this reason, PDW are considered to be provide a significant positive effect on this VSEC.

Potential for Cumulative Effects

No negative effects are assessed to arise from PDW in relation to the Economic Development and Self-Reliance VSEC. Therefore no residual effects are carried over to the cumulative effects assessment.

13.6 Human Health and Well-Being

Assessment of the effects of PDW on the Human Health and Well-Being VSEC considers a range of interactions related to individual, family and community well-being. The source of these interactions will primarily arise from direct employment and from the income this employment generates. The most important issue, reflecting community concerns, is considered to arise from potential interactions between PDW and substance abuse, particularly alcohol abuse. This is assessed as a key indicator.

Other issues and interactions may also occur. These relate to the effects of fly-in/fly-out work on families and households. Due to the short-term duration of PDW and the nature of these interactions, they will be addressed as subjects of note.

13.6.1 Substance Abuse

Community residents have raised specific concerns about unhealthy spending decisions that may lead to increased substance abuse and the associated effects this implies. Alcohol abuse is a particular concern. Although the PDW are of short term duration, the potential for longer-term effects arising from substance abuse is recognized. For this reason the effect of PDW on alcohol and drug abuse will be considered in further detail. The assessment question related to substance abuse is:

- Will PDW substantially affect levels of substance abuse in the LSA relative to the baseline?

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Assessment Methods

The assessment of PDW effects on substance abuse is carried out by considering how PDW are likely to affect the factors that influence substance abuse. For the purpose of this assessment the following are assumed to be important determinants of substance abuse in the North Baffin LSA:

- availability
- affordability
- individual and peer-group attitudes
- addictions and dependencies.

The following assumptions are made:

- consumption of alcohol and drugs is constrained by low income across the LSA
- in the North Baffin LSA, alcohol consumption is further constrained by availability
- attitudes and practices related to alcohol consumption are variable. It is assumed that most alcohol is consumed responsibly, but that binge drinking patterns of consumption are common and this is sometimes associated with anti-social and criminal behaviours
- drug use in the North Baffin primarily involves soft drugs.

Direct Interactions between PDW and Substance Abuse

Determination of the significance of PDW effects on substance abuse will consider the possible interactions and then use this understanding to generate a qualitative assessment on the expected outcomes of these interactions on substance abuse. The following potential effects are considered:

- transportation of drugs and alcohol through PDW sites
- ability to afford drugs and alcohol
- attitudes toward drug and alcohol use and desire to overcome addictions.

While these effects are related to each other, they are not interdependent. A change in attitude toward alcohol will affect "substance abuse" regardless of whether there is any effect on transportation or on the ability to afford alcohol. Likewise with the other potential effects. Therefore these are assessed separately.

Outcome of the Direct Interactions on Substance Abuse in the LSA

The effect of PDW on any of the interactions described above does not determine the outcome in terms of alcohol abuse levels. Therefore, a second-level assessment is carried out to consider the overall outcome of these interactions on substance abuse. This assessment will be very qualitative in nature, but is useful in establishing a conceptual frame for understanding PDW interactions.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

For the purpose of this second-level assessment, it is assumed that for some residents of the LSA, the net effect of PDW may be neutral or beneficial with respect to their use of substances. Others who are exposed to the same effects may respond in adverse ways. The combination of these individual responses by residents of the LSA to PDW will determine the overall significance of the residual effects on substance abuse in the LSA. This overall effect is assessed in a qualitative manner with the following index used to come to a significance determination:

- low, negative outcome - increased substance abuse may be perceived in individuals but is not noticeable at the community level by those who deal with these issues, such as RCMP, health, and social service workers
- moderate, negative outcome - increased substance abuse is noticeable at the community level and is considered by those who deal with these issues, such as RCMP, health, and social service workers, to be associated with PDW. However, the increase does not cause major concern
- high, negative outcome - Increased substance abuse at the community level is widely perceived by community members as well as by "front-line" workers to be a cause of major concern and is considered to be associated with PDW
- low, positive outcome - decreased substance abuse may be perceived in individuals but is not noticeable at the community level by those who deal with these issues, such as RCMP, health, and social service workers
- moderate, positive outcome - decreased substance abuse is noticeable at the community level and is considered by those who deal with these issues, such as RCMP, health, and social service workers, to be associated with PDW
- high, positive outcome - decreased substance abuse at the community level is widely noticed by community members as well as by "front-line" workers to improve the quality of life of the community, and this is considered to be associated with PDW.

Potential Effects and Proposed Mitigation

PDW may affect substance use in three ways:

- transportation of alcohol through PDW sites
- ability to afford drugs and alcohol
- influence attitudes toward substances and addictions.

Importation of Substances

Increased mobility between sources of these substances and the North Baffin communities could facilitate transportation of both alcohol and illegal drugs, with PDW sites serving as a transfer point. To avoid this scenario, PDW includes measures designed to prevent the import of alcohol and drugs through the site and the use of these substances at the site. These include a "no drugs, no alcohol policy" and effective baggage searches.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Affordability of Drugs and Alcohol

Increased income from direct employment during PDW is expected to increase the ability of some residents to afford these substances during the short duration of this employment.

Attitudes toward Substance Abuse and Addictions

Increased income from PDW employment will be contingent on an ability to work without access to substances for two weeks out of four, and an ability to maintain the discipline needed to show up for travel to site on time. For those who have addictions problems, these constraints will introduce positive incentives to come to terms with these addictions. PDW may also serve as a tangible "signal" that Baffinland is seriously intending to proceed to implementation of the Mary River Project. This may spur some individuals to get any addictions issues under control.

There is, though, a potential that some individuals will find the alternation between the availability of alcohol during time off work in the community followed by unavailability during the work rotation may encourage a binge-drinking approach to alcohol consumption. This potential has been suggested in interviews carried out during a review of the Jericho project in the Kitikmeot region (Brubacher Development Strategies, 2009).

Design and Mitigation Measures

Steps to address these potential effects, and to support individuals who are seeking to deal with their addictions, have been considered in the design of PDW.

- The use of these substances at the sites will be prohibited, introducing a period of enforced abstinence from use of these substances.
- Planned orientation and training programs may include components that provide information about substances, substance abuse, productive approaches to stress management, healthy living, money management practices and other components that may influence choices made by individuals related to lifestyle choice.

These measures should help to create a supportive environment for those seeking to make healthy choices to do so.

Assessment of Residual Effects

PDW effects on three components contributing to substance abuse are assessed. These include the effect of increased transportation linkages between the south and the North Baffin on substance availability, the effect of increased household income on substance affordability, and the effects of PDW employment on attitudes toward substances and addictions.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Component Assessment: Transport of Substances through PDW sites

Ratings of the significance criteria for this effect are presented in Table 13-2, "*Effects Assessment Summary - Substance Abuse*." Transportation of substances through the PDW sites is considered to be a negative effect, since this would be illicit importation into the region. If this were to occur, it would potentially affect the North Baffin LSA communities that supply workers to the site, since access to drugs and alcohol in these communities is either controlled (in the case of alcohol) or prohibited (in the case of illegal drugs). The social extent of this effect would be the entire community, as these substance could be sold on the black market. Therefore, the effect would affect bystanders who are not directly involved in PDW activities.

With the planned mitigation in place, the magnitude and frequency of this potential effect are both assessed to be low. While it is possible that some drugs may not be detected, it is considered unlikely that substantial quantities of these substances will be undetected, relative to the baseline. Control at PDW sites, involving search of baggage, will be more stringent than that of the regular transportation links into the LSA communities.

Determination of Component Significance on Substance Abuse

With described mitigation in place, the importation of drugs and alcohol through PDW sites is considered not to be significant relative to the baseline for illicit importation into the North Baffin LSA.

Therefore, the effect of importation of substances through PDW sites on substance abuse in the LSA is assessed to be not significant.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 13-2: Effect Assessment Summary – Substance Abuse

Key Indicator: Substance Abuse			
VSEC: Human Health and Well-being			
Effect	**Transport of Substances through PDW sites**	**Affordability of Substances**	**Attitudes toward Substances and Addictions**
Design / Mitigation Measure(s)	"No drugs or alcohol" policy, Baggage search	No mitigation	Include health and safety, addictions issues, and Baffinland policy during orientation and training
Direction	Negative	Neutral	Positive
Geographic Extent	North Baffin point of hire communities	Point of hire communities	Point of hire communities
Social Extent	Community	Families	Community
Equity	Bystanders	Engaged families	Bystanders
Magnitude	Low	Moderate	Moderate
Frequency	Intermittent	Continuous	Continuous
Duration	Short-term	Short-term	Long term
Reversibility	Spontaneous	Spontaneous	Non-reversible
Significance of Adverse Residual Effects	Not significant	Not significant	
Significance of Beneficial Residual Effects	No beneficial residual effects	Not significant	
Probability of effect occurring	Moderate	High	High

Note(s):

The significance of "affordability" and "attitudes" are not assessed, as their relationship to substance abuse is complex and interrelated. Increased income from pdwp is assessed to be significant, therefore affordability of substances for those who wish to spend their income in this manner may be significant. However, whether this will have a negative or positive effect will depend on attitudes toward substance use and abuse. Likewise, improved attitudes are expected to be significant, but whether this leads to positive outcomes on overall substance abuse will depend on the behaviours of those whose attitudes do not change.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Component Assessment: Affordability of Substances

Ratings of the significance criteria for this effect are presented in Table Table 13-2, "*Effects Assessment Summary - Substance Abuse*." PDW is expected to have a significant positive effect on household income, given the level of local employment that is expected to be gained. This income may, therefore, make drugs and alcohol more affordable to those who choose to purchase these substances. Therefore the "direction" of this effect is to increase affordability. Whether this is considered to be "negative" or "positive" will depend on attitudes and practices related to substance use. Therefore the direction is determined to be "neutral."

This "affordability" effect may be particularly relevant to legal purchases of alcohol obtained through permits issued by the local alcohol education committees. Black market "bootleg" alcohol may either become more affordable—if supply keeps up with demand—or simply become more expensive if the volumes that bootleggers are able to bring into the community fail to keep up with increased demand. It is expected that a mid-point will be found where prices rise and the increased profitability then encourages higher efforts to supply the market. Affordability of illegal drugs is expected to increase with increased income, as it is assumed that transportation is less of a limiting factor to the volumes supplied.

The geographic extent of this effect will be the point of hire communities as these are where employment will be mostly be experienced. The social extent is expected to be the family. These families will also share in the other benefits and challenges associated with engagement in PDW. The magnitude of increased affordability of substances is expected to be moderate, relative to the income of many households in the absence of PDW employment. This effect will be experienced continuously over the duration of PDW, and will spontaneously reverse when employment ceases at the termination of PDW. The probability that substances will become more affordable is considered to be high.

Significance of PDW on this Component

Increased household income from employment at PDW is expected to increase the affordability of substances in the LSA. Whether or not this improved affordability will lead to significant negative effects on levels of substance abuse will depend on attitudes and behaviours related to substance use. Therefore, determination of significance is deferred to a consideration of these combined effects, below.

Component Assessment: Attitudes toward Substances and Addictions

Ratings of the significance criteria for this effect are presented in Table 13-2, "*Effects Assessment Summary - Substance Abuse*." PDW is expected to provide positive incentives for individuals to reduce their level of substance abuse and to address addictions they may have. Those who manage to develop healthy behaviours toward alcohol, for example, will be better able to maintain their employment. Therefore, the direction of PDW effects is positive. This will mostly affect employed

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

individuals, therefore these effects will be mostly experienced at point of hire communities. Within these communities, the change in attitudes amongst employed individuals is expected to affect other family members and peer groups as well. Therefore, the social extent is expected to extend to the entire community, and will include "bystanders" who are not directly engaged in PDW.

These positive changes in attitudes toward substance abuse and decisions to deal with addictions issues are not expected to be adopted by all workers who have substance abuse issues. However, with the planned mitigation measures—such as addressing substance abuse and its effects during training and orientation sessions—combined with the increased consequences associated with uncontrolled substance abuse behaviours, it is expected that a noticeable change will be detectable by front-line workers. Therefore a moderate level of magnitude is assigned to this effect. The influence of PDW will be continuous throughout this phase. The change in attitudes, however, will extend beyond the PDW and will be essentially non-reversible.

Significance of PDW on this Component

The PDW effect related to improved attitudes and behaviours related to substance abuse is expected to be significant. Whether or not this will lead to significant positive effects on overall levels of substance abuse will depend on how affordability issues play out amongst those whose behaviour related to substances does not change. Therefore, determination of significance is deferred to a consideration of these combined effects, below.

Determination of Overall Significance of PDW on Substance Abuse

The overall effect of PDW on substance abuse is expected to be determined by the balance between two contrasting effects:

Increased affordability of drugs and alcohol due to increased income; and

Changing attitudes toward substance abuse due to increased incentive to get addictions and abuse issues under control in order to succeed at work, combined with employee assistance to succeed in these efforts.

Planned mitigation includes a "no drugs/ no alcohol" policy and inclusion of discussions related to substance abuse during orientation activities. These may reduce residual adverse effects on substance abuse and should assist those individuals seeking to develop healthy attitudes towards substances and bring their addictions under control. Further, baggage checks at PDW sites will minimize any potential for PDW to introduce new transportation routes for illegal importation of substances. In addition to these Baffinland measures, the local alcohol education committees have the ability to control and limit access to legal supplies of alcohol. The RCMP has a mandate and authority to control illegal imports of alcohol into the North Baffin LSA.

Attitudes toward the use and abuse of substances are expected to change more slowly than affordability of substances. As a consequence, it is assumed that there may be a period of adaptation

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

during which higher levels of wealth mixed with baseline attitudes and practices may lead to increased frequency of incidents of substance abuse. This outcome is anticipated by community residents and by front-line workers.

However, individuals who do not get substance abuse issues under control will, in short order, find their employment relationship with PDW activities in jeopardy. The consequences of substance abuse with respect to employment, combined with mitigation activities designed to assist individuals in recognizing and dealing with addictions, is expected to reverse any initial wealth-induced spike in substance abuse incidents.

The net effect is expected to be that those Project workers who initially come to PDW with substance abuse issues will either learn to control their substance abuse behaviours or will lose their engagement with PDW, along with the income and the improved affordability of substances associated with this income.

Significance Determination

Concerns related to the effect that increased income may have on substance abuse were raised by community residents and stakeholders. These concerns are recognized and are consistent with the assessment that increased wealth may lead some individuals to increase their consumption of substances. However, PDW is also expected to have a positive overall effect by raising the "opportunity cost" of substance abuse and by providing knowledge and support to actively encourage individuals to recognize and deal with their addictions and unhealthy practices.

Considering these interactions, there is a reasonable probability that a moderate negative outcome may be noticeable during a brief transitional period of adaptation to the income generated by PDW. Should this occur, some increase in substance abuse incidents would be noticed by front line workers. This overall negative residual effect of PDW on substance abuse is assessed to be not significant due to its short duration and moderate magnitude.

Over the medium term of PDW and extending beyond PDW termination, an overall positive residual effect on substance abuse is anticipated to arise due to improved attitudes and increased "opportunity cost" brought about by PDW. This positive effect is expected to be moderate—noticeable by front-line workers but not necessarily perceived generally in the community. This positive residual effect is assessed to be not significant based on the moderate magnitude and a moderate level of uncertainty related to its occurrence.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Prediction confidence and risk assessment

Component Assessment: Transport of Substances through Project Site

Confidence in the assessment that importation of drugs and alcohol through PDW site will not have a significant effect on substance abuse in the North Baffin LSA is high. This confidence is contingent on proposed mitigation, including the prohibition of substances on site as well as the on-going implementation of effective baggage search protocols throughout the life of PDW.

Determination of Overall Significance of PDW on Substance Abuse

Confidence in the assessment that PDW has no significant adverse effect on levels of substance abuse is moderate, due to the complexity of the factors determining substance abuse.

A risk to the assessment may lie in the level of engagement of family members in mitigation programs designed to support healthy living and healthy attitudes toward substance utilization. Project-generated income may enter the entire household, but orientation and training activities and other on-going measures might tend to focus more on workers than on their partners. The planned mitigation does provide access for support to family members, however there is uncertainty related to how well this will be picked up by those individuals.

Follow-up

The incidence of seizures of drugs or alcohol at PDW sites will be monitored in order to inform future developments.

Determination of Overall Significance of PDW on Substance Abuse

The potential adverse effects of PDW on substance abuse is probably the social issue of greatest concern raised by community residents. Baffinland will be able to monitor and evaluate substance abuse-related incidents that arise during the course of PDW, such as the number of individuals whose employment with the Company is terminated as a result of substance issues.

13.6.2 Subjects of Note

Employment during the PDW phase may lead to several additional effects related to the Human Health and Well-Being VSEC. Of particular interest is how the well-being of children may be affected in households where one or more residents are engaged in PDW.

Well-being of Children

Fly-in/fly-out work presents both rewards and challenges to families and households related to the coming and going of working family members. In this context, a particular issue of interest is how children fare under these situations. This issue is assessed in detail in Section 6.2 of the DEIS (2011).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

It is noted that many households have gained experience in fly-in/fly-out work during the bulk sample phase. These families will understand the challenges associated with this work and can make choices and arrangements based on this experience.

For most children, having a parent working at PDW will be experienced as an overall benefit. A minority of children may experience temporary, negative effects related to this employment. However, in the context of PDW, both the negative and positive effects on child well-being are expected to be modest and of short duration.

Other issues or relevance to human health and well-being

Positive mental health effects may be associated with employment and with the income associated with employment. This income is also expected to reduce economic stress within households and improve food security by improving the ability to purchase groceries and to undertake harvesting activities. However, since the PDW activities will be of such short duration, these effects will be temporary are not considered further.

The fly-in/fly-out nature of PDW means that local workers will be coming and going from the community. In large numbers this could have an effect on community stability. For example, participation in community events and sports activities could be affected. Given the short duration of PDW this is not considered to affect community processes.

The potential for injury on-the-job is also recognized. It is assumed that accidents leading to personal injury will occur. Most injuries should be minor, however some serious and potentially life-changing or even fatal injuries may occur. However, these incidents are not expected to be frequent as PDW is designed to include a strong focus on worker safety. Further, safety and risk awareness skills gained during PDW employment may be carried over to community life, thereby reducing injury in the community setting.

13.6.3 Impact Statement

Effects of PDW on Human Health and Well-Being will primarily arise from the employment relationship that is engaged in by some households in the LSA. These effects will be mostly positive, however both positive and negative effects are expected to be not significant due to the short term nature of PDW.

Potential for Cumulative Effects

The potential for negative residual effects on substance abuse and absence from the community arising from PDW are carried over to the cumulative effects assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.7 Community Infrastructure and Public Services

The Community Infrastructure and Public Services VSEC addresses indicators related to local services and infrastructure.

The ability of hamlets to retain and recruit staff is an issue of concern that is raised in relation to community infrastructure and public services that may be relevant to PDW when major new employment opportunities emerge in a region. This is relevant to PDW, and is assessed here.

Other issues such as increased demand for infrastructure and services, and the potential for synergistic partnerships are sometimes raised. These are not considered here, as the scope of PDW is not expected to lead to interactions in these areas.

13.7.1 Recruitment and Retention of Hamlet Workers

Community concerns related to effects on hamlet staffing outcomes are typically raised in the context of a tightening of the labour market for licensed drivers and heavy equipment operators. These are the types of positions most likely to be affected by PDW.

"Loss" of some hamlet employees to PDW should be anticipated. A few full-time workers may choose to leave hamlet jobs for work during PDW. In addition, the pool of workers formerly drawn on by hamlets for casual work may be reduced as these individuals find full time work at PDW. Factors that are expected to influence individual choice may include the number of hours of work available (full-time versus part-time), the fly-in/fly-out nature of PDW employment versus work in the community, potential for a wage and benefits differential, supervisory support, and career development opportunities.

For individual residents, the shift from a "buyers" market to a "sellers" market for labour supply will be a good thing. However, the potential for disruption of municipal services is recognized to be a negative effect. It is this latter effect that is assessed here.

In relation to the local hamlet work force, PDW are seen as a slow ramp-up toward the larger Mary River Project. To mitigate labour force capacity issues, local people will be provided with training opportunities, as described earlier in Section 8.2. These activities will support the development of local labour force capacity.

Assessment of Residual Effects

Ratings of the assessment criteria for labour market competition and for labour force capacity on the ability of hamlets to recruit and retain the workers they require are presented in Table 13-3, "*Effects Assessment Summary - Hamlet Staff Recruitment and Retention*."

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 13-3: Effects Assessment Summary – Hamlet Staff Recruitment and Retention

Key Indicator: Hamlet Staff Recruitment and Retention		
VSEC: Community Infrastructure and Services		
Effect	**Competition for Skilled Workers**	**Labour Force Capacity**
Design / Mitigation Measure(s)	Early start for skills training	Employment experience
Direction	Negative	Positive
Geographic Extent	Point of hire communities	Point of hire communities
Social Extent	Community	Community
Equity	Bystanders	Bystanders
Magnitude	Low	Low
Frequency	Infrequent	Occasional
Duration	Short term	Short term
Reversibility	Reversible	Non-reversible
Significance of Adverse Residual Effects	Not significant	No adverse residual effects
Significance of Beneficial Residual Effects	No beneficial residual effects	Not significant
Probability of effect occurring	High	High

Note(s):

1. For individual residents, the shift from a "buyers" market to a "sellers" market for labour supply will be a good thing. However, the potential for disruption of municipal services is recognized to be a negative effect, hence the "negative" direction.

Over the short term period of the PDW, increased competition for labour is anticipated to be experienced by some hamlets, as they may face challenges in their ability to retain and recruit workers. While this will be a positive effect for local skilled workers, hamlet employers may experience this as a negative effect.

The community-level outcomes, should hamlets experience skills shortages, may include longer wait times for water delivery or sewage pump out services or reduced levels of service in other areas of hamlet responsibility. These outcomes may on occasion be perceived as an inconvenience but are not expected to lead to any serious health or safety concerns, as hamlet management will be able to allocate its resources to these areas on a priority basis.

The magnitude of short-term staffing challenges is expected to be low, given the scope of PDW. Workers who gain skills during PDW will bring these new skills and experience to other employers and other projects when they terminate their employment in the PDW. Therefore, while the

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

challenges to hamlet hiring will be short-term and reversible, the improvements will continue beyond completion of the PDW, with increased labour force capacity continuing as a non-reversible benefit into the future. Some of these trained and experienced former PDW employees may choose in the future to seek community-based employment instead of pursuing opportunities for fly-in/fly-out work at future projects.

Significance Determination

Negative residual effects of PDW on hamlet recruitment and retention are determined to be not significant, due to the short term duration and low magnitude of these effects. Positive residual effects are expected to accrue as training and experience builds in the local labour force. Within the narrow window of PDW, these capacity improvements are not expected to be significant due to the moderate magnitude and short duration of these activities.

13.7.2 Impact Statement

PDW may lead to some residual adverse effects on the ability of hamlets to recruit and retain workers as the level of competition for these workers increases due to PDW hiring. However, these effects are not considered to be significant, based on their short-term duration and due to the off-setting effects that will arise from PDW-related labour force capacity development.

Potential for Cumulative Effects

The potential for negative residual effects that PDW may have on competition for skilled public service workers over the short term is carried over to the cumulative effects assessment.

13.8 Contracting and Business Opportunities

The Contracting and Business Opportunities VSEC addresses indicators related to PDW effects on the business sector of the RSA and LSA economy. This VSEC is addressed as a subject of note.

13.8.1 Subjects of Note

Issues of importance related to contracting and business opportunities include potential opportunities for small local businesses as well as for the larger birthright corporations, and increased local business arising from increased wealth. The potential for increased competition for skilled employees to affect local businesses is also identified. Given its modest scale and short duration, none of these areas are expected to be substantially affected by PDW.

Rather than creating direct opportunities for local and regional businesses, the PDW will serve as an important strategic step toward advancement of the Mary River Project. Initiation of PDW is expected to trigger collaborative preparations between Baffinland and Inuit businesses for business partnerships with local and regional businesses so that these can come up to speed quickly should the Mary River Project commence.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Employment income flowing into local communities from individuals hired from these communities will be substantial but of short duration. It may provide a short boost to local retail sales. Local purchases by Baffinland and its contractors to support PDW may also lead to increased local sales. These one-time infusions into the local economy are not expected to lead to business expansion, given their transitory nature.

13.8.2 Impact Statement

The direction of PDW effects on the Contracting and Business Opportunities VSEC are assessed to be positive. However, given the short-term duration of these activities these effects are not expected to lead to significant positive outcomes for local contracting and business.

Potential for Cumulative Effects

PDW is not expected to generate negative residual effects on the business sector. No residual effects are carried over to the cumulative effects assessment.

13.9 Cultural Resources

The Cultural Resources VSEC assessment addresses archaeological sites, special places, historical sites, and gravesites. The PDW will entail advanced implementation of a portion of the project activities that were assessed in DEIS Volume 4 (2011), Section 9. The DEIS assessment is fully applicable to the PDW assessment.

Several conclusions of the archaeological assessment are important to the PDW. First, without distinguishing between the age/source of an archaeological site, it is concluded that archaeological sites are viewed by Inuit as important to their own heritage. Further, Inuit continue to use many of the same areas as their ancestors and other groups who preceded them, and they view the following of their ancestors footsteps as an important element of their cultural heritage. Secondly, mitigation measures that will be implemented, as described in the DEIS Volume 4 (2011), are sufficient to ensure the activities undertaken during PDW will not lead to any significant adverse effects on the Cultural Resources VSEC.

13.9.1 Impact Statement

PDW will not result in significant adverse effects on cultural resources. Appropriate procedures including excavation and flagging will be undertaken prior to development to limit the effect of PDW on cultural resources in the area.

Potential for Cumulative Effects

Negative residual effects generated by PDW on the Cultural Resources VSEC are carried over to the cumulative effects assessment. These relate to the disturbance of PDW activities on archaeological and other cultural resources.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.10 Resources and Land Use

The Resources and Land Use VSEC assessment focuses on how PDW may affect Inuit access to wildlife and other renewable resources, as well as how Inuit make use of the land within the land use study area Figure 13-4, "*Land Use Study Area*" (DEIS Figure 4-10.1) illustrates key features of this area. Due to the open water shipping, short duration, and limited spatial extent of PDW, no substantial effects are anticipated. Issues of potential concern are therefore addressed as subjects of note.

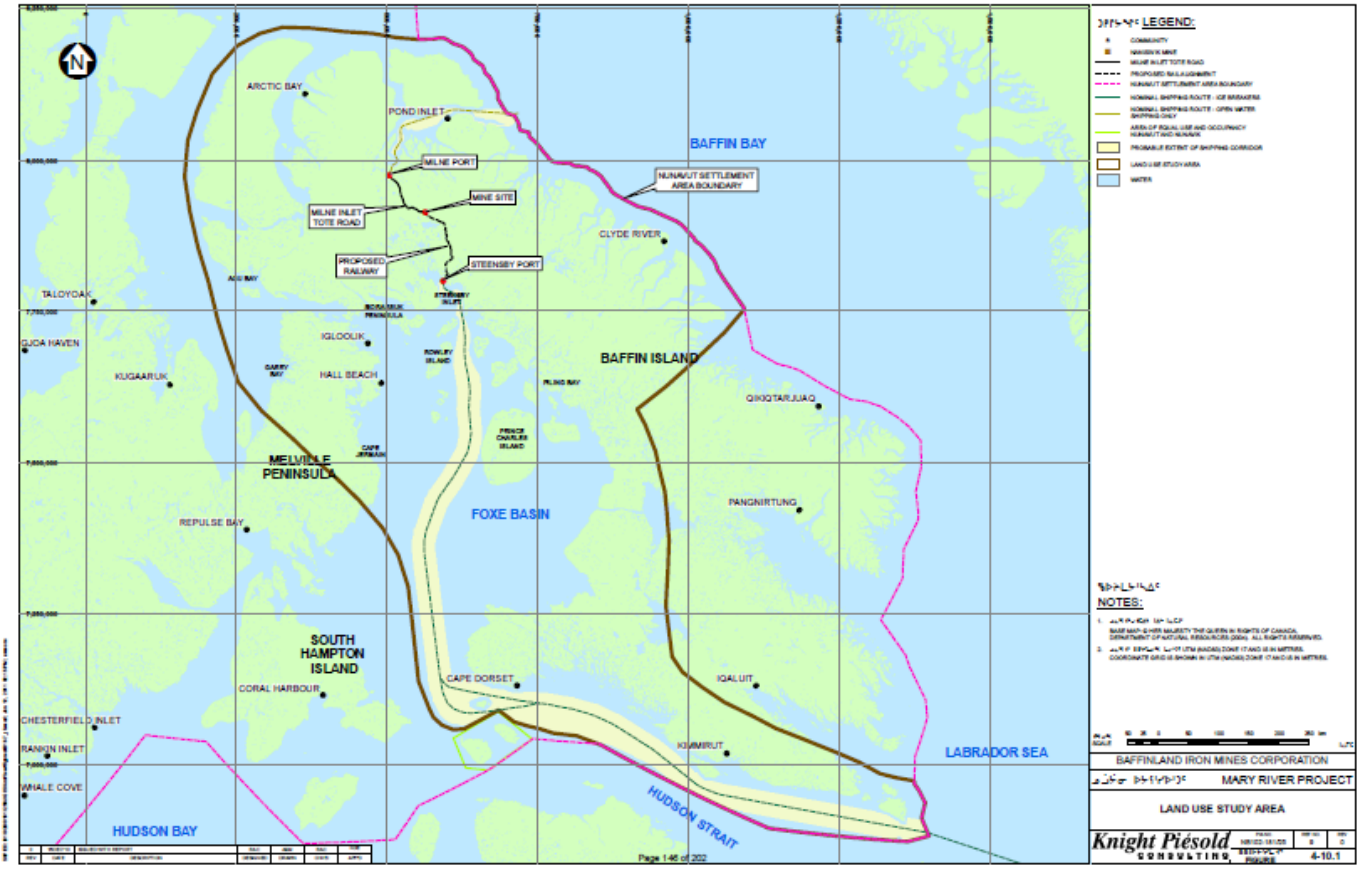


Figure 13-4: Land Use Study Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

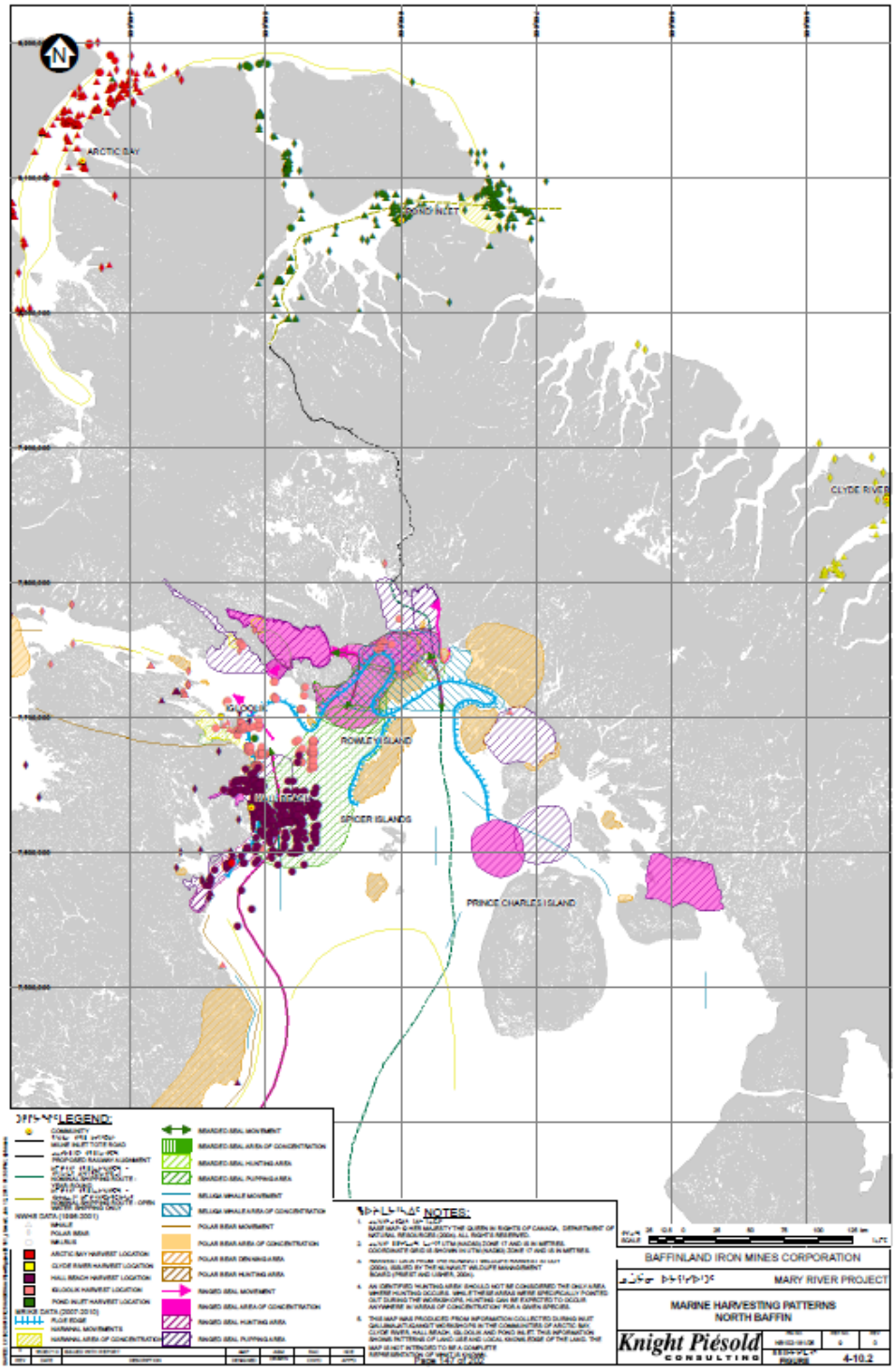


Figure 13-5: Marine Patterns – North Baffin

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

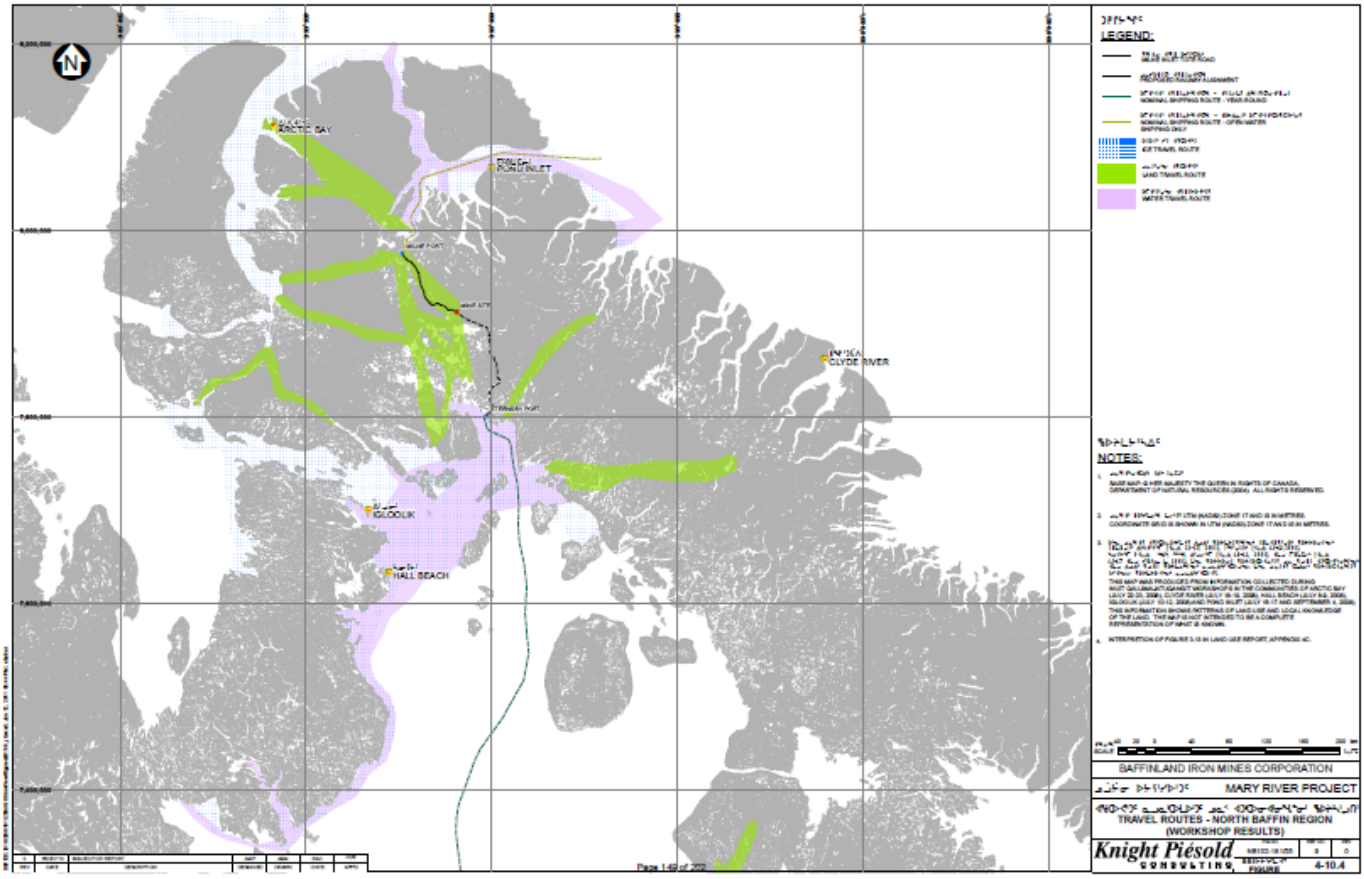


Figure 13-6: Travel Routes – North Baffin Region (workshop Results)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

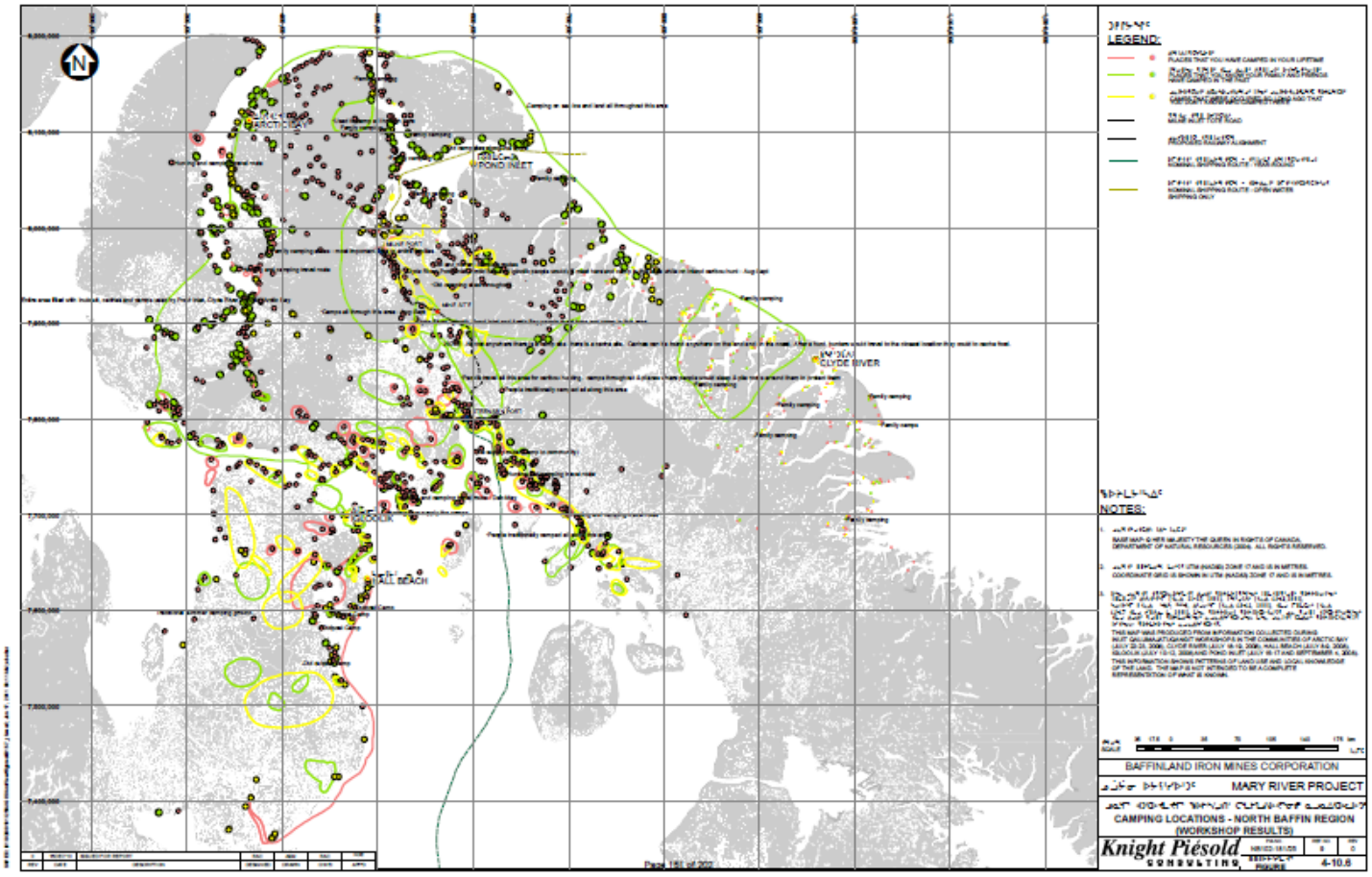


Figure 13-7: Camping Locations – North Baffin Region (Workshop Results)

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.10.1 Subjects of Note

The assessment focuses on how PDW may affect Inuit harvesting, particularly in relation to four mammal species. These include: narwahl, walrus, caribou, and polar bear. In addition, effects of PDW on Inuit travel and camps within the land use study area are presented.

Narwhal

Narwhal are commonly harvested by Pond Inlet residents. North Baffin LSA harvest data presented in Figure 13-5, "*Marine Harvesting Patterns North Baffin*" (DEIS 2011 Figure 4-10.2) suggests that narwhal harvesting is carried out within Milne Inlet, and throughout Eclipse Sound and Pond Inlet, including at the floe edge at Pond Inlet. The marine mammal impact assessment (Volume 8, DEIS 2011) focuses mainly on the movement of ships in and out of Milne Inlet during summer, when narwhal are present in large numbers. Vessel movements through Eclipse Sound into Milne Inlet will be frequent during PDW.

Mortality of narwhal as a result of the project is not expected. Further, effects to narwhal habitat are not predicted. Therefore, population level effects are not anticipated. Changes to distribution of narwhal are also not expected to arise due to the PDW shipping activities. Aerial surveys carried out during shipping of the bulk sample documented the movements of large groups of narwhal between various areas of Eclipse Sound and surrounding fjords, and could not detect a change in movement patterns that could be attributed to the ship presence.

As a consequence, PDW–related disturbances to narwhal hunting are not expected to arise from impacts on narwhal themselves. Some effects may arise from the fact that hunting will need to avoid proximity to sealift ships. Given that Milne Inlet is only one area of hunting, disturbance effects even during the height of sealift activities are expected to be modest, and that PDW will affect only one hunting season, harvesting activities of narwhal are not expected to be meaningfully affected.

Beluga and Walrus

Beluga and walrus are the main larger marine mammal species hunted in Northern Foxe Basin. Beluga and walrus mortalities as a result of PDW are not expected. Changes to the distribution of walrus as a result of PDW sealift activities are not anticipated in the DEIS (2011). As a result, harvesting of walrus in Foxe Basin is not anticipated to be affected by PDW.

Changes to the distribution of beluga in Foxe Basin as a result of Project disturbances are variable in that belugas' response to shipping varies from avoidance of the area to ignoring the disturbance. The DEIS (2011) predicted that belugas would avoid ore carriers travelling during the open water season along nominal shipping route by 6 to 7 km depending on the vessel location and speed. If similar effects are found in relation to PDW sealift activities, a zone of disturbance may be generated for this species.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

However, as presented in Section 10.4.2, DEIS Volume 4 (2011) most harvesting activities, according to harvest data and IQ, occurs close to the community and to the west of Rowley Island. This is illustrated in Figure 13-5, "*Marine Harvesting Patterns North Baffin*" (DEIS 2011 Figure 4-10.2). The ships' zone of disturbance is distant from these areas. This, combined with the short duration of PDW leads to a conclusion that the harvesting of beluga and walrus in Foxe Basin by Igloolik and Hall Beach residents will not be significantly affected.

Caribou

Interactions between PDW and caribou harvesting are not anticipated to be substantial. The DEIS (2011) concluded that no detectable change in the abundance and distribution of caribou would result from the Mary River Project. Further, residual effects on the habitat, movement, and mortality of caribou would be not significant (DEIS Volume 4 2011, Section 10.4.2). PDW will have fewer residual effects on caribou than the Mary River Project. This is due to the focus of PDW on off-loading of materials at Milne Inlet and Steensby Inlet, and transportation of materials to the Mary River site over a short period of time. As a result, PDW will have no significant effect on Inuit harvesting of caribou.

Polar bears

The potential for destruction of nuisance bears as a last-resort safety measure is acknowledged to arise with any land-based activities in the land use study area. Location of PDW in the Steensby and Milne Inlet areas falls within areas where human – bear encounters are likely to arise. In the event that a bear has to be destroyed, this will lead to the loss of bear quota from the designated community. While compensation will be paid to the respective HTO for this loss. However the probability that a bear kill will be required is low, based on the experience gained during Mary River development activities to date. Further, since PDW will take place over a short period of time should such a kill be necessary it would have no significant effect on hunter access to polar bear tags overall.

Travel and camps

Figure 13-6, "*Travel Routes – North Baffin Region*" (DEIS Figure 4-10.4) and Figure 13-7, "*Camping Locations - North Baffin Region*" (DEIS Figure 4-10.6) illustrate Inuit land use patterns in the North Baffin region of PDW. The effects that PDW may have on Inuit travel and camping activities are defined by the open water nature of shipping and the concentration of land-based activities at Steensby, Milne Inlet, and at the Mary River site. Some interactions may also arise from PDW use of the tote road connecting Milne Inlet to Mary River. These interactions are expected to be benign in terms of their effect on Inuit travel and camping behaviours and in terms of public safety.

Public safety related to PDW sealift traffic will be mitigated by community public safety awareness campaigns, informing the community of vessel movements, potentially tracking route, and timing of ship's passage, and by periodic public meetings and information sessions. Public safety related to the

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

industrial sites of Steensby, Milne Inlet, and Mary River site will be mitigated by procedures to encourage travelers inform PDW staff of their presence and travel plans.

The presence of PDW in the land use study area will have some effect on camping areas, as discussed in the DEIS Volume 4 (2011). The combined effects of certain project interactions (i.e. noise, dusting, lighting, visual change to the landscape, etc) could be perceived as negative effects and may cause some Inuit to avoid some of these areas. Others may be satisfied to make use of the services available at these sites. Given the short duration of PDW, these interactions are considered to be negligible in their overall effect on Inuit land use.

13.10.2 Impact Statement

Given the short term nature of PDW and the nature of interactions with the Resources and Land Use VSEC, effects from PDW on this VSEC are considered to be not significant.

Potential for Cumulative Effects

Negative residual effects generated by PDW on the Resources and Land Use VSEC are carried over to the cumulative effects assessment. These relate to the effect of development activities on Inuit land use.

13.11 Cultural Well-Being

The Cultural Well-Being VSEC addresses indicators related to the interaction between PDW and Inuit culture. These are addressed as subjects of note.

13.11.1 Subjects of Note

For those Inuit who choose to engage in PDW employment, these activities will be of a similar nature to other activities that are familiar to many residents of the LSA. These include remote fly-in/fly-out rotational employment, receiving and handling sea-lift materials, earth-moving and construction activities, and living in remote, multi-cultural camp settings.

The short duration of PDW is not amenable to generating lasting interactions with the Cultural Well-Being VSEC. Its more substantial interaction may be its role in advancing implementation of the Mary River Project by one year. The effects of the Mary River Project on culture is assessed in the DEIS (2011).

13.11.2 Impact Statement

Given the short term nature of PDW, interactions with Inuit culture arising from these activities are considered to be not significant.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Potential for Cumulative Effects

PDW is not expected to generate negative residual effects on the Cultural Well-Being VSEC. No residual effects are carried over to the cumulative effects assessment.

13.12 Benefits, Royalty, and Taxation

PDW will generate monetary benefits and tax revenues for Inuit and government. However, these will be of short duration. For this reason revenues to Inuit and to the Nunavut government are addressed as subjects of note.

13.12.1 Subjects of Note

Importance of PDW to advancement of Mary River Project benefits

PDW are intended to permit commencement of the Mary River Project's construction phase a full year earlier than would be possible in the absence of these activities. This, in turn, means that benefits that are anticipated to be generated by the Mary River Project to begin flowing to government and Inuit a year earlier than they otherwise would. A description of these benefits is provide in the DEIS (2011).

Territorial government own-source revenues

Revenues to the territorial government generated directly by PDW will include payroll taxes on income earned by all qualifying PDW employees, tax paid on income earned by Nunavut residents, and fuel taxes. These are expected to total between $7.5 and $10 million in 2012, accounting for less than 1% of total territorial government revenues. It is noted that this level of taxes would represent roughly 10% of Nunavut's own-source revenues in 2012. This is a substantial beneficial effect. However, PDW will only generate this level of revenue for one year.

Benefits to Inuit

PDW will generate quarry royalties to the respective land owners—QIA and Canada. This will entail payments estimated to exceed $1.5 million to QIA. These payments will represent a short-term flow of benefits, reflecting the nature of PDW.

An IIBA pertaining to the Mary River Project is currently being negotiated. This agreement will not be implemented within the timeframe of PDW, however. The PDW are considered to be a critical step in the advancement of the Mary River Project, allowing it to commence a full year earlier than it otherwise could. From this perspective, PDW will have a strategic value in bringing the benefits negotiated in the IIBA closer to fruition.

PDW may also interact with territorial social expenditures, such as levels of income support assistance, housing rental subsidies, demands for child care and other government-supported services. These effects will be modest and short-term, given the scale and duration of employment and income generated in the LSA.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

13.12.2 Impact Statement

The short duration and modest amounts of tax revenues and other monetary payments that will flow from PDW to the territorial government and Inuit suggests that the beneficial effects of PDW would not, on their own, be significant. However, PDW will also lead to an earlier flow of the benefits that are expected to arise from the Mary River Project. This is considered to lead to a conclusion that PDW will have a significant effect on the Benefits, Royalty, and Taxation VSEC.

Potential for Cumulative Effects

No adverse residual effects are assessed. Therefore no residual effects are carried over to the cumulative effects assessment.

13.13 Governance and Leadership

The Government and Leadership VSEC addresses indicators related to the interaction between PDW and the various strategic priorities and initiatives of Nunavut's leadership. These are addressed as subjects of note.

13.13.1 Subjects of Note

Strategic value of PDW

The Government and Leadership VSEC addresses the interaction between PDW and the various strategic priorities and initiatives of Nunavut's leadership. As PDW serve to facility future mining development—namely the Mary River Project—it fits well both the Nunavut Economic Development Strategy and the Mineral Exploration and Mining Strategy, "*Parnautit.*"

Development of opportunities related to the mining sector is identified as a strategic priority in local community economic development plans. These plans particularly identify the need to build local capacity to participate in near-by mining projects both through direct employment relationships as well as through the direct and indirect business opportunities that may arise from these projects. PDW will fit well with these local strategic objectives. The employment and training opportunities generated during these activities will help to build capacity to participate in future fly-in/fly-out opportunities that may arise in the region, particularly should the Mary River Project proceed.

Project agreement governance regime

PDW will be carried out prior to implementation of the Mary River Project IIBA with QIA, and any Development Partnership Agreement (DPA) that may be negotiated with the Government of Nunavut.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Contribution to socio-economic monitoring

Baffinland has contributed in the past to regional socio-economic monitoring initiatives such as the Qikiqtani Socio-Economic Monitoring Committee (Q-SEMC) and intends to continue to do so into the future.

In this capacity Baffinland intends to work with relevant partners in the region to identify indicators of relevance to regional monitoring programs, share data generated by PDW activities, and discuss the interpretation of this data with others involved in these initiatives.

13.13.2 Impact Statement

PDW are considered to fit well with the strategic priorities identified for both the RSA as well as for the communities of the North Baffin LSA. Baffinland intends to contribute to socio-economic monitoring of importance to the region's leadership through partnerships with key players in the region. Therefore, PDW are considered to have a positive and significant effect on the Government and Leadership VSEC.

Potential for Cumulative Effects

No adverse residual effects are assessed. Therefore no residual effects are carried over to the cumulative effects assessment.

13.14 Summary and Conclusions

13.14.1 Impact Statements Summary

Impact Statement for the Population and Demographics VSEC

PDW are expected to have only negligible effects on the Population Demographics VSEC, due to the short duration of these activities. As a result, PDW will have no significant impact on this VSEC.

Impact Statement for the Education and Training VSEC

Considering the effects on lifeskills, training opportunities, and domestic responsibilities of students, PDW are expected to have a positive effect on education and training. However, given the short duration of these effects, this is not expected to be a significant overall effect. These "non-significant" effects are, however, recognized to have a importance in terms of positioning individuals from the LSA to benefit from further opportunities if and when the Mary River Project were to proceed.

Impact Statement for the Livelihood and Employment VSEC

PDW is assessed to have no significant adverse residual effects on the Livelihood and Employment VSEC. PDW will have a positive effect on wage employment in the North Baffin by introducing new job opportunities and assisting local residents to access these jobs. However, given their short duration, these effects are not considered to be "significant" relative to the overall state of Livelihood and Employment in the LSA.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Impact Statement for the Economic Development and Self-Reliance VSEC

The direction of the effects of PDW on the Economic Development and Self-Reliance VSEC are assessed, with a high level of confidence, to be positive, but of short duration. The more important contribution of PDW to territorial economic development and self-reliance is that it will advance implementation of the Mary River Project. For this reason, PDW are considered to be provide a significant positive effect on this VSEC.

Impact Statement for the Human Health and Well-Being VSEC

Effects of PDW on Human Health and Well-Being will primarily arise from the employment relationship that is engaged in by some households in the LSA. These effects will be mostly positive, however both positive and negative effects are expected to be not significant due to the short term nature of PDW.

Impact Statement for the Community Infrastructure and Public Services VSEC

PDW may lead to some residual adverse effects on the ability of hamlets to recruit and retain workers as the level of competition for these workers increases due to PDW hiring. However, these effects are not considered to be significant, based on their short-term duration and due to the off-setting effects that will arise from PDW-related labour force capacity development.

Impact Statement for the Contracting and Business Opportunities VSEC

The direction of PDW effects on the Contracting and Business Opportunities VSEC are assessed to be positive. However, given the short-term duration of these activities these effects are not expected to lead to significant positive outcomes for local contracting and business.

Impact Statement for the Cultural Resources VSEC

PDW will not result in significant adverse effects on cultural resources. Appropriate procedures including excavation and flagging will be undertaken prior to development to limit the effect of PDW on cultural resources in the area.

Impact Statement for the Resources and Land Use VSEC

Given the short term nature of PDW and the nature of interactions with the Resources and Land Use VSEC, effects from PDW on this VSEC are considered to be not significant.

Impact Statement for the Cultural Well-being VSEC

Given the short term nature of PDW, interactions with Inuit culture arising from these activities are considered to be not significant.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Impact Statement for the Benefits, Royalty, and Taxation VSEC

The short duration and modest amounts of tax revenues and other monetary payments that will flow from PDW to the territorial government and Inuit suggests that the beneficial effects of PDW would not, on their own, be significant. However, PDW will also lead to an earlier flow of the benefits that are expected to arise from the Mary River Project. This is considered to lead to a conclusion that PDW will have a significant effect on the Benefits, Royalty, and Taxation VSEC.

Impact Statement for the Government and Leadership VSEC

PDW are considered to fit well with the strategic priorities identified for both the RSA as well as for the communities of the North Baffin LSA. Baffinland intends to contribute to socio-economic monitoring of importance to the region's leadership through partnerships with key players in the region. Therefore, PDW are considered to have a positive and significant effect on the Government and Leadership VSEC.

13.14.2 Conclusion

The effects of PDW on the human environment are expected to arise mostly from interactions associated with employment of local residents during the thirteen-month duration of these activities.

An important defining feature of PDW in relation to its effects on the human environment is the short duration of these activities. Developmental processes such as changing attitudes toward the value of education, acquisition of accredited skills and advancement of careers, or the development of entrepreneurial capacity leading to business development simply will not have time to "incubate" over the thirteen month period of PDW. In addition, PDW will be carried out prior to implementation of the IIBA that is being negotiated in the context of the Mary River Project. Many of the initiatives planned in the IIBA to support attainment of Inuit benefits—including achievement of labour force capacity, business capacity, and overall community development objectives—may not be fully in place during PDW.

For these reasons, many of the beneficial effects that might typically be expected to be substantial are found in this assessment not to attain the combination of attributes, particularly in terms of their magnitude and duration, to be considered "significant." Similarly, the short term nature of PDW means that features of "project – human environment" interactions that might otherwise develop over time—such as effects on families and children, community stability, and cultural development—are not expected to be affected, even in the absence of IIBA-related mitigative measures.

A further feature of PDW that influences the assessment findings is the fact that these works will not generate the revenue flows typical of operating mines. In the absence of tax flows from corporate profits and royalty flows from the extraction and sale of minerals the cash contributions arising from PDW will be modest.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

In spite of the modest benefits expected to accrue in terms of contributions to major community and economic development objectives of importance to the affected communities and to the territory, the strategic value of PDW is evident. PDW activities cannot be fully assessed in isolation from their relation to the potential advancement of the Mary River Project. This context leads to several findings of "significant positive" effects.

PDW is assessed to have no significant negative residual effects on any component of the human environment. PDW is assessed to present significant positive effects related to the Economic Development and Self-Reliance VSEC, the Benefits, Royalty, and Taxation VSEC, and the Government and Leadership VSEC components of the human environment. These arise out of the strategic value of PDW in relation to the potential advancement of the Mary River Project, and to the advancement of potential taxes, royalties and other benefits accruing from that project by a full year

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

14. Air Quality and Climate Change

14.1 Air Quality

The Project is in a remote location with no existing local sources of air pollutants other than exploration facilities at the Mine Site area. Contaminants present in the air are primarily due to long-range transport from the more southerly industrial and urban areas located in North America and Eurasia.

This section identifies existing air quality conditions in the PDW area and describes potential effects of the PDW on air quality. Potential effects associated with the PDW were evaluated qualitatively on the basis of previous experience gained from the Bulk Sampling Campaign carried out in 2008.

The baseline conditions for air quality, noise and vibration within the PDW areas are discussed in Section 12 while the regulatory context and thresholds for air quality, noise and vibrations are presented in Section 11.2.

14.1.1 Air Emission Sources During PDW

Details of the PDW activities at the three sites are provided in Section 2 through 6.

The PDW activities will introduce new, local sources of air contaminants such as particulate matter (TSP, $PM_{10,}$ and $PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO) to the Project area. A reduction in air quality due to these emissions may, in the extreme, result in potential effects to vegetation or wildlife species; an ecosystem's structure or processes; or human health. These potential effects can either result from exposure to ambient air concentrations or from accumulation in (i.e., deposition to) the environment.

The sources of emissions are listed below:

Milne Port

The PDW activities at Milne Port that have the potential to affect local air quality include:

- Sealift activities
- Earthworks associated with the construction of laydown areas and pads for infrastructure such as camps, fuel storage tank foundations, and landfarm
- extraction of gravel from quarry and borrow area
- Operation of mobile equipment and generaters for electricity
- Incineration of domestic waste.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Milne Inlet Tote Road

The Tote Road is the only overland transportation link between the Milne Port and the Mine Site. During the PDW, the road and stream crossings will be maintained. Sections of the road will be upgraded to reduce hazards and risks. The PDW activities consist of:

- Improvement to the road base
- Realignment of the road where necessary to facilitate passage of large loads and fuel tanker trucks
- Improvement to the grade in certain areas
- On-going efforts to reduce risk at stream crossings through the implementation of the freshet management plan.

No work other than routine maintenance and some improvements to stream crossings are envisaged. Therefore, there is no requirement for an additional HADD authorization.

Large heavy loads will be transported during the winter months and over ice at stream crossings that do not have sufficient load bearing capacity. These crossings are likely limited to the four box culvert crossings. Damage to the stream bed and banks will be minimized through proper selection of crossing locations and the adoption of appropriate stream bank protection measures.

Mine Site

The PDW activities at Mine Site that have the potential to affect local air quality include:

- Upgrade of the airstrip
- Earthwork activities associated with construction of laydown areas and pad for infrastructure
- Development and operation of new and existing aggregate sources for rock, sand and gravel
- Operation of mobile equipment and generators for electricity
- Incineration of domestic waste.

Steensby Port

The PDW activities at Steensby Port that have the potential to affect local air quality include:

- Preparation of additional laydown areas and work areas
- Development of the airstrip and the access road from the port site to the airstrip
- Development and operation of quarries and borrow sources for construction of the port, airstrip and railway
- Construction of access road to the explosives storage area and preparation of the site for the emulsion plant

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Operation of mobile equipment and generators for electricity
- Incineration of domestic waste.

Cut and fill operations will occur at the airstrip and other development areas at Steensby Port, and will consist of drilling, blasting, screening and placement.

14.1.2 Issues Scoping

Air quality

For the PDW, potential effects to air quality can occur from vehicle emissions and dust emissions resulting from the earthwork activities.

Both gaseous and particulate emissions can result in air contaminants (i.e., TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO) which can be measured as concentrations on a mass of contaminant per volume of air basis ($\mu g/m^3$). The Valued Ecosystem Component and key indicator is air quality, and the above air contaminants are the measurable parameters.

Due to gravitational settling and other influences, TSP can be deposited to the earth's surface and potentially accumulate in terrestrial and aquatic systems. Here the contaminant is measured as deposition on a mass per area basis (g/m^2).

Climate Change and Greenhouse Gas Emissions

GHG emissions and climate change are concerns for all new developments. The source of GHG is related to fuel consumption during the PDW. Fuel consumption for PDW is estimated at 7.5 ML, which corresponds to .012 Mt CO_2 eq for the period of Q2 2012 to Q1 2013.

With respect to the range in the percentage of the Project's emissions to Nunavut's total, several different totals have been reported for Nunavut's annual GHG emissions. Environment Canada (2010a) reports a 2008 total of 0.36 Mt CO_2 eq. The Government of Nunavut (2003) reported 0.696 Mt CO_2 eq for the year 1995, and separately reported annual totals for the years 2000, 2005, 2006 and 2007 ranging from 0.412 Mt CO_2 eq to 0.472 Mt CO_2 eq (Government of Nunavut, undated). The Government of Nunavut (2003) source is thought to be most representative since the resultant per capita emissions for Nunavut align quite well with the per capita estimates for the Northwest Territories and Yukon.

Because of Nunavut's small population and manufacturing base, total GHG emissions in Nunavut are currently very low. The contribution of the PDW to Nunavut 2012 GHG emissions is expected to be .012 Mt CO_2 eq. On a national level, the emissions from the Project are very small, and compared with global emissions they are insignificant.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

14.1.3 Effects Assessment

A detailed emissions inventory and dispersion modelling assessment was not conducted for the PDW due to the intermittent and temporary nature of the PDW activities. Potential air quality effects were therefore assessed qualitatively based on previous experience and some ambient monitoring that was conducted over a three-week period (August 31 to September 23, 2007) at Milne Port during the preparation for bulk sampling (DEIS, January 2011, Appendix 5C-2)(1) . Activities during the bulk sampling included a sealift and ancillary equipment operations including, cranes, barges, a tugboat, and front-end loaders. In addition to the sealift operations, other activities during the monitoring period included five to seven aircraft flights a day, light-duty vehicle trips, and road construction. This is comparable to the types of activities that will be carried out during the PDW.

Residual effects are those that remain when all mitigation options have been incorporated into the Project design and operation. The PDW activities will occur at various intensities over the period of Q2 2012 to Q1 2013. Dust emissions will occur during earthwork activities, traffic and quarry operation. Best management practices will be adopted as mitigation measures for reducing dust emissions. These will include:

- Watering of roads and/or application of approved dust suppressants such as calcium chloride, as necessary, to reduce visible plumes when it is practical to do so (e.g., when temperatures are above freezing)
- Observe appropriate speed limits
- Optimum design of operations to avoid double handling of materials.

Mobile equipment, generators, boilers and camp incinerators will be the sources of gaseous emissions. A routine maintenance program will be implemented to ensure efficient operations of all equipment.

Due to the low intensity of the PDW activities and the implementation of best management practices, the resultant dust emissions and gaseous emissions are expected to be well below the regulated guidelines criteria for air quality. This is supported by Baffinland's experience at the site since 2008.

Effects Assessment

The criteria identified in Table 14-1 were used to rate the effects on air quality of these residual effects from PDW activities. The overall rating is a professional judgment based on consideration of the magnitude in relation to indicator thresholds, the geographic extent, the duration, frequency, reversibility of the effects and the certainty and probability of the occurrence.

For the PDW activities, the ambient concentrations of the air quality parameters will be at a Level 1 for the duration of the PDW. Concentrations in excess of the thresholds are predicted to generally be confined to the immediate vicinity work areas (within 100 m) and the effects are fully reversible.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

14.1.4 Impact Statement

The residual air quality effects are predicted to be NOT SIGNIFICANT. PDW activities at Milne Port, along the Milne Tote Road, the Mine Site, along the rail corridor and at Steensby Port are predicted to have a Level 1 magnitude, duration, extent, frequency and reversibility (see Table 14-2: Effects Assessment Summary - Air Quality). On the basis of repeated observations for similar activities, the level of confidence in this assessment is high and the certainty is high.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 14-1: Residual Effect Rating Criteria used for the Air Quality Assessment

Criteria	Rating Term	Definition
Magnitude	Level 1	The expected emission, ambient concentration, or deposition is less than the background value; is less than 10% of the indicator threshold; or the associated change is less than 5%
	Level 2	The expected emission, ambient concentration, or deposition is more than the background value; is less than the indicator threshold; or the associated change is greater than 10%
	Level 3	The expected emission, ambient concentration or deposition is predicted to exceed the indicator threshold
Geographic Extent	Level 1	The expected measurable changes are confined to the LSA
	Level 2	The expected measurable changes extend beyond the LSA
Duration	Level 1	The predicted effect persists briefly - no longer than several hours or several days for the duration of the PDW.
	Level 2	The predicted effect persists continuously for the duration of the PDW
	Level 3	The predicted effect persists beyond the duration of the PDW.
Frequency	Level 1	Predicted effects occur only a few hours per day for the duration of the PDW.
	Level 2	The predicted effect occurs continuously for the duration of the PDW.
Reversibility	Level 1	The predicted effect is reversible after the activity ceases
	Level 2	The predicted effect is reversible with cost/effort when the activity ceases
	Level 3	The effect cannot be reversed
Qualifiers		
Certainty	High	Baseline data is comprehensive; predictions are based on quantitative data; effect relationship is well understood
	Medium	Intermediate degree of confidence between high and low
	Low	Baseline data are limited; predictions are based on qualitative data; effect relationship is not well understood
Probability	Unlikely	Less than 20% likelihood of occurrence
	Moderate	Between 20 and 60% likelihood of occurrence
	Likely	Over 60% likelihood of occurrence

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 14-2: Effects Assessment Summary - Air Quality

Potential Effects			Evaluation Criteria				
Project Activity	Direction and Nature of Interaction	Mitigation Measures	Magnitude	Duration	Frequency	Extent	Reversibility
PDW and Closure/ Post Closure	Negative: increased concentrations of CACs	Best practices to minimize air emissions	**Level 1** The expected emission, ambient concentration, or deposition is less than the background value; is less than 10% of the indicator threshold; or the associated change is less than 5%.	Level 1 The predicted effect persists briefly - no longer than several hours or several days for the duration of the PDW.	Level 1 Predicted effects occur only a few hours per day for the duration of the PDW	Level 1 The expected measurable changes are confined to the LSA	Level 1 **Air Emissions** The predicted effect is reversible after the activity ceases Level 2 **Earthworks** The predicted effect is reversible with cost/effort when the activity ceases.

NOTE(S):

CACs = CRITERIA AIR CONTAMINANTS [TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, Fe, Mn, As, Ca, Co and POI (potential acid input)]

14.2 Noise and Vibration

The baseline conditions for noise within the PDW areas are discussed in Section 12 while the regulatory context and thresholds for noise are presented in Section 11.2.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

14.2.1 Issues Scoping

Noise and Vibration Issues

The Mary River Project site is in a remote location with no existing local sources of industrial noise or vibration. The PDW will introduce new, local sources of noise and vibration. Noise and vibration have the potential to affect wildlife species and human receptors. Table 14-3: Key Issues for Noise and Vibration, summarizes the noise and vibration issues, which have been addressed in qualitative manner for the PDW.

This assessment concentrates on comparisons with guideline limits and effects on human receptors. The effects of potential noise and vibration effects on other biophysical components, including wildlife and human health, are addressed separately by the appropriate disciplines.

Table 14-3: Key Issues for Noise and Vibration

Project Phase	Key Issue	Relevance to Project
PDW and closure/post-closure	Noise	Construction and decommissioning of PDW facilities, may generate substantial amounts of noise, which can affect human receptors and other VECs, such as wildlife.
	Vibration	

With respect to vibration, this assessment focuses on ground-borne vibration that may be perceptible to humans or wildlife.

Valued Ecosystem Components and Indicator Selection

High levels of environmental noise and vibration can affect people by impairing their enjoyment of using the land. High noise and vibration levels can also affect wildlife, causing changes in behaviour or avoidance of affected areas, for at least temporary periods of time. Environmental noise and vibration levels are therefore Key Indicators for assessing the significance of residual effects.

Noise Guidelines

There are no regulations or guidelines in Nunavut that address environmental noise levels. Good management practices are required to reduce the potential for effects.

14.2.2 Noise Effects

Effects during the PDW and closure and reclamation phases were assessed qualitatively. Sound levels from deliveries by sealift at Milne Inlet and bulk sampling activities at Mine Site were assessed as part of a monitoring program conducted in September 2007 and 2008.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Noise emissions will originate from:

- Mobile equipment, generators and incinerators
- Blasting and crushing operation at the quarries.

Due to the limited and intermittent nature of PDW activities, potential effects of noise were assessed qualitatively based on:

- Previous experience and some limited noise monitoring that was conducted in September 2007 at Milne Inlet during the preparation for the bulk sampling phase
- Noise monitoring conducted at Mary River during bulk sampling activities in April 2008.

There may be elevated noise levels at the hunting camp located at the east side of the beach, which is occasionally used by Pond Inlet hunters.

14.2.2.1 Milne Port

The PDW activities at the Mine Site with the potential for noise emissions include:

- Upgrade of the airstrip
- General earthwork consisting of preparation of laydown areas, infrastructure pads and access roads
- Development and operation aggregate sources for rock, sand and gravel.

As a result of these activities, noise levels at some locations within the Milne Port area may be moderate to loud. Louder noise levels would occur in closer proximity to the noise sources (quarry and mobile equipment). With the exception of blasting at the quarry, it is unlikely that the PDW noise will extend out to 1.5 km from the PDA of the PDW. This may affect the aesthetic use of the eastern end of the beach by residents of Pond Inlet, if or when they seek to use the area for camping. The duration of effect from PDW activities is short-term (Q2 2012-Q1 2013), the frequency of effect is occasional and the effect is reversible.

Conclusions

Elevated noise levels may occur near construction activities at the Milne Port; however, significant effects are not anticipated.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

14.2.2.2 Mine Site

Activities, Equipment and Schedule

The PDW activities at the Mine Site that have the potential to affect local noise levels include:

- Earthworks associated with the preparation of laydown areas, infrastructure pads and access roads
- Development and operation of aggregate sources for rock, sand and gravel.

It is unlikely that PDW activities noise at the Mine Site will generate audible noise that extends out to 1.5 km from the PDA. Noise levels at some locations within the Mine Site area may be moderate to loud. The duration of effect from PDW activities is short-term, the frequency of effect is occasional and the effect is reversible.

Conclusions for Mine Site

Elevated noise levels may occur near PDW activity. However, significant effects are not anticipated.

14.2.2.3 Steensby Port

Activities, Equipment and Schedule

The PDW activities at Steensby Port that have the potential to affect local noise levels include:

- earthworks associated with the preparation of laydown areas, infrastructure pads and access roads
- development of the airstrip and the access road from the port site to the airstrip
- development and operation of aggregate sources for rock, sand and gravel to be used in the above construction activities

PDW activities at Steensby Port have the potential to generate audible construction noise. This noise may extend out to 1.5 km from the PDA. Noise levels at some locations within the Steensby Port area may be moderate to loud. The duration of effect from PDW activities is short-term, the frequency of effect is occasional and the effect is reversible.

Conclusions

Elevated noise levels may occur near PDW activity. However, significant effects are not anticipated.

14.2.2.4 Aircraft Take-off and Landing at Mary River, Milne and Steensby

The airstrips at Milne and the Mine Site will be used on a regular basis for the duration of the PDW and used to land turboprop aircraft such as the Bombardier Dash 8. At the on-set of PDW, workers will be transported from the Mine Site to Steensby by helicopter until the Steensby airstrip if operational. The expected air traffic for each site is presented in the table below. The airstrip at

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Steensby will be under construction for the better part of the PDW, and utilized during the latter period of the PDW for use. Please refer to Section 9.2 for the estimated number of freights.

The primary mitigation of aircraft noise is adherence when safe at practical flight altitude requirements specified in land use permits of 600 m. Aircraft noise disturbance will be concentrated within a limited area surrounding each of the Project sites.

Due to the localized and intermittent nature of aircraft noise, noise effects from aircraft are expected to be minor.

14.2.3 Assessment of Residual Effects

The overall rating is a professional judgment based on consideration of the magnitude in relation to the geographic extent, the duration, the frequency and the reversibility of the effect. Residual effects from the PDW are considered to be minimal for noise. The extent of effects is limited to areas directly surrounding the Mine Site, Steensby Port, and Milne Port.

Table 14-4: Effects Assessment Summary - Noise presents a summary of the potential effects applicable to each site. Noise effects are anticipated to include small exceedances during the PDW (blasting at quarries). These effects are confined to the PDA, area short in duration and are fully reversible.

Table 14-4: Effects Assessment Summary - Noise

Potential Effects			Evaluation Criteria				
Project Activity	**Direction and Nature of Interaction**	**Mitigation Measure (s)**	**Magnitude**	**Duration**	**Frequency**	**Extent**	**Reversibility**
PDW and closure phases: all	Negative: increased noise levels	Mufflers on mobile equipment, adherence to flight altitude requirements	Level 2 Daytime affect for duration of PDW	Level 2 (throughout PDW and closure operations)	Level 2 Daily for duration of PDW	Level 1 Within PDA	Level 1 fully reversible

14.2.4 Impact Statement

The residual noise effects for the PDW are predicted to be NOT SIGNIFICANT. PDW activities contributing to noise at Milne Port, along the Milne Tote Road, the Mine Site and at Steensby Port are predicted to have a Level 2 magnitude, duration and frequency. The extent is limited to the immediate vicinity of the activity and effect is fully reversible (see Table 14-4). On the basis of repeated observations for similar activities, the level of confidence in this assessment is high and the certainty is high.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

14.3 Vibration

The source of vibration during PDW activities will be from the development and operation of quarries at Steensby Port and the Mine Site, and, to a limited extend, from blasting required for some of the earthwork (levelling off the ground for air strip and in some cases, preparation of laydown areas and roads).

PDW blasting operations related to cut and fill activities and exploration of quarries at the Mine Site, Milne Port or Steensby Port have the potential to generate perceptible vibration levels that extend outwards from blasting activities. The duration of effect from PDW activities is short-term, the frequency of effect is occasional and the effect is fully reversible. Therefore, the residual effects associated with vibration are deemed Not Significant.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15. Terrestrial Environment

15.1 Landforms, Soils, and Permafrost

Pre development works (PDW) are proposed to occur between Q2 2012 to Q1 2013. The work will largely include the delivery and staging of materials and equipment at Milne and Steenby Ports. The full extent of PDW at each of the locations in the Project area are described in Section 2 Section 6 of this document. The effects assessment for terrestrial Valued Ecosystem Components (VECs) focuses on PDW activities of Milne Port, the Tote Road, the Mine Site, and Steensby Port.

15.1.1 Issues Scoping

Sensitive landforms are the key indicator for assessment within the landforms, soils and permafrost VEC, based on the scoping process and the criteria presented in Volume 2, Section 3 of the DEIS. Thaw sensitive soils and massive ice deposits common to permafrost regions including the Project area, are the most common sensitive landforms in the RSA.

PDW works occurring at Milne Port, the Milne Inlet Tote Road, the Mine Site and Steensby Port all have the potential to effect landforms, soils and permafrost.

15.1.2 Assessment Methods

Ground disturbance during PDW activities such as excavation/cuts, fills, and changes to drainage patterns can change the thermal regime and induce thaw settlement. Therefore, road construction, development of borrow areas for aggregate, and the clearing of Project development areas have the potential to affect sensitive landforms.

Thaw weakening is due to inability to dissipate excess pore pressure upon melting of the soil and soil looses strength. This weakening occurs more often with soils that are fine grained and are saturated. These soils cannot support the weight of vehicles and equipment, and if excess weight is applied to these soils, severe rutting and erosion may occur.

15.1.3 Potential Sensitive Landforms

For the PDW, effects to sensitive landforms are primarily related to changing the thermal regime of permafrost. High ice content soils and thaw sensitive soils are the primary issues which lead to areas with potential for slope/ground instability. Areas of solifluction, active thermokarst, and previous/ongoing ground movements (slides) result from changes to thermal regimes and have been identified in the Project area as part of the geotechnical investigations carried out to date.

Potential effects from PDW relating to sensitive landforms for specific areas of the Project are summarized below.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.1.3.1 Milne Port

- Potential for ice-rich permafrost and ground ice
- Potential for saline permafrost (i.e. high salt content pore ice)
- Thaw sensitive ground.

15.1.3.2 Milne Inlet Tote Road

- Potential for shallow ice-rich soils and ground ice
- Thaw sensitive ground (Thaw Weakening/Liquefiable Soils).

15.1.3.3 Mine Site

- Thermokarst terrain in the air strip area
- Random subsurface massive ice deposits
- Ice-rich soil and rock

15.1.3.4 Winter Access Roads and Camps

- Ice rich soil and rock
- Thaw sensitive ground.

15.1.3.5 Steensby Port

- Potential for thermokarst development in ice-rich organic soils along road alignment; and
- Potential for saline permafrost (i.e. high salt content pore ice).

15.1.4 Potential Effects and Proposed Mitigation

Generally, the following PDW activities have the potential to affect sensitive landforms, where they occur:

- Fills over the existing ground which can change drainage patterns and consequently disrupt the thermal regime
- Earth moving: excavation, drilling, grading, trenching, backfilling
- Aggregate sources/ borrow sites: drilling, blasting, extraction, hauling
- Fuel storage: construction of bermed facility, operation of trucks
- Waste management: garbage and sewage waste facilities, including incinerator use;
- Water use and management: water supply intake, pumphouse, pipeline, ditching, ponding, berms, and snow management and stockpiling
- Construction of roads: land clearing, blasting, grading, water body crossings

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Power generation and distribution: installation of surface structures, land clearing
- Closure activities including dismantling and removal of infrastructure, demolition, drainage restoration, excavation and backfilling/plugging, waste management, and ground restoration, open pit closure, waste rock storage facility restoration, re-vegetation.

Avoidance of sensitive landforms and potential hazard areas is the first mitigation measure that has been used in the planning of PDW to date. Not all areas of concern can be avoided. The following sub-sections provide an overview of the site specific potential effects and the proposed mitigation measures to be used in development of the PDW.

15.1.4.1 Milne Port

Project activities at Milne Port to date have consisted of the development of camp facilities, upgrades to an airstrip, laydown areas, sewage ponds and tank farm. Due to the geological composition there has been minimal thaw settlement and thaw weakening identified to date. Standard issues related to the creation and control of sediment and erosion has been the focus, although standard measures for design and construction of foundations in/on permafrost soils will be used. Wet areas (i.e. west and south of airstrip) that are covered with a substantial layer of organics over thaw sensitive soils will be avoided for PDW to the maximum extent possible and infrastructure will be established in areas with better ground conditions where possible. At Milne Port, the majority of PDW will occur in areas already occupied by past Project activity. For PDW at Milne Inlet laydown areas and various infrastructure may interact with sensitive landforms:

General permafrost mitigation guidelines that will be used for infrastructure placed during PDW are summarized as follows:

- Excavations in overburden materials found will be avoided as much as possible. Disturbance of the natural ground surface will be avoided, leaving the limited natural vegetation and organic cover and permafrost in place when constructing embankments or pads
- Any excavation of natural materials will require over excavation with replacement of an insulting cover of thaw stable granular fill materials of a minimum 1.5 m thickness to protect against thaw and instability in the underlying ice rich overburden soils
- Embankments or granular fill pads should be constructed with maximum side slopes of 2H:1V.
- Where surface water collection or diversion is required, the thermal effect of runoff must be considered. Ideally, ditches should be avoided wherever possible. Diversion berms are the preferred method of redirecting surface water flows if feasible. If ditches are required, they may have to be created by over-excavation and replacement with thaw stable processed rock fill material and perhaps be lined with geotextile.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.1.4.2 Milne Inlet Tote Road

Road upgrades to the Tote Road during PDW activities has the potential to disrupt sensitive landforms, and measures can be implemented to prevent or mitigate effects, and long-term maintenance may be necessary. Baffinland has experience in sensitive landforms encountered during the 2007-2008 upgrade of the road for the bulk sample and the main issues encountered are described in the DEIS under Section 2.1.2 of Volume 6 of the DEIS (DEIS 2011). Based on this knowledge, mitigation measures addressing sensitive landforms during PDW road upgrades are described below.

The following mitigation measures will be implemented during the proposed upgrades to the Milne Inlet Tote Road during PDW:

- Cuts will be minimized to the extent possible with a preferential use of fills over cuts.
- The road embankment will be constructed of sand and gravel or quarried rock, with an increased reliance on quarried rock as a construction material, since it is generally a more superior construction material with less erosion potential. The rock or well-compacted sand and gravel will minimize erosion of the road embankment due to water flows near the road.
- The road embankment will be sufficiently elevated to allow blowing snow to blow across the surface.
- Borrow of road construction materials along the road alignment will be minimized. This will reduce the chance of suspension of fines in the runoff from the road embankment. Borrow materials will primarily be obtained from rock quarries or larger centralized borrow sources to minimize the potential for sediment transport and erosion.
- Riprap or other erosion protection measures will be applied to upstream and downstream ends of culverts to prevent scour and erosion of the road embankment.
- Water crossings with a history of overtopping or with observed higher flows will be upgraded to include additional culverts and/or be replaced by box culverts, arch culverts or bridges. Operation observations since construction of the road upgrades in 2007 and 2008 will be critical to the design of these upgrades.

15.1.4.3 Mine Site

The Mine Site is located in an area of continuous permafrost conditions and therefore the foundation designs must consider its effect. PDW are proposed to occur in the Mary River Valley, where foundation conditions are typically ice-rich permafrost and where competent thaw stable bedrock is not found within reasonable depth. The foundations for all the facilities located in the valley must be designed in a way that permafrost is not thermally affected because for the most part they are located where the depth to competent bedrock precludes them from being founded on bedrock. All facilities in the area have been sited based on available geotechnical information (including air photo

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

interpretation) as best as possible to avoid areas of potential geo-hazards or instabilities. For PDW the Mine Site laydown areas and various building infrastructure may interact with sensitive landforms:

General permafrost mitigation guidelines that will be used for infrastructure placed during PDW are summarized as follows:

- Excavations in overburden materials found will be avoided as much as possible. Disturbance of the natural ground surface will be avoided, leaving the limited natural vegetation and organic cover in place when constructing embankments or pads
- Any excavation of natural materials will require over excavation with replacement of an insulting cover of thaw stable granular fill materials of a minimum 1.5 m thickness to protect against thaw and instability in the underlying ice rich overburden soils
- Embankments or granular fill pads should be constructed with maximum side slopes of 2H:1V.
- Where surface water collection or diversion is required, the thermal effect of runoff must be considered. Ideally, ditches should be avoided wherever possible. Diversion berms are the preferred method of redirecting surface water flows if feasible. If ditches are required, they may have to be created by over-excavation and replacement with thaw stable processed rock fill material and perhaps be lined with geotextile.

15.1.4.4 Winter Roads and Camps

Winter roads will be developed to avoid sensitive landforms to the extent possible. Footprints for camps will be minimized to the extent possible. Granular pads and collection or diversion will be as described for Milne Port and the Mine Site.

15.1.4.5 Steensby Port

Steensby Port is typically dominated by bedrock outcrops or bedrock close to surface. In the thin deposits of overburden within the lower depressions, some evidence of ice rich permafrost were noted underlying a layer of wetter organic material. Additionally, some thaw-sensitive soils may be present near surface below the organic layer in these depressions and mid slopes along the Steensby Inlet shoreline.

For PDW, structure locations have been optimized to take advantage of these conditions. Where structures must be placed on materials other than bedrock, special consideration may need to be given to the potential for there to be areas of saline permafrost, whereby the salinity of the pore water/ice can affect the temperature at which the ground is frozen and subsequently the strength of the pore ice in ice rich areas.

Where foundations on bedrock are not possible, similar guidelines as discussed above for the Mine Site and Milne Port area infrastructure will be used for the design and construction of the port site infrastructure.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.1.5 Assessment of Residual Effects

PDW activities have the potential to create changes to sensitive landforms. The nature of interaction of potential effects is a change to the thermal regime of sensitive landforms resulting from Project infrastructure and activities, which is negative in direction. Engineering and geotechnical design and controls will mitigate changes to the thermal regime and have been described in the previous sections. For all infrastructure associate with the Milne Inlet Tote Road, Mine Site, access roads and Ports, monitoring and maintenance will be essential for mitigating problems that may arise associated with degradation of the permafrost. As mitigation will occur, the assessment of residual effects takes this into account. Using the assessment criteria defined in Volume 2 of the DEIS, the residual effects are assessed as:

- The magnitude of the effects is a change will not be distinguishable from natural variation and will be within regulated values (Level 1)
- The extent of the effects confined to the PDA (Level 1)
- The frequency of how often the effect occurs will be negligible as the mitigative measures will ensure that no effects occur (negligible)
- The duration is the length of time over which a PDW effect will occur which will be negligible as there is negligible frequency (negligible)
- The reversibility is the likelihood of the sensitive landforms to recover from the effect will be negligible as there is negligible frequency and duration (negligible).

As changes are expected to be limited to small areas within the PDA, the potential residual effect to permafrost is predicted to be not significant.

15.1.6 Prediction Confidence

High Confidence in Prediction: Based on the degree of coverage during the baseline studies and geotechnical investigation programs, including:

- Identification of geologic and sensitive landforms and potential hazards from aerial photos in the Mine Site, Railway Corridor, and Steensby Port areas
- Site reconnaissance and surface mapping for all areas
- Geotechnical drilling using diamond drilling techniques
- Excavation of shallow test pits by hand and mini-excavator
- Collection of soil and bedrock samples for on-site and laboratory testing
- Installation and monitoring of thermistors
- Oriented core drilling for rock mass classification
- Geophysical surveys were carried out by EBA in April and May of 2008.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Additionally, the extent of PDW works is going to occur within approximately 5, 10 and 15 % of the PDA of the Mine Site, Steensby Port and Milne Port respectively, increasing confidence that any residual effects will no be significant.

15.1.7 Subjects of Note

Pre development works (PDW) are proposed to occur between Q2 2012 to Q1 2013. The work will largely include the delivery and staging of materials and equipment at Milne and Steenby Ports. The full extent of PDW at each of the locations in the Project area are described in Section 2 to Section 6 of this document. The effects assessment for terrestrial Valued Ecosystem Components (VECs) focuses on PDW activities of Milne Port, the Tote Road, the Mine Site, and Steensby Port.

15.1.8 Soils

There are a series of potential PDW effects to the surficial soils that are mostly unrelated to permafrost (although can result in effects to permafrost). These effects include the following:

- Soil contamination
- Soil structure alteration
- Soil destabilization and erosion.

The following provides additional detail relating to these effects.

Soil Contamination

Spills can have a serious effect on soils and ultimately water quality. Baffinland will provide training in and implement a Spill Contingency Plan located in Section 7.0 of this document to mitigate the potential for adverse effects to soil and water resources quality in the event of an accidental spill or release during PDW. Both Baffinland employees and contractors will be bound by the procedures in the Plan. Appropriate containment will be provided around areas where spills could occur, such as storage tanks, and areas where chemicals, fuels, or lubricants are being handled or used will be underlain by a suitable liner to prevent any accidental spills from reaching the underlying soils.

Appropriate sorptive materials for the materials stored or in use in a particular area will be provided and kept stocked in an easily accessible location, so that in the event of a spill or accidental discharge, the spill can be contained and wiped up immediately.

Soil Structure Alteration

Due to the generally unsuitability of local soils for re-vegetation purposes and because effects will be limited in general to direct PDW footprints, alteration of soil structure is considered to be a Subject of Note. Ground-clearing and construction activities within the PDW locations in areas where natural soils are left in place will cause disturbance to soil structure. Compaction of soils (either directly via earthmoving equipment or indirectly by burial under a foundation or other covering) has the

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

potential to alter the soils' natural structure; decreasing its water storage capacity and ability to support vegetative growth and wildlife.

In all cases, mitigation measures consist of limiting the area of disturbance to the extent practical to avoid disruption of native soils outside of PDW footprints. Re-establishment of soil structure within PDW may occur over the extreme long-term post-closure in areas where closure activities will consist of infrastructure removal along the Milne Inlet Tote Road and other access roads, and in the port areas.

Soils Destabilization and Erosion

Soil destabilization and erosion are potential effects in all areas where the naturally occurring topography and soils are altered as a result of PDW. Most of these activities are expected to occur after PDW (during Project construction), when the majority of major ground clearing and earthworks will be performed.

Soil destabilization and erosion are easily mitigated by using Best Management Practices for sedimentation and erosion control; effects are thus expected to be minor. Erosion protection and control measures are described in the Surface Water and Aquatic Ecosystems Management Plan in Section 7.0 of this document. Limiting the zone of disturbance to the minimum necessary during construction and operation is the main mitigative action that will take place.

Effects associated with erosion of topsoil will be mitigated by instituting Best Management Practices for sediment and erosion control for all Project facilities, including topsoil stockpiles. Re-vegetation of disturbed areas has been determined to be ineffective as a mitigative action in the region, due to the thin and generally poor quality of local soils and the difficulty involved in trying to re-grow Arctic flora. Implementation of the following control measures during ground clearing will greatly reduce any erosion or sediment loading that may arise from the stripping activity:

- Use geotextile silt fencing, silt traps, and/or other methods to reduce sediment transport within the area of PDW; overland flow from disturbed areas should be avoided
- Divert "clean" water away from the works area
- Suppress dusting on roads by wetting (during summer months) or application of a dust control agent
- Grade the site and channel surface flow into ditches to reduce flow velocities and decrease the potential for erosion
- Collect and pump runoff to settling facilities or treat potentially affected water, including water used to decontaminate equipment, and affected runoff
- Inspect and maintain silt control measures
- Provide temporary storm water retention capacity
- Proof-roll sub grade or stockpile materials

© Hatch 2011/09

- Implement a site-wide operational surface water quality-monitoring program to assess effects of site runoff on receiving surface water bodies and effectiveness of construction control measures.

Stream bank erosion is addressed in the Surface Water and Aquatic Ecosystem Management Plan located in Section 7 of this document.

15.1.9 Wetlands and Eskers

There are no major eskers or wetlands within the LSA that will be affected by PDW.

15.1.10 Aesthetics of Natural Environment

PDW activities will have an effect on the aesthetics of the environment. The Project infrastructure, dust generated, and noise will be the main activities that will affect aesthetics. However, due to the intermittent and short duration of PDW and the remote location of the activities, effects on aesthetics will be minimal.

15.1.11 Paleontological Resources

A study of paleontological resources (including fossils) was carried out for the DEIS. No paleontological resources have been identified at the PDW sites (Milne, Mine Site and Steensby).

15.1.12 Impact Statement

PDW will have a not significant residual effect on sensitive landforms. The PDW will affect sensitive landforms within the small areas of the PDA but the extent of the effect relative to the RSA is minor. PDW at Milne Port, Milne Inlet Tote Road, the Mine Site and Steensby Port will not disturb sensitive landforms outside the PDA. No cumulative effects are expected.

15.2 Vegetation

Vegetation within the Mary River Project area is described in the Vegetation Baseline Study Report is described in Appendix 6C of the DEIS (DEIS 2011).

The RSA was chosen to represent vegetation distribution and abundance at an ecologically relevant scale and to reflect the regional vegetation. The RSA is a 30,711 km^2 area centred on the Project's PDAs (Figure 6-3.1 of the DEIS). The southern end of the study area centres on Steensby Port, the northern portion includes Milne Inlet, and the central portion includes many large lakes to the south and west of Angajurjualuk Lake.

Pre development works (PDW) are proposed to occur between Q2 2012 to Q1 2013. The work will largely include the delivery and staging of materials and equipment at Milne and Steenby Ports. The full extent of PDW at each of the locations in the Project area are described in Section 2 to Section 6 of this document. The effects assessment for terrestrial Valued Ecosystem Components (VECs) focuses on PDW activities of Milne Port, the Tote Road, the Mine Site, and Steensby Port.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.2.1 Issues Scoping

Vegetation is a Valued Ecosystem Component (VEC) based on ecological, social and/or legislated importance, and its potential to interact with PDW.

15.2.2 Vegetation

There are three measurable parameters that allow for the prediction of effects of PDW on vegetation:

- Vegetation abundance and diversity
- Vegetation health
- Culturally valued vegetation.

As no plant species with formal recognition as "rare plants" were identified during baseline studies, rare vegetation was not included as an issue for PDW. Figure 6-3.1 of the DEIS shows vegetation communities within the RSA.

Vegetation Abundance and Diversity

Vegetation abundance and diversity can be affected through direct loss of vegetation within the footprint of PDW activities, or through indirect loss from Project infrastructure that cause changes to the microclimate directly adjacent to Project infrastructure. Dust deposition and emissions to air also have the potential to cause changes in vegetation abundance and diversity, but this issue is addressed within the measurable parameter vegetation health.

In general, any physical disturbance to plant cover will likely result in the loss of plants in the immediate area. All PDW activities will occur within approximately 5, 10 and 15% of the PDA of the Mine Site, Steensby Port and Milne Port respectively, so direct loss of vegetation will occur and be much less than the area within the PDA. During PDW activities, direct habitat loss will occur primarily due to surface disturbance including compaction, burial, and removal. During any closure activities the Project footprint should not expand, but there may be incidental vegetation loss due to some reclamation activities. For the assessment of effects on vegetation diversity and abundance it is assumed that all vegetation will be removed within the footprint of PDW.

Indirect changes to vegetation abundance and diversity that could occur as a result of PDW activities include introduction of invasive plant species, changes to surface drainage, permafrost, erosion, and snow accumulation patterns. Indirect changes to vegetation abundance and diversity are possible, but this loss would be limited to a few cases and will not occur at the scale of the RSA.

If any reclamation activities were to occur after PDW, it would be limited to providing physical and chemical stability and would not be designed to promote re-vegetation — the area will not be re-seeded. The effects to vegetation will be long-term as natural re-vegetation is expected to occur slowly.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Vegetation Health

Vegetation health can be affected by dust deposition (TSP) and combustion emissions (NOx, nitrogen deposition, SO2), or be indirectly affected by acid depositions resulting in soil acidity. A detailed emissions inventory and dispersion modelling assessment was not conducted for the PDW due to the intermittent and temporary nature of the PDW activities. Potential effects on vegetation health from dust were therefore assessed based on previous experience and some ambient air quality monitoring that was conducted over a three-week period (August 31 to September 23, 2007) at Milne Port during the preparation for bulk sampling (DEIS, January 2011, Appendix 5C-2) . Activities during the bulk sampling included a sealift and ancillary equipment operations including, cranes, barges, a tugboat, and front-end loaders. In addition to the sealift operations, other activities during the monitoring period included five to seven aircraft flights a day, light-duty vehicle trips, and road construction. This is comparable to the types of activities that will be carried out during the PDW. Mobile equipment, generators, boilers and camp incinerators will be the sources of gaseous emissions. Potential effects on plant health from emissions of NOx, SO2 and acid deposition are described below.

Dust (TSP)

The PDW activities will occur at various intensities over the period of Q2 2012 to Q1 2013. Dust emissions will occur during earthwork activities, traffic and quarry operation. Dust (Total Suspended Particle - TSP) deposition will occur as a result of various PDW activities (i.e. dust from moving machinery, earth grading). Mining, crushing and handling of ore will not occur during PDW. Therefore the associated metals in dust from those activities will not be generated during PDW and will not be considered further in this assessment. The effects of dust on vegetation during PDW will be primarily associated with dust generated from machinery traveling on access roads and earth grading only during the short duration of PDW. Dust generation will be limited so small areas within the PDA. Potential effects on plant health will therefore be associated with dust deposition only during the span of PDW activities. Direct effects of dust on vegetation include decreased chlorophyll and photosynthesis and blocking or covering the stomata, resulting in a physical inhibition to function. This in turn can result in reduced growth and health of a plant (DEIS 2011). Indirect effects of dust result mainly from compounds (i.e. metals, nitrogen) carried in dust that have the potential to either be absorbed through the leaf surface or roots of the plant when deposition in soil occurs (DEIS 2011). Due to the low intensity of the PDW activities and the implementation of best management practices, the resultant dust emissions are expected to be well below the regulated guidelines criteria for air quality (DEIS 2011). This is supported by Baffinland's experience at the site since 2008. Furthermore, dust emissions will occur almost entirely within the footprint of PDW activities, so any potential effects on plants health are covered in the abundance and diversity section.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Nitrogen Emissions

Nitrogen emissions during PDW activities will be associated primarily with the burning of fuel for machinery and power generation. Emissions to air during PDW are expected to be within regulated guidelines. Atmospheric nitrogen oxides can encourage growth in plants at relatively low concentrations, particularly in nitrogen-limited environments like the Arctic. Lichens are particularly sensitive to changes in atmospheric chemistry, as they depend primarily on the atmosphere for nutrients but lack a protective cuticle to control their intake of both nutrients and pollutants. This is particularly relevant in arctic climates where many habitats are lichen-dominated (DEIS 2011). Deposited nitrogen from the atmosphere has the potential to accumulate in the soil over time, which gradually increases the acidity of the soil. However, due to the short duration of PDW activities, deposition of nitrogen in soils from atmospheric emissions are expected to be negligible in the approximate 1 year (Q2 2012 – Q1 2013) of activity. Changes in species abundance and composition are only likely if increased nitrogen is applied in significant quantities for more than five years (DEIS 2011). Due to the short duration and intermittent nature of PDW, it is highly unlikely that nitrogen emissions (which will abide by required regulations) or deposition will cause significant exposure to plants. Therefore nitrogen emissions resulting from PDW will not be a significant issue and will not be discussed further.

Sulphur Emissions

Sulphur is also essential for plant growth and development, in particular for the production of plant proteins. It also encourages plant growth and increases plant resistance to low temperatures. As a result of PDW, sulphur emissions (to the environment) will be deposited as sulphur dioxide (SO_2) mostly from fuel combustion and refuse incineration. Sulphur dioxide can have effects on plant health. Lichens are particularly sensitive to elevated SO_2 in the atmosphere, as they allow for passive gaseous exchange and are unable to exclude excess sulphur. Sulphur can also be deposited as dry deposition, and foliar injuries or changes in growth patterns in plants can result (DEIS 2011). However, the duration, magnitude and frequency of exposure determines the extent of injury to flora. Due to the short duration and intermittent nature of PDW, it is highly unlikely that sulphur dioxide emissions (expected to be within regulated limits) or deposition will cause significant exposure to plants. Therefore sulphur emissions resulting from PDW will not be a significant issue and will not be discussed further.

Acid Deposition

Acid deposition is the general term for the transfer of atmospheric pollutants to the earth's surface either by wet or dry deposition. Sulphur oxides, sulphates, nitrogen oxides, nitrates, and ammonium compounds are the main sources of increased acidity in the environment. Higher concentrations of these compounds in the atmosphere increase the likelihood of negative effects on local vegetation. Wet deposition is the most common pathway from the atmosphere to the local ecosystem, but in arid areas like the Arctic, dry deposition plays a significant role in soil and water acidification. Vegetation

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

can be directly affected; however, the primary effects are changes in the soil and water chemistry. The parent material, substrate texture, weathering rate, base cation availability and vegetation cover are factors in determining the susceptibility of soils to acidification. However, acidification in the Arctic is a sub regional issue, and typically a concern only occurs in areas immediately downwind of non-ferrous smelters (DEIS 2011). Since the only sources of sulphur dioxide from PDW are from vehicle operations and power generation, both of which will abide by required regulations, it was determined that soil acidification is not a significant issue for PDW and will not be discussed further.

Culturally Valued Vegetation

Interviews with elders during the traditional plant use study identified 18 plant species that are currently or have historically been used by local Inuit (see Appendix 6C of the DEIS). Today the plant species that are most commonly used by Inuit include blueberries (*Vaccinium uliginosum*), crowberries (*Empetrum nigrum*) and mountain sorrel (*Oxaia digyna*).

All the effects from PDW to culturally valued plants will be within the footprint of PDW areas. This area will only represent approximately 5, 10 and 15 % of the PDA area of the Mine Site, Steensby Port and Milne Port respectively. Consequently, effects to plants within the RSA that are currently valued and used by Inuit because of PDW activities will be negligible and indistinguishable from natural variation.

15.2.3 Assessment Methods

The assessment of the PDW effect on vegetation is based on three measurable parameters: 1) Vegetation Abundance and Diversity; 2) Vegetation Health; and 3) Culturally Valued Vegetation. Assessment methods are described for each measurable parameter below. The magnitudes of the effects were determined relative to the scale of occurrence within the Regional Study Area (RSA).

15.2.3.1 Vegetation Abundance and Diversity

New disturbance within the PDA from PDW will be the main cause of reduced plant abundance and diversity. For the purpose of quantifying the effects of the PDW, several assumptions are made to simplify the assessment:

1. New disturbance within the footprint of PDW will remove all vegetation. The footprints of PDW are small areas within the PDA.
2. All land is terrestrial habitat and, therefore, is potentially vegetated; though much of the RSA is considered barren or sparsely vegetated.
3. Regeneration of the disturbed area is a slow process and will not occur until beyond the life of the Project.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

To assess the predicted effects of PDW on vegetation abundance and diversity the area of disturbance that the PDW footprint would cause was identified. It was assumed that the entire area of PDW would represent the area of vegetation lost and this was compared to the area of the PDA for future Project activities. The results of the analysis were an overestimate of the reduction of vegetation because much of the PDW footprints are sparsely or non-vegetated terrain; therefore, the results were best described as a reduction in terrestrial habitat.

PDW activities will occur entirely inside of the PDA and will represent approximately 5, 10 and 15 % of the Mine Site, Steensby Port and Milne Port PDA respectively. All PDW footprints will be subsequently occupied by Project construction, operations and closure activities.

15.2.3.2 Vegetation Health

This section discusses dust (TSP) in relation to PDW activities and the potential effects on plant health.

Dust (TSP)

There are no known dust deposition thresholds specific to effects on vegetation. Health Canada/Environment Canada's national ambient air quality objectives for particulate matter (CEPA/FPAC Working Group, 1998) state that for the lack of quantitative dose-effect information, it is not possible to define a reference level for vegetation and dust deposition. However, it is expected that for PDW activities, dust from PDW activities will not migrate more than 100 meters from the activity and this dust will be within the PDW footprint and well within the PDA's described in the DEIS, 2011. Since it is assumed that all vegetation within PDW footprints will be removed, any potential effects from dust on vegetation health are addressed in the abundance and diversity key parameter.

15.2.3.3 Culturally Valued Vegetation

Many traditionally culturally valued plants were identified during a community workshop with local Inuit elders (DEIS 2011). Only a few species are still regularly used, including blueberry, crowberry, and mountain sorrel. The distribution of most of these plant species could not be modelled; however, blueberry was modelled for the RSA in the DEIS, 2011. The blueberry model predicted the percent of blueberry cover for the RSA. This assessment assumes that all blueberry cover within the PDW footprints will be lost which represents approximately 5, 10 and 15 % of the area of the Mine Site, Steensby Port and Milne Port PDA's respectively. The change in abundance of blueberry plants within the RSA is quantitatively assessed by comparing blueberry abundance before and after PDW.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.2.4 Potential Effects and Proposed Mitigation

15.2.4.1 Vegetation Abundance and Diversity

Surface disturbance has already occurred at the Milne Port site, Milne Inlet Tote Road and Mine Site as a result of the original exploration and bulk sampling activities. Given that each of these components already exists, loss of vegetation because of these infrastructures will be limited. A conservative approach was used in the assessment by assuming that the entire PDA is currently pristine. Winter access roads and lamps along the railway corridor will have an insignificant footprint on vegetation at the scale of the RSA.

All plant communities and species documented during baseline studies will likely be present after PDW activities. It was concluded in the DEIS, 2011 (Table 6-3.4), that less than 1% of the area occupied by each plant community within the RSA will be removed in the PDA. Given that the PDW footprints will occupy approximately 5, 10 and 15% of the PDA's of the Mine Site, Steensby Port and Milne Port respectively, the reduction of plant communities will likely be much less than 1%.

Establishment of invasive species within the RSA is unlikely. Baffinland intends to mitigate the potential effect by ensuring that equipment brought to the Project site has been cleaned of soils that could contain plant seeds that do not currently occur within the RSA, and by allowing natural re-vegetation of disturbed areas (i.e., no reseeding will be included in reclamation activities).

Mitigation measures:

1. PDW activities will be planned and conducted to minimize the footprint within the PDA.
2. Project vehicles will stay on the established roads within the PDW footprint during operation, limiting new disturbance.
3. Disturbed terrestrial habitat will not be reseeded. Re-vegetation of the terrestrial habitat will be allowed to occur naturally. The mitigation will reduce the likelihood of invasive plant species getting established within the RSA due to PDW activities.
4. Equipment brought to site will be cleaned of soils that could contain plant seeds that do not naturally occur in the RSA. The mitigation will reduce the likelihood of invasive plant species getting established within the RSA due to PDW activities.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.2.4.2 Vegetation Health

Dust (TSP)

For the PDW activities, the ambient concentrations of the air quality parameters are expected to occur only for Level 1 durations (several hours or 1 to 2 days). Dust (TSP) is expected to be generally confined to the immediate vicinity of work areas (within the PDW footprint) and therefore will be confined to the PDA. Direct effects from dust on vegetation are therefore not expected as effects to vegetation with the PDW footprint are addressed using the key parameter vegetation abundance and diversity.

In the DEIS, it was predicted that no vegetation classes would be disproportionally affected by TSP deposition outside of the PDA. Since TSP is expected to remain within the footprint of PDW and within the PDA, it is not expected that there will be any vegetation classes that are disproportionally affected by TSP deposition from PDW activities.

Mitigation of dust effects on vegetation will be addressed by those measures used to mitigate effects on air quality as described in Section 14 of this document.

Atmospheric Emissions

Due to the intermittent, short duration and minor magnitude of air emissions during PDW works in comparison to Project construction and operations assessed in the DEIS, it is unlikely that any threshold for NOX, SO2 or acid deposition will be exceeded outside of the PDW footprint at Milne Port, the Tote Road, the Mine Site, access roads to the rail corridor or at Steensby Port. Effects on vegetation within the PDW footprint are addressed by the key parameter Abundance and Diversity.

The most noticeable effects on vegetation would occur in areas where the thresholds are exceeded for all three air quality parameters (i.e., annual TSP deposition, annual NO_2 emission concentrations, and annual deposition of nitrogen). It is not expected that any areas outside of the PDA will have thresholds exceeded for all air quality parameters since the DEIS predicted that even with construction and operations this would not occur. Since the vegetation within the PDA is assumed to be removed through construction and operation activities, that loss is accounted for in the abundance and diversity section. Therefore it is not expected that air emissions from PDW will effect vegetation health.

15.2.4.3 Culturally Valued Vegetation

Direct loss of blueberry cover because of the footprint of the Project will occur within the 109.6 km^2 PDA, and PDW footprints will occupy considerably less area. As estimated in the DEIS, even if the entire PDA is cleared, the reduction of blueberry cover will be minor and indistinguishable from the baseline condition at the scale of the RSA. PDW activities will occupy less area making this estimation less significant at the scale of the RSA. Furthermore, much of the Milne Port, Tote Road and Mine Site are already disturbed areas, so the reduction of blueberry cover will be small because

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

there will be limited new disturbance in those areas. Finally, not all vegetation removed will be blueberry cover; consequently, estimates of blueberry cover loss is likely an overestimate of the true effect.

Mitigations identified for reducing effects of the Project on vegetation abundance and diversity will be suitable for mitigating effects to culturally valued vegetation.

15.2.5 Assessment of Residual Effects

The following text describes the potential residual effects that will remain after mitigations have been applied for each measurable parameter. After a discussion/description of the residual effects, the predictions are tabled and summarized for each measurable parameter using the language and evaluation criteria described in Volume 2, Section 3 of the DEIS.

Vegetation Abundance and Distribution

Loss of vegetation within areas of PDW is a residual effect — it is not expected that disturbed areas will become re-vegetated until after closure and reclamation. Some of the footprints may never return to baseline conditions. The predicted levels of vegetation abundance and distribution effects based on the evaluation criteria are summarized in Table 15-1.

Vegetation Health

It is not expected that during PDW activities the annual dust deposition will occur beyond threshold levels outside of the PDA and that effects on vegetation communities will result. Effects, if any, occurring outside the PDW footprint would be reversible when the dust-producing activities cease.

After PDW activities air emissions will cease for PDW. The prediction is that those effects, if any, will be limited to areas within the PDW footprints and therefore any effects would be addressed in the Abundance and Diversity section which conservatively assumes all vegetation within the PDW footprint will be eliminated from ground clearing.

Culturally Valued Vegetation

Loss of blueberry cover within the footprint of PDW is a residual effect — it is not expected that blueberry cover will return to the pre-development state until after closure. Some of the blueberry producing habitat will likely be permanently changed. However, the reduction in blueberry habitat is estimated to be indistinguishable at the scale of the RSA even if the entire PDA was cleared.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.2.6 Prediction Confidence

Vegetation Abundance and Diversity

High confidence in prediction. Effects are expected to be limited to the footprint of PDW. If any changes to vegetation abundance and diversity occur outside of the PDW footprint due to dust, NO_2 emission or N deposition, the magnitude of the effects and the extent will be insignificant. The establishment of invasive vegetation in the area because of PDW can be mitigated. Consequently, effects of PDW on vegetation abundance and diversity will be insignificant at the scale of the RSA.

Vegetation Health

High confidence in prediction. Prediction confidence is high for the effects on vegetation health. Although thresholds have not been developed for dust effects on plants, it is unlikely that effects, if any, would extend beyond the PDW footprint considering the short duration and intermittent activity of PDW. Atmospheric emissions will also be short in duration and intermittent and are not expected to exceed any regulated guidelines beyond the PDW footprint. Therefore any effects to vegetation health within the PDW footprint are addressed in the Abundance and Diversity section.

Culturally Valued Vegetation

High confidence in prediction. Effects will be limited to the footprint of PDW. If any changes to Culturally Valued Vegetation occur outside of the footprint of PDW, the magnitude of the effects and the extent will be small and will likely be within the PDA. Consequently, effects of PDW on culturally valued vegetation will be insignificant at the scale of the RSA.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 15-1: Effects Assessment Summary: Vegetation

Issue	Magnitude/ Complexity	Geographical Extent	Frequency	Duration	Reversibility	Likelihood	Overall Significance	Degree of Confidence
Issue 1 Abundance and Diversity	**Level 1**: Effect will be indistinguishable from natural variation.	**Level 1**: The effect will occur within the PDW footprint.	**Level 1**: The effect will occur once.	**Level 1**: The effect will occur from Q2 2012-Q1 2013.	**Level 2**: The effect is reversible with cost.	High	Not significant at the scale of the RSA.	High
Issue 2 Health (general)	**Level 1**: Effect will be indistinguishable from natural variation.	**Level 1**: The effect will occur within the PDW footprint.	**Level 1**: The effect will be intermittent for PDW.	**Level 1**: The effect will occur from Q2 2012-Q1 2013	**Level 2**: The effect is reversible with cost.	High	Not significant at the scale of the RSA.	High
Issue 4 Culturally Valued Plants	**Level 1**: Effect will be indistinguishable from natural variation.	**Level 1**: The effect will occur within the PDW footprint.	**Level 1**: The effect will occur once.	**Level 2**: The effect will occur from Q2 2012-Q1 2013	**Level 2**: The effect is reversible with cost.	High	Not significant at the scale of the RSA.	High

© Hatch 2011/09

15.2.7 Follow up

The Terrestrial Environment Management and Monitoring Plan is located in Section 7 of this document.

15.2.8 Subjects of Note

No rare plants were found during field surveys and PDW is not expected to have any effects on rare arctic plants.

15.2.9 Impact Statements

15.2.9.1 Vegetation Abundance and Diversity

There is high confidence that PDW related activities will have a not significant effect on vegetation abundance and diversity within the Regional Study Area.

15.2.9.2 Vegetation Health

There is high confidence that PDW related activities will have a not significant effect on plant heath within the Regional Study Area.

15.2.9.3 Culturally Valued Vegetation

There is high confidence that PDW related activities will have a not significant effect on culturally valued vegetation within the Regional Study Area.

15.3 Migratory Birds and Habitat

Baseline studies were conducted on birds in 2006–2008 and included reviews of regional literature and existing databases, discussions with federal (Environment Canada Canadian Wildlife Service, CWS) and territorial (Government of Nunavut, GN) wildlife agencies, Inuit Qaujimajatuqangit (IQ) studies, and three years of field surveys (DEIS 2011). These studies and consultations were conducted to characterize the pre-existing conditions within the RSA.

Pre development works (PDW) are proposed to occur between Q2 2012 to Q1 2013. The work will largely include the delivery and staging of materials and equipment at Milne and Steenby Ports. The full extent of PDW at each of the locations in the Project area are described in Section 2 to Section 6 of this document. The effects assessment for terrestrial Valued Ecosystem Components (VECs) focuses on PDW activities of Milne Port, the Tote Road, the Mine Site, and Steensby Port.

15.3.1 Issues Scoping

A variety of studies and consultations were conducted to characterize the pre-existing conditions within the Project's RSA enabling important bird issues to be identified. Scoping activities included the following:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- A literature review of all published scientific reports documenting previous studies in the RSA, including primary literature, Canadian Wildlife Service reports on key terrestrial and marine migratory bird documents from the region, and long-term monitoring reports from research on nearby Bylot Island;
- A literature review of other northern Projects' Environmental Assessment Statements (i.e. Snap Lake Diamond Mine (DeBeers', 2004), Diavik Diamond Mines (Diavik, 2005), Doris North Gold Mine (Miramar, 2005), Ekati Diamond Mine (Rescan, 2005), Jericho Diamond Mine (Golder, 2005), High Lake Base Metals Mine 2006), and CWS intervener comments on the corresponding reviews;
- Discussions with CWS biologists via teleconference, email, and in-person meetings held with CWS biologists February 6, 29, and June 13, 2008;
- Discussions and site visits by GN biologists in 2006 and 2007;
- Consultation with residents of the nearby communities of Arctic Bay, Clyde River, Hall Beach, Igloolik and Pond Inlet;
- Inuit Qaujimajatuqangit (IQ) Studies (Inuit Traditional Knowledge studies) carried out in the same communities above;
- A Mary River Project team scoping meeting held in November 2007;
- Review of GN, COSEWIC and SARA Species at Risk lists; and
- Field surveys conducted in 2006, 2007 and 2008.

The above scoping activities contributed to the identification of migratory birds and their habitat as a VEC and potential interactions with the Project.

15.3.2 Key Indicators

Four KIs for Birds as a VEC were chosen based on criteria outlined in Volume 2, Section 3 of the DEIS, 2011, and baseline information gathered from scoping activities are listed above. The bird KIs chosen were:

- Peregrine Falcon
- Snow Goose
- Common and King Eider
- Red-throated Loon.

An explanation of each KI selection is provided in Section 4.2.1 to 4.2.4 of the DEIS, 2011.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.3.3 Potential Project Interactions with Birds

There are several mechanisms or pathways through which PDW activities could potentially affect bird KIs that use the Project area for part or all of their annual cycle:

- Direct and indirect loss of habitat for staging, nesting, foraging, and brood-rearing due to the PDW footprints
- Localized but chronic noise disturbance due to PDW activities
- Infrequent, brief and localized disturbance of open-water marine foraging and brood-rearing areas due to ships entering Milne and Steensby Port with equipment and materials for PDW
- The alteration of local marine water quality or food supply due to contamination from bilge water, grey water, or ballast water discharges from ships
- The accidental introduction of other chemical contaminants into the marine waters from the ports or ships resulting in direct and indirect mortality to birds
- Fuel or oil spills resulting in direct and indirect mortalities and long-term loss of foraging and brood-rearing habitat
- Direct mortalities due to collisions with vehicles, aircraft, and structures
- Direct mortalities due to increased access to the area by hunters.

All of these potential effects could occur as a result of PDW activities and are described in more detail in the DEIS, 2011.

15.3.4 Key Issues

The identified bird KIs have the potential to be affected by the Project due to:

- Issue 1: Habitat changes
- Issue 2: Potential mortality
- Issue 3: Effects to individuals' health.

The following have been identified as potential effect pathways:

- Pathway 1: Direct habitat loss due to the Project footprint
- Pathway 2: Indirect habitat loss due to sensory disturbances in a surrounding zone of influence
- Pathway 3: Direct mortality from Project infrastructure, equipment, aircraft, ships, and other activities
- Pathway 4: Indirect mortality through increased harvest through changes in access to the area
- Pathway 5: Potential effects to bird health through contamination of the surrounding environments.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Some of these pathways for potential effects only apply to one bird KI while other pathways apply to all Kis and the issues and pathways are described in more detail within the DEIS, 2011.

15.3.5 Assessment Methods

The RSA and Local Study Area (LSA) for land birds in this assessment are consistent with study areas chosen for landforms, soil and permafrost and vegetation in the DEIS, 2011, because of the linkages between vegetation classification and wildlife habitats. The RSA is a 30,711 km^2 area centred on the Project's PDA. The RSA extends from Milne Inlet to the north and follows an approximate 50 km wide corridor centred on the Milne Inlet Tote Road, Mine Site, and the Railway to Steensby Port (Figure 6-4.1, DEIS, 2011).

The terrestrial RSA is characterized by a wide variety of bird habitats including:

- Rocky uplands and steep cliffs (used by raptors for nesting)
- Inland water bodies such as wetlands, lakes, streams, and rivers (used by geese, loons, and duck)
- Productive coastal plains, river deltas, and tundra (used by songbirds, shorebirds, Snowy Owl, and other upland birds such as Sandhill Crane and ptarmigan)
- Coastal and marine environments (used by shorebirds, seabirds, gulls, Eiders, loons, and some species of ducks).

The marine birds RSA is consistent with study areas chosen for marine mammals (Volume 8, Section 5 of the DEIS, 2011). The marine bird RSA includes the coastal and open water areas of Milne Inlet and Eclipse Sound in the north and Steensby Inlet, Foxe Basin, and Hudson Strait in the south (Figure 6-4.2, DEIS, 2011).

The PDA is the area that is directly affected by Project development and includes all Project components. The PDW footprints are contained within the PDA represent less than 15% percent of the PDA's. The PDW footprints are entirely within the PDA's and represent approximately 5, 10 and 15% of the area of the PDA's for the Mine Site, Steensby Port, and Milne Port respectively.

For this assessment it is assumed that effects on habitat suitability would be less for PDW activites since footprints will be much smaller than for construction and operation of the Project in the DEIS.

15.3.6 Measurable Parameters

Measurable parameters (indicators) are variables related to the biology of KIs that can be used to assess the predicted adverse environmental effects of PDW activities. Changes in the quality and availability of KI habitat can be used to assess potential effects of PDW activities on bird KI's. Due to the short duration of PDW activities (Q2 2012 to Q1 2013), changes in measurable parameters such as nesting success rate or the distribution or overall abundance of KI species as a result of PDW activities would be undetectable due to natural variability.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.3.7 Peregrine Falcon

Baseline surveys were used to estimate pre-development Peregrine Falcon distribution to assess current habitat quality and availability within the LSA and RSA. Potential PDW effects on Peregrine Falcons and their habitat were identified, the magnitude of each of these effects was calculated (including estimates of habitat loss due to the PDW footprint), mitigation measures that might eliminate or reduce these effects were produced, and the significance of the residual effects after mitigation was determined.

15.3.7.1 Potential Effects and Proposed Mitigation

Issue 1 - Habitat

A number of Peregrine Falcon and other raptor nests were recorded in proximity to PDA of the Project (Milne Port, Tote Road, Mine Site and Steensby Port (DEIS 2011). Peregrine Falcons will experience both direct and indirect habitat loss to nesting and foraging areas as a result of the Project footprint. Indirect habitat loss can result from disturbances from various human activities and noise generated from these activities.

There is an abundance of cliff-nesting and foraging habitat available within 30 km either side of the Milne Inlet Tote Road. Approximately 35% of the RSA and 30% of the LSA consists of suitable cliff-nesting habitat. Therefore, both the RSA and the LSA have an abundance of suitable cliff-nesting habitat, particularly in the eastern and southern areas, with productive tundra foraging habitat nearby. Cliff-nesting habitat is not saturated with territorial raptors in this area, and the availability of nesting habitat for Peregrine Falcons and other cliff-nesting species does not appear to be limiting. Most of these cliffs are located in close or immediate proximately to seemingly productive tundra hunting grounds with abundant supplies of prey species such as ptarmigan, small birds, and small mammals. Approximately 30% of the RSA and 25% of the LSA consists of productive tundra (DEIS 2011).

In Table 6-4.2 the DEIS, 2011, is was determined that within the RSA there could be a loss of 3.4% and 0.5% of high and medium quality nesting habitat. Similarly for foraging, there could be a loss of 2.2% and 1.4% of high and medium quality foraging habitat respectively. Based on the fact that the habitat effectiveness in the DEIS was reduced as a result of direct loss to the PDA, and the reduced effectiveness within a zone of influence due to sensory disturbances, these estimations will likely be considerable less since the PDW footprints are approximately 5, 10 and 15% of the PDA of the Mine Site, Steensby Port and Milne Port respectively. In addition, PDW will not include construction of the rail, therefore habitat in this footprint will not be disturbed, other than for small areas at the two lamps along the corridor.

Issue 2 - Mortality

Direct mortality to Peregrine Falcons could result from bird strikes with aircraft during take-off and landing, at the Mine Site and Milne Port airstrips. However, mining developments in the Arctic

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

typically do not result in increased direct mortality to raptors (DEIS 2011). Given reasonable traffic speeds, collisions with vehicles are rare, and there have been few cases of birds hitting infrastructure or being hit by vehicles (DEIS 2011). Direct mortality resulting from PDW activities (flights, vehicle traffic or collision with infrastructure) are not expected. In the unlikely event of direct mortality of Peregrine Falcons it will be limited to only a few individuals, and given that these birds are abundant and well distributed throughout the study areas, a few individual mortalities will represent a low percentage of the population.

Peregrine Falcons are generally not harvested, unless through a permit. There is limited to no potential for increased harvest of Peregrine Falcon as a result of PDW. Given that the PDW will have no-hunting policies for workers, mortality of falcons from harvest is not expected to increase.

Issue 3 - Health

PDW activities may result in the release of contaminants into the surrounding environments that could be taken up in water or vegetation by birds such as Snow Geese. Potential sources of contaminants that may be introduced into the environment include those from accidental spills of oil, gas or chemical products, emissions from diesel generators and other equipment, and the generation of dust along roads. Bird KIs may be exposed to contaminants through ingestion of plants, accidental soil ingestion while foraging, ingestion of water, epidermal contact with contaminated plants, soils or water, or direct inhalation of air and dust.

The PDW activities will include procedures to control emissions and discharges from activities, as well as measures to avoid uncontrolled releases. Spill contingency plans, emission reduction measures, water treatment protocols and dust control measures will help to guard against unacceptable contaminant levels in the surrounding environment, and therefore effluent, dust and air emissions are expected to have minor to no effect on the health of birds.

Mitigation

Although the above assessment has concluded that PDW will have no population-level effects, the potential to disturb and disrupt individuals is possible and proper mitigation procedures must still be put in place to minimize these. The two main focuses will be on minimizing habitat loss (nesting and foraging habitat) and minimizing behavioural disturbances (disruption of migratory patterns, foraging and nesting behaviour) by establishing 500 m protective buffers zones around all active nests. General mitigation procedures that will be applied in all areas PDW footprints and overall zone of influence will focus primarily on the avoidance by personnel and equipment to the extent possible of known nests, or avoidance of areas where birds exhibit territorial behaviour indicative of a nearby nest.

Breeding Peregrine Falcons have demonstrated a certain degree of tolerance to mining activities. However, these birds are still susceptible to disturbance during the breeding season, especially during nest initiation (when breeding pairs are more likely to abandon a nest site) and late nestling

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

stages (when nestlings are susceptible to premature nest departure). Based on the results of previous published studies, and based on the results of the 2008 bulk sample monitoring program, 500 m no-disturbance buffer zones are suggested to minimize disturbance, to be adjusted on a nest-specific basis. Peregrine Falcons are also protected by the Government of Nunavut's *Wildlife Act* which sets forth further regulations and guidelines designed to minimize disturbance to these birds. This information was incorporated into this mitigation and management planning process.

15.3.7.2 Assessment of Residual Effects

Residual effects refer to those effects that remain after all mitigation attempts have been made to try to minimize PDW effects. Residual effects are described below for each bird KI and are then rated for each of the key issues facing the different KIs. The rating is a professional judgment based on consideration of magnitude, geographical extent, duration, frequency, and reversibility of the effects.

Residual effects on Peregrine Falcon could include:

i) unavoidable habitat loss from the PDW footprint;

ii) disturbance to nesting habitat and nesting success; and

iii) disturbance to foraging habitat and behaviour.

Table 15-2 shows the key issues facing Peregrine Falcons as a result of the PDW and assesses their significance. For each of the three key issues, the potential residual effect to Peregrine Falcons is not significant. While some individual-level disturbance is expected to occur from various PDW activities, no changes to the overall Peregrine Falcon population is expected. Therefore, these potential residual effects are considered to have a low likelihood of causing an effect, have a low magnitude, remain within 1 km of the PDW footprint, will be infrequent but have short-term effects that are easily reversible. Direct mortality of any individual Peregrine Falcon due to Project activities is not expected nor is any increase in contaminants levels expected that would adversely affect falcon health.

15.3.7.3 Prediction Confidence

The level of confidence of the assessment is considered to be high based on the analyses of a large database gathered during three years of field work, discussions with local research agencies and the gathering of IQ knowledge, and the examination of results from previous mining Projects in northern Canada. The degree of prediction confidence is considered high and the likelihood of a significant effect on Peregrine Falcon is considered low.

15.3.7.4 Follow Up

A monitoring program for Peregrine Falcons is described in the Terrestrial Environment Management and Monitoring Plan (Appendix B.8).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 15-2: Effects Assessment Summary: Peregrine Falcon

Issue	Magnitude/Complexity	Geographical Extent	Frequency	Duration	Reversibility	Likelihood	Overall Significance	Degree of Confidence
Issue 1 Habitat Loss (direct and indirect)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints and LSA	**Level 1:** effect is intermittent between Q2 2012-Q3 2013	**Level 1:** Duration is between Q2 2012-Q3 2013	**Level 1:** habitat losses/disturbance are comparatively low as alternative sites are available in close proximity	**Level 2:** direct loss and/or disturbance of some habitat is likely due to their proximity to some Project components	Not Significant	High
Issue 2 Mortality (collisions, increased harvests)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints	**Level 1:** effect is intermittent between Q2 2012-Q3 2013	**Level 1:** Duration is between Q2 2012-Q3 2013	**Level 3:** effect is not reversible	**Level 1:** direct mortality is unlikely, mitigation measures regarding collisions and wildlife protection are addressed in the Mitigation and Monitoring Plan	Not Significant	High
Issue 3 Health (spills and introduced contaminants)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints	**Level 1:** effect is intermittent between Q2 2012-Q3 2013	**Level 2:** Duration is between Q2 2012-Q3 2013 and possibly longer	**Level 2:** effect of minor levels of contaminants likely to be reversible while major increase in contaminant levels may persist or be irreversible	**Level 1:** changes to health are unlikely, mitigation measures for spills, effluent, dust, and air emission controls will be in place	Not Significant	High

© Hatch 2011/09

15.3.8 Snow Goose

The methods used to assess the potential effects of PDW on Snow Goose are similar to those used to assess potential effects on Peregrine Falcons.

15.3.8.1 Potential Effects and Proposed Mitigation

Issue 1 - Habitat

Thousands of Snow Geese used the Milne and Steensby Inlet portions of the LSA as a migratory stop-over site when migrating through in the spring (late May to early June) and as a stop-over and moulting site in the fall (late August and early September). During these periods there is potential for disturbance from these areas during PDW due to port activities and associated shipping of supplies and aircraft traffic at Milne Port and the Mine Site. However, the majority (approximately 85%) of migrating Snow Geese recorded during the surveys did not stop directly within the port footprints. Instead, most of these birds were seen resting, foraging, and moulting in nearby areas and other areas scattered throughout the entire RSA. Therefore, although many Snow Geese were seen in, or flying over the LSA, and although many could be displaced by PDW activities (spring and fall of 2012), these birds will move to nearby, less disturbed areas. It is likely that these changes could result in a shift in their migratory flight paths of approximately 1 km to either side of the port areas, but these changes will not affect this species (DEIS 2011)

The DEIS estimated that within the RSA there could be a loss of 1.9% and 1.1% of high and medium quality nesting and foraging habitat (Table 6-4.5, DEIS, 2011). Based on the fact that the habitat effectiveness is reduced as a result of direct loss to the Project PDA, and reduced effectiveness within a zone of influence due to sensory disturbances, this loss of habitat will be substantially less due to the fact that PDW footprints will only be 5, 10 and 15% the PDA's at the Mine Site, Steensby Port and Milne Port respectively.

Issue 2 - Mortality

Direct mortality due to collisions with aircraft flying in and out of the two port sites is possible, especially for Snow Geese that migrate through these areas in very large flocks. However, other mining developments in the Arctic have not resulted in increased mortalities to geese through aircraft collisions or any other means. Direct mortalities due to collisions with ships or structures on land at the two port sites are also possible but are not expected. Direct mortalities from hunting are not expected to increase as best management practices will be employed to prevent increased access into the area by hunters. The PDW will have a no-hunting policy for all mine workers and workers will not be permitted to disturb wildlife under any circumstances. Therefore, PDW is not expected to increase the harvest of Snow Geese through increased site access or any other means. In the unlikely event that a few individual mortalities occur during PDW this would represent a very low percentage of the population.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Issue 3 - Health

Potential influences on health for Snow Geese will be similar to those described for Peregrine Falcon.

Mitigation

The potential effects on geese are expected to be low and localized to only a few waterbodies found directly adjacent to the Milne Inlet Tote Road, and therefore, no specific additional mitigation measures are proposed for these species. Baseline surveys indicated that there is an abundant supply of nearby suitable habitat for these species to move to. Very few birds will be disturbed enough to abandon their traditional breeding sites.

15.3.8.2 Assessment of Residual Effects

Residual effects on Snow Goose could include i) the unavoidable loss of migratory stop-over and moulting habitats from the port PDW footprints, and ii) aspects of disturbance to these habitats adjacent to the footprints. Table 15-3 shows the key issues facing Snow Goose as a result of PDW and assesses their significance. For each of the three key issues, the potential residual effect to Snow Goose is not significant. This assessment has determined that while some individual-level disturbance and displacement is expected to occur in a zone of influence during PDW, no changes to the overall Snow Goose population are expected. Therefore, these potential residual effects are considered to have a low likelihood of causing an effect, have a low magnitude, remain within 1 km of the PDW footprints, and may be frequent but have short-term effects that are easily reversible. Direct mortality of any individual Snow Goose due to PDW activities is not expected nor is any increase in contaminants levels expected that would adversely affect any individuals' health.

15.3.8.3 Prediction Confidence

The degree of prediction confidence is considered high and the likelihood of a significant effect on Snow Goose is considered low. A high degree of confidence is based on a high degree of survey coverage of suitable terrestrial and freshwater habitats was conducted during baseline studies and a high degree of survey coverage of coastal marine waters in Milne and Steensby Inlet that may be used for nearshore foraging and raising young.

15.3.8.4 Follow Up

The Terrestrial Environment Management and Monitoring Plan is in Section 7 of this document.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 15-3: Effects Assessment Summary: Snow Goose

Issue	Magnitude/Complexity	Geographical Extent	Frequency	Duration	Reversibility	Likelihood	Overall Significance	Degree of Confidence
Issue 1 Habitat Loss (direct and indirect)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints and LSA	**Level 1:** effect will be intermittent during PDW	**Level 1:** effect will only occur during Q2 2012 to Q1 2013	**Level 1:** habitat losses/disturbance are comparatively low as alternative sites are available in close proximity	**Level 2:** direct loss and/or disturbance of some habitat is likely due to their proximity to some PDW activities	Not Significant	High
Issue 2 Mortalities (collisions, increased harvests)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints and LSA	**Level 1:** effect if any, will be intermittent during PDW	**Level 1:** effect will only occur during Q2 2012 to Q1 2013	**Level 3:** effect is not reversible	**Level 1:** direct mortality is unlikely, mitigation measures regarding collisions and wildlife protection are addressed	Not Significant	High
Issue 3 Health (spills and introduced contaminants)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints and LSA	**Level 1:** effect could occur infrequently during PDW	**Level 2:** effect will only occur during Q2 2012 to Q1 2013and possibly longer	**Level 2:** effect of minor levels of contaminants likely to be reversible while major increase in contaminant levels may persist or be irreversible	**Level 1:** changes to health are unlikely, mitigation measures for spills, effluent, dust, and air emission controls are in place	Not Significant	High

© Hatch 2011/09

15.3.9 Common and King Eider

The methods used to assess the potential effects of PDW on Common and King Eider are similar to those used to assess potential effects on Snow Goose.

15.3.9.1 Potential Effects and Proposed Mitigation

Issue 1 - Habitat

Hundreds of Common and King Eider used both the proposed port sites as migratory stop-over sites during their spring and fall migrations, and dozens of female Eiders were seen raising young in the marine waters of Steensby Inlet. These birds will may be displaced from coastal marine and terrestrial habitat used for staging, nesting, foraging, and brood-rearing during PDW activities. However, it is also predicted that they will simply move approximately 1 km to either side of the port PDW footprints, to less disruptive, seemingly suitable habitat. Aerial and ground surveys in 2006–2008 indicated that there is an abundant supply of suitable habitat nearby for these species to move to. Although it is possible that during the approximate one year of PDW, displaced birds may be forced to forego breeding for a single year as they become confused and spend time seeking out and establishing themselves in new breeding habitats or they will be able to move quickly to nearby habitat and will not be affected at all. Therefore, displacement of Eiders from the relatively small (relative to the overall habitat availability) port PDW footprints and zones of influence, to nearby areas will have little to no effect on their migratory behaviour and nesting success during PDW.

In the DEIS, 2011, it was predicted that within the RSA there could be a loss of 2.0% and 1.2% of high and medium quality nesting and foraging habitat (Table 6-4.7, DEIS 2011). Based on the fact that the habitat effectiveness is reduced as a result of direct loss to the Project PDA footprint, and reduced effectiveness within a zone of influence due to sensory disturbances, habitat loss resulting from PDW will be substaintially less since PDW footprints will only be 3, 9 and 14% of the area of PDA footprints described for the Mine Site, Steensby Port and Milne Port respectively.

Issue 2 - Mortality

Potential influences on mortality for Eider will be similar to those described above for Snow Goose.

Issue 3 - Health

Potential influences on health for Eiders will be similar to those described above for Peregrine Falcon and Snow Goose.

Mitigation

The potential effects on Eider are expected to be low and localized. Therefore, no specific additional mitigation measures are proposed for these species. Baseline surveys indicated that there is an abundant supply of nearby suitable habitat for these species to move to. It is estimated that very few birds will be disturbed enough to abandon their traditional breeding sites.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.3.9.2 Assessment of Residual Effects

For Eiders residual effects could include i) the unavoidable loss of coastal and terrestrial habitat for staging, nesting, foraging, and brood-rearing from the port PDW footprints, ii) aspects of disturbance to these habitats adjacent to the footprints, and 3) aspects of disturbance to foraging habitat and behaviour. Table 15-4 shows the key issues facing Eiders as a result of PDW and assesses their significance. For each of the three key issues, the potential residual effect to Eiders is not significant.

This assessment has determined that while some individual-level disturbance and displacement is expected to occur in a zone PDW, no changes to the overall Eider population are expected. Therefore, these potential residual effects are considered to have a low likelihood of causing an effect, have a low magnitude, remain within 1 km of the PDW footprint, will not be frequent and will have short-term effects that are easily reversible. Direct mortality of any individual Eiders due to PDW activities is not expected nor is any increase in contaminants levels expected that would adversely affect any individuals' health.

15.3.9.3 Prediction Confidence

The degree of prediction confidence is considered high and the likelihood of a significant effect on Common and King Eider is considered low. Confidence is based on a high degree of survey coverage (100%) of suitable terrestrial and freshwater habitats; and a high degree of survey coverage (100%) of coastal marine waters in Milne and Steensby Inlet that may be used for nearshore foraging and raising young.

15.3.9.4 Follow Up

The Terrestrial Environment Management and Monitoring Plan is located in Section 7 of this document.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 15-4: Effects Assessment Summary: Common and King Eider

Issue	Magnitude/Complexity	Geographical Extent	Frequency	Duration	Reversibility	Likelihood	Overall Significance	Degree of Confidence
Issue 1 Habitat Loss (direct and indirect)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints and LSA	**Level 1:** effect expected to occur only during PDW	**Level 1:** effect will occur during Q2 2012 to Q1 2013	**Level 1:** habitat losses/disturbance are comparatively low as alternative sites are available in close proximity	**Level 2:** direct loss and/or disturbance of some habitat is likely due to their proximity to some Project components	Not Significant	High
Issue 2 Mortalities (collisions, increased harvests)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints	**Level 1:** effect could occur during PDW	**Level 1:** effect could occur during Q2 2012 to Q1 2013	**Level 3:** effect is not reversible	**Level 1:** direct mortality is unlikely, mitigation measures regarding collisions and wildlife protection will be in place	Not Significant	High
Issue 3 Health (spills and introduced contaminants)	**Level 1:** local disturbance relative to the extent of the features	**Level 1:** disturbance will be limited to PDW footprints	**Level 1:** effect could occur during PDW	**Level 2:** effect could occur during Q2 2012 to Q1 2013 and possibly longer	**Level 2:** effect of minor levels of contaminants likely to be reversible while major increase in contaminant levels may persist or be irreversible	**Level 1:** changes to health are unlikely, mitigation measures for spills, effluent, dust, and air emission controls will be in place	Not Significant	High

© Hatch 2011/09

15.3.10 Red-throated Loon

The methods used to assess the potential effects of PDW on Red-throated Loon are similar to those used to assess potential effects on Snow Goose.

15.3.10.1 Potential Effects and Proposed Mitigation

Issue 1 - Habitat

Red-throated Loon nests were found near marine coastlines in the Milne and Steensby Port areas as well as on freshwater bodies throughout the LSA that will be affected by the construction of Project facilities. Loons were also seen foraging and raising young throughout the LSA (DEIS 2011).

Loons may be displaced by port PDW, and/or disrupted by noise disturbances during PDW activities. The effects of sensory disturbance could be the abandonment of traditional nesting and foraging areas in the zone of influence. Based on 2006–2008 baseline studies around the Mary River exploration camp, loons will likely move only 300–500 m to less disruptive habitat. Baseline surveys also indicated that there is an abundant supply of nearby suitable habitat for this species to move to along the LSA. Therefore, displacement of loons from the zones of influence to nearby areas will have little to no effect on their nesting success during PDW.

In the DEIS, 2011, it was predicted that within the RSA there could be a loss of 1.6% and 1.3% of high and medium quality nesting and foraging habitat (Table 6-4.9, DEIS 2011). Based on the fact that the habitat effectiveness is reduced as a result of direct loss to the Project footprint or PDA (DEIS 2011), and reduced effectiveness within a zone of influence due to sensory disturbances, reduced habitat effectiveness for PDW will be substantially less. PDW footprints will only be 5, 10, and 15% of the footprints of the PDA described in the DEIS, significantly reducing potential effects from habitat loss on Red-throated Loon.

Issue 2 - Mortality

PDW are not expected to cause direct mortalities to loons. Loons are in low enough densities (they do not form flocks) that collisions with aircraft are unlikely and they are capable of avoiding the relatively slow moving ships, even when accompanied by flightless young. PDW is not expected to result in increased harvesting of loons as they are not a species typically harvested by the Inuit and PDW will have a no-hunting policy for all mine workers. Also, workers will not be permitted to disturb wildlife under any circumstances.

Issue 3 - Health

Potential influences on health for Red-throated Loons will be similar to those described above for Peregrine Falcon, Snow Goose and Eiders.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Mitigation

The potential effects on Red-throated Loons are expected to be low and localized to only a few water bodies found directly adjacent to the Milne Inlet Tote Road, and therefore, no specific additional mitigation measures are proposed for this species. Baseline surveys indicated that there is an abundant supply of nearby suitable habitat for these species to move to but very few birds will be disturbed enough to abandon their traditional breeding sites. Individual loon nests will be avoided by observation prior to PDW activities within the vicinity of the coastal areas and ensuring that equipment, such as water pumps are not placed on or within 100 m of an active loon nest.

15.3.10.2 Assessment of Residual Effects

Residual effects on Red-throated Loons could include i) the unavoidable loss of coastal and terrestrial habitat for staging, nesting, foraging, and brood-rearing from the port PDW footprints, ii) aspects of disturbance to these habitats adjacent to the footprints, and 3) aspects of disturbance to foraging habitat and behaviour. Table 15-5 shows the key issues facing loons as a result of PDW and assesses their significance. For each of the three key issues, the potential residual effect to loons is not significant. This assessment has determined that while some individual-level disturbance and displacement may occur in a zone of influence during PDW, no changes to the overall loon population are expected. Therefore, these potential residual effects are considered to have a low likelihood of causing an effect, have a low magnitude, remain within 1 km of the PDW footprint, and may be frequent but have short-term effects that are easily reversible. Direct mortality of any individual loons due to PDW activities is not expected nor is any increase in contaminants levels expected that would adversely affect any individuals' health. All effects will eventually be eliminated after carefully planned closure and post-closure procedures.

15.3.10.3 Prediction Confidence

The degree of prediction confidence is considered high and the likelihood of a significant effect on Red-throated Loons (and all other bird species) is considered low. Confidence is based on a high degree of survey coverage of coastal marine waters in Milne and Steensby Inlet that may be used for nearshore foraging and raising young.

15.3.10.4 Follow Up

The Terrestrial Wildlife Management Plan is located in Section 7 of this document.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.3.11 Proposed Mitigation Measures Common to Bird Key Indicators

15.3.11.1 General Mitigation Measures for all Bird KIs

The bird key indicators (KIs) are considered both ecologically and socially important to the local area, are members of at least four trophic guilds (carnivores, piscivores, herbivores, crustaceavores), and use at least three distinct ecosystems (terrestrial, freshwater, marine). Therefore, PDW effects can be mitigated and monitored on many different bird species that use portions of the LSA in similar ways.

A Wildlife Mitigation and Monitoring Plan was implemented in 2007 for the Mary River Bulk Sample Program and the associated port and shipping activities in Milne Inlet and Eclipse Sound, and for the Mary River Geotechnical Drilling Program (DEIS 2011). In both of these WMMPs, important bird KIs and their respective nesting and foraging sites were protected by 500 m buffers. In some instances where Project activity within these 500 m buffers was unavoidable, nest-specific management guidelines were established to minimize the duration and magnitude of the disturbance to these sites. These documents have been reviewed and updated to include mitigation measures for the protection of birds during the construction, operation, and closure phases of the overall Mary River Project. A summary of the main mitigation measures proposed for birds is presented below and these are described in more detail in Appendix 10D-11.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 15-5: Effects Assessment Summary: Red-throated Loon

Issue	Magnitude/Complexity	Geographical Extent	Frequency	Duration	Reversibility	Likelihood	Overall Significance	Degree of Confidence
Issue 1 Habitat Loss (direct and indirect)	**Level 1**: local disturbance relative to the extent of the features	**Level 1**: disturbance will be limited to PDW footprints and LSA	**Level 1**: effect will be intermittent during PDW	**Level 1:** effect will occur from Q2 2012 to Q1 2013	**Level 1**: habitat losses/ disturbance are comparatively low as alternative sites are available in close proximity	**Level 2:** direct loss and/or disturbance of some habitat is likely due to their proximity to some Project components	Not Significant	High
Issue 2 Mortalities (collisions, increased harvests)	**Level 1**: local disturbance relative to the extent of the features	**Level 1**: disturbance will be limited to PDW footprints	**Level 1**: effect could occur infrequently (if at all) during PDW	**Level 1:** effect could occur from Q2 2012 to Q1 2013	**Level 3:** effect is not reversible	**Level 1**: direct mortality is unlikely, mitigation measures regarding collisions and wildlife protection will be in place	Not Significant	High
Issue 3 Health (spills and introduced contaminants)	**Level 1:** local disturbance relative to the extent of the features	**Level 1**: disturbance will be limited to PDW footprints	**Level 1**: effect could occur infrequently during PDW	**Level 2:** effect could occur from Q2 2012 to Q1 2013 and possibly longer	**Level 2:** effect of minor levels of contaminants likely to be reversible while major increase in contaminant levels may persist or be irreversible	**Level 1**: changes to health are unlikely, mitigation measures for spills, effluent, dust, and air emission controls will be in place	Not Significant	High

© Hatch 2011/09

The potential effects on falcons, geese, Eiders, and loons is expected to be low and localized to only a relatively small zone of influence (relative to the amount of suitable habitat available). However, Canada's *Migratory Birds Convention Act* (1917, 1994) regulates the protection and conservation of these species and prevents the disturbance or destruction of these birds, their nests and eggs. Therefore, all bird KIs warrant special consideration and protection during all PDW activities conducted between mid May and October. If construction activity is in progress when the migrants arrive (typically in May and June) then most birds would become discouraged from nesting in these disturbed areas and PDW activities would be allowed to continue. Otherwise, general mitigation measures that will be applied to all KIs includes the avoidance of areas of large concentrations of foraging or moulting birds, and the avoidance of known nests or nesting areas by personnel and equipment to the extent possible. If nests are found in a work area environmental staff will be contacted and mitigation plans such as closure of the area within a 500 m radius of the nest until fledging occurs (typically late July) will be implemented. Nest-specific management plans (discussed below) will then be developed and issued to all employees working in that area.

Other general mitigation measures could include as needed:

- Minimizing the PDW footprint to the extent possible, thus minimizing the direct loss of habitat or the reduction of habitat effectiveness (indirect habitat loss)
- Conducting nest searches for falcons, geese, Eiders and loons in areas to be disturbed, prior to commencing PDW activities
- Minimizing potential effects to breeding birds by limiting PDW activity and noise emissions to the extent possible, to non-nesting periods (August–April);
- Implementing nest-specific management plans for any nest sites that may require PDW activity to take place within 500 m
- Implementing no-hunting policies and employee training to ensure workers do not disturb, harass, or feed wildlife
- Preventing air traffic below 610 m above ground level (agl) over known nests and nesting areas during the nesting period, and over any large concentrations of birds
- Developing appropriate aircraft approach and departure flight paths, to the extent possible, for the airstrips at the Milne with consideration for nearby bird populations to avoid disturbance and to minimize the likelihood of bird strikes
- Routing ships to maximize distances between the ships and shorelines to remain at least 2 km from seabird colonies
- Handling ship discharges in a way that conforms with the *Canada Shipping Act* and the *Arctic Waters Pollution Prevention Act*
- Developing effective oil spill emergency response plans in accordance with the *Arctic Waters Pollution Prevention Act*

© Hatch 2011/09

- Minimizing dust production by implementing dust suppression methods, and thereby minimizing the PDW zone of influence.

15.3.12 Nest-Specific Management Plans

In some cases it may not be feasible to maintain a 500 m buffer between known nests and Project activities. In such cases, specific nest management plans will be developed and these will outline proper operating procedures for all Project personnel to follow to ensure the duration of the activity and the magnitude of the disturbance to that nest is minimized. Project biologists will monitor each individual case as often as possible and in a manner that does not cause added disturbance to the nest, to assess the effectiveness of the nest-specific management plans. To prevent thermoregulatory stress to eggs, incubating adults should not be disturbed/flushed from their nests during inclement weather (rain, snow, cold temperatures) in June and July.

15.3.13 Subjects of Note

The following subjects of note were identified in the scoping process of the Project for bird studies:

- The potential destruction of nests of any species as part of Project construction and mining activities and the resultant contravention of the *Nunavut Wildlife Act* and the *Migratory Birds Convention Act*. This issue, common to all construction Projects in North America, will be addressed through the timing of construction activities defined Section 7.0 of this document
- Habitat loss of bird species from ground disturbance and displacement from Project infrastructure
- Effects on seabirds
- Presence of Species at Risk.

Although songbirds and shorebirds were not considered to be KIs for the Project, monitoring related to these species will be conducted and will focus on compliance with the *Nunavut Wildlife Act* and *Migratory Birds Convention Act* during PDW.

15.3.14 Important Habitat Areas

There are no habitat areas within the RSA that have been federally or territorially designated as important habitat areas, or conservation areas. However, as mentioned in the Baseline Summary above, Sirmilik National Park and the Bylot Island Bird Sanctuary lie along the northern tip of the RSA and there are various *Key Marine Habitat Sites*, *Key Terrestrial Habitat Sites*, *Important Bird Areas* (DEIS 2011) scattered along the edges of the shipping lanes, particularly in Foxe Basin and Hudson Strait. No direct effects are expected for these important habitat areas as disturbance and habitat loss due to PDW activities will be restricted to small areas in and around the port site PDW footprints (i.e., local scale effects). However, all birds may be exposed to PDW activities if they use portions of the LSA at any time.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.3.15 Seabirds and Seabird Colonies

No major seabird colonies or large feeding flocks were identified around the shoreline and waters of Milne Inlet, and nearby Koluktoo Bay, Eskimo Inlet, Tremblay Sound, and the southern half of Eclipse Sound, nor in Steensby Inlet. Therefore, no significant effects are predicted to occur to seabirds in Milne or Steensby Inlet during the short duration of PDW.

Ships travelling in and out of Eclipse Sound must by necessity pass within proximity of Canada's largest Greater Snow Goose colony on Bylot Island, as well as large seabird colonies at Cape Graham Moore. Ships travelling through Foxe Basin and Hudson Strait will also pass several *Key Marine* and *Key Terrestrial Habitat Sites* and *Important Bird Areas*. These ship passages may disturb nesting birds at their colonies, but it is possible that these birds could come into contact with the ships when foraging on the water. However, it is thought that ship movements for PDW (only for approximately 10 weeks during the 2012 open water season) will have inconsequential effects on foraging marine birds along the shipping lanes as bird collisions with ships is unlikely and the periodic requirement to move out of a ship's path will not be a major energetic stress to birds. Sealift, Navy, and cruise ships have long been entering into Pond Inlet, Eclipse Sound, Navy Board Inlet, Foxe Basin and Hudson Strait and there have been no reports of noticeable long-term effects to seabird and goose colonies in these areas.

The likelihood of a large-scale catastrophic fuel spill is low, but none-the-less remains a potential threat during PDW. The potential for smaller fuel spills or chronic leakage from ships is higher, but also remains low overall. Regardless, all marine birds, and seabirds in particular, are vulnerable to even minor exposure to fuel through contamination of their plumage and through the ingestion of fuel contaminated food. Shipping of fuel for PDW will only occur during an approximate 10 week period during 2012. Birds that feed at the water surface, along the shoreline, or dive under the surface to feed are all highly vulnerable to exposure in the event of even a minor spill. Colonial nesting species and species that form large concentrated feeding aggregations are also highly vulnerable to spills of any size. Therefore, the effect of oil spills in Eclipse Sound, Pond Inlet, Foxe Basin, and Hudson Strait have the potential to be long-lasting to many species' populations and could potentially extend outside of the RSA. Of all the potential PDW related effects to marine birds, the effects of a large fuel or oil spill would have the greatest magnitude.

15.3.16 Species at Risk

The Mary River Project area has a relatively high density of breeding Peregrine Falcons and although the above assessment has concluded that the PDW will have no population-level effects, the potential to disturb and disrupt individuals is possible and proper mitigation procedures must still be put in place to minimize these. Harlequin Duck, Ivory Gull, Ross's Gulls, and Short-eared Owl were all seen in very low numbers (DEIS 2011) and none were seen breeding within the LSA, nor have they ever been reported to breed in the area by other studies. Therefore, based on data collected and

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

discussions with local experts, it is unlikely that PDW facilities will have any effect on the behaviour or population dynamics of these species.

15.3.17 Impact Statements

Project-related activities could potentially alter bird behaviour and cause displacement during the short duration PDW but this will be confined to the relatively small PDW footprint (only 5, 10 and 15 % of the PDA of the Mine Site, Steensby Port and Milne Port respectively) relative to the availability of suitable habitat nearby. As a result, densities of bird KIs are expected to decline within the PDW footprint, and possibly within adjacent zones of influence. These changes are expected to be a result of displacement out of the affected areas and not a result of mortalities to the birds or their offspring. Because of the vast amount of available suitable habitat nearby, the overall effect of the PDW to the KIs specifically, and to all bird species in general, is expected to be negligible.

In summary, the residual effects of PDW activities on bird KIs include habitat changes such as localized direct habitat loss and disturbance; however, overall effects are not likely to have serious implications for any species' regional populations. Species abundance and habitat use may be altered within the port PDW footprints, and to some extent within a certain zone of influence around them as some individuals will move to less disturbed neighbouring areas. Mitigation measures will be in place to minimize the potential for collisions, increased harvesting, or exposure to contaminants as a result of the PDW.

15.3.18 Peregrine Falcon

PDW will have a not significant residual effect on Peregrine Falcon population dynamics and habitat. Although minor changes in falcon density may occur within the PDW footprint as birds move to less disturbed habitat nearby, the overall effect of PDW on these birds is expected to be minimal. No cumulative effects are expected.

15.3.19 Snow Goose

PDW will have a not significant residual effect on Snow Goose population dynamics and habitat. Although minor changes in goose densities may occur within PDW footprints as birds move to less disturbed habitat nearby, the overall effect of PDW on these birds is expected to be minimal. No cumulative effects are expected.

15.3.20 Common and King Eider

PDW will have a not significant residual effect on Common and King Eider population dynamics and habitat. Although minor changes in Eider population densities may occur within the PDW footprints as birds move to less disturbed habitat nearby, the overall effect of the PDW on these birds is expected to be minimal. No cumulative effects are expected.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.3.21 Red-throated Loon

PDW will have a not significant residual effect on Red-throated Loon population dynamics and habitat. Although minor changes in loon population densities may occur within PDW footprints as birds move to less disturbed habitat nearby, the overall effect of PDW on these birds is expected to be minimal. No cumulative effects are expected.

15.4 Terrestrial Wildlife and Habitat

Terrestrial wildlife on north Baffin Island was described in the terrestrial wildlife baseline report (Appendix 6F of the DEIS 2011).

Pre development works (PDW) are proposed to occur between Q2 2012 to Q1 2013. The work will largely include the delivery and staging of materials and equipment at Milne and Steenby Ports. The full extent of PDW at each of the locations in the Project area are described in Section 2 to Section 6 of this document. The effects assessment for terrestrial Valued Ecosystem Components (VECs) focuses on PDW activities of Milne Port, the Tote Road, the Mine Site, and Steensby Port.

15.4.1 Issues Scoping

Terrestrial wildlife valued ecosystem components (VECs) were identified based on ecological and social importance and relevance to the potential interactions with the Project. PDW activities, although at a much reduced scale and footprint compared to construction and operation phases of the Project, have the potential to interact with Caribou. PDW will occur from Q2 of 2012 until Q1 of 2013 (approximately one year). PDW footprints will only be approximately 5, 10 and 15 % of the area for the Mine Site, Steensby Port and Milne Port PDA's respectively. During baseline data collection for the DEIS, Caribou were consistently identified as an important species to the communities. They are abundant during population cycle "highs" and may interact with the proposed Project. When present, caribou are harvested and consumed by local people, and hunters from communities surrounding the Project. There are harvest records back to the 1920s, and caribou certainly remain a key component of Inuit diet and culture. Caribou also appear to be a keystone species in the north Baffin Island ecosystem as the abundance of many other animals, particularly the island's carnivores, seem to be related to their abundance and distribution. Additionally, many studies have been conducted on caribou responses to industrial activities throughout the species range. For these reasons, caribou were identified as a VEC for the Project and are in part representative of a north Baffin Island terrestrial wildlife response to PDW activities.

Baffinland conducted a number of workshops, interviews, radio call-in shows and written requests to collect baseline information and determine public perceptions and concerns with the Project's interaction with terrestrial wildlife. This engagement is listed in Volume 2 of the DEIS and is summarized in Section 5 of Volume 6 in the DEIS.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.4.2 Caribou

PDW and potential closure activities have the potential to effect distribution and abundance of wildlife VECs in the RSA. The key indicator of the Project's effects on the VEC "Terrestrial Wildlife" is caribou. There are four measurable parameters that allow a prediction of the effects of PDW on caribou and include habitat, movement, mortality, and health. A review of the potential interaction of PDW with the four measurable parameters is described below.

Habitat

Habitat can be affected through direct loss within the footprint PDW that is either temporary or permanent, or through indirect loss from Project activities that create sensory disturbances and temporarily reduces the effectiveness (usefulness) of adjacent habitats.

Loss of caribou foraging habitat will occur because of the infrastructure footprint of PDW. In addition, the presence of infrastructure is considered a negative effect on caribou as caribou have been reported to generally avoid infrastructure (DEIS 2011).

Indirect or functional loss of habitat includes reduction of habitat effectiveness due to PDW activities that will occur from Q2 of 2012 until Q1 of 2013 (approximately one year). Sensory disturbances can result in behavioural responses such as flight responses or avoidance of particularly disturbing areas. These behavioural responses can ultimately affect the energetic benefits of particular habitats. Sensory disturbances associated with the Project can be categorized by the senses they stimulate: sight (vision), hearing (audition), smell (olfaction), touch (tactition) and taste (gustation). Human caused visual stimuli that cause behavioural responses can include people (walking, etc.), off-road vehicles, automobiles, trains, aircraft and ships travelling across a landscape/seascape. Aural stimuli include noises associated with motors, generators, automobiles, aircraft, blasting, etc. Olfactory stimuli include scents associated with human presence (cooking), motors (exhaust) or dust. Tactile disturbances may be related to an animal's response to vibration. A taste response may be elicited by dust deposition on forage that affects palatability. A number of Project activities can be associated with several sensory disturbances; for example, caribou could see, smell, hear and feel blasting around the mine and a resulting behaviour could be to avoid some areas of otherwise useable habitat (DEIS 2011).

Dust from mining activities, handling and transportation of ore will not occur as part of PDW. Therefore, metals in dust from mining and ore handling will not be discussed further as it is not applicable to PDW.

Movement

Traditional movement patterns could be altered by PDW related infrastructure or activities that act as a barrier or filter (i.e., limiting some but not all) to movement.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Infrastructure could change, restrict or stop the movement of caribou. Barriers that limit or change caribou movement may cause changes in the distribution and abundance of caribou through limiting access to portions of their traditional range. Changes to the traditional movement pattern of caribou could have unpredictable effects on a population. Effects are dependent on the scale of an animal's environment. For example, migratory caribou require access to distant ranges which are used for portions of their seasonal life cycles, including calving grounds, post calving range, rutting areas and winter range. Non-migratory caribou such as the North Baffin caribou select habitat at a more local scale and the distance travelled between seasonal habitats is much smaller. It is unlikely that PDW infrastructure will change caribou movement due to the relatively small footprints of infrastructure and activities relative to the PDA. Furthermore, the footprints of infrastructure for PDW are already largely occupied by existing infrastructure at Milne Port , the Tote Road and the Mine Site.

Point source disturbances that are discrete and separated by large distances (e.g., PDW activities at ports and Mine Site) are unlikely to cause changes to caribou movement because caribou can use adjacent habitat to get to their target habitats. It is unlikely that linear infrastructure, such as access roads or the Tote Road would block movement or cause caribou to change movement routes due to the intermittent use of the roads and short duration of PDW activities. The Tote Road has existed since the 1960's, so it does not present a new feature in the landscape from PDW.

During PDW it is expected that few caribou will occur within the RSA (as defined in Section 5 of Volume 6 of the DEIS); currently, the caribou are thought to be in the trough (bottom) of a 70-year population cycle. The caribou that currently occupy the RSA are not migratory. The local caribou on average move less than 4 km per day during all seasons (DEIS 2011).

As PDW activities will occur for approximately one year Q2 2012 – Q1 2013, a potential long term upswing in caribou numbers and migratory patterns are not considered in this assessment.

Mortality

It is unlikely that caribou mortality will occur as a direct result of PDW through collisions, or indirectly through increased harvesting access, however it is possible. PDW related activities could directly cause wildlife mortality through collisions with vehicles (planes, and automobiles) or through problem animal kills. Higher mortality through increased hunter harvest because of easier access into hunting areas or greater knowledge about caribou in the area is not expected to occur for PDW since the Tote Road is already present and use of access roads from the Mine Site and Steensby Port along the proposed rail corridor would not likely make access on ATV's or snowmobiles any easier. Additionally, Baffinland implemented a wildlife policy in the past that has resulted in no direct mortality of local caribou. This experience and success will be carried forward for PDW activities.

Health

Effluent, dust (TSP) and air emissions released into the environment have the potential to be absorbed, ingested or inhaled by wildlife, which may have an effect on the health of individual

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

animals and, consequently, wildlife abundance. Emissions from diesel generators and other equipment, and dust along transportation corridors are most likely contributors to contaminants within the RSA. Dust is expected to remain within the footprint of PDW areas and is expected to contain background levels of metals since no ore mining, handling or transport will occur as part of PDW. Therefore, health effects dust on caribou are not expected.

15.4.3 Assessment Methods

The assessment of PDW potential effects on caribou was based on four measurable parameters: 1) habitat, 2) movement, 3) mortality, and 4) health. Habitat and movement effects were predicted using a quantifiable procedure. Mortality and health effects were assessed qualitatively. Assessment methods are described for individual measurable parameters below.

The magnitudes of the effects were determined relative to the scale of occurrence within either the RSA or within the range of the north Baffin Island caribou herd. The RSA was identified to ensure that the range of direct and indirect potential disturbances as a result of PDW activities could be examined and potential effects could be spatially quantified. The RSA was chosen to represent wildlife and habitat at an ecologically relevant scale and to reflect regional habitat use and seasonal movement patterns on north Baffin Island. The RSA also had to be a reasonable size so that baseline surveys and information for the DEIS could be gathered in an economical fashion and provide information that is directly relevant to Project management and mitigation. The 21,053 km^2 RSA was described in the terrestrial wildlife baseline report (Appendix 6F of the DIES 2011). The range of the north Baffin Island caribou herd encompasses an area from south of the Barnes Ice cap, extending north along the southern coast to the southern Brodeur Peninsula, and inland to east of Pond Inlet. Caribou are known to exist throughout this region, and effects on caribou as a result of the PDW are assessed within the entire range. The maximum extent of the north Baffin Island caribou range is estimated at 134,308 km^2 (DEIS 2011).

Habitat

Direct habitat effects were assessed by assuming that the habitat within the footprint of PDW will become unavailable to caribou (*i.e.*, the probability of finding caribou within the footprint of PDW are reduced to 0). For indirect effects on caribou habitat, a conservative approach for this assessment assumes that the zone of influence (ZOI) will be similar for all PDW areas. A recent article that documents a 14 km ZOI around the EKATI™ and Diavik Mine Sites in the Northwest Territories (DEIS 2011). The approach assumes a 75% reduction of animals in the ZOI. It is likely that this ZOI is a combination of noise, dust, vibration or sensory (smell) stimuli. This ZOI is considered conservative for this assessment but applicable due to activities causing noise, dust, vibration and smell (i.e. blasting, earthworks, vehicles moving along access roads).

To assess the magnitude of the effect, a comparison of habitat effectiveness estimated within the RSA for the DEIS were compared. Habitat effectiveness takes into consideration habitat loss from within the PDA as well as effects of ZOI that may deter caribou from occupying that space. For PDW,

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

footprints only occupy approximately 5, 10 and 15% of the area of PDA's assessed in the DEIS. Therefore, it is highly likely that estimates for reductions in habitat effectiveness predicted for the DEIS will be less for PDW.

Movement

The potential effect of PDW infrastructure on caribou movement was qualitatively assessed through information from a literature search, professional opinion, or self-evident effects.

The railway corridor is not included in PDW, however, winter access roads may cause a barrier to caribou movement due to periodic vehicle traffic. It is not expected that access roads or winter access roads will have embankments or cuts that present difficulty for caribou movement based on surrounding topography that caribou are known to traverse. It is assumed that caribou will be able to see over embankments that are 2 meters in height or less and that caribou will be able to climb embankments that are less than 2 meters high. Embankments for access roads exceeding 2 meters in height, if any, would not likely be of sufficient length to prevent a caribou from traversing alongside the embankment until the embankment lessened in height making crossing possible. The Tote Road has been part of the landscape since the 1960's and will not be altered significantly due to any road upgrades. Periodic vehicle movements on the Tote Road may present a minor barrier to caribou movement.

Mortality

PDW effect on caribou mortality was assessed as the probability of increased risk of activities killing caribou: collisions with caribou on the Tote Road, access roads or on air strips. The assessment is considered within the framework of Baffinland's wildlife policy of wildlife having the right-of-way for travel and a no-hunting policy for on-site staff.

Health

In the DEIS, the Project's effects on caribou health were considered as it relates to potential contamination of forage as a result of dust and emissions from the Project. For PDW activities, dust is expected to remain within PDW footprints and will only be associated with road traffic or earth works. Metals associated with dust from mining, crushing, handling and transportation of ore will not be part of PDW and therefore potential effects of metals on vegetation and caribou health are not included in this assessment. The duration, frequency and magnitude of air emissions (NOx and SO2) are not expected to cause changes in vegetation health and therefore will not affect the quality of a caribou's diet. The potential effect of sensory disturbances on caribou health (e.g., noise) is accommodated within the assessment of habitat effectiveness as noted above (e.g., caribou avoiding suitable habitat and resulting negative effects on health from reduced foraging).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.4.4 Potential Effects and Proposed Mitigation

Habitat

In the DEIS, a proportional representation estimated that there may be a 1.9% reduction in habitat effectiveness over the entire north Baffin Island caribou range (i.e., 12% effect on the RSA equals 1.9% on the entire north Baffin Island caribou range) in summer, and a 2.0% reduction in winter habitat effectiveness (DEIS 2011). Therefore, it was estimated that approximately 2% of habitat utilized by caribou would not be available for caribou in summer and winter months, based on the size of the PDA's and ZOI around the PDA's. For PDW, footprints will only occupy 5, 10 and 15 % the PDA's for the Mine Site, Steensby Port and Milne Port described in the DEIS respectively. Therefore, the loss of habitat effectiveness for the north Baffin Island caribou will most certainly decrease to less than 2% for PDW activities.

Mitigation of habitat loss includes reclamation of disturbed areas post PDW, dust suppression, and limiting potential sensory disturbances.

Movement

The mine and ports will not be significant barriers to caribou movement. Currently, the caribou within the region are non-migratory and it is not expected that migratory caribou will return to the area until the population begins to increase, which is expected to occur long after PDW activities (DEIS 2011).

Winter shipping during the winter (ice) season will not occur during PDW. Therefore, potential caribou movement to and from the islands south in Steensby Inlet will not be effected.

Traffic along the winter access roads and the Tote Road may result in barriers to caribou movement while the vehicles are travelling along the corridor. It is difficult to quantify a "moving" barrier to caribou movement, so it was determined the quantity of the effect by considering a caribou standing on one side of a transportation corridor and estimating the quantity of time that they will be unable to cross the road or rail because of traffic. Estimating barrier effects in this way underestimates the actual barrier effect because caribou are very unlikely to cross immediately before or after a vehicle passes. Traffic along any of the access roads or Tote Road is not expected to exceed 50 vehicles passing by in any given day. Making the assumption that the trucks are an average of 35 m long and travel 50 km/h, then a caribou standing beside the road will be blocked from crossing by trucks for no longer than 4.5 minutes per day. This corresponds to approximately 0.3% of a normal operation day that caribou are unable to cross the roadway because of vehicles. If caribou will not cross the roadway 100 m before and after a truck passes, then the barrier affect increases to approximately 2% of a normal operation day. Other road maintenance and snow removal vehicles will also travel the road route during some days, but will not substantially increase the barrier.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Truck traffic has the potential to cause a barrier to caribou movement across the roadway; however, currently there are very few caribou in the region, and specifically the roadway is in an area where caribou numbers are particularly low. No significant adverse effect to caribou movement across the roadway is anticipated because of trucks causing a barrier to movement during PDW.

Mortality

During the previous four years of exploration, there was no caribou mortality caused by Baffinland personnel or from Project activities. Wildlife are given the right-of-way, thus traffic controls are in place should caribou be observed on or near the road. On-site staff are restricted from harvesting wildlife. Garbage (as a potential attractant to scavengers) is incinerated and not stored on site. With the appropriate mitigations, monitoring and the implementation of a comprehensive wildlife policy, no effects of PDW on caribou mortality is expected.

Caribou abundance is expected to remain low during PDW and migratory caribou are not expected to return to the area in the short-term. Currently, the caribou are in the trough (bottom) of a population cycle. Consequently, a very low probability of direct Project-related mortality is expected.

If caribou mortality were to increase as a direct result of PDW, the effects can be readily mitigated by increasing traffic controls including seasonal traffic limitations of the Tote Road and access roads.

15.4.5 Assessment of Residual Effects

The following text describes the residual effects that will remain after mitigations have been applied for each measurable parameter. After a discussion/description of the residual effects, the predictions are tabled and summarized for each measurable parameter using the language and evaluation criteria described in Volume 2, Section 3 of the DEIS.

Habitat

Loss of habitat within the footprint of PDW is a residual effect - Habitat will not be reclaimed (re-vegetated) within a generation of caribou. Sensory disturbances that reduce habitat effectiveness within a zone of influence can only be partially mitigated. Caribou could find some PDW activities disturbing. It is uncertain to what degree caribou will adapt to those disturbances. However, over the entire range of the north Baffin Island caribou, habitat effectiveness is predicted to be reduced by < 2 % during all seasons. This effect will last only for the duration of PDW (approximately one year). The predicted levels of habitat effects based on the evaluation criteria are summarized in Table 15-6.

Movement

On an area-by-area basis there are no barriers to movement for caribou travelling around Milne and Steensby Port and the Mine Site. Insignificant barriers to movement could occur along the tote and access roads, although these barriers will be extremely small in frequency and duration.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Transportation embankments and building foundations do not exceed the characteristics of the current landscape.

Alterations to the landscape that would remain post-closure are consistent with the surrounding environment and will be immeasurable features on the landscape given the rough terrain in the RSA.

The overall residual effect of PDW on caribou movement will be not significant.

© Hatch 2011/09

Table 15-6: Effects Assessment Summary: Caribou

Issue	Magnitude/ Complexity	Geographical Extent	Frequency	Duration	Reversibility	Likelihood	Overall Significance	Degree of Confidence
Issue 1 Habitat Loss (direct and indirect)	**Level 1**: Effect will be indistinguishable from natural variation in caribou distribution.	**Level 1**: The Zone of Influence occurs within the PDA.	**Level 3**: The effect will be continuous through PDW.	**Level 1**: The effect will occur only during PDW (Q2 2012-Q1 2013)	**Level 1**: The effect is fully reversible.	High	Not significant at the scale of the North Baffin caribou population	High
Issue 2 Movement (reduced frequency of caribou crossing infrastructure)	**Level 1**: The effect will be indistinguishable from natural variation in caribou movement across access roads and around PDW footprints.	**Level 1**: The effect will occur within the Project footprint.	**Level 1**: The effect will be intermittent during PDW.	**Level 1**: The effect will occur only during PDW (Q2 2012-Q1 2013)	**Level 1**: The effect is fully reversible.	High	Not significant at the scale of the North Baffin caribou population	High
Issue 3 Mortality (collisions and harvest)	**Level 1**: minor to no effect, and undetectable at the population scale.	**Level 1**: The effect will occur within and near the Project footprint.	**Level 1**: The effect will be intermittent during PDW.	**Level 1**: The effect will occur only during PDW (Q2 2012-Q1 2013)	**Level 1**: The effect is fully reversible.	Moderate	Not significant at the scale of the North Baffin caribou population	High

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Mortality

PDW related mortality on caribou, if it occurs, is readily reduced by adjusting speed limits, seasonal traffic limits, regular monitoring of caribou numbers and proximity to transportation corridors, and a no-hunting policy for staff while on-site. There are no known features of PDW that will reduce health to a level of increased mortality for the north Baffin Island caribou herd.

There are no expected residual effects of PDW on caribou mortality. Mortality, if it occurs, will be limited to individuals, within PDW footprints. The effect of the Project on caribou mortality is not significant. The predicted levels of mortality effects based on the evaluation criteria are summarized in Table 15-6.

15.4.6 Prediction Confidence

Habitat

High Confidence in Prediction. The zone of influence in based primarily on work from EKATI™ and Diavik mines in the Northwest Territories (one study). However, the results of the study are based on mining activities during operations which is likely an over estimation of potential effects for PDW. Never the less, it represents a conservative approach in assessing predictions. Additionally, it is certain that PDW activities will only occupy a small percentage of the PDA used to assess effects to habitat effectiveness in the DEIS. Therefore, there is a high prediction of confidence that habitat effectiveness will be greater for PDW than that predicted for full Project construction and operations in the DEIS.

Movement

High Confidence in Prediction. There is high confidence that access roads will not provide a significant barrier to caribou movement. Vehicle traffic on the roads will be intermittent and for short duration during PDW. There is a high degree of confidence that PDW footprints at Milne Port, the Mine Site and Steensby Port will not cause a barrier as caribou will be able to move around the footprint area.

Mortality

High Confidence in Prediction. There are few caribou in the area. Mitigation is readily enacted (e.g., speed limits, seasonal traffic limitations). No hunting is allowed by mine staff. General Project activity monitoring will include a component tracking Project-related animal mortality.

15.4.7 Follow Up

An adaptive wildlife management plan will be the key to reducing any effects of PDW on the terrestrial wildlife. Appendix B.8 of this document provides all management plans.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

15.4.8 Subjects of Note

Carnivores

Wolves and foxes are the dominant predators within the RSA, but they occur at very low densities. Though they are rarely observed, they occur within the RSA during the entire year and there are likely active den sites every year. None of the local carnivores are designated as being of conservation concern. Interviews with local people suggest that few carnivores are harvested each year. Wolf numbers are mostly dependent on caribou abundance, so any effects from PDW will likely be insignificant compared to the main effect of carnivore response to caribou abundance. Mitigation will include:

- garbage management
- monitoring of den sites that may be disturbed by PDW activities.

15.4.9 Impact Statements

15.4.10 Caribou Habitat

We are confident that PDW related activities will have a not significant loss of habitat and a not significant reduction in the effectiveness of caribou habitat within the North Baffin caribou range.

15.4.11 Caribou Movement

We are confident that PDW related activities will have a not significant effect on traditional caribou migration on north Baffin Island.

15.4.12 Caribou Mortality

We are confident that the PDW will have a not significant effect on overall north Baffin Island caribou mortality.

A summary of the terrestrial wildlife effects is provided in Table 15-7.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 15-7: Terrestrial Wildlife Impact Statement Summary for PDW

Measurable Parameter	Significance of Residual Effect	Mitigation Measures	Level of Confidence
Habitat	No significant reduction in the effectiveness of caribou habitat within the north Baffin Island caribou range.	• No immediate measures	High
Movement	No significant effect on traditional movement on north Baffin Island caribou.	• Wildlife monitoring by employees • Speed limits on roads	High
Mortality	No significant effect on overall mortality of north Baffin Island caribou.	• Record of collision on Tote Road and access roads • Record of all observed wildlife mortality reported by personnel • Log of hunters passing through the camp • "no harvesting/hunting" camp policy • Speed limits on road	High

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16. Freshwater Environment

This section presents environmental effects assessment with respect to the Freshwater Environment.

16.1 Boundaries

The temporal boundaries of this assessment are restricted to the one year period (March 2012 – March 2013) during which the PDW will be carried out.

The spatial boundaries of this assessment are limited by the locations at the Project Site where PDW activities will occur. It comprises four Local Study Areas - Steensby Inlet, Milne Inlet, Milne Tote Road and the Mine Site. The selected (local study areas) have been defined as "those areas where there exists the reasonable potential for immediate impacts due to project activities, ongoing normal activities, or to possible abnormal operating conditions".

The primary watershed boundaries potentially interacting with the PDW include Phillips Creek, the Ravn River, Cockburn River, and a few small unnamed watersheds near Milne and Steensby Inlets. The Ravn and Cockburn Rivers general flow in a southerly direction, while Phillips Creek flows in a northerly direction. Stream flow typically occurs between June and September, although the timing of the onset and end of open channel flow can vary by a few weeks within any given watershed, depending upon the year. Watercourses are generally dry or frozen from October through May. All watercourses within the region eventually freeze solid during the winter. In the spring, early runoff is directed into the stream channels, where it flows on top of the ice frozen in place during the winter. Eventually, the channel ice is eroded and melted away. Subsurface flow is limited by permafrost, which only melts to a depth of approximately 1 to 2 m. essentially no subsurface flow occurs below the active permafrost layer.

Four LSAs were defined for the freshwater effects assessment. From north to south the LSAs are Milne Port, Milne Inlet Tote Road, Mine Site, and Steensby Port. The boundaries of each LSA are described as follows:

- **Milne Port:** The Milne Port LSA is defined by watershed boundaries that encompass all PDW project infrastructure and activities associated with Milne Port that have potential effects on freshwater. The largest watercourse and delineated watershed within the Milne Port LSA is Phillips Creek.
- **Milne Inlet Tote Road:** The Milne Inlet Tote Road LSA extends from Milne Port in the North to the Mine Site in the south. It is defined using a 500 m buffer on either side of the alignment centre line. For streams that are fish habitat, the LSA also extends upstream to the extent of fish accessibility and downstream to the nearest major watercourse or potential overwintering water body. The LSA encompasses all PDW infrastructure and activities associated with the Milne Inlet Tote Road that have potential effects on freshwater. The northern half of the alignment is located

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

within the Phillips Creek watershed, while the southern half is located in the north-western corner of the Ravn River watershed.

- **Mine Site:** The Mine Site LSA for PDW is within the Ravn River watershed, but does not extend beyond the outlet of Mary Lake, as project effects to freshwater are unlikely to extend further downstream.
- **Steensby Port:** The Steensby Port LSA is defined by several small local watershed boundaries, the largest of which is the Ikpikitturjuaq River which has a drainage area of 323km^2 and includes 10km Lake, Steensby Port's proposed operational phase water source.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

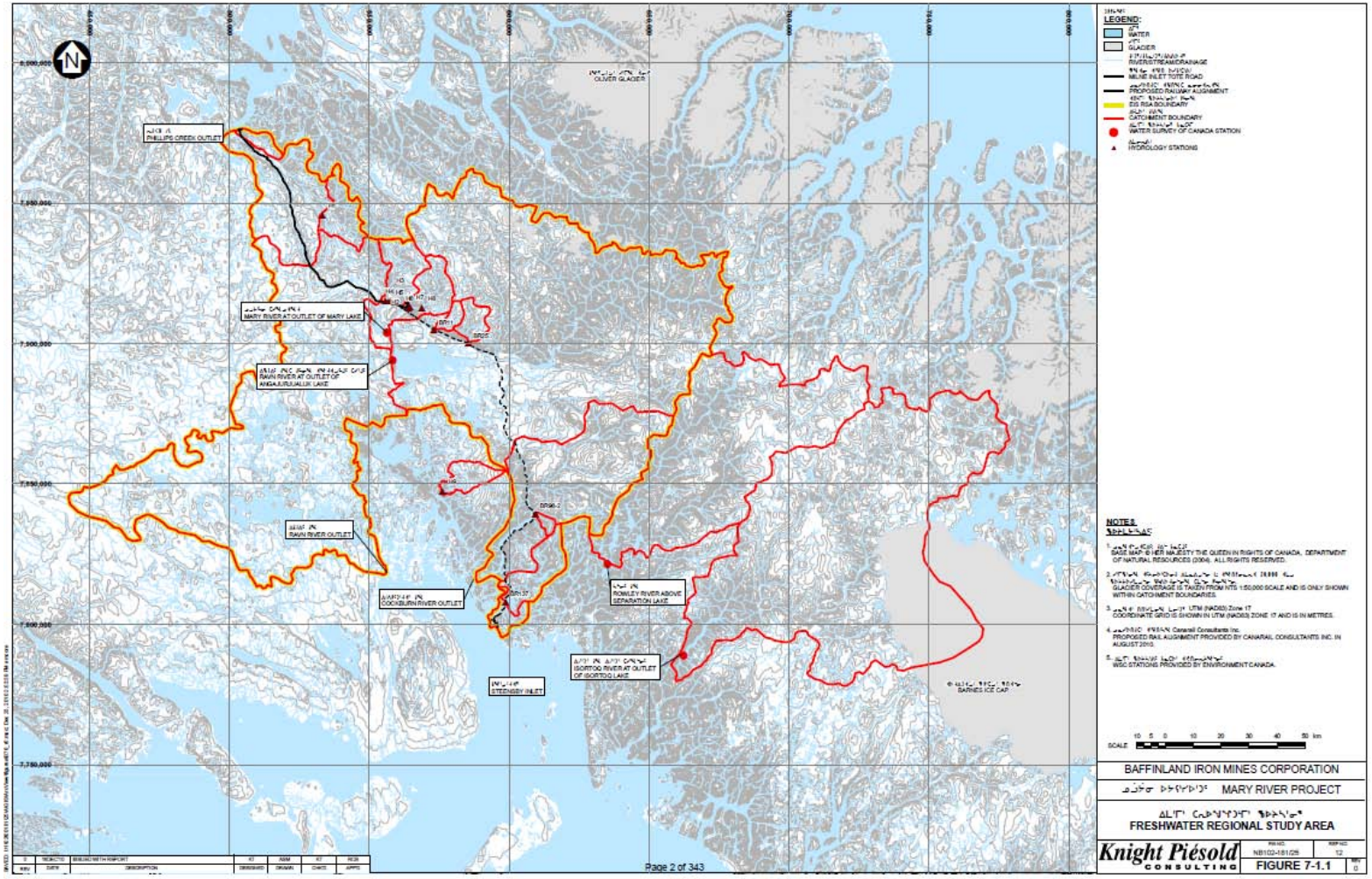


Figure 16-1: Freshwater Regional Study Area

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

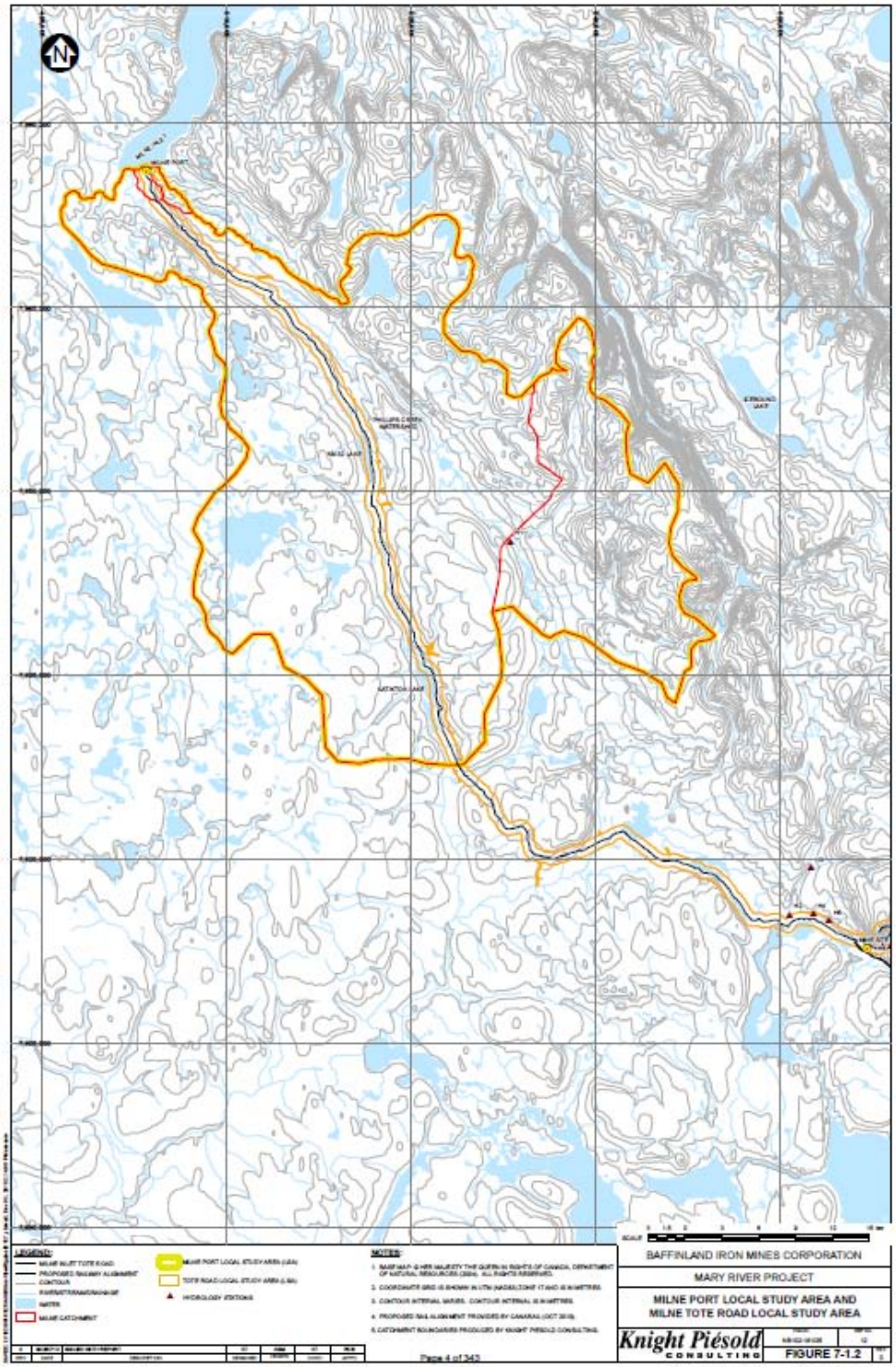


Figure 16-2: Milne Port Local Study Area and Milne Tote Road Local Study Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

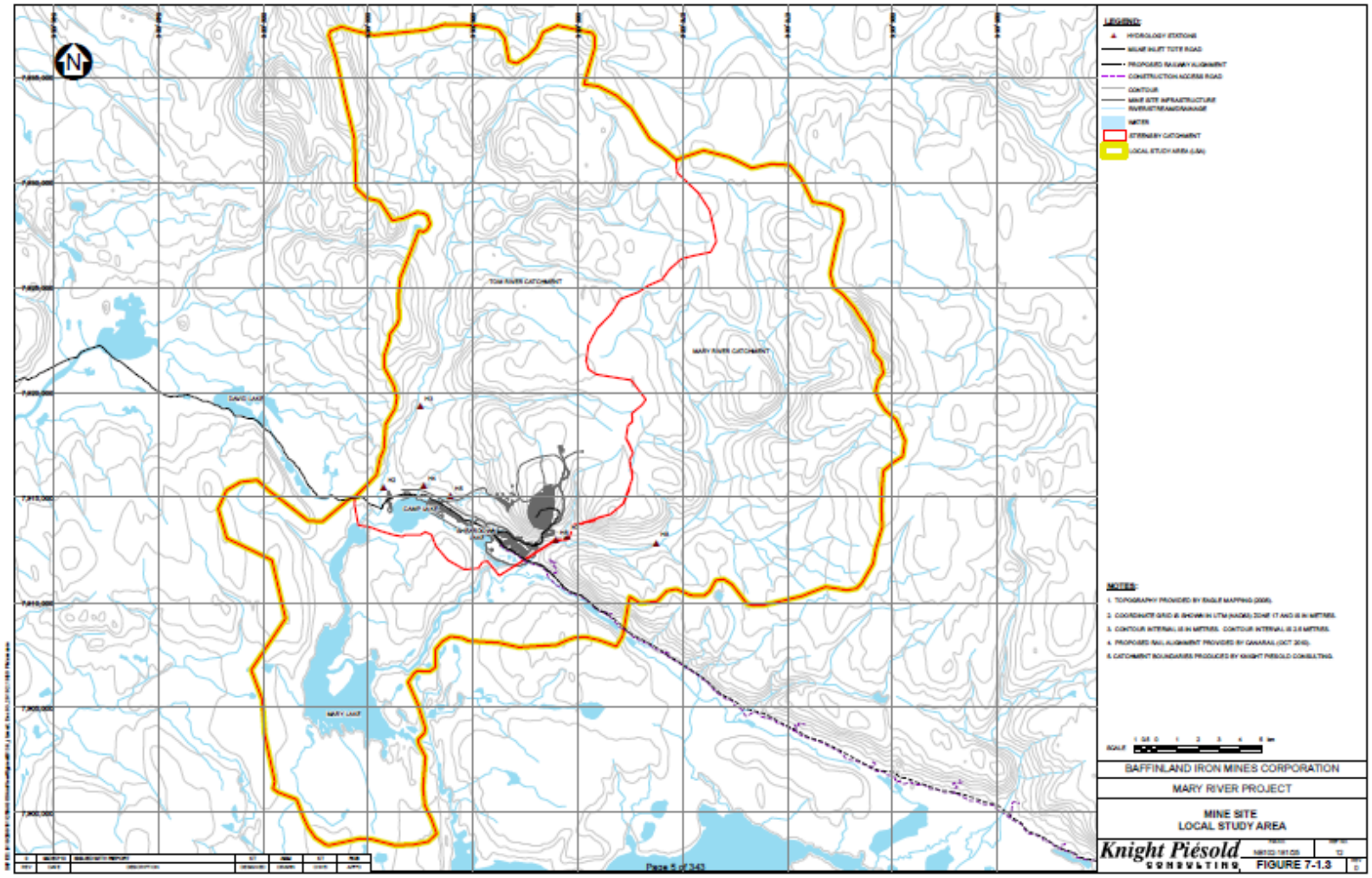


Figure 16-3: Milne Site Local Study Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

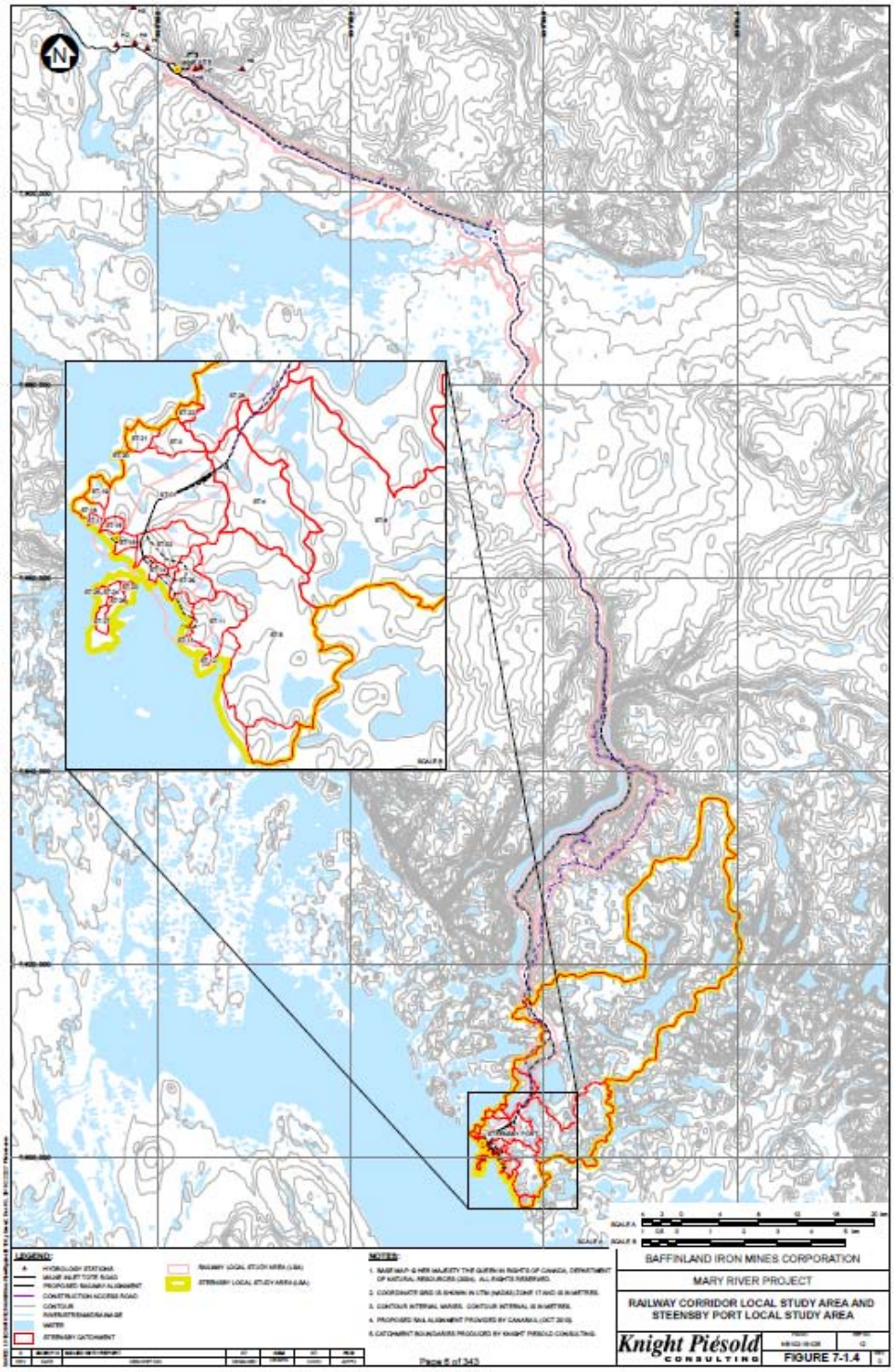


Figure 16-4: Steensby Port Local Study Area

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.2 Issues Scoping

The issues identified for consideration have been drawn from the Mary River Project draft Environmental Impact Assessment and include three categories:

- Water Quantity
- Water and Sediment Quality
- Aquatic Biota (Arctic Char) and Habitat

Each of these three issues has been considered in the following sub-section and considered in terms of:

- identification of the interactions between the Project features and the environment
- identification of measurable parameters and effects thresholds
- an overview consideration of potential environmental effects)
- a discussion of mitigation measures to be implemented
- a predictions for residual environmental effects
- a discussion of required follow-up.

A concluding section summarizes the predicted residual environmental effects of the Project on the freshwater environment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.3 Water Quantity

Table 16-1 presents the interactions by LSA with respect to water quantity changes anticipated as a result of the PDW. Table 16-2 shows the forecasted requirement (domestic and Industrial) for water withdrawal associated with the PDW by month. These include both reductions and increases in flow, i.e. either water extractions for domestic (potable water for camps) or industrial use, and discharges (as effluent).

Table 16-1: Interactions and Potential Effects of PDW on Water Quantity

Location/Activity	Interaction	Potential Effect
Milne Inlet		
Water withdrawal from Phillips Creek and 32 Km Lake	Alters lake volume	Reduced size of water body
	Affects downstream flow	Reduced volume of downstream flow in water body
Effluent discharge to a watercourse	Nil – effluent reports to marine waters.	No effect.
Milne Tote Road		
Incidental withdrawals – various locations	Alters flow regime	Reduction in downstream flow
Mary River Mine Site		
Water withdrawal from Camp Lake	Alters lake volume	Reduced size of water body
	Affects downstream flow	Reduced volume of downstream flow
Discharge of water/effluent to a watercourse	Increased inflow	Increased downstream water flow
Steensby Site		
Water withdrawal from 3Km. Lake	Alters lake volume	Reduced size of water body
	Affects downstream flow	Reduced volume of downstream flow

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Measurable parameter for these interactions is the volume of water (either reduction or increase) in comparison with natural flows. The generally accepted threshold for detection of a potential effect is a change in flow volume of 10% of the available water volume at the point of withdrawal, or location of inflow. The 10% exceedance value used to assess hydrologic effects is a general industry standard and may not be specific to the Project location. The values generally include considerable safety factors, and should therefore be conservative.

Table 16-2: PDW – Water Demand Forecast (m^3/day) by Month

PDW Water Demand Forecast (m^3/day) by Month													
Local Study Area	2012										2013		
	M	A	M	J	J	A	S	O	N	D	J	F	M
Milne- Phillips or 32Km L.	40	40	40	40	50	50	95	95	40	30	20	20	20
Mary – Camp Lake.	35	35	70	70	80	80	80	80	80	80	35	35	35
Steensby - 3 km Lake	0	0	0	0	0	50	50	50	50	50	50	50	50

16.4 Water Quantity Potential Effects

As shown in Table 16-2 the PDW will require modest water usage over a twelve month period (March 2012 to 2013). Most of the requirement is in support of camp operations at Milne Camp and Mary River Mine Site. At Steensby site, the requirement will be restricted to industrial use. Discharges will be restricted to the camp operations. All extractions will be within existing permitted limits.

Water withdrawal will affect Water Quantity by reducing the volume of water within the water body subject to the withdrawal, as well as the downstream flow from the water body. Volume reduction of lakes is of particular importance during the winter months when lake surfaces are frozen and water levels are below the lake outlet elevation. During this period water withdrawal will lower the water surface elevation within the lake, potentially causing dewatering and stranding of fish. In lakes used by Arctic Char for spawning, there is a potential for ice contact freezing or smothering of eggs in shallow spawning beds. Once water begins flowing again in the spring, outflow from the drawn down water body will not occur until the lake has refilled, such that the water surface elevation is above the outlet elevation of the water body. This refilling will act to delay outflows from the lake. Once flowing, outflow will continue as it would naturally, only reduced by the rate of summer withdrawals. Reduction in summer outflow may also affect downstream fish biota, including a reduction in fish habitat, both through changes to substrate conditions and stranding of previous habitat, a reduction in benthic invertebrate transport, or the prevention of fish passage. Reduction in

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

summer outflow may also impact terrestrial wildlife relying on these flows for drinking water or for other purposes.

Effluent discharge to freshwater will affect Water Quantity by increasing the water within a watercourse. Potential effects of this increase in discharge are identical to those for water diversion.

16.4.1 Mitigation Measures

Potential effects from water withdrawal were mitigated for during selection of the withdrawal water bodies and during the design of the water withdrawal program. Mitigation activities as identified in the Project EIS are applicable to the PDW work. These included:

- Desktop assessment of potential withdrawal water bodies. The assessment considered lake size, upstream watershed area and accessibility during candidate water body selection
- Collection of bathymetric data on the best candidate water body identified during the high level review in order to accurately calculate quantify water depths and volumes
- Volume reduction calculations were conducted using preliminary assumptions of water withdrawal volumes to ensure that DFO guidelines were met.

Potential effects of effluent discharge to the receiving watercourse were mitigated through the location of the point of discharge. Mitigation activities included:

- Desktop assessment of potential discharge locations. Assessment considered the probable location of fish habitat, as well as the watercourse length to be effected.
- Ground truthing of assumptions made during desktop assessment.

16.4.2 Water Quantity Eeffects Assessment

The following section rates residual effects on Water Quantity, organized by LSA and watershed (see Table 16-1: Interactions and Potential Effects of PDW on Water Quantity). The residual effects considered and assessed are:

Milne Port LSA

- Phillips Creek Watershed water withdrawal

Milne Tote Road LSA

- Local and intermittent water withdrawals

Mine Site LSA

- Ravn River Watershed
  - Water withdrawal
  - Effluent discharge

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Steensby Port LSA

- Local watersheds water withdrawal

16.4.2.1 Milne Port LSA

Residual effects ratings for the withdrawals from Phillips Creek and Km 32 Lake are discussed below and consistent with the evaluation presented in the Project EIS. Note, while withdrawals from Phillips Creek are permitted, this has been an intermittent activity and the majority of water withdrawal has been from Km 32 Lake.

Magnitude

Water will be withdrawn from Km 32 Lake during all months. Water withdrawal activities will peak in September to October, 2012 and will drop off to a minimum level in January-February 2013. Withdrawals will result in a negligible reduction of the lake or outflow volume. This reduction is several orders of magnitude less than threshold, and is therefore rated as a Level I residual effect.

Extent

The reduction in water volume will only occur within the water body. The effect was therefore rated as Level I in extent.

Duration

Water withdrawal will occur throughout the Pre-Development Works, a period of twelve months a Level I rating has therefore been assigned.

Frequency

Water will be withdrawn at a low volume, but more or less continuously. As a result, the reduction of under-ice water volume will also occur continuously throughout the winter. The frequency of the effect has therefore been rated as Level III.

Reversibility

The reduction in water volume will cease once water withdrawal stops. The effect is fully reversible and has therefore been rated as Level I.

Significance

Based on the ratings criteria described above, water withdrawals are not expected to result in an adverse effect on km 32 Lake within the Milne Port LSA. The residual effect is ranked as ***Not Significant***.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.4.2.2 Milne Tote Road LSA

Residual effects ratings for the withdrawals from water bodies along the Milne Tote Road are discussed below, and consistent with the evaluation presented in the Project EIS

Magnitude

Water will be withdrawn intermittently and generally during open water periods. Withdrawals will result in a negligible reduction of the total available water volume. This reduction is several orders of magnitude less than threshold, and is therefore rated as a Level I residual effect.

Extent

The reduction in volume will only occur within the LSA. The effect was therefore rated as Level II in extent.

Duration

Water withdrawal will occur throughout the Pre-Development Works, a period of twelve months. A Level I rating has therefore been assigned.

Frequency

Water will be withdrawn at a low volume, and intermittently. The frequency of the effect has therefore been rated as Level II.

Reversibility

The effects will cease once water withdrawal stops. The effect is fully reversible and has therefore been rated as Level I.

Significance

Based on the ratings criteria described above, water withdrawals are not expected to result in an adverse effect on water bodies adjacent to the Milne Inlet Tote Road. The residual effect is ranked as ***Not Significant***.

16.4.2.3 Mary River Mine Site LSA

Residual effects ratings for the withdrawals and effluent discharge at the existing Mary River Camp infrastructure are discussed below, and consistent with the evaluation presented in the Project EIS.

Magnitude

Water will be withdrawn from Camp Lake during all months. Water withdrawal activities will peak over the period May to December 2012 and will drop off to a minimum level in January- March 2013. Withdrawals will result in a negligible reduction of lake or outflow volume. This reduction is several orders of magnitude less than threshold, and is therefore rated as a Level I residual effect.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Extent

The changes in water volume will only occur within the affected water body. The effect was therefore rated as Level I in extent.

Duration

Water withdrawal and effluent discharge will occur throughout the Pre-Development Works, a period of twelve months. A Level I rating has therefore been assigned.

Frequency

Water will be withdrawn and discharged at a low volume, but more or less continuously. As a result, the changes of water volume will also occur continuously throughout the PDW period. The frequency of the effect has therefore been rated as Level III.

Reversibility

The change in water volume will cease once water withdrawal and discharge stops. The effect is fully reversible and has therefore been rated as Level I.

Significance

Based on the ratings criteria described above, water withdrawals and effluent discharges are not expected to result in an adverse effect on water bodies within the Mary River Mine LSA. The residual effect is ranked as ***Not Significant***.

16.4.2.4 Steensby LSA

Residual effects ratings for the withdrawals from water bodies within the Steensby LSA are discussed below, and consistent with the evaluation presented in the Project EIS

Magnitude

Water will be withdrawn at a modest volume for various industrial activities over a nine month period. Withdrawals will result in a negligible reduction of the total under-ice lake volume. This reduction is several orders of magnitude less than threshold, and is therefore rated as a Level I residual effect.

Extent

The reduction in volume will occur within the LSA. The effect was rated as Level I in extent.

Duration

Water withdrawal will occur through a nine month period from August 2012 to March 2013. A Level I rating has therefore been assigned.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Frequency

Water will be withdrawn at a modest volume, and intermittently. The frequency of the effect has therefore been rated as Level II.

Reversibility

The effects will cease once water withdrawal stops. The effect is fully reversible and has therefore been rated as Level I.

Significance

Based on the ratings criteria described above, water withdrawals are not expected to result in an adverse effect on water bodies in the Steensby LSA. The residual effect is ranked as ***Not Significant***.

16.5 Water and Sediment Quality

Legal recognition of the importance of water and concern regarding potential effects on water quality is included in Article 20 Inuit Water Rights of the NLCA. Under the NLCA, Inuit have special water rights, and if a project or activity will substantially affect the quality of water through Inuit-Owned Lands, compensation is required. Therefore, "water quality" has been identified as an issue for this EIS.

The water component of "water quality" refers to surface water (rivers, streams, lakes) and groundwater; however, groundwater quality is generally not considered to be at risk in the Project area because the extensive permafrost layer acts as an impermeable barrier eliminating/limiting potential migration of contaminants into the groundwater located below.

Sediment quality is also an essential component of the aquatic environment with the potential to affect the food chain, fish and fish habitat, and local residents. Project-related effects on sediment quality were assessed along with the surface water quality, i.e. residual effects on water quality were considered likely to induce a similar residual effect on sediment quality.

The interactions which were assessed with respect to surface water and sediment quality are listed in Table 16-3.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 16-3: Interactions and Potential Effects of PDW on Water Quality

Project Location (LSA)	Project Activity or Interaction	Potential Effect (Key Indicator impaired)
Milne Inlet	Ground Preparation, Earthworks and dust deposition	pH, TSS; Metals; Nutrients
	Laydown Areas	pH, TSS; Metals
	Equipment and Vehicle Use	TSS, Calcium Chloride; Petroleum Hydrocarbons
	Camps, Waste Management and Fuel	TSS ; Petroleum Hydrocarbons
	Water Use and Site Water Management	pH, TSS; Metals; Nutrients ; Petroleum Hydrocarbons
Milne Tote Road	Ground Preparation, Earthworks and dust deposition	pH, TSS; Metals; Nutrients
	Equipment and Vehicle Use	TSS, Calcium Chloride; Petroleum Hydrocarbons
	Water Use and Site Water Management	pH, TSS; Metals; Nutrients ; Petroleum Hydrocarbons
Mary River Mine Site	Ground Preparation, Earthworks and dust deposition	pH, TSS; Metals; Nutrients
	Laydown Areas	pH, TSS; Metals
	Equipment and Vehicle Use	TSS, Calcium Chloride; Petroleum Hydrocarbons
	Equipment and Vehicle Use	TSS, Calcium Chloride; Petroleum Hydrocarbons
	Water Use and Site Water Management	pH, TSS; Metals; Nutrients; Petroleum Hydrocarbons
	Camps, Waste Management and Fuel	TSS;Petroleum Hydrocarbons
	Treated Sewage Discharge	BOD; Oil and Grease; TSS;Nutrients

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Project Location (LSA)	Project Activity or Interaction	Potential Effect (Key Indicator impaired)
Steensby Site	Ground Preparation, Earthworks and dust deposition	pH, TSS; Metals; Nutrients
	Laydown Areas	pH, TSS; Metals
	Quarries and Borrow Sources	pH, TSS; Metals; Nutrients
	Equipment and Vehicle Use	TSS, Calcium Chloride; Petroleum Hydrocarbons
	Airstrips and Airstrip Use	TSS; Petroleum Hydrocarbons
	Explosives use	Nutrients; Petroleum Hydrocarbons
	Water Use and Site Water Management	pH, TSS; Metals; Nutrients; Petroleum Hydrocarbons

For the assessment of potential effects on surface water and sediment quality a list was assembled of key indicators that were considered to be the most relevant and important. These generally fall into one of the following four categories:

1) General Parameters
2) Metals
3) Nutrients
4) Petroleum Hydrocarbons.

After identifying the key indicators, thresholds for each were identified as representing a level of change at which adverse effects can be expected to occur. In the case of water and sediment quality, it is important to note that the thresholds do not relate to water or sediment quality in itself, rather they relate to known effects on aquatic receptors that rely on water and sediment to exist.

The thresholds used in this assessment were consistent with the Project EIS. As a general rule, the CCME Guidelines for the Protection of Aquatic Life (PAL) were used for defining thresholds for key indicators of the surface water and sediment quality VEC. The relationship between potential surface water and sediment quality effects, key indicators, and thresholds are summarized in Table 16-4.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 16-4: Potential Effects, Key Indicators, and Thresholds for the Surface Water and Sediment Quality VEC

Potential Effect	Key Indicator	Thresholds (Magnitude and Extent)			
		MMER[1]	CWQG (PAL)[2]	CDWQG[3]	NWB[4]
Water Quality from Contact Water and Site Runoff	TSS (mg/L)	15	+5		**35**
	pH (pH unit)	6.0 - 9.5	6.5 - 9.0	6.5 - 8.5[12]	**6.0 - 9.5**
	Hardness $CaCO_3$ (mg/L)				
	Alkalinity $CaCO_3$ (mg/L)				
	Chloride (mg/L)		230[5]	<250[12]	
	Sulphate SO4 (mg/L)			<500[12]	
	Ammonia N (mg/L)		1.78 - 38.6[6]		
	Nitrate N (mg/L)		2.93	10	
	Nitrite N (mg/L)		0.06	3.2	
	Total P (mg/L)		Narrative Table 7-3.6		
	Total Aluminum (mg/L)		0.005 - 0.1[7]		
	Total Antimony (mg/L)			0.006	
	Total Arsenic (mg/L)	0.5	0.005	0.005[13]	
	Total Barium (mg/L)			1	
	Total Beryllium (mg/L)		0.0053[8]		
	Total Boron (mg/L)		1.50[8]		
	Total Cadmium (mg/L)		0.000097[9]	0.005	
	Total Chromium (mg/L)		0.001[8]	0.051	
	Total Cobalt (mg/L)		0.004		
	Total Copper (mg/L)	0.3	0.002 - 0.004[10]	<1.0[12]	
	Total Cyanide (mg/L)	1.0			
	Total Iron (mg/L)		0.3	<0.3[12]	
	Total Lead (mg/L)	0.2	0.001 - 0.007[10]	0.01	
	Total Manganese (mg/L)			<0.05	
	Total Mercury (mg/L)		0.000026		
	Total Molybdenum (mg/L)		0.073		
	Total Nickel (mg/L)	0.5	0.025 - 0.15[10]		
	Total Selenium (mg/L)		0.001		

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Potential Effect	Key Indicator	Thresholds (Magnitude and Extent)			
		MMER[1]	CWQG (PAL)[2]	CDWQG[3]	NWB[4]
	Total Silver (mg/L)		0.0001		
	Total Thallium (mg/L)		0.0008[11]		
	Total Uranium (mg/L)		0.0026[11]		
	Total Vanadium (mg/L)		0.02[11]		
	Total Zinc (mg/L)	0.5	0.03	<=5.0[12]	
	1-2 Propylene Glycol		500 (interim)		
Water Quality from Fuel Contact	Benzene (µg/L)		370		
	Toluene (µg/L)		2		
	Ethyl benzene (µg/L)		90		
	Lead (µg/L)		1		
	Oil and Grease (µg/L)		15,000		
Water Quality from Discharge of Sewage	BOD_5 (mg/L)				**30**
	FecalColiform (CFU/100mL)				**1,000**
Potential Effect	**Key Indicator**	Thresholds (Magnitude and Extent)			
		ISQG[13]	PEL[13]		
Sediment Quality	Arsenic (mg/kg)	5.9	17		
	Cadmium (mg/kg)	0.6	3.5		
	Chromium (mg/kg)	37.3	90		
	Copper (mg/kg)	35.7	197		
	Lead (mg/kg)	35.0	91.3		
	Mercury (mg/kg)	1.7	4.86		
	Zinc (mg/kg)	123	315		

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Potential Effect	Key Indicator	Thresholds (Magnitude and Extent)			
		MMER[1]	CWQG (PAL)[2]	CDWQG[3]	NWB[4]

Note(s):

1. Mean monthly maximum averages in schedule 1 of the metal mining effluent regulation under the federal fisheries act.
2. Canadian council of ministers of the environment (ccme) Canadian water quality guidelines for the protection of aquatic life (pal) (2003).
3. Health Canada Canadian drinking water guidelines (2004).
4. Nunavut water board wastewater criteria.
5. Criteria continuous concentration (chronic) national recommended water quality criteria, usepa (2006).
6. Varies with temperature and ph.
7. Varies with ph and calcium concentration.
8. Bc moe approved and working water quality guidelines.
9. Criteria continuous concentration (us epa), varies with hardness.
10. Varies with caco3 concentration.
11. Suter thresholds.
12. Aesthetic objective.
13. Proposed guideline.
14. Interim sediment quality guidelines (isqg) and probable effects level (pel) identified in the ccme Canadian sediment quality guidelines for the protection of aquatic life (2003).

The thresholds identified in Table 16-4 were applied in the effects assessment in the following manner:

- CCME PAL were applied as receiving environment criteria for all sources;
- CCME DWQG were applied as receiving environment criteria for all sources; and
- NWB were applied as 'end of pipe' criteria for wastewater (sewage effluent) discharge.

16.5.1 Water Quality Potential Effects

The assessment of potential environmental effects on Water Quality will be organized by addressing each of the nine categories of interaction listed in Table 16-3, and considering their relevance to each of the four LSAs.

16.5.1.1 Ground Preparation and Earthworks

There will be several activities at each of the LSAs involving ground preparation and earthworks over a single, short work period. The work will comprise clearing, grading, levelling (cut and fill), contouring, construction of ditches and settlement ponds, and surface placement of granular material. This work will be carried out for:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- the preparation of the approaches to the temporary docks at Steensby and Milne
- the establishment of laydown areas at Steensby, Milne and Mary River camps
- the development of the Steensby airstrip (and associated access roads)
- to provide laydown areas at Steensby Camp, Milne Camp and Mary River Mine Camp
- to establish foundations for fuel storage tanks at Milne Camp, Mary River Camp and Steensby Camp
- to provide for site accommodations, offices and warehousing at Milne Camp, Mary River Camp and Steensby Camp
- for route improvements along the Milne Tote Road
- for access to explosive storage and emulsion plant.

The identified footprint of all ground preparation activities associated with the PDW lies within the areas described and assessed in the Project EIS.

Ground preparation involves the removal of vegetation and stripping away of surface material, resulting in erosion-prone conditions that can result in altered water quality, mainly related to pH and suspended solids levels. Incidental contamination form machinery and equipment can introduce petroleum hydrocarbon and nutrient contamination. The implementation of best management practices, including the application of standard and proven mitigation measures will result in minimal effects from ground preparation and earthworks on water quality.

The mitigation measures applicable to the PDW are:

- minimize the footprint of disturbance (confine to Project footprint area)
- schedule work to avoid excessive exposure of work surface areas during anticipated periods of high rainfall
- install water management surface features (ditching) to avoid co-mingling of site and offsite water
- install and operate erosion control features
- install and maintain adequate sediment transport control features (filters, settlement basins)
- install systems with a capability to capture and treat any suspect water that might become contaminated as a result of ground preparation and earthworks.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The environmental management plans presented in Appendix B will be applied to the Pre-Development Works. These include:

- Environmental Design Guidelines
- Emergency Response and Spill Contingency Plan
- OPEPs for Milne Port and Steensby Port
- Environmental Protection Plan
- Site Water Management Plan.

Residual Effects Rating

Magnitude

Based on a qualitative assessment, it is anticipated that there is the potential for minor water quality effects associated with PDW-related ground preparation and earthworks activities. Generally, the mitigation measures described above are expected to prevent contact of sediment-laden water with natural surface water bodies in each LSA; however, mitigation measures may have limitations associated with their implementation and effectiveness, especially considering the extreme climatic conditions in the Project area. Examples of these limitations include the effectiveness of the installation and performance of sediment transport mitigation (e.g. silt fences) in frozen ground conditions, challenges in providing adequate ground cover, and challenges in completing earthworks in areas of permafrost.

Given the limitations of mitigation measures, it is anticipated that TSS loading may occasionally exceed the CCME threshold of +5 mg/L relative to baseline conditions. These effects are most likely to coincide with freshet conditions, which have the potential to mitigate the magnitude of the potential effect through added capacity to buffer these inputs. On-site monitoring is expected to be successful in identifying potential effects as they arise and adaptive management will be adopted to minimize the risk of exceeding the CCME PAL guidelines and improve the performance of mitigation measures.

In the event that existing (pre-Project) contaminated media are identified on any of the PDW work sites, appropriate measures will be taken to collect, treat and dispose of the material without increasing the footprint of the contamination and/or creating new pathways for contaminant transport. Currently, there are no known instances of existing contamination located in the Project area. It is anticipated that negligible to minor effects may be associated with existing contaminated media in the event that it is identified during ground preparation and earthworks activities.

Based on the potential for water quality to occasionally exceed the identified thresholds, a Level II magnitude rating was assigned to residual water and sediment quality effects associated with PDW -related ground preparation and earthworks activities in the four freshwater LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Duration

The total duration of the PDW is twelve months, only part of which will be dedicated to ground preparation and earthworks. Potential effects are anticipated to coincide with the timing of freshet, when any potential effect is expected to be diluted by high flow conditions resulting in TSS concentrations indistinguishable from baseline. A Level I duration rating was assigned to residual water and sediment quality effects associated with PDW-related ground preparation and earthworks activities in the four freshwater LSAs.

Frequency

Considering the temporal relation between freshet and/or extreme weather conditions and residual water and sediment quality effects, it is anticipated that these effects would only occur on infrequent occasions within the one-year timeframe of the PDW, and be limited to summer months when construction activities are scheduled and when freshet and the majority of rain events in the Project area occur. A Level I frequency rating was assigned to residual water and sediment quality effects associated with PDW-related ground preparation and earthworks activities in the four freshwater LSAs.

Extent

The extent of residual water and sediment quality effects associated with PDW-related ground preparation and earthworks activities will be limited to the LSA where the work is occurring. Site environmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to limit the extent of the effect. A Level I extent rating was assigned to residual water and sediment quality effects associated with PDW-related ground preparation and earthworks activities in the four freshwater LSAs.

Reversibility

Residual surface water and sediment quality effects associated with PDW-related ground preparation and earthworks activities are anticipated to be fully reversible. Following the termination of ground preparation and earthworks activities, key indicators are generally expected to return to baseline conditions through natural attenuation processes. A Level I reversibility rating was assigned to residual water and sediment quality effects associated with PDW-related ground preparation and earthworks activities in the four freshwater LSAs.

Significance

Based on the ratings described above, PDW-related ground preparation and earthworks activities are not expected to result in significant adverse environmental effects on water and sediment quality in the four freshwater LSAs. The residual effect is ranked as ***Not Significan***t. The level of confidence associated with this ranking of significance is Medium due to the qualitative nature of the assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.5.1.2 Laydown Areas

PDW-related laydown areas may result in changes to surface water and sediment quality in the Steensby LSA as well as, to a lesser extent in Milne Camp and Mary River Mine Camp.

Laydown areas are temporary sites used for the storage of equipment and construction materials during the construction phase of a project. Laydown area requirements are dictated by equipment needs as well as the sequence of construction activities, and the timing of construction material delivery. These factors can be optimized to reduce the number of anticipated laydown areas, and to minimize their anticipated footprints. With respect to surface water quality effects, the two main considerations are (1) sediment and erosion control, and (2) introduction of hazardous substances, leading to discharge of sediment-laden or contaminated water into the receiving environment.

By implementing standard Best Management Practices (as described in the Mary River Project EIS – see Vol. 10) during development and use of the laydown areas, water quality effects can be avoided or reduced to the level where minor adverse effects are anticipated. In addition to the mitigation measures described in the ground preparation section, the following mitigation measures will be employed in laydown areas, as required:

- Sitting of laydown areas over competent bedrock or impermeable ground layers
- Placement and grading of clean, free draining material to promote a workable lay down area environment
- Installation of adequate storm water management infrastructure to restrict runoff from overland flow or seepage through the active layer into receiving water bodies
- Appropriate handling and storage of hazardous materials.

Residual Effects Rating

Magnitude

Based on a qualitative assessment, it is anticipated that minor water quality effects may be associated with PDW-related laydown areas and activities. Generally, the mitigation measures described above are expected to prevent contact of sediment-laden or contaminated water with natural surface water bodies.

Even with the application of effective mitigation measures, some TSS loading can be expected and could occasionally exceed the CCME threshold of +5 mg/L relative to baseline conditions. These effects are most likely to coincide with freshet conditions, which have the potential to mitigate the magnitude of the potential effect through added capacity to buffer these inputs. Site environmental monitoring is expected to be successful in identifying potential effects as they arise and adaptive management will be adopted to avoid the exceedance of CCME PAL guidelines, and to improve the performance of mitigation measures.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Potentially hazardous materials will be stored in appropriate containment in designated locations away from water bodies, to ensure the potential for introduction of hazardous materials into the aquatic environment is avoided or limited.

Based on the potential for occasional exceedances in water quality thresholds to occur, a Level II magnitude rating was assigned to residual water and sediment quality effects associated with Project-related laydown areas in the three freshwater LSAs.

Duration

The total duration of the PDW is twelve months. Potential effects are anticipated to coincide with the timing of freshet, when any potential effect would be expected to be diluted by high flow conditions resulting in key indicator concentrations indistinguishable from baseline. A Level I duration rating was assigned to residual water and sediment quality effects associated with PDW-related laydown areas in the three freshwater LSAs.

Frequency

Considering the temporal relation between freshet and/or extreme weather conditions and residual water and sediment quality effects, it is anticipated that these effects would only occur on infrequent occasions during summer months of 2012 when construction activities are scheduled and when freshet and the majority of rain events in the Project area occur. A Level I frequency rating was assigned to residual water and sediment quality effects associated with PDW-related laydown areas in the three freshwater LSAs.

Extent

The extent of residual water and sediment quality effects associated with PDW-related laydown areas will be limited to the LSA where they are located. Site environmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to avoid or limit the extent of the effect. A Level I extent rating was assigned to residual water and sediment quality effects associated with PDW-related laydown areas in the three freshwater LSAs.

Reversibility

Residual surface water and sediment quality effects associated with PDW-related laydown areas are anticipated to be fully reversible. Following the closure and rehabilitation of laydown areas, key indicators are generally expected to return to baseline conditions through removal of the contaminant source. A Level I reversibility rating was assigned to residual water and sediment quality effects associated with PDW-related laydown areas in the three freshwater LSAs.

Significance

Based on the ratings described above, laydown areas are not expected to result in significant adverse environmental effects on water and sediment quality in the three affected freshwater LSAs. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.5.1.3 Equipment and Vehicle Use

During Pre-Development Works, equipment and vehicle use may result in changes to surface water and sediment quality in the four freshwater LSAs.

Equipment and vehicle use will be required throughout the PDW area during all work phases. There are numerous potential effects that equipment and vehicle use may have on surface water quality, including:

- Petroleum hydrocarbon contamination from leaks, spills, accidents and malfunctions
- Fugitive dust generation and suppression
- Designated fleet parking, maintenance and wash areas.

The potential for petroleum hydrocarbon contamination to result from leaks and spills exists throughout the PDW area. A discussion of Accidents and Malfunctions is provided in Section 19.

Fugitive dust will be generated and dust suppression activities will be required on unfinished surfaces during the 2012 summer season. Dust suppression will be achieved through application of water using a tanker truck and/or application of calcium chloride solution. The Department of Sustainable Development, Environmental Protection Service (EPS) has currently approved calcium chloride dust suppressants for use in Nunavut. Application of calcium chloride will be dictated by road surface conditions and traffic volume and will be restricted or avoided in the vicinity of sensitive environments, areas of flooding, or during periods of intense or expected precipitation. Under these circumstances calcium chloride is generally considered nontoxic with rapid dissolution in the environment.

Sediment-laden or salt-laden runoff that is generated will be directed into water management features, designed to segregate and prevent comingling of 'clean' and sediment-laden water. These water management features will be designed and operated in order to treat potentially affected site run-off to applicable water quality standards prior to discharging to the receiving environment. This is achieved through the design and implementation of appropriate solids settling features such as check dams and constructed settling basins.

Based on the levels of anticipated traffic, the nature of the material used in road surfacing and the anticipated efficacy of dust suppression methods, it is anticipated that dust generation from equipment and vehicle use and subsequent deposition in freshwater receiving bodies will result in negligible to minor adverse residual effects.

Equipment maintenance will utilize existing facilities in the Milne Port and Mine Site. A suitable location will be selected and employed at Steensby Port, with engineered drainage and sumps to collect potentially contaminated water. Any contaminated water will be treated via an oil-water separator to applicable water quality standards prior to discharging to the receiving environment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

For additional details on environmental management considerations regarding equipment and vehicle use refer to the following environmental management plans included in Appendix B:

- Environmental Design Guidelines
- Environmental Protection Plan (see Mary River Project EIS Appendix 10B)
- Wastewater Management Plan
- Site Water Management Plan
- Waste Management Plan.

Residual Effects Rating

Magnitude

A qualitative assessment was conducted to determine the magnitude of residual effects associated with dust suppression activities and discharges from the equipment maintenance facilities and heavy equipment parking.

Dust suppression activities are anticipated to result in negligible to minor residual water quality effects. By following the guidance provided in the EPS document endorsing calcium chloride use, the application of calcium chloride is generally considered nontoxic with rapid dissolution in the environment and it is unlikely that the chloride concentration in run-off will exceed the CCME threshold. Any water used for dust suppression will be applied to finished roads with established storm water management features; therefore, it is anticipated that TSS loading will not exceed the CCME threshold of +5 mg/L relative to baseline conditions.

The equipment maintenance facilities and heavy equipment parking will be sited on competent materials with engineered drainage and sumps to collect and treat potentially contaminated water to applicable water quality standards prior to being discharged to the receiving environment. It is not expected that the contact water that is treated and discharged would exceed the CCME thresholds for TSS, oil and grease, or petroleum hydrocarbons.

Environmental construction monitoring, ongoing water quality monitoring, and adaptive management are expected to limit the magnitude of potential chloride, TSS, oil and grease, and/or petroleum hydrocarbon related effects, should they be detected.

A Level I magnitude rating was assigned to residual water and sediment quality effects associated with equipment and vehicle use in the five freshwater LSAs.

Duration

Equipment and vehicle use will be required during all aspects of the PDW work. Potential effects are anticipated to coincide with the timing of freshet, when any potential effect is expected to be diluted by high flow conditions resulting in key indicator concentrations indistinguishable from baseline. A

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Level I duration rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Frequency

The frequency of the potential effect would be limited to one snow-free summer months when dust suppression is required (note: the majority of precipitation occurs in the Project Area in the summer, precluding the requirement for constant dust suppression activities). A Level I frequency rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Extent

The extent of the potential effect is likely to be limited to watercourses in the four LSAs where the vehicles or equipment are operating and equipment maintenance facilities and heavy equipment parking areas are located. A Level I extent rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Reversibility

The potential effects associated with equipment and vehicle use are anticipated to be fully reversible, once dust suppression is discontinued and the equipment maintenance facilities and heavy equipment parking areas are restored. A Level I reversibility rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Significance

Based on the ratings described above, equipment and vehicle use are not expected to result in significant adverse environmental effects on water and sediment quality. The residual effect is ranked as ***Not Significan***t. The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

16.5.1.4 Camps, Waste Management and Fuel

PDW-related camps, fuel storage and waste management may result in changes to surface water and sediment quality in three of the freshwater aquatic LSAs.

The Pre-Development Works will utilize the existing camps at Milne Inlet, Mary River and Steensby Inlet, to the extent room is available. Additionally, a 150 person camp will be constructed and operated at Milne Inlet and two 150-person barge camps will be located at Steensby Inlet to support the needed PDW labour force at Steensby. At Mary River, a 1 000 person Project Construction camp will be constructed, but not available for use during the PDW period. Consequently, the PDW workforce will use the existing Mary River Camp to capacity.

The barge camps at Steensby will be self- sufficient and there will be no interaction between them (in terms of waste management, fuel consumption or sewage treatment) and the freshwater environment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

During the Pre-Development Works, the existing waste management facilities and procedures will be utilized to capacity. At Milne Inlet, non-hazardous solid waste will be incinerated at the existing site facility, or transported to Mary River Mine site Camp for secure storage and appropriate disposal. All hazardous wastes will be stored in sealed containers and shipped off-site to an approved treatment/disposal facility.

For PDW work carried out at Mary River Mine site Camp, non-hazardous waste will be either incinerated or placed in the existing landfill, as appropriate. Any waste oils, lubricant or hazardous waste will be properly contained, stored and transported to Milne Inlet for shipment off-site to an approved treatment/disposal facility.

At Steensby Inlet, only small quantities of waste material will be generated. All waste from the floating camps will be treated onboard and will not come ashore. At the site for onshore activity, the relatively small amount of waste produced will be stockpiled in secure areas of the laydown area and held pending completion of a suitable landfill site. All waste oil, lubricants and hazardous wastes will be stored in suitable (secure) containers and shipped offsite for treatment/disposal at a licensed facility.

All solid waste generated as part of the PDW will comply with the Project "Predevelopment Work Waste Management Plan (Appended).

Initially the PDW will rely on available on-site fuel storage facilities. At Milne Inlet a new steel tank is currently under construction and will supply fuel for the PDW. As part of the PDW work, however, fuel will be transferred from bladders to the new steel tank. As well, PDW will include the construction of an additional four steel fuel storage tanks, and their fuelling up at the end of the open water 2012 season. At the Mary River Mine site Camp, as part of the PDW, the existing bladder farm will be replaced with three steel tanks. The work will include construction of the tanks as well as filling them with a combination of fuel from the bladders as well as fuel trucked from Milne Port.

At Steensby, two approaches will be taken to the supply and storage of fuel. A fuel barge will be anchored near shore and overwinter in Steensby inlet over the 2012-2013 winter. As well, a fuel farm comprising 20 prefabricated storage tanks will be installed within the area planned for a larger (Operations) tank farm. The PDW work will include the provision of fuel to the Construction tank farm. During the PDW work at Steensby Inlet, fuel will be supplied from the moored fuel barge.

All fuel transfers will be carried out in areas that are bermed so that spills can be readily contained and managed.

Residual Effects Rating

Magnitude

Effects associated with camps, waste management, and fuel storage and use, were all assessed qualitatively.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Mitigation measures adopted for handling of fuel storage and use described above are anticipated to prevent the discharge of fuel contact water that exceeds CCME thresholds for TSS, oil and grease, or petroleum hydrocarbons.

Waste management mitigation measures described above is expected to limit any potentially adverse water and sediment quality effects to a negligible to minor magnitude.

A Level I magnitude rating was assigned to residual water and sediment quality effects associated with camps, fuel storage and waste management in the three freshwater LSAs.

Duration

Camps, fuel storage and waste management will be required throughout the twelve month period of Pre-Development Works, therefore, a Level I duration rating was assigned to residual water and sediment quality effects.

Frequency

The frequency of potential effects would be periodic and limited to one summer season when the majority of precipitation falls in the Project Area. A Level II frequency rating was assigned to residual water and sediment quality effects in the five freshwater LSAs.

Extent

The extent of the potential effect is likely to be limited to watercourses located in the LSA where the camp is situated. A Level I extent rating was assigned to residual water and sediment quality effects in the three freshwater LSAs.

Reversibility

The potential effects associated with construction and operation of camps, fuel storage and waste management is anticipated to be partially reversible, once this infrastructure is either integrated into the overall Project or decommissioned and rehabilitated. A Level II reversibility rating was assigned to residual water and sediment quality in the three freshwater LSAs.

Significance

Based on the ratings described above, construction and operation of camps, waste management and fuel are not expected to result in significant adverse environmental effects on water and sediment quality. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

16.5.1.5 Water Use and Site Water Management

Project-related site water management may result in changes to surface water and sediment quality in the four freshwater aquatic LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Water usage is described in Section 1.2 above (Water Quantity). At Milne Camp, Mary River Minister Camp and Steensby Camp, the existing water extraction locations will continue to be used. The barge accommodation will be self-sufficient and not consume freshwater from the LSA. Intermittent water extraction will occur along the Milne Tote Road for occasional usage on the road.

Management of storm water, is required throughout the four freshwater LSAs during the PDW, and will generally rely on existing infrastructure. There will be some extensions to the developed sites as described in Section 1.3.1.1 (Ground Preparation and Earthworks). The mitigation measures described in that section apply equally with respect to site water management.

A general approach to site water management is provided in the Site Water Management Plan as presented in the Mary River Project EIS (Appendix 10-D2).

Storm water sources have the potential to affect surface water quality through the alteration of pH and/or introduction of TSS, petroleum hydrocarbons, metals, and nutrients. Left unmitigated, direct effects may be observed in surface water and sediment quality in the receiving environment. By implementing standard BMPs such as the Land Development Guidelines for the Protection of Aquatic Habitat (DFO, 1993), effects can be avoided or reduced to the point where only minor to moderate adverse effects are anticipated. As required, the following mitigation measures will be used to reduce or eliminate the effects of PDW water management on surface water quality:

- minimize the footprint of disturbance (confine to Project footprint area)
- schedule work to avoid excessive exposure of work surface areas during anticipated periods of high rainfall
- install water management surface features (ditching) to avoid co-mingling of site and offsite water
- install and operate erosion control features
- install systems with a capability to capture and treat any suspect water that might become contaminated as a result of ground preparation and earthworks
- Where required, site infrastructure on competent bedrock or provide ground conditions that limit permeability and transport into the active layer
- Capture and treat potentially contaminated site run-off to applicable water quality standards prior to discharging to the receiving environment.

Various PDW-related water uses have the potential to affect water and sediment quality when process water is released back into the freshwater environment, including:

- Truck wash
- Dust suppression for the quarry crushers
- Equipment wash down.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The truck wash carried out at designated locations with water management features, designed to segregate and prevent co-mingling of offsite water and on-site water as well as a drain system and sump to capture and treat potentially contaminated wash water to applicable water quality standards prior to discharging to the receiving environment.

Water used for dust suppression for the quarry crushers will be contained within the crusher area and recycled. The main concern with water that has been in contact with the crushed rock is elevated TSS and, potentially elevated metals concentrations. Excess contact water will be collected on site if practicable and held for transfer to a treatment facility to meet applicable water quality standards prior to discharging it to the receiving environment.

Snow, ice, soil or water that has been in contact with petroleum hydrocarbons has the potential to affect water quality. To address this concern, materials that have been in contact with fuels will be transported to Milne Port, the Mary River Mine site or Steensby Port for collection in existing facilities, where available. As required, suitable holding facilities will be constructed (e.g. at Steensby Inlet) and will consist of lined, bermed holding structures. A portable treatment unit will be located at Steensby Camp and available as required to treat material that has been contaminated.

Residual Effects Rating

Magnitude

Preliminary site observations coupled with construction and management experience gained from the existing operations in the Project area indicate that untreated site water can typically be managed in a way that prevents contact with natural surface water bodies and water contained in the active layer. It is assumed that the underlying bedrock and permafrost conditions present throughout the proposed development areas will act as a relatively impermeable barrier to migration, eliminating downward movement of potential contaminants into groundwater.

Potentially affected storm water sources (by TSS, nutrients, and petroleum hydrocarbons) will be collected, contained and treated to applicable water quality criteria prior to discharge to the receiving environment. In order to avoid or reduce potential effects, site environmental monitoring will emphasize regular sampling, including in receiving water bodies.

Based on the likelihood of success of effectively controlling storm water and treating it to applicable discharge standards, it is anticipated that only minor to moderate water quality effects may be associated with site water management. A Level II magnitude rating was assigned to residual water and sediment quality effects associated with PDW-related site water management in the four freshwater LSAs.

Duration

Residual water and sediment quality effects associated with site water management are expected during the PDW. Potential interactions are anticipated to coincide with the timing of freshet, when

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

any potential effect would be expected to be diluted by high flow conditions resulting in key indicator concentrations indistinguishable from baseline. A Level I duration rating was assigned to residual water and sediment quality effects associated with PDW-related site water management in the four freshwater LSAs.

Frequency

Considering the temporal relation between freshet and/or extreme weather conditions and residual water and sediment quality effects, it is anticipated that these effects would only occur on a few occasions during the one year duration of the PDW, and will likely be limited to summer when most work activities are scheduled and when freshet and the majority of rain events in the area occur. A Level I frequency rating was assigned to residual water and sediment quality effects associated with PDW-related site water management in the four freshwater LSAs.

Extent

Based on the scale of the surface areas where site water is being collected, the extent of residual water and sediment quality effects associated with PDW-related site water management is not expected to extend beyond the LSA where the source is located. Site environmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to limit the extent of the effect. A Level I extent rating was assigned to residual water and sediment quality effects associated with PDW-related site water management in the four freshwater LSAs.

Reversibility

Residual surface water and sediment quality effects associated with PDW-related water works and site water management activities are anticipated to be partially reversible. The majority of PDW areas where site water management is required will be returned to the pre-disturbed state during closure phase, or incorporated into the overall Project, once approved. Following rehabilitation, key indicators are generally expected to return to baseline conditions through removal of the contaminant source. A Level II reversibility rating was assigned to residual water and sediment quality effects associated with PDW-related site water management in the four freshwater LSAs.

Significance

Based on the ratings described above, site water management infrastructure and site water discharge are not expected to result in significant adverse environmental effects on water and sediment quality in the four freshwater LSAs. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.5.1.6 Treated Sewage Discharge

The existing sewage treatment facility at Milne Camp will be used by personnel during the early phases of the PDW. The new 150 person camp will be constructed with its own sewage treatment facility, constructed to meet Water Licence standards. It will discharge to the same location as the current discharge. The new sewage treatment plant will be decommissioned once the PDW work has been completed.

At Mary River Mine site Camp, the existing facility and sewage treatment system will be utilized.

The barge accommodations at Steensby will discharge treated effluent directly to the marine environment, hence there will be no interaction with freshwater and sediment quality.

Magnitude

The performance levels achieved at Site over the past several years can provide an indication of the magnitude of potential effects on water and sediment quality from the discharge of treated sewage effluents from the camps to be constructed or employed as part of the Pre-Development Works

As well, quantitative modelling was carried out with respect to the Mary River Project EIS. This modelling predicted that there are no key indicators expected to exceed the applicable CCME PAL guidelines. This prediction was premised on the assumption that discharge quality would be similar to that observed at the existing exploration camp.

Given that only negligible to minor magnitude residual water quality effects are predicted from the discharge of sewage effluent from the 1,200 person camp into the Mary River, the much smaller scale sewage treatment facilities proposed for the PDW can also prudently be assigned a Level I magnitude rating.

Water Licence compliance monitoring and routine water quality monitoring are expected to be successful in identifying potential effects as they arise and adaptive management will be adopted to minimize the risk of exceeding the CCME PAL guidelines and augment the mitigation by design approach being implemented here.

Duration

The discharge of treated sewage effluents from the PDW camps will occur over a twelve month period, consequently a Level I duration rating was assigned to residual water and sediment quality effects associated with discharge of sewage effluent from Pre-Development Works.

Frequency

The frequency of the potential effect will be continuous as discharge of sewage effluent will continue throughout the 2012 open water season, estimated to be 80 days. A Level III frequency rating was assigned to residual water and sediment quality effects associated with discharge of sewage effluent from the camps to be used for the Pre-Development Works...

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Extent

The extent of the potential effect is limited to the mixing area downstream of the confluence of the discharge point and receiving waters. A Level I extent rating was assigned to residual water and sediment quality effects associated with discharge of sewage effluent from the camps to be used for the Pre-Development Works.

Reversibility

The potential effects associated with discharge of sewage effluent from the camps to be used for the PDW are anticipated to be fully reversible, once each camp site is decommissioned and rehabilitated. A Level I reversibility rating was assigned to discharge of sewage effluent from the camps to be used for the Pre-Development Works.

Significance

Based on the ratings criteria described above, discharge of sewage effluent from the camps to be used for the PDW is not expected to result in an adverse environmental effect on water and sediment quality in the three relevant LSAs. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the semi-quantitative nature of the assessment.

16.5.1.7 Quarries and Borrow Sources

Project-related quarries and borrow sources may result in changes to surface water and sediment quality in the three freshwater aquatic LSAs.

At Steensby Camp, aggregate is required for site earthworks and will be accessed either from blasting (cut and fill) associated with the airstrip construction, or by developing local borrow pits/quarries. At Mary River Mine site Camp, the existing quarry source will be utilized for aggregate production.

The primary concerns associated with quarries and borrow sources is the potential for acid rock generation and metals leaching (ARD/ML) and sediment generated at these locations to affect water quality when released into the natural environment.

As a mitigative step, materials from identified quarries and borrow sources have undergone representative geochemical testing, which has indicated that the material is non-reactive (Mary River Project EIS, see Volume 6). Additional testing will be completed to ensure that any newly selected quarries and borrow sources used during PDW consist of non-reactive material.

Quarries and borrow sources are generally sited in competent ground conditions away from sensitive receiving water bodies to avoid or eliminate the potential for adverse effects. As an additional measure, collection sumps will be constructed to capture and treat potentially affected contact water to applicable water quality standards prior to discharging it to the receiving environment. It is not anticipated that treatment will be required to address ARD/ML issues based on the results of the testing done to date

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

For additional details on environmental management considerations regarding quarries and borrow sources, refer to the following environmental management plans presented in Appendix B.

- Quarry Management Plan
- Environmental Design Guidelines
- Environmental Protection Plan (Mary River Project EIS, Appendix 10B)
- Site Water Management Plan
- Explosives Management Plan.

The applications for quarry permit at Steensby (Appendix A.4) and the 2012 QIA Work Plan (Appendix A.1) provide quarry specific information for the three quarries that will be utilised during PDW.

Residual Effects Rating

Magnitude

A semi-quantitative assessment of magnitude was based on the available results from Site geochemical which indicated that the sampled materials are non-reactive. The use of non-reactive materials makes it likely that run-off from quarries and borrow sources will meet the CCME thresholds for pH and metals (ARD/ML). It was also noted in the Mary River Project EIS that none of the streams or lakes of the freshwater receiving environment in the Project area is particularly sensitive to acidic inputs.

Aside from ARD/ML concerns, nitrogenous and petroleum hydrocarbon residues originating from blasting activities as well as sediment-laden water will be confined to the water management infrastructure within each quarry and borrow site. Generally, mitigation measures are expected to prevent contact of impacted storm water with natural surface water bodies in the LSA; however, mitigation measures may have limitations associated with their implementation and effectiveness. Given the limitations of mitigation measures, it is anticipated that uncontrolled discharges of water from quarries and borrow sources may occasionally exceed applicable CCME thresholds. These exceedances would likely coincide with freshet conditions during snow melt, which is likely to mitigate the potential effect through dilution.

Site environmental monitoring is intended to be comprehensive with an emphasis on testing of receiving water bodies.

A Level II magnitude rating was assigned to residual water and sediment quality effects associated with the PDW-related quarries and borrow sources in the two affected freshwater LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Duration

Quarries and borrow sources will be required throughout the twelve month schedule for Pre-Development Work. Potential effects are anticipated to coincide with the timing of freshet, when any potential effect would be expected to be diluted by high flow conditions resulting in key indicator concentrations indistinguishable from baseline. A Level I duration rating was assigned to residual water and sediment quality effects associated with PDW-related quarries and borrow sources in the two freshwater LSAs.

Frequency

Considering the temporal relation between freshet and/or extreme weather conditions and residual water and sediment quality effects, it is anticipated that these effects would only occur on several occasions over the one year of the PDW and be limited to the summer when freshet and the majority of rain events in the region occur. A Level I frequency rating was assigned to residual water and sediment quality effects in the two freshwater LSAs.

Extent

The extent of residual water and sediment quality effects associated with PDW-related quarry or borrow sources will be limited to the two LSAs where they are located. The relative insensitivity of Project area watercourses to acidic inputs suggests a relatively high potential to buffer through elevated levels of calcium carbonates that are present. Site environmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to limit the extent of the effect. A Level I extent rating was assigned to residual water and sediment quality effects in the two freshwater LSAs.

Reversibility

The potential effects associated with quarry or borrow sources are anticipated to be fully reversible, once blasting is completed and these locations have been closed and rehabilitated. A Level I reversibility rating was assigned to residual water and sediment quality effects in the two freshwater LSAs.

Significance

Based on the ratings described above, quarries and borrow sources associated with Pre-Development Works are not expected to result in significant adverse environmental effects on the water and sediment quality VEC. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the semi-quantitative nature of the assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.5.1.8 Airstrips and Airstrip Use

Project-related airstrips and airstrip use may result in changes to surface water and sediment quality in the three freshwater aquatic LSAs.

The Pre-Development Works will involve usage of the existing airstrips at Milne Camp and Mary River Mine site Camp. As well, the Mary River airstrip will be extended and a new airstrip will be constructed at Steensby Camp.

Construction and operation of airstrips have the potential to affect surface water quality in adjacent receiving water bodies. The primary concern during construction stems from erosion and sediment transport during ground preparation and earthworks.

During the operation phase the primary concern stems from the possibility of contamination of receiving water bodies by contaminated or sediment-laden runoff originating from the surface of the airstrip, including de-icing agents such as propylene glycol. De-icing facilities at the airstrip will consist of a portable discharge unit for application of the de-icing fluid. De-icing will be carried out in a defined area to the side of the runway using propylene glycol. A synthetic organic polymer (EK 35) will be used as a dust suppressant on the airstrip as needed.

In the case of runoff originating from the airstrip, water management features will be installed and maintained in order to prevent co-mingling of offsite water with potentially affected onsite water. Any potentially contaminated water arising from the airstrip will be treated to applicable water quality standards prior to being discharged to the receiving environment.

For additional details on environmental management considerations regarding airstrips and airstrip use, refer to the following environmental management plans included in Appendix B:

- Environmental Design Guidelines
- Environmental Protection Plan (Mary River Project EIS, Appendix 10B)
- Emergency Response and Spill Contingency Plan
- Wastewater Management Plan
- Surface Water Management Plan.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Residual Effects Rating

Magnitude

As a result of their crowned configuration, surface run-off from airstrips will be directed to water management structures located around the perimeter prior to discharge to the receiving environment. Mitigation measures serve to prevent contact of sediment-laden water from the airstrip with natural surface water bodies; however, mitigation measures may have limitations associated with their implementation and effectiveness. Given the limitations of mitigation measures, it is anticipated that TSS loading may occasionally exceed the CCME threshold of +5 mg/L relative to baseline conditions. These exceedances would likely coincide with freshet conditions during snow melt, which is likely to dilute and mitigate any potential effects.

Use of propylene glycol as a de-icing agent is anticipated to result in negligible to minor water quality effects as collection and treatment will be provided as necessary to ensure that the CCME interim guideline is not exceeded. It should be noted that the CCME interim guideline for propylene glycol does not take into account secondary effects such as BOD loading and reduced DO concentration.

The synthetic organic polymer EK 35 is not an identified substance under CCME PAL; therefore, it is recommended that potential effects be assessed through routine water quality monitoring.

Based on the potential for occasional exceedances of applicable CCME thresholds, a Level II magnitude rating was assigned to residual water and sediment quality effects associated with airstrips and airstrip use in the three freshwater LSAs.

Duration

Airstrips and airstrip use will be required throughout the duration of the Pre-Development Works. Potential effects are anticipated to coincide with the timing of freshet, when any potential effect would be expected to be diluted by high flow conditions resulting in key indicator concentrations indistinguishable from baseline. A Level I duration rating was assigned to residual water and sediment quality effects in the three freshwater LSAs.

Frequency

The frequency of the potential effects would be limited to summer months when the majority of precipitation falls in the region resulting in erosion and transportation of sediment and other potential contaminants of concern. A Level I frequency rating was assigned to residual water and sediment quality effects in the three freshwater LSAs.

Extent

The extent of the potential effect is likely to be limited to water bodies adjacent to the airstrips. A Level I extent rating was assigned to residual water and sediment quality effects in the three freshwater LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Reversibility

The potential effects associated with airstrips and airstrip use is anticipated to be fully reversible, once the infrastructure is decommissioned and rehabilitated. A Level I reversibility rating was assigned to residual water and sediment quality effects in the three freshwater LSAs.

Significance

Based on the ratings described above, airstrips and airstrip use are not expected to result in significant adverse environmental effects on water and sediment quality. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

16.5.1.9 Explosives use

Explosives transportation, storage, and handling have the potential to affect surface water quality in receiving environments adjacent to Pre-Development works during the duration of the undertaking.

Explosives for the Mine Site will be shipped and airlifted to Site. Explosives and detonators will be shipped to Milne Camp where they will be off-loaded, stored temporarily and then trucked along the Milne Tote Road to the mine site. At the Mary River Mine site Camp, seven bermed magazines will be constructed and then supplied with explosives. At Steensby Camp, explosives will be shipped and (once the airstrip has been completed) airlifted. Seven magazines will be constructed and supplied with explosives for use during the Pre-Development Work, as well as for subsequent stages of the Project.

Explosives transportation, storage, and handling may result in the introduction of nitrogenous and petroleum hydrocarbon-based components into the surface water environment. Certain nitrogenous compounds can be toxic to aquatic life depending on the form (e.g. nitrate, nitrite, or ammonia) and relative concentration and characteristics of nitrogen in the receiving environment. Elevated nitrogen concentrations can also result in the eutrophication of receiving waters where phosphorus is not limiting.

The following mitigation will be used to mitigate potential effects on surface water and sediment quality:

- Explosives will be stored in explosives magazines positioned in accordance with the *Nunavut Mine Health and Safety Act* and Regulations. Detonators and explosives will be stored in separate magazines, and inventory will be strictly controlled by designated supervisors
- Prefabricated magazines will be positioned and appropriately bermed to store explosives as they are unloaded from ships before being transported to areas of use.

By implementing standard Best Management Practices for explosives transportation, storage, and handling, water quality effects can be reduced or eliminated to the point where only minor adverse effects are anticipated.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Relative to explosives transportation, storage, and handling, the effects of explosives use on water quality are less controllable. The primary forms of mitigation to avoid contamination by nitrogen and petroleum hydrocarbons is to use appropriate weights of explosives to achieve desired blasting results, employ blast guards to prevent 'fly-away', and engineer and construct adequate water management features in order to prevent co-mingling of contact and noncontact water at the point of use. The primary area of use of explosives during construction are quarries and borrow sources that are generally sited in competent ground conditions, away from sensitive receiving water bodies to minimize the potential for adverse effects. As an additional measure, and where practical, collection sumps can be constructed to capture and treat potentially contaminated contact water to applicable water quality standards prior to discharging to the receiving environment.

For additional details on environmental management considerations regarding the explosives magazine and explosives use, refer to the following environmental management plans included in Appendix B):

- Environmental Design Guidelines
- Environmental Protection Plan (Mary River Project EIS, Volume 10
- Site Water Management Plan
- Explosives Management Plan.

Residual Effects Rating

Magnitude

Based on a qualitative assessment, it is anticipated that minor to moderate water quality effects may be associated with explosives transportation, storage and use. Due to the potentially serious nature of health and safety effects associated with the manufacture, storage, transportation and use of explosives, mitigation is expected to be tightly controlled and effective. It is not anticipated that nitrogenous and petroleum hydrocarbon residues originating from explosive sources will exceed applicable CCME thresholds. Residual effects on water quality and sediment quality associated with these activities are expected to be negligible to minor.

The majority of blasting associated with the Pre-Development Work will be confined to the Steensby airstrip and nearby quarries where pit water containing elevated levels of nitrogenous and petroleum hydrocarbon residues can be monitored and, as necessary collected and treated prior to discharge.

Despite the implementation of mitigation measures, it is anticipated that ammonia, nitrates, nitrites and petroleum hydrocarbon residues originating from blasting activities in less confined locations may occasionally exceed their respective CCME thresholds in the freshwater receiving environment. These effects would likely coincide with the snow melt when accumulated nitrogen and petroleum hydrocarbon residues are released during the thaw and freshet conditions, which have the potential to mitigate the magnitude of the potential effect.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Nutrient characteristics of the receiving streams and lakes indicate that all of the freshwater receiving environments in the Project area are relatively sensitive to nutrient inputs; therefore, Site environmental monitoring coupled with adaptive management should consider blasting related effects in order to limit the magnitude of residual effects.

A Level II magnitude rating was assigned to residual water and sediment quality effects associated with explosives transport, storage and use in the four freshwater LSAs.

Duration

Explosives manufacture, explosives transportation, explosives magazine and explosives use will be required during the construction and operation phases of the Project. Considering that the most likely uncontrolled contribution of nitrogen to the aquatic environment would come from blasting in unconfined areas along the Milne Inlet Tote Road or Railway Alignment, it is likely the source would not persist beyond the construction phase. In the event that nitrogen is introduced into the environment in the form of ammonium, it is anticipated that it would be assimilated into biomass relatively rapidly resulting in a relatively short duration of effect. Assuming the nitrogen source would be removed after construction and rapid assimilation of ammonium in the receiving environment, a Level II duration rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Frequency

Considering the temporal relation between freshet and/or extreme weather conditions and residual water and sediment quality effects, it is anticipated that these effects would only occur on several occasions during the one-year timeframe of the Pre-Development Works, and be limited to summer months when work activities are scheduled and when freshet and the majority of rain events in the region occur. A Level I frequency rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Extent

The extent of residual water and sediment quality effects associated with PDW-related explosives transportation, explosives magazine and explosives use will be limited to the LSA where it is located. Site environmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to limit the extent of the effect. A Level I extent rating was assigned to residual water and sediment quality effects in the four freshwater LSAs.

Reversibility

The potential effects associated with explosives transport, explosives magazine and explosives use are anticipated to be fully reversible, once blasting activities have ceased. This assumes that residual nutrient levels will be attenuated through nitrification/denitrification and that the conclusion of blasting activities will terminate the nitrogen source. A Level I reversibility rating was assigned to

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

residual water and sediment quality effects associated with the explosives transport, explosives magazine and explosives use in the four freshwater LSAs.

Significance

Based on the ratings described above, the explosives transportation, explosives magazine and explosives use is not expected to result in significant adverse environmental effects on water and sediment quality. The residual effect is ranked as ***Not Significant***. The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

16.6 Aquatic Biota and Habitat

Consistent with the Mary River Project EIS, Arctic char (*Salvelinus alpinus*) was selected as the key indicator for the assessment of aquatic biota and habitat. Arctic char are abundant and widely distributed in the LSAs and the RSA, are socially important, are ecologically important, and are good general bio-indicators of environmental condition.

The interactions between the Pre-Development Works and aquatic biota and habitat have been organized into three categories:

- Health and condition of Arctic char
- Arctic char habitat alteration or loss (including loss of access)
- Direct mortalities of Arctic char

Table 16-5 below provides an overview of the potential interactions between the Pre-Development Works and aquatic biota and habitat. Project activities are described by LSA. Some PDW site features, (e.g. Laydown areas at Milne Camp and Mary River Mine site Camp) will lie within existing developed locations and hence will not result in an interaction that could affect aquatic biota or habitat. The general category of Ground Preparation, Earthworks and Dust Deposition addresses the construction phase of other site features (i.e. construction interactions for laydown areas, airstrip) hence these are assessed only if the operating aspect of these is likely to create an interaction with aquatic biota and habitat.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 16-5: Interactions and Potential Effects of PDW on Aquatic Biota and Habitat

Location/Activity	Interaction	Potential Effect
Milne Inlet		
Ground Preparation, Earthworks and dust deposition	Impaired water/sediment quality	Health and Condition
Equipment and Vehicle Use	Impaired water/sediment quality	Health and Condition.
Camps, Waste Management and Fuel	Impaired water/sediment quality	Health and Condition
Water Use and Site Water Management	Reduced productive capacity	Habitat Alteration or Loss. Mortalities
Milne Tote Road		
Ground Preparation, Earthworks and dust deposition	Encroachments into aquatic habitat	Habitat Alteration or Loss
	Impaired water/sediment quality	Health and Condition
	Fish passage impairment	Habitat Alteration or Loss
Equipment and Vehicle Use	Impaired water/sediment quality	Health and Condition
Water Use and Site Water Management	Reduced productive capacity	Habitat Alteration or Loss. Mortalities
Mary River Mine Site		
Effluent discharge to a watercourse	Impaired water/sediment quality.	Health and Condition
Ground Preparation, Earthworks and dust deposition	Encroachments into aquatic habitat	Habitat Alteration or Loss
	Impaired water/sediment quality	Health and Condition
	Fish passage impairment	Habitat Alteration or Loss
Equipment and Vehicle Use	Impaired water/sediment quality	Health and Condition

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Location/Activity	Interaction	Potential Effect
Camps, Waste Management and Fuel	Impaired water/sediment quality	Health and Condition.
Water Use and Site Water Management	Reduced productive capacity	Habitat Alteration. or Loss Mortalities
Steensby Site		
Ground Preparation, Earthworks and dust deposition	Encroachments into Aquatic Habitat	Habitat Alteration or Loss
	Impaired water/sediment quality	Health and Condition
	Fish passage impairment	Habitat Alteration or Loss
Quarries and Borrow Sources	Impaired water/sediment quality	Health and Condition
Equipment and Vehicle Use	Impaired water/sediment quality	Health and Condition
Airstrips and Airstrip Use	Impaired water/sediment quality	Health and Condition
	Encroachments into aquatic habitat	Habitat Alteration or Loss
Water Use and Site Water Management	Reduced productive capacity	Habitat Alteration or Loss. Mortalities

16.6.1 Aquatic Biota and Habitat Potential Effects

The assessment of potential environmental effects on Aquatic Biota and Habitat will be organized by addressing each of the categories of interaction listed in Table 16-3, and considering their relevance to each of the four LSAs.

Note that the potential effect of the PDW on Health and Condition is attributable to impaired water and sediment quality. Since water and sediment quality have been considered on its own such effects need only be addressed in general terms.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.6.1.1 Aquatic Biota – Fish Health and Condition

Project-related changes in water and/or sediment quality have the potential to affect the health and condition of Arctic char. The major pathways of effects considered in the assessment for this key issue are based on the residual effects identified in the water and sediment quality assessment (see Section 3.4).

At Milne Camp, the ground preparation/earthworks, equipment and vehicle use, and camp operations (including waste management and fuel) each have the potential to affect the health and condition of aquatic biota. Along the Milne Tote Road, the work on road alignment, as well as vehicle travel can affect Aquatic Biota health and condition. At Mary River Mine site Camp, the continued operation of the sewage treatment facility and its associated effluent can contribute to effects on Aquatic Biota health and condition, as could the activities comprising earthworks and equipment and vehicle use. At Steensby Camp, all four site activities have the potential to affect Aquatic Biota health and condition.

Residual Effects Rating

The PDW activities that could affect Aquatic Biota health and condition are:

- Ground Preparation, Earthworks and dust deposition (all four LSAs)
- Equipment and Vehicle Use (all four LSAs)
- Camps, Waste Management and Fuel ((Milne Camp LSA, Mary River Mine site Camp LSA)
- Effluent discharge to a watercourse (Mary River Mine site Camp LSA)
- Quarries and Borrow Sources (Steensby Camp LSA)
- Airstrips and Airstrip Use (Steensby Camp LSA)

The health and condition of Arctic char will be most directly influenced by changes in water and sediment quality as assessed in the previous section. The measurable parameters and thresholds as developed for water and sediment quality apply to the health and condition of Arctic char.

Aquatic habitat is measured in terms of surface area, with various descriptors (substrate, water depth, clarity, species/life cycle stages present) used to indicate productive capacity. The threshold for habitat effects is set by the regulator (Fisheries and Oceans Canada) in accordance with various policy directives and published guidance documents. For purposes of this assessment, the threshold was set at any change greater than 1% of the area of habitat under consideration. This approach is consistent with the Mary River Project EIS.

Table 16-6 has been adapted from the Mary River Project EIS (Table 7-4.2). Criteria used for defining the magnitude of residual effects on the indicator for freshwater biota and habitat (i.e., Arctic char) were developed in specific consideration of ecological relevance for this VEC, available thresholds, and site-specific information.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 16-6: Criteria Determination of the Magnitude of Effect of Changes in Water Quality on Arctic Char Health and Condition

Level	Descriptor	Criteria[1,2]
Not Assessed (Level 0)	Negligible	**Water quality change within CCME PAL guidelines or other water quality thresholds**
Level I	Low	**Water quality change 1-10 times the CCME PAL guidelines or other water quality thresholds**
Level II	Moderate	**Water quality change 10-100 times the CCME PAL guidelines or other water quality thresholds**
Level III	High	**Water quality change >100 the CCME PAL guidelines or other water quality thresholds**

Note(s):

1. Magnitude of effect modified based on ecological factors/scientific judgement.
2. Other published water quality guidelines or thresholds were applied for parameters for which there are no ccme pal water quality guidelines.

Magnitude

Using conservative assumptions, and applying the Magnitude criteria developed for the Mary River Project EIS, Level I magnitude is assigned to the residual environmental effects of Pre-Development Work on Aquatic Biota Health and Condition as a result of water and sediment quality changes.

Duration

A Level I duration rating was assigned to residual water and sediment quality effects associated with all of the applicable PDW-related activities. A Level I duration rating is, therefore applied to the residual environmental effects of Pre-Development Work on Aquatic Biota Health and Condition as a result of water and sediment quality changes.

Frequency

A Level III Treated Sewage Discharge; Level II to Camps, Waste Management and Fuel; and Level I to the remaining four applicable Activities. Considering the temporal relation between freshet and/or extreme weather conditions and residual water and sediment quality effects, it is anticipated that these effects would only occur on infrequent occasions within the one-year timeframe of the PDW, and be limited to summer months when construction activities are scheduled and when freshet and the majority of rain events in the Project area occur. A Level I frequency rating was therefore assigned to the residual environmental effects of Pre-Development Work on Aquatic Biota Health and Condition as a result of water and sediment quality changes.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Extent

A Level I extent rating was assigned to residual water and sediment quality effects associated with all of the applicable PDW-related activities. A Level I extent rating is, therefore applied to the residual environmental effects of Pre-Development Work on Aquatic Biota Health and Condition as a result of water and sediment quality changes.

Reversibility

A Level II rating for reversibility was assigned to Camps, Waste Management and Fuel; all of the other five relevant PDW activities were assigned a Level I for reversibility. A Level II reversibility rating was conservatively assigned to the residual environmental effects of Pre-Development Work on Aquatic Biota Health and Condition as a result of water and sediment quality changes.

Significance

Based on the ratings described above, PDW-related activities are not expected to result in significant adverse environmental effects on Aquatic Biota Health and Condition as a result of water and sediment quality changes in the four freshwater LSAs. The residual effect is ranked as ***Not Significan***t. The level of confidence associated with this ranking of significance is Medium due to the qualitative nature of the assessment.

16.6.1.2 Habitat Alteration or Loss

Water Use and Site Water Management activities at each of the LSA sites have the potential to result in Habitat Alterations. Large rates of water extractions can reduce water levels such that a reduced wetted perimeter is available as fish habitat. This can affect both standing water as well as streams. As well, excessive draw-down of water levels can act to desiccate incubating fish eggs and, in extreme cases result in stranding of juvenile and mature fish.

At Milne Camp, water extractions will be taken from the existing Camp water supply (Phillips Creek, 32Km. Lake). All extractions will be within permitted levels, so that negative effects on the productive capacity of Aquatic biota and habitat will be avoided. Along the Milne Tote Road, occasional water withdrawals may occur for spot uses, such as dust control. Any extractions will be in accordance with applicable guidelines or permit conditions. At the Mary River Mine site Camp, the existing camp water supply will be used to its existing capacity, but water withdrawals will not exceed permit limitations. At Steensby camp, the only freshwater extraction will be for industrial use, e.g. dust control, equipment wash down. The small water bodies in the work area will be accessed and used as required. Several of these water bodies do not contain fish and water will be drawn preferentially from these sources.

Ground Preparation Earthworks along the Milne Tote Road, at the Mary River Mine site Camp and at Steensby Camp have the potential to affect aquatic habitat, either through direct habitat loss or by hampering access for fish. Aspects such as dust generation have a negligible potential to result in habitat effects.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Improvements along the Milne Tote Road will include some alignment adjustments, as well as placement of sub-surface material and gravels on the road surface. At water crossings, such work has the potential to destroy habitat. As well, any replacement of existing culverts, or introduction of new crossings, if not done carefully, could impair fish movement and thus reduce habitat utilization.

At Mary River Mine site Camp, the proposed work is contained within the existing developed site, and does not involve stream crossings or incursions into water bodies.

At Steensby Camp, the work will comprise clearing, grading, levelling (cut and fill), contouring, construction of ditches and settlement ponds, and surface placement of granular material. The focus of work will be in an area of very small watersheds, comprising small water bodies, most of which freeze to the bottom in winter and are consequently not fish habitat. All streams are intermittent. The construction of the airstrip will involve infilling of a small water body and possible incursion into 3 Km. Lake. The smaller water bodies along the airstrip footprint are not fish habitat, i.e. no fish were captured during fishing efforts and water depths are such that these bodies freeze to the bottom in winter. Fisheries and Oceans Canada (DFO) will be consulted with respect to 3 km. Lake in order to develop approaches that avoid a HADD determination, and protect existing productive fish habitat. Letter of Advise will be sought for activities that are in or near fish habitat (Appendix A.7). It is not expected that any Harmful Alteration, Damage or Destruction (HADD) will be identified with respect to the PDW.

Residual Effects Rating

The PDW activities that could result in Habitat Alteration or Loss are:

- Ground Preparation, Earthworks and Dust Deposition- Milne Tote Road LSA, Mary River Mine site Camp LSA, Steensby Camp LSA
- Water Use and Site Water Management – all four LSA's
- Airstrips and Airstrip Use (Steensby Camp LSA)

The Mary River Project EIS developed specific criteria for determining the magnitude of effect on fish habitat. Table 7-4.3 of the Project EIS is repeated (see Table 16-7 below) and these criteria applied to the residual effects assessment of the PDW.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 16-7: Criteria for Determination of the Magnitude of Effect on Fish Habitat Alteration or Loss

Level	Descriptor	Criteria[1]
Not Assessed (Level 0)	Negligible	**Negligible: <1% reduction in productive capacity**
Level I	Low	**Low: 1-10% reduction in productive capacity**
Level II	Moderate	**Moderate: 10-20% reduction in productive capacity**
Level III	High	**>20% reduction in productive capacity**

Note(s):
1. Magnitude of effect modified based on ecological context/scientific judgement.

Magnitude

Using conservative assumptions, and applying the Magnitude criteria developed for the Mary River Project EIS, a Level O magnitude is assigned to the residual environmental effects of Pre-Development Work on Fish Habitat Alteration or Loss as a result of Pre-Development Works.

Duration

A Level I duration rating was assigned to residual Fish Habitat Alteration or Loss, given the twelve month duration of the Pre-Development Works undertaking.

Frequency

A Level I frequency (Infrequent) rating was assigned to the residual environmental effects of Pre-Development Work on Fish Habitat Alteration or Loss.

Extent

A Level I extent rating is assigned to residual Fish Habitat Alteration or Loss effects associated with Pre-Development Work.

Reversibility

Any effects from the Project on fish habitat will be inadvertent, and will be required to be addressed either through mitigation measures, remedial actions or, in the extreme by development of an acceptable Fish Habitat Compensation Plan that meets the "No Net Loss" objective set by DFO with respect to Productive Fish Habitat. Therefore a Level I rating for reversibility is assigned to the residual effects of PDW on Fish Habitat Alteration or Loss.

Significance

Based on the ratings described above, PDW-related activities are not expected to result in significant adverse environmental effects on Fish Habitat in any of the four freshwater LSAs. The residual effect is ranked as ***Not Significan***t. The level of confidence associated with this ranking of significance is High.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.6.1.3 Fish Mortality

In assessing the potential for direct mortalities, no absolute thresholds were set, and the evaluation was carried out in a qualitative manner. In general, any level of mortality whether to incubating fish eggs or to adults would be considered to be an exceedance.

Water Use and Site Water Management was the only activity identified for the Pre-Development Work where the interaction was identified as having potential to produce fish mortalities. Excessive water extraction can result in stranding of fish and desiccation of exposed incubating eggs, especially during winter months. By careful selection of extraction sources, and through careful adherence to calculated guideline levels for water extraction, such effects can be avoided.

At Milne Inlet, the existing water source (Phillips Creek) is more than capable of sustaining the levels of extraction set by permits. Baffinland will carefully monitor and report on water extraction to confirm adherence to these limits. The occasional extraction of water along the Milne Tote Road will be carefully selected to ensure the up gradient watershed area is more than adequate. At Mary River Mine site Camp, the existing Camp Lake water supply has been shown to operate without any notable challenges in terms of winter drawdown. The existing limits on water extraction will be observed during the Pre-Development Works undertaking. At Steensby Camp, there will be no requirement for a potable water source for the two 150 person camps and freshwater demand will be for industrial purposes. Water extraction will be from 3 Km. Lake, a water body of adequate size to absorb these minor volumes of water.

Magnitude

Using conservative assumptions, and applying the Magnitude criteria developed for the Mary River Project EIS, a Level O magnitude is assigned to the residual environmental effects of Pre-Development Work on Fish Habitat Alteration or Loss as a result of Pre-Development Works. .

Duration

A Level I duration rating was assigned to residual Fish Habitat Alteration or Loss, given the twelve month duration of the Pre-Development Works undertaking.

Frequency

A Level I frequency (Infrequent) rating was assigned to the residual environmental effects of Pre-Development Work on Fish Habitat Alteration or Loss.

Extent

A Level I extent rating is assigned to residual Fish Habitat Alteration or Loss effects associated with Pre-Development Work.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Reversibility

Any effects from the Project on fish habitat will be inadvertent, and will be required to be addressed either through mitigation measures, remedial actions or, in the extreme by development of an acceptable Fish Habitat Compensation Plan that meets the "No Net Loss" objective set by DFO with respect to Productive Fish Habitat. Therefore a Level I rating for reversibility is assigned to the residual effects of PDW on Fish Habitat Alteration or Loss.

Significance

Based on the ratings described above, PDW-related activities are not expected to result in significant adverse environmental effects on Fish Habitat in any of the four freshwater LSAs. The residual effect is ranked as ***Not Significant***. The level of confidence associated with this ranking of significance is High.

16.7 Effects Assessment Summary

The significance of residual effects of PDW activities on Aquatic Biota and Habitat are summarized below in Table 16-8.

Table 16-8: Significance of Residual Environmental Effects on Aquatic Biota and Habitat by LSA

Watershed - Project Activity	Significance of Predicted Residual Environmental Effect		Likelihood (1)	
	Significance Rating	Level of Confidence	Probability	Certainty
Milne Camp LSA	N	2	N/A	N/A
Milne Tote Road LSA	N	2	N/A	N/A
Mary River Mine LSA	N	2	N/A	N/A
Steensby LSA	N	2	N/A	N/A

KEY:
Significance Rating: S = Significant, N = Not Significant, P = Positive
Level of Confidence : 1 = Low; 2 = Medium; 3 = High
(1) Likelihood - only applicable to significant effects
Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely
Certainty: 1 = Low; 2 = Medium; 3 = High

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

16.8 Follow-Up

Some adaptive management of water quantity will be required for the Mary River Project. Most notably, the magnitude threshold of 10% change to baseline conditions should be confirmed, to ensure that no significant water quantity effects occur below this threshold. Specific details regarding adaptive management, mitigation and monitoring of water quantity for Mary River are presented in the Mary River Site Water Management Plan.

Environmental construction monitoring will be relied on during PDW program with respect to activities that have the potential to alter or degrade water and sediment quality. These construction activities tend to occur when work is located in or around water or when surface materials are exposed. This form of monitoring aids in ensuring effectiveness of mitigation measures and compliance with applicable water quality criteria.

Site investigations will be required along the Milne Tote Road at locations requiring alignment and grade improvements. The water bodies at Steensby Camp LSA may need to be checked for fish presence and water depth. These requirements can be confirmed following consultation with regulators.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17. Marine Environment

17.1 Marine Environment

This section of the EIS discusses potential effects on the Marine Environment from the proposed Project. Emphasis of the assessment is on the marine operations in Milne Inlet and Steensby Inlet where the sealift vessels will offload the considerable volume of equipment and supplies associated with the Project. The assessment will focus on the activities and operations on and near the marine environment. The Mary River Project Draft EIS and EIS Addendum address the entire Mary River Project, with emphasis on year-round shipping and potential effects on marine water quality, marine biota and habitat, as well as marine mammals. This assessment will focus on the operational aspects of Pre-Development Work at each port. As described in greater detail in Appendix B.9, a Shipping Management Plan has been developed to address the measures to be taken and the procedures to be followed in order to ensure that marine operations are conducted in a safe and environmentally responsible manner.

The Pre Development Works comprises an open-water sealift to place equipment and material on site at the proposed Mary River Project. Shipping activity will occur over a period of up to ten weeks between August and October, 2012. The assumed shipping season will be July 30 - Oct 10 for Milne Inlet and Aug 10 – Oct 30 for Steensby Inlet.

The first shipments to each location will include the tugs, barges, machinery and equipment necessary to establish the temporary docks – one at Milne Inlet and two at Steensby Inlet. This arrangement of a temporary shoreline berm and spud barges will provide an offloading facility for lightering barges or vessels. Tugs will provide lightering in cases where direct offloading is not practical. A specialized contractor will be retained to handle the cargo transfer between vessels and the onshore laydown areas. This contractor will supply and install the spud barges, and operate the lightering barges.

Containerized supplies, equipment and materials will be shipped to both Milne Inlet and Steensby Inlet. Items bound for Milne Inlet site as well as the Mine Site will be shipped to Milne Inlet and then transported over the Milne Inlet Tote Road as appropriate. Steensby Inlet will receive cargo for that site as well as for the railroad construction site. The pattern of shipping will likely involve bringing vessels in as pairs with approximately 4-5 days between passages.

Ships will not be serviced at either Milne Inlet or Steensby Inlet. Since vessels will be travelling with cargo to each site, it is not anticipated that ballast water discharge at Milne Inlet or Steensby Inlet will be a feature of site activities.

Fuel (diesel, gasoline and jet fuel) will be delivered to Milne Inlet by tanker, and to Steensby Inlet by both fuel barge and tanker. Fuel will be transferred to shore by the commonly-employed floating hose fuel transfer method. At Steensby Inlet, the initial delivery of fuel will be by tug and barge, and

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

fuel will be transferred from the barge to shore as storage facilities are made available. At the end of the shipping season, a tanker will re-fill both the onshore storage as well as the fuel barge. The barge will provide over-winter storage of a full load of fuel during the winter of 2012-2013. During periods when fuel is being transferred from vessel to shore, there will be a suspension of all other offloading activities.

Table 17-1 presents the estimated volume of vessel traffic at Mine Inlet and at Steensby Port Site during 2012 as well as the approximate tonnage of materials to be delivered. The estimated number of voyages is based on use of conventional sealift ships, of around 7,000 to 16,000 DWT capacity. Larger ships or barges may be used depending on cost and availability. A fleet of 8 -12 vessels will be required to meet the sealift requirements of the PDW operation.

Table 17-1: Shipping Traffic During Pre-Development Works

Estimated Maritime Transportation	Milne	Steensby	Total
# Shipments	20-23	18 -20	38 - 43
General Cargo (tonnes x 1,000)	200 -350	180 -300	380-650
Fuel (tonnes x 1,000)	62.5	47	109.5

A freight-forwarding team will be responsible for receiving all cargo in the port of discharge and for directing freight to the consolidation point. The Project Description for the PDW lays out the routine to be followed in offloading, laydown and transport of all cargo and fuel.

At Steensby Inlet two self-contained accommodation barges will be moored securely and remain in place for the duration of the Pre-Development Works program. The camps will include onboard sewage treatment, potable water desalination, power supply and incinerator.

The Milne Inlet port site is located at the southern tip of Milne Inlet on a fjord-head delta. Shorelines within Milne Inlet include a mix of rock cliffs, alluvial fans and raised beach ridges. Like many peri-glacial shorelines, coastal sediments are coarse boulders, cobbles and sand. The Inlet is ice-covered most of the year, with a short three-month open-water season. Icebergs are common and often become grounded in shallow, nearshore areas. During the open-water season, anadromous Arctic char, as well as a variety of bird and marine mammal species use Eclipse Sound and Milne Inlet extensively for summer feeding and rearing. On average, approximately 20,000 narwhal summer in Milne Inlet, Eclipse Sound, and other adjoining Inlets.

Steensby Inlet is a wide bay, characterized by shallow waters (< 100 m) and gentle terrestrial relief around most of its perimeter. Shorelines include wide tidal flats along the west cost of the Inlet, lagoon complexes to the north, and a mix of bedrock and coarse alluvial shorelines along the east coast. The tidal range within the Inlet is over 4 m and tidal currents dominate water circulation.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Steensby Inlet is covered by landfast ice from late October to late July/August. The proposed port is located on the eastern shore, about 50 km into the Inlet. Steensby Inlet provides year-round habitat for ringed seals and polar bears, and is used during open-water periods by beluga, bearded seal and walrus. Bird species such as Arctic tern, brant, Canada geese, common eiders, glaucous gulls, king eiders, Pacific loons, red-breasted mergansers, red-throated loons, jaegers, and snow geese use Steensby Inlet as a nesting and staging area. Nearshore habitat in Steensby Inlet provides feeding habitat for anadromous Arctic char populations from several watersheds, including the Ikpikitturjuaq, Cockburn, and Rowley rivers.

17.1.1 Boundaries

The spatial boundaries of this assessment are confined to the inshore areas of Steensby Inlet and Milne Inlet, since sealift operations in the North are a common occurrence with known effects. Additionally, the Project EIS addresses the larger (Regional Study Area) comprising the Shipping routes to and from these ports.

For the purposes of this assessment, therefore, we have selected the Local Study Areas as described in the Mary River Project EIS, for the assessment of water quality and sediment quality, and applied it throughout the PDW Marine Environment assessment.

For Milne Inlet, the LSA extends northeast from the proposed port site (at the south end of the Inlet) for a total of 4 km, and spans the whole width of the Inlet (see Mary River Project draft EIS Figure 8-3.1). The southwest boundary of the LSA ends at the confluence of the Inlet with Phillips Creek. Milne Inlet and Eclipse Sound are the water and sediment quality RSA.. The Steensby Inlet LSA contains all of the marine waters within an 8 km radius of the proposed port site (see Mary River Project draft EIS - Figure 8-3.2). This area spans approximately two-thirds the width of Steensby Inlet, and includes the Steensby Port Island and a large part of Ikpikitturjuaq Bay.

The temporal boundary of this assessment is limited to the twelve month duration of the Pre-Development Works. Since most of the marine activity will occur during the open water season (ten weeks between August and October), it is this timeframe that will form the focus of the assessment.

17.1.2 Issues Scoping

A detailed review was completed of the Pre-Development Works project description and compared against the results for the Mary River Project Draft EIS and EIS Addendum. Utilizing the results from these exercises, three Valued Ecosystem Components (VECs) were identified to provide a focus for the PDW effects assessment:

- Marine Water and Sediment Quality
- Marine Habitat and Biota
- Marine Mammals.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The sources of potential water and sediment quality impairment include sewage effluent from the accommodations barges, cargo vessel wastes and discharges, tug wastes and discharges, and shoreline runoff from work sites.

The sources of potential interaction with marine biota and habitat include installation of temporary docks, moorings for barges, propwash from vessels and tugs.

The anticipated sources of interaction with marine mammals in Steensby Inlet and Milne Inlet include vessel noise and visual disturbance, onshore construction activity, and aircraft (helicopter) operation.

Each of the three VECs has been considered in the following sub-section and considered in terms of:

- identification of the interactions between the Project features and the environment;
- identification of measurable parameters and effects thresholds
- an overview consideration of potential environmental effects)
- a discussion of mitigation measures to be implemented
- predictions for residual environmental effects
- a discussion of required follow-up.

A concluding section summarizes the predicted residual environmental effects of the Project on the freshwater environment.

17.2 Marine Water and Sediment Quality

Water quality is an important component of the aquatic environment as it forms a significant facet of the environment for aquatic life and wildlife. Sediment quality is also important to the health of aquatic biota that live in or on sediments, or that are part of the food chain that includes sediments and/or benthic communities.

17.2.1 Interactions and Potential Effects

The various Pre-Development Works activities that could affect water and sediment quality in the vicinity of the proposed port sites are presented in Table 17-2.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 17-2: Interactions and Potential Effects of PDW on Marine Water/Sediment Quality

Project Location (LSA)	Project Activity or Interaction	Potential Effect (Key Indicator)
Milne Inlet	Vessel operations - wastes and discharges	**TSS; Metals, Petroleum Hydrocarbons**
	Land-based Sewage Effluent	**Nutrients, TSS**
	Fuel transport, storage and transfer	**Petroleum Hydrocarbons**
	Shoreline runoff and dust deposition	**TSS; Metals; Nutrients; Petroleum Hydrocarbons**
Steensby Site	Vessel operations - wastes and discharges	**TSS; Metals. Petroleum Hydrocarbons**
	Marine – based Sewage effluent	**TSS; Metals; Nutrients**
	Fuel transport, storage and transfer	**Petroleum Hydrocarbons**
	Shoreline runoff and dust deposition	**TSS; Metals; Nutrients; Petroluem Hydrocarbons**

Indicators and thresholds used to assess the potential effects of Pre-Development Work on marine water and sediment quality were drawn from the Mary River Project draft EIS. For assessing effects on water quality at Milne and Steensby Inlets, a suite of water quality parameters were considered, including TSS, nutrients, metals, and hydrocarbons. For sediments, indicators focused on a suite of metals, as well as PAHs.

Effects on water or sediment quality were identified based on the potential for exceedances of water and sediment quality thresholds, which were defined as:

- The maximum average concentrations listed in the Water License Agreement for the Wastewater Treatment Facility
- Schedule 1 of the Metal Mining Effluent Regulation under the Federal Fisheries Act
- The CCME Water Quality Guidelines for the Protection of Marine Aquatic Life (PMAL)
- The CCME sediment quality guidelines for the PMAL (i.e., ISQGs and PELs; CCME, 1999; updated to 2010).

A list of these thresholds is provided in the Mary River Project draft EIS (see Table 8-3.7). As a general rule, the CCME PMAL was used for defining thresholds for surface water and sediment quality VEC, as the CCME PMAL thresholds are typically the most stringent of those identified above. When assessing potential effects of the Project relative to these thresholds, consideration was made to conditions in the Inlets prior to the Project (i.e., baseline conditions).

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Vessel wastes and discharges could include sewage, solid waste, leaks and spills, engine exhausts bilges and ballast water. Vessel, tug and barge traffic within the port areas could also stir up bottom sediments. Propeller-generated currents can re-suspend sediments into the water column in shallow waters such as at the Milne and Steensby dock sites. Sediment disturbance will likely cause localized increases of TSS, nutrients, and metals in the water column, possibly to levels in excess of the water quality thresholds. These effects will subside rapidly (hours) after the disturbance (i.e., as vessel operation ceases or moves to a different area) as particles settle back to the seabed or are redistributed by tidal or wind currents.

Sewage Effluent will enter Milne Inlet from the on-land operation of Milne Camp, while at Steensby Inlet the two accommodation barges will discharge treated sewage effluent.

Fuel for Project Construction will be shipped to each port in tanker vessels. At Steensby a fuel barge will be brought to site by a tug, moored in place and used for storage of fuel. A floating hose will be used for fuel transfer to shore. Fuel will be transferred from tanker to onshore storage tanks at Milne Inlet, with a portion also trucked to the Mary River Minesite Camp. At Steensby, fuel will be transferred from tanker to onshore storage tanks. a tug and barge will be also be used to ship fuel to Steensby Port. The fuel barge will be moored and used to store fuel. As required, fuel will be transferred from the barge to onshore facilities. Equipment fuelling will be carried out onshore as part of the site activities comprising the Pre-Development Works. Vessels and tugs will all be carrying fuel onboard for their own operation.

Shoreline runoff from the work sites at Milne and Steensby ports will report to the marine environment, as will dust from earthworks, blasting, road traffic and engine exhausts.

All of these activities have the potential to affect marine water and sediment quality.

17.2.2 Mitigation Measures

The control and management of vessel wastes is addressed in the Shipping Management Plan (Appendix B.9). All vessels will have a waste management plan for sewage and solid waste. Vessels will not discharge sewage effluent while at Steensby Port or Milne Port. Vessels will be required to comply with all applicable regulations and, as a condition of their charter will be required to meet the performance standards described in the Shipping Management Plan. Since the Pre-Development Works involves the transport of inbound cargo, it is not anticipated that any ballast water discharges will occur at either Milne or Steensby ports. The potential for sediment disturbance will be moderated by the modest draft of the sealift vessels and tigs used for the lightering operations.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Precautions as described in the Shipping Plan will apply to the transport, transfer and storage of fuel. Oil Pollution Emergency Plans (OPEPs) have been developed for both ports (Appendix B.2, Appendix B.3). During the transfer of fuel from tankers to shore via floating fuel lines, all other marine activities will be suspended so that the focus of attention will be on the transfer operation.

The various mitigation measures associated with onshore activities are described elsewhere in this document (see, e.g. Section 16).

17.2.3 Effects Assessment

The effects assessment for water and sediment quality has been carried out simultaneously for both LSAs due to the similarity of interactions associated with Milne and Steensby ports

The magnitude of residual effects of the Project on water and sediment quality were described as low (Level I), moderate (Level II), or high (Level III) using the thresholds identified in Table 17-3. Effects that were predicted to result in changes to water or sediment quality that would be unlikely to be detectable were identified as negligible and were not assessed further.

Table 17-3: Pre-Development Works Criteria for Determination of the Magnitude of Effect of Changes in Water and Sediment Quality

Level	Descriptor	Criteria[1,2]
Not Assessed (Level 0)	Negligible	Water/sediment quality change not expected to be detectable
Level I	Low	Water/sediment quality change may be detectable but would remain within CCME PAL guidelines
Level II	Moderate	Water/sediment quality change within an order of magnitude of the CCME PAL guidelines
Level III	High	Water/sediment quality change greater than an order of magnitude above the CCME PAL guidelines

Note(s):
1. Magnitude of effect modified based on ecological factors/scientific judgement.
2. Other published water quality guidelines or thresholds were applied for parameters
For which there are no ccme pmal water quality guidelines.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.2.3.1 Vessel Operations

Vessel operations will extend over a ten week period at each port and involve up to two vessels and two tugs at one time within the LSA. Appropriate Management Plans will be in place, along with monitoring and enforcement to ensure compliance with requirements. Nevertheless, vessel activity will result in some releases to the marine environment.

The following assessment, while qualitative, is based on the evaluation carried out for the Mary River Project EIS and is consistent with the findings of that evaluation.

Residual Effects Rating

Magnitude

Based on the potential for occasional exceedances in water quality thresholds to occur, a Level II magnitude rating was assigned to residual marine water and sediment quality effects associated with the PDW vessel operations in the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a tenweek period in 2012. A Level I duration rating was assigned to residual marine water and sediment quality effects associated with the PDW vessel operations in the two marine LSAs.

Frequency

it is anticipated that effects would only occur on infrequent occasions during the open water months of 2012 when vessel movements and cargo transfer is scheduled to occur. A Level I frequency rating was assigned to residual marine water and sediment quality effects associated with PDW vessel operations in the two marine LSAs..

Extent

The extent of residual marine water and sediment quality effects associated with PDW vessel wastes and discharges will be limited to the LSA where they are located. Site evironmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to avoid or limit the extent of the effect. A Level I extent rating was assigned to residual marine water and sediment quality effects associated with PDW-related vessel operations in the two marine LSAs.

Reversibility

Residual marine water and sediment quality effects associated with PDW-related vessel operations are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the contaminant source. A Level I reversibility rating was assigned to residual marine water and sediment quality effects associated with PDW-related vessel operations in the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Significance

Based on the ratings described above, vessel operations are not expected to result in significant adverse environmental effects on marine water and sediment quality in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.2.4 Sewage Effluent

The stationary sources of sewage effluent (accommodation barges at Steensby; land-based sewage treatment at Milne Camp) will each be expected to operate efficiently and within regulated standards. Vessel discharges will be limited and controlled by regulation as well as charter conditions.

Residual Effects Rating

Magnitude

Based on the anticipated high performance of sewage treatment facilities, compliance with regulated standards is predicted. Consequently, a Level I magnitude rating was assigned to residual marine water and sediment quality effects associated with the PDW sewage effluent discharges in the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual marine water and sediment quality effects associated with the PDW sewage effluent discharges in the two marine LSAs.

Frequency

it is anticipated that effects would occur on a continuing basis throughout the operation of sewage treatment facilities throughout 2012.. A Level III frequency rating was therefore assigned to residual marine water and sediment quality effects associated with PDW sewage effluent discharges in the two marine LSAs..

Extent

The extent of residual marine water and sediment quality effects associated with PDW sewage effluent discharges will be limited to the LSA where they are located. Site environmental monitoring will identify residual water and sediment quality effects and where necessary, mitigation efforts will be managed to avoid or limit the extent of the effect. A Level I extent rating was assigned to residual marine water and sediment quality effects associated with PDW-related sewage effluent discharges in the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Reversibility

Residual marine water and sediment quality effects associated with PDW-related sewage effluent discharge are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the contaminant source. A Level I reversibility rating was assigned to residual marine water and sediment quality effects associated with PDW-related sewage effluent discharge in the two marine LSAs.

Significance

Based on the ratings described above, sewage effluent discharges are not expected to result in significant adverse environmental effects on marine water and sediment quality in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.2.4.1 Fuel Transport, Storage and Transfer

Extensive precautions will be in place to prevent any accidental releases of fuel during transport, storage and transfer. High standards will apply to the selection of vessels. During operations, detailed procedures will be followed, and close monitoring for compliance included as part of the management of the Pre-Development Works. Nevertheless, the potential exists for small leaks, drips or undetected releases of fuel to occur.

Residual Effects Rating

Magnitude

Based on the anticipated high performance of the fuel supply program, compliance with regulated standards is predicted. Consequently, a Level I magnitude rating was assigned to residual marine water and sediment quality effects associated with the PDW fuel transport, storage and transfer at the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual marine water and sediment quality effects associated with the PDW fuel transport, storage and transfer at the two marine LSAs.

Frequency

it is anticipated that negligible releases of petroleum hydrocarbons will occur throughout the PDW operation period.. A Level I frequency rating was therefore assigned to residual marine water and sediment quality effects associated with PDW fuel transport, storage and transfer at the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Extent

The extent of residual marine water and sediment quality effects associated with PDW fuel transport, storage and transfer will be limited to the LSA where they are located. A Level I extent rating was assigned to residual marine water and sediment quality effects associated with PDW-related fuel transport, storage and transfer at the two marine LSAs.

Reversibility

Residual marine water and sediment quality effects associated with PDW-related fuel transport, storage and transfer at the two marine LSAs. are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the contaminant source. A Level I reversibility rating was assigned to residual marine water and sediment quality effects associated with PDW-related fuel transport, storage and transfer at the two marine LSAs.

Significance

Based on the ratings described above, fuel transport, storage and transfer are not expected to result in significant adverse environmental effects on marine water and sediment quality in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.2.4.2 Shoreline Run-off and Dust Deposition

Overall, it is predicted that on land Pre-Development Works may cause localized and temporary increases of TSS and associated nutrients and metals in the water column. Therefore, potential effects of this pathway on water and sediment quality at Milne Inlet and Steensby Inlet are considered to be moderate in magnitude.

Residual Effects Rating

Magnitude

Based on the potential for some short term exceedances associated with aspects of the onshore PDW activities a Level II magnitude rating was assigned to residual marine water and sediment quality effects associated with the PDW shoreline runoff and dust deposition at the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012, however land-based activities will extend over a longer portion of the overall schedule. A Level I duration rating was assigned to residual marine water and sediment quality effects associated with the PDW shoreline runoff and dust deposition at the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Frequency

it is anticipated that small volume discharges will occur throughout the 2012 open water season. A Level I frequency rating was therefore assigned to residual marine water and sediment quality effects associated with PDW shoreline runoff and dust deposition at the two marine LSAs.

Extent

The extent of residual marine water and sediment quality effects associated with PDW shoreline runoff and dust deposition at the two marine LSAs will be limited to the LSA where they are located. A Level I extent rating was assigned to residual marine water and sediment quality effects associated with PDW-related shoreline runoff and dust deposition at the two marine LSAs.

Reversibility

Residual marine water and sediment quality effects associated with PDW-related shoreline runoff and dust deposition at the two marine LSAs are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the contaminant source. A Level I reversibility rating was assigned to residual marine water and sediment quality effects associated with PDW-related shoreline runoff and dust deposition at the two marine LSAs .

Significance

Based on the ratings described above, shoreline runoff and dust deposition at the two marine LSAs are not expected to result in significant adverse environmental effects on marine water and sediment quality in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.2.4.3 Summary of Residual Effects

Table 17-4 presents a summary of the results from the residual environmental effects predictions. Overall, the predicted residual environmental effects of Pre-Development Works on Marine Water and Sediment Quality is ***Not Significant***.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 17-4: Pre-Development Works Significance of Residual Effects on Marine Water and Sediment Quality

Project Activity	Significant of Predicted Residual Environmental Effect		Likelihood[1]	
	Significance Rating	Level of Confidence	Probability	Certainty
Vessel operations -wastes and discharges	N	2	-	-
Sewage Effluent	N	2	-	-
Fuel transport, storage and transfer	N	2	-	-
Shoreline runoff and dust deposition	N	2		
KEY: **Significance Rating**: S = Significant; N = Not Significant **Level of Confidence**: 1 = Low; 2 = Medium; 3 = High **Certainty**: 1 = Low; 2 = Moderate; 3 = High **Probability**: 1 = Unlikely; 2 = Moderate; 3 = Likely				
NOTE(S): 1. LIKELIHOOD: ONLY APPLICABLE TO SIGNIFICANT EFFECTS.				

17.3 Marine Habitat and Biota

The Mary River Project draft EIS provides an exhaustive description of the existing marine habitat and biota. The overall importance of the marine environment to overall productivity of the region is emphasized, along with its consequent role in the life of northern residents.

Two key indicators were selected to represent the marine aquatic habitat and biota VEC:

- Marine fish habitat
- Arctic char.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Marine fish habitat was selected as an indicator because it supports marine biota and their food supply. Any Project-related changes to fish habitat have the potential to negatively affect marine biota or their food supply. Further, fish habitat is protected under the federal *Fisheries Act* and its accompanying policy framework.

Arctic char was identified as an appropriate key indicator for marine biota and habitat. Arctic char are seasonally abundant in marine coastal waters, and are of social and ecological importance.

Because of the close link between fish and fish habitat, these two indicators will be considered together in the Pre-Development Works assessment.

17.3.1 Interactions and Potential Effects

The various Pre-Development Works activities that could affect fish and fish habitat in the vicinity of the proposed port sites are presented in Table 17-5. Effects related to marine water and sediment quality are addressed in Section 17.2 above. Effects of the Pre-Development Works on marine habitat and biota from altered water and sediment quality can reasonably be concluded to be negligible, given the outcome of the previous assessment.

Table 17-5: Interactions and Potential Effects of PDW on Marine Habitat and Biota

Project Location (LSA)	**Project Activity or Interaction**	Potential Effect (Key Indicator)
Milne Inlet	Vessel operations – noise and propwash	**Arctic char, Habitat**
	Temporary docks	**Habitat**
	Anchorage and Moorings	**Habitat**
Steensby Inlet	Vessel operations – noise and propwash	**Arctic char, Habitat**
	Temporary docks	**Habitat**
	Anchorage and Moorings	**Habitat**

Vessel operations within the two LSAs will extend over an estimated ten week period at each site during the 2012 open water season. The activities will involve the transfer of cargo – equipment, supplies and machinery as described in the Project Description. In most cases a lightering operation will be required, with the cargo vessel moored off and a lightering barge moved by tug to receive, transport and offload cargo. These activities will involve some limited potential to affect fish and fish habitat

The placement of temporary docks will be the first activity associated with the Pre-Development Works at each port site. The initial sealift vessel will include spud barges, lightering barges and tugs. These will be deployed to establish the designated temporary docks. The footprint for these docks will fall within the overall Project footprint, and should result in minimal habitat effects. Each spud

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

barge will be secured to the seabed by the barge spud legs. As required, additional mooring lines will be deployed to anchoring points in order to secure the dock arrangement. The accommodation barges and the fuel barge at Steensby Inlet will each require the placement of secure moorings, most of which will be secured to the seabed.

A minimum quantity of rock fill will be used along each shoreline to provide a driving surface for transfer of cargo to shore. This fill material is not expected to intrude beyond the nearshore zone.

The plan for operation will see vessels arriving and departing in pairs, and many of the vessels will be moored using their ships anchors to secure the vessel and facilitate the lightering operation. When dock access and water depths permit, some vessels may tie up a the temporary dock or raft onto a lightering barge adjacent to the dock.

Vessel movements within each LSA will involve the normal sounds associated with such operations. The operation of tugs in shallow water could generate propwash effects on the seabed, especially on areas of fine substrate.

Most of the described marine activities within the LSAs have the potential to interact with fish and fish habitat.

17.3.2 Mitigation Measures

The Shipping Management Plan (Appendix B.9) presents the details of Baffinland's commitments and obligations intended to ensure that the sealift is carried out in a safe and environmentally acceptable manner. As the Plan makes clear, contractors and charters will be bound by the environmental performance standards set by Baffinland. Active performance and compliance monitoring will be integrated into the Site management of the Pre-Development Works.

17.3.3 Effects Assessment

The magnitude of residual effects of the Pre-Development Works undertaking on Aquatic Biota was assessed using the same criteria as for marine water and sediment quality (Table 17-3), For fish habitat, the criteria were adopted as used in the Mary River Project draft EIS, and repeated below as Table 17-6.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 17-6: Criteria for Determination of the Magnitude of Effect on Marine Fish Habitat

Level	Descriptor	Criteria[1]
Level 0	Negligible	Negligible: <1% reduction in productive capacity
Level I	Low	Low: 1-10% reduction in productive capacity
Level II	Moderate	Moderate: 10-20% reduction in productive capacity
Level III	High	>20% reduction in productive capacity

NOTE(S):
1. MAGNITUDE OF EFFECT MODIFIED BASED ON ECOLOGICAL CONTEXT/SCIENTIFIC JUDGEMENT.

A qualitative assessment, employing professional judgement, was carried out for Aquatic Biota and Habitat.

17.3.3.1 Vessel Operations

Vessel operations will extend over a ten week period at each port and involve up to two vessels and two tugs at one time within each LSA. Appropriate Management Plans will be in place, along with monitoring and enforcement to ensure compliance with requirements. Nevertheless, vessel activity will result in the production of noise in air and water, as well as potential propwash interaction with the seabed, especially adjacent to the temporary dock locations.

Residual Effects Rating

Magnitude

Based on the likelihood of noise disturbance proximate to the sealift vessels and tugs, as well as the likely mobilization of seabed sediments, a Level I magnitude rating was assigned to residual Marine Biota and Habitat effects associated with the PDW vessel operations in the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual Marine Biota and Habitat effects associated with the PDW vessel operations in the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Frequency

It is anticipated that effects will occur regularly during the open water months of 2012 when vessel movements and cargo transfer is scheduled to occur. A Level III frequency rating was assigned to residual Marine Biota and Habitat effects associated with the PDW vessel operations in the two marine LSAs.

Extent

The extent of residual effects associated with PDW vessel operations will be limited to, and well within the LSA where they are located. A Level I extent rating was assigned to residual Marine Biota and Habitat effects associated with the PDW vessel operations in the two marine LSAs.

Reversibility

Residual Marine Biota and Habitat effects associated with PDW-related vessel operations are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the source of interaction. Noise levels will revert to previous levels. Moorings will be removed and temporary dock facilities removed.. A Level I reversibility rating was assigned to residual Marine Biota and Habitat effects associated with the PDW vessel operations in the two marine LSAs.

Significance

Based on the ratings described above, vessel operations are not expected to result in significant adverse environmental effects on marine Biota and Habitat in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.3.3.2 Temporary Docks.

The placement and operation of temporary docks will extend over a ten week period at each port and involve two sites at Steensby LSA and one at Milne LSA. Appropriate Management Plans will be in place, along with monitoring and enforcement to ensure compliance with requirements. Nevertheless, dock placement and operation will result in the some intrusion into the seabed, potential interference with fish movement and noise disturbance as a result of cargo movement and vehicle operation.

Residual Effects Rating

Magnitude

Based on the likelihood of noise disturbance proximate to the temporary docks a Level I magnitude was assigned to Marine Biota (fish). The limited extent of temporary intrusion into seabed habitat, would result in a Level 0 magnitude rating with respect to Habitat. For the purposes of this combined assessment, a Level of I is assigned to residual Marine Biota and Habitat effects associated with the PDW temporary dock placement and operation in the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual Marine Biota and Habitat effects associated with the PDW Temporary dock placement and operations in the two marine LSAs.

Frequency

it is anticipated that, while effects on Aquatic Biota (fish) and Habitat will occur throughout the open water months of 2012 this will be a one-time phenomenon, consequently a Level I frequency rating was assigned to residual Marine Biota and Habitat effects associated with the PDW temporary dock placement and operation in the two marine LSAs.

Extent

The extent of residual effects associated with PDW temporary dock placement and operation will be limited to, and well within the LSA where they are located. A Level I extent rating was assigned to residual Marine Biota and Habitat effects associated with the PDW temporary dock placement and operation in the two marine LSAs.

Reversibility

Residual Marine Biota and Habitat effects associated with PDW-related temporary dock placement and operation are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the source of interaction. Noise levels will revert to previous levels. Moorings will be removed and temporary dock facilities removed.. A Level I reversibility rating was assigned to residual Marine Biota and Habitat effects associated with the PDW temporary dock placement and operation in the two marine LSAs.

Significance

Based on the ratings described above, temporary dock placement and operations are not expected to result in significant adverse environmental effects on Marine Biota and Habitat in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.3.3.3 Anchorage and Moorings.

The anchorage of barges (in Steensby LSA) and vessel mooring (both LSAs) will extend over a ten week period at each port and involve limited areas at Steensby LSA and at Milne LSA. Appropriate Management Plans will be in place, along with monitoring and enforcement to ensure compliance with Site requirements. Nevertheless, anchorage and moorings will result in the some intrusion into the seabed, potential interference with fish movement and noise disturbance as a result of vessel presence.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Residual Effects Rating

Magnitude

Based on the limited extent of noise disturbance proximate to the anchorage and mooring areas a Level I magnitude was assigned to Marine Biota (fish). The limited extent of temporary intrusion into seabed habitat, would result in a Level 0 magnitude rating with respect to Habitat. For the purposes of this combined assessment, a Level of I is assigned to residual Marine Biota and Habitat effects associated with the PDW anchorages and moorings in the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual Marine Biota and Habitat effects associated with the PDW Anchorages and Moorings in the two marine LSAs.

Frequency

it is anticipated that, effects on Aquatic Biota (fish) and Habitat will occur intermittently throughout the open water months of 2012, consequently a Level II frequency rating was assigned to residual Marine Biota and Habitat effects associated with the PDW Anchorages and Moorings in the two marine LSAs.

Extent

The extent of residual effects associated with PDW Anchorages and Moorings will be limited to, and well within the LSA where they are located. A Level I extent rating was assigned to residual Marine Biota and Habitat effects associated with the PDW Anchorages and Moorings in the two marine LSAs.

Reversibility

Residual Marine Biota and Habitat effects associated with PDW-related Anchorages and Moorings are anticipated to be fully reversible. Following the completion of the sealift, key indicators are generally expected to return to baseline conditions through removal of the source of interaction. Moorings will be removed as required. A Level I reversibility rating was assigned to residual Marine Biota and Habitat effects associated with the PDW Anchorages and Moorings in the two marine LSAs.

Significance

Based on the ratings described above, Anchorages and Moorings are not expected to result in adverse environmental effects on Marine Biota and Habitat in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.3.3.4 Summary of Residual Effects

Table 17-7 presents a summary of the results from the residual environmental effects predictions. Overall, the predicted residual environmental effects of Pre-Development Works on Marine Biota and Habitat is ***Not Significant***.

Table 17-7: Pre-Development Works Significance of Residual Effects on Marine Biota and Habitat

Project Activity	Significant of Predicted Residual Environmental Effect		Likelihood[1]	
	Significance Rating	Level of Confidence	Probability	Certainty
Vessel operations – noise and propwash	N	2	-	-
Temporary docks	N	2	-	-
Anchorage and Moorings	N	2	-	-

KEY:
Significance Rating: S = Significant; N = Not Significant
Level of Confidence: 1 = Low; 2 = Medium; 3 = High
Certainty: 1 = Low; 2 = Moderate; 3 = High
Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely

NOTE(S):
1. LIKELIHOOD: ONLY APPLICABLE TO SIGNIFICANT EFFECTS.

17.4 Marine Mammals

Marine mammals formed a major focus of attention in the Mary River Project draft EIS because of the importance attached to this aspect of the environment. It was also a central focus because of the Project need to conduct shipping year-round through Steensby Port. For the Pre-Development Works undertaking, the assessment has been much more focused and confined to the Local Study Area for Milne Inlet and Steensby Inlet. The PDW involves a single season of shipping activity, to occur during the ten weeks of open water available at both Milne Inlet and Steensby Inlet. As well, the assessment has relied extensively on the results from the Mary River Project draft EIS, as well as the Shipping Management Plan developed for the Mary River Project, and adapted as Appendix B.9 of this submission.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.4.1 Interactions and Potential Effects

The anticipated sources of interaction with marine mammals in Steensby Inlet and Milne Inlet include vessel noise, visual disturbance and, onshore construction activity.

The likelihood of mortalities as a consequence of vessel collisions in open water is considered negligible and has not been included in the assessment.

Table 17-8: Interactions and Potential Effects of PDW on Marine Mammals

Project Location (LSA)	Project Activity or Interaction	Potential Effect (Key Indicator)
Milne Inlet	Vessel Noise	Marine Mammal disturbance, hearing impairment
	Visual Presence	Marine Mammals disturbance
	Onshore Activities	Marine Mammals disturbance, hearing impairment
Steensby Inlet	Vessel Noise	Marine Mammals, disturbance, hearing impairment
	Visual Presence	Marine Mammals disturbance
	Onshore Activities	Marine Mammals disturbance, hearing impairment

The Mary River Project draft EIS provides extensive background on the phenomena of hearing and noise as it affects marine mammals, including hearing impairment and disturbance due to noise. The assessment also considers a broad range of species – ringed seal, walrus, beluga whale, bowhead whale, and polar bear.

During the open water season when the Pre-Development Works sealift is scheduled (August – October 2012) many of these species will likely be present in the area. In particular narwhal will be present in Milne Inlet and may enter the LSA. It is notable however, that given the timing (open water season) duration (ten weeks) and extent of the sealift associated with the Pre-Development Works, the anticipated interactions and potential environmental effects on marine mammals is very modest, consequently only a limited scope of assessment is required.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.4.2 Mitigation Measures

The Mary River Project draft EIS and associated Shipping and Marine Wildlife Management Plan contain a considerable number of mitigation measures, many of which are applicable to the Pre-Development Works. These are detailed and presented as Appendix B.9 of this PDW-EIS.

Vessels will observe speed limitations when transiting Milne Inlet and approaches.

An Inuit Observer will be on-board vessel while operating in the LSA. They will carry out monitoring observations for the presence of marine mammals and advise the vessel Master of any required action to reduce interactions.

Helicopter traffic will avoid low level flying when over the LSA.

Note, blasting is not proposed as par to the Pre-Development Works, however will occur at Steensby Port relatively close to the shoreline. Monitoring will be carried out prior to any blast proximate to the shoreline. Should any marine mammals be present, appropriate precautions will be taken, e.g. to clear the area prior to the blast, and to monitor for response to the activity.

17.4.3 Effects Assessment

The effects threshold for magnitude of effect with respect to marine mammals has been established as:

- Disturbance - 10% of exposed animals exhibit strong disturbance and avoidance reactions.
- Hearing Impairment due to noise in water – 10% of animals in the LSA are exposed to sound levels that exceed a set (measurable) limit.
- Effects thresholds for mortalities from any cause is set at zero, i.e. any mortality is considered to be an exceedance level.

A more detailed explanation of disturbance and hearing impairment thresholds is available in the Mary River Project draft EIS.

17.4.3.1 Vessel Noise

Vessel operations will extend over a ten week period at each port and involve up to two vessels and two tugs at one time within each LSA. Appropriate Management Plans will be in place, along with monitoring and enforcement to ensure compliance with requirements. Nevertheless, vessel activity will result in the production of noise in air and water, as a consequence of vessel movements, deployment of anchors and moorings, cargo transfer, and general activity, especially adjacent to the temporary dock locations. It is considered highly improbable that vessel operations could result in noise levels that would produce hearing impairment. It is possible that disturbance effects will result in some cases, i.e. avoidance behaviour. The assessment is, therefore based on this likely effect.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Residual Effects Rating

Magnitude

Because noise disturbance will be modest and generally proximate to the operating area for sealift vessels and tugs, a Level I magnitude rating was assigned to residual effects on Marine Mammals as a result of PDW vessel noise in the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual effects on marine mammals associated with the PDW vessel noise in the two marine LSAs.

Frequency

it is anticipated that effects will occur regularly during the open water months of 2012 when vessel movements and cargo transfer is scheduled to occur. A Level III frequency rating was assigned to residual Marine Mammal effects associated with the PDW vessel noise in the two marine LSAs.

Extent

The extent of residual effects associated with PDW vessel noise will be limited to, and well within the LSA where they are located. A Level I extent rating was assigned to residual Marine Mammal effects associated with the PDW vessel noise in the two marine LSAs.

Reversibility

Residual Marine Mammal effects associated with PDW-related vessel noise are anticipated to be fully reversible. Following the completion of the sealift, conditions are generally expected to return to baseline conditions through removal of the source of interaction. Noise levels will revert to previous levels. A Level I reversibility rating was assigned to residual Marine Mammal effects associated with the PDW vessel noise in the two marine LSAs.

Significance

Based on the ratings described above, vessel noise is not expected to result in significant adverse environmental effects on Marine Mammals in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.4.3.2 Visual Presence

Vessels, including tugs will likely be present at each port site throughout the ten week period of the sealift, with peaks of up to two vessels and two tugs at one time within each LSA. Appropriate Management Plans will be in place, along with monitoring and enforcement to ensure compliance with requirements. Nevertheless, vessel activity will result in the physical presence of vessels and barges, especially adjacent to the temporary dock locations and at assigned anchorages. It is considered highly improbable that vessel operations could result in visual cues that would produce strong avoidance behaviour. It is possible that some disturbance responses will occur for some species and individuals.

Residual Effects Rating

Magnitude

Because vessels will be of a type and size commonly associated with sealift operations, a Level I magnitude rating was assigned to residual effects on Marine Mammals as a result of PDW vessel presence in the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012. A Level I duration rating was assigned to residual effects on marine mammals associated with the PDW vessel presence in the two marine LSAs.

Frequency

it is anticipated that effects will occur regularly during the open water months of 2012 when vessel movements and cargo transfer is scheduled to occur. A Level III frequency rating was assigned to residual Marine Mammal effects associated with the PDW vessel presence in the two marine LSAs.

Extent

The extent of residual effects associated with PDW vessel presence will be limited to, and well within the LSA where they are located. A Level I extent rating was assigned to residual Marine Mammal effects associated with the PDW vessel presence in the two marine LSAs.

Reversibility

Residual Marine Mammal effects associated with PDW-related vessel presence are anticipated to be fully reversible. Following the completion of the sealift, conditions are generally expected to return to baseline conditions through removal of most of the sources of interaction. A Level I reversibility rating was assigned to residual Marine Mammal effects associated with the PDW vessel presence in the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Significance

Based on the ratings described above, vessel presence is not expected to result in significant adverse environmental effects on Marine Mammals in the two affected LSAs. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.4.3.3 Onshore Activities

Onshore activitiess associated with the Pre-Development Works at both sites will include a considerable level of work onshore and adjacent to the port areas. This work will be ongoing throughout the duration of the PDW and will include geotechnical drilling, earthworks, structural construction and assembly, and vehicle (including occasional helicopter) traffic. As well, at Steensby Camp, there will be drilling and blasting at the airstrip site. Al of these activities have the potential to interact with Marine Mammals present in the adjacent waters either directly as a result of noise and motion, but also indirectly as a result of site runoff and dust.

All onshore work will be carried out in accordance with the Project Environmental Protection Plan. It is highly unlikely that the levels of the onshore activity and noise will be of such an intensity as to result in hearing impairment to any nearby marine mammals. It is likely, however that nearby marine mammals would be aware of the activities and consequently could exhibit disturbance and avoidance reactions.

Residual Effects Rating

Magnitude

Based on the potential for some aspects of the onshore PDW activities to intrude into the adjacent marine environment a Level II magnitude rating was assigned to residual effects on Marine Mammals associated with the PDW onshore activities at the two marine LSAs.

Duration

The total duration of the PDW is twelve months. Sealift operations will span a ten week period in 2012, however land-based activities will extend over a longer portion of the overall schedule. A Level I duration rating was assigned to residual effects on Marine Mammals from the PDW onshore activities at the two marine LSAs.

Frequency

it is anticipated that Onshore activities will continue throughout the twelve month period of Pre-Development Work. A Level III frequency rating was therefore assigned to residual effects on Marine Mammals as a result of PDW onshore activities at the two marine LSAs.

Extent

The extent of residual effects on marine mammal as a result of PDW onshore activities at the two marine LSAs will be limited to the LSA where they are located. A Level I extent rating was assigned to residual marine mammal effects associated with PDW-related onshore activities at the two marine LSAs.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Reversibility

Residual effects on marine mammals associated with PDW-related onshore activities at the two marine LSAs are anticipated to be fully reversible. A Level I reversibility rating was assigned to residual effects on marine mammals as a result of PDW onshore activities at the two marine LSAs .

Significance

Based on the ratings described above, the effects on marine mammals at the two marine LSAs are not expected to result in significant adverse environmental consequences. The residual effect is ranked as ***Not Significant*** . The level of confidence associated with the significance ranking is Medium due to the qualitative nature of the assessment.

17.4.3.4 Summary of Residual Effects

Table 17-8 presents the summary of significance of residual environmental effects on marine mammals with respect to the Pre-Development Works.

Table 17-9: Pre-Development Works Significance of Residual Effects on Marine Mammals

Project Activity	Significant of Predicted Residual Environmental Effect		Likelihood[1]	
	Significance Rating	Level of Confidence	Probability	Certainty
Vessel Noise	N	2	-	-
Visual Presence	N	2	-	-
Onshore Activities	N	2	-	-

KEY:
Significance Rating: S = Significant; N = Not Significant
Level of Confidence: 1 = Low; 2 = Medium; 3 = High
Certainty: 1 = Low; 2 = Moderate; 3 = High
Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely

Note(s):
1. Likelihood: only applicable to significant effects.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

17.5 Effects Assessment Summary

Table 17-10 provides a summary of the environmental effects of the Pre-Development Works on the Marine Environment.

Table 17-10: Pre-Development Works- Summary of Residual Effects on the Marine Environment

Project VEC	Significant of Predicted Residual Environmental Effect		Likelihood[1]	
	Significance Rating	Level of Confidence	Probability	Certainty
Marine Water and Sediment Quality	N	2	N/A	N/A
Marine Biota and Habitat	N	2	N/A	N/A
Marine Mammals	N	2	N/A	N/A

KEY:
Significance Rating: S = Significant; N = Not Significant
Level of Confidence: 1 = Low; 2 = Medium; 3 = High
Certainty: 1 = Low; 2 = Moderate; 3 = High
Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely

Note(s):
1. Likelihood: only applicable to significant effects.

17.6 Follow-Up

A program of monitoring will be implemented as described in this EIS and appended documents. It will be designed and executed in a manner that allows for consistent transition to meet the needs of the Mary River Project. In fact the Pre-Development Works will provide an excellent opportunity to train observers and monitors, to test monitoring designs and to evaluate field methods.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

18. Effects of the Environment on the PDW

18.1 Engineering Hazard Assessment

The environment has the potential to affect the Project. Extreme weather (storms, extreme rainfall or snowfall, extreme low temperatures) and geo-hazards (seismicity, ground and slope instabilities) have the potential to affect Project infrastructure and in turn represent concerns for human safety and the environment. Included in the context of extreme weather is the potential for global climate change to affect the Project.

Environmental hazards which could potentially affect the engineering structures in the Project are assessed in Tables 9-2.1 to 9-2.5 in Volume 9 of the DEIS. The tables identify the potential engineering hazards which could occur for each Project component, describe the hazard within the context of the specific Project component, describe and assess potential consequences of the hazard, assess the risk factor, and describe potential mitigation measures which will be used for each hazard. DEIS Tables 9-2.1 to 9-2.3 have been revised to reflect the environment risks to PDW for Milne Port, the Milne Inlet Tote Road, and the Mine Site.

The PDW activities are a small subset of those to be undertaken by the larger Project. And the majority of potential risks of effects of environment on the Project are related to ongoing operation of the Project and in particular the railway, and are associated with ground disturbance activities. Ground disturbance activities associated with the PDW are limited to the quarrying of (relatively) small volumes of aggregate with a small footprint.

Nevertheless, as with any activities in the North, with extreme cold weather, long winters, spring freshets that occur largely while the ground is frozen, there are potential effects of the environment that may result to the Project.

At Milne Port there are some low to moderate risks associated with ice-rich permafrost and thaw sensitive soils that could result in failures of structures, creep settlement, or movement of foundations for heavy structures. Permafrost protection measures will be used to mitigate these risks.

Along the Milne Inlet Tote Road there are a number of risks associated with the ice-rich permafrost and thaw-sensitive soils that could result in creep settlement in high embankment, thermokarst development along the route or in borrow areas and some general road embankment instability. These risks will generally be mitigated through proper design and construction in an effort to protect and maintain the thermal conditions along the road. Maintenance will most likely be required at some locations due to thermal degradation of the underlying foundations. Another more significant risk present along the road is related to the hydrology and the fact that high runoff events can lead to flows beyond the capacity of the hydraulic structures established along the road alignment. This risk is further increased by the spring icing of culverts further reducing capacity and leading to potential overtopping and washes out of road sections causing high sediment loadings to the downstream

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

environment and increase erosion. The risk of high runoff events overloading structures and causing erosion is reduced as the length of the PDW program is far shorter than the main Project.

No mining will occur with the PDW so these potential risks will be avoided. For ice rich areas near other Mine Site infrastructure, the majority of the structures locations have been optimized to avoid problem areas or founded on competent bedrock. In areas where this optimization is not possible, adequate permafrost protection measures will be implemented.

No railway construction will be undertaken as part of PDW, so no effects of the environment on the Project are expected.

At Steensby Port there are no significant engineering hazards associated with the environment.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 18-1 Engineering Hazard Assessment - Milne Port

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Permafrost/ Thaw Susceptible Soils	- Construction over ice rich or thaw sensitive permafrost ground causing technical issues with Project infrastructure foundations - Saline permafrost - Problems potentially leading to environmental impacts	- Heavy structure experiencing creep settlement over ice-rich permafrost - Thaw weakening of surficial soils causing failure or movement of foundations - Melting of massive deposits below or adjacent to structure causing settlement or movement	Moderate	Moderate	- Geotechnical investigations to understand ground conditions - Movement of structures to avoid problem areas - Excavations in overburden materials will be avoided as much as possible. - If possible found most significant structures on bedrock - Disturbance of the natural ground surface will be avoided - Over excavation of natural materials and backfill with an insulating cover of thaw stable granular fill materials of a minimum 1.5 m thickness to protect against thaw and instability in the underlying ice rich overburden soils - Embankments or granular fill pads used to protect underlying permafrost should be constructed with maximum side slopes of 2H:1V - Use cooling or refrigerated foundations where required and possible - Rock socketed and adfreeze piles

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Seismicity	- Significant earthquake event subjecting structures to dynamic loading - Moderate seismicity of region (higher in north, lower in south)	- Failure of infrastructure or foundations (dock)	Low	High	- Concerns mitigated through seismic hazard assessment and understanding loading potential - Adequate design of structures and dock piers - Adequate construction using suitable fill materials, construction practices and QA/QC procedures - Monitoring during operations for indicators of potential problems - Impact of seismicity on structures in permafrost is low - Many of same mitigation measures as for static stability
Flood / Hydrology	- Although not expected to have significant impact, runoff and water pooling could impact thermal regime. - Although carefully sized, significant runoff event exceeds capacity of access road culverts (i.e. icing of culverts or debris reduces capacity)	- Surface water induced thermal degradation leading to thaw settlement or weakening of soils/foundations - Overtopping of roads causing failure and potential downstream sediment issues	Moderate	Low	- Where surface water collection or diversion is required, the thermal impact of runoff must be considered. Ideally, ditches should be avoided wherever possible. Diversion berms are the preferred method of redirecting surface water flows if feasible. If ditches are required, they may have to be created by over-excavation and replacement with thaw stable processed rock fill material and perhaps be lined with geotextile. - Maintain grading and drainage of all areas near infrastructure - Extensive hydrology baseline studies - Over design of culvert capacity - Regular monitoring of culverts to identify icing or other debris blockages

© Hatch 2011/09

Table 18-2 Engineering Hazard Assessment - Milne Inlet Tote Road

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Permafrost/ Thaw Susceptible Soils	- Massive ice or ice rich soils at depth below higher embankments or in areas of cut - Thaw sensitive soils near ground surface below low embankments - Thermal degration of borrow areas and development of thermokarst areas	- High embankments may experience creep settlement over time - Cut areas may cause thermal degradation and settlement - Thaw weakening of soil leading to instability of structures - Construction disturbance or new ponding of water could impact thermal regime causing settlement, thermokarst development and potentially impact stability of road - Poor aesthetics	High	Low	- Geotechnical investigations should be conducted, although issues associated with settlement of road not as significant as rail line - Adequate design of embankments (i.e. flatter slopes in problem areas, minimum fill thickness for thermal protection, over excavation and backfill in cuts, etc) - Adequate design of bridge abutments (i.e. maximize use of bedrock, rock socketed and adfreeze piles, refrigerated pile groups, thermal protection above pile caps, etc) - Minimize cuts - Maintain proper grading and drainage from borrow areas - Replace some of cover material removed during excavation in borrow areas - Runoff and sediment control measures - On-going inspections and maintenance

© Hatch 2011/09

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Seismicity	- Significant earthquake event subjecting structures to dynamic loading - Moderate seismicity of region (higher in north, lower in south)	- Failure of larger bridge structure along rail alignment - Sudden failure of road embankment - Landslide, overburden/bedrock cut slope instability impacting road - Same impacts for items above	Low	Moderate	- Adequate design (i.e. suitable slopes for seismic design parameters) - Adequate construction using suitable fill materials, construction practices and QA/QC procedures - Monitoring during operations for indicators of potential problems - Impact of seismicity on structures in permafrost is low - Many of same measures as for standard/static stability
Flood / Hydrology	- Significant runoff event exceeds capacity of culverts or other water crossings. - Icing of culverts reduces capacity for normal flows - Debris build-up causes reduced capacity for flows	- Overtopping of road leading to operational shutdown, repairs and environmental impacts due to high downstream sediment loading - Ponded water impacting thermal regime and overall stability of structures	High	Low to Moderate	- Hydrology baseline studies - Over design culvert capacity - Regular monitoring of culverts to identify icing or other debris blockages

© Hatch 2011/09

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Road Embankment Stability	- Sudden failure of road embankment due to physical failure of embankment fill or underlying foundations	- Failure causing operational shutdown - Costs of repairs - Environmental impacts due to high downstream sediment loading	Low	Low	- Geotechnical investigations - Adequate design (i.e. suitable slopes) - Adequate construction using suitable fill materials, construction practices and QA/QC procedures - Monitoring during operations for indicators of potential problems
Landform Stability	- Large scale landslide or slope instability outside footprint of road - Medium or large scale landslide through embankment footprint	- Sudden failure of road embankment - Blockage of culverts - Impact to thermal regime effecting longer term integrity of embankment permafrost foundations - Temporary shutdown of road operations	Low	Moderate	- Avoiding areas of major concern - Monitoring of potential problem areas

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Stability of Overburden Cuts	- Failure of large slope upstream of rail cut into overburden causing impacts to rail.	- Slope failure could block, interrupt or even destroy section of road - Blockage of culverts - Impact to thermal regime effecting longer term integrity of embankment permafrost foundations - Temporary shutdown of road operations	Low	Low	- Geotechnical investigations - Minimize cuts - Cut slopes will be designed to address stability issues. - Ice rich slope will be constructed with thermal and erosion protection barrier - Diversion ditches may be utilized where seasonal flows can impact the cut face
Bridges Stability	- Failure of larger bridge structure - Bridge abutment failure due to thawed areas or impacts of flows on thermal regime - Erosion of abutment or pier foundations by water flows causing failure	- Failure of bridge causing operational shutdown, - Costs of repairs - Injury or fatality - Environmental impacts	Low	Moderate	- Geotechnical investigations - Adequate design (i.e. maximize use of bedrock, piles, refrigerated piles, thermal protection above pile caps, etc) - Scour protection around abutments and piers - Instrumentation and monitoring for notification in event of potential failure

© Hatch 2011/09

Table 18-3 Engineering Hazard Assessment - Mine Site

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Permafrost /Thaw Susceptible Soils	- Construction over ice rich or thaw sensitive permafrost ground causing technical issues with project infrastructure foundations - Problems potentially leading to environmental impacts	- Heavy structure experiencing creep settlement over ice-rich permafrost - Thaw weakening of surficial soils causing failure or movement of foundations - Melting of massive deposits below or adjacent to structure causing settlement or movement	Moderate	High	- Geotechnical investigations to understand ground conditions - Movement of structures to avoid problem areas - Found significant structures on bedrock to maximum extent possible - Excavations in overburden materials will be avoided as much as possible. - Disturbance of the natural ground surface will be avoided - Over excavation of natural materials and backfill with an insulating cover of thaw stable granular fill materials of a minimum 1.5 m thickness to protect against thaw and instability in the underlying ice rich overburden soils - Embankments or granular fill pads used to protect underlying permafrost should be constructed with maximum side slopes of 2h:1v - Use cooling or refrigerated foundations where required and possible - Rock socketed and adfreeze piles

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Seismicity	- Significant earthquake event subjecting structures to dynamic loading - Moderate seismicity of region (higher in north, lower in south)	- Failure of Infrastructure	Low	Moderate to High	- Concerns mitigated through seismic hazard assessment and understanding loading potential - Adequate construction using suitable fill materials, construction practices and qa/qc procedures - Impact of seismicity on structures in permafrost is low
Flood/ Hydrology	- Although not expected to have significant impact, runoff and water pooling could impact thermal regime. - Significant runoff event exceeds capacity of access road culverts - Icing of culverts reduces capacity for normal flows - Debris build-up causes reduced capacity for flows	- Surface water induced thermal degradation leading to thaw settlement or weakening of soils/foundations - Overtopping of roads causing failure and potential downstream sediment issues	Moderate	Low	- Where surface water collection or diversion is required, the thermal impact of runoff must be considered. Ideally, ditches should be avoided wherever possible. Diversion berms are the preferred method of redirecting surface water flows if feasible. If ditches are required, they may have to be created by over-excavation and replacement with thaw stable processed rock fill material and perhaps be lined with geotextile. - Maintain grading and drainage of all areas near infrastructure - Over design culvert capacity - Regular monitoring of culverts to identify icing or other debris blockages

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 18-4 Engineering Hazard Assessment - Steensby Port

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Permafrost/ Thaw Susceptible Soils	- Construction over ice rich or thaw sensitive ground causing technical issues with project infrastructure foundations - Problems potentially leading to environmental impacts	- Heavy structure experiencing creep settlement over ice-rich permafrost - Thaw weakening of surficial soils causing failure or movement of foundations - Melting of massive deposits below or adjacent to structure causing settlement or movement	Low	High	- Geotechnical investigations to understand ground conditions - Movement of structures to avoid problem areas - Majority of structures on bedrock excavations in overburden materials will be avoided as much as possible. - Disturbance of the natural ground surface will be avoided - Overexcavation of natural materials and backfill with an insulating cover of thaw stable granular fill materials of a minimum 1.5 m thickness to protect against thaw and instability in the underlying ice rich overburden soils - Embankments or granular fill pads used to protect underlying permafrost should be constructed with maximum side slopes of 2h:1v
Seismicity	- Significant earthquake event subjecting structures to dynamic loading - Moderate seismicity of region (higher in north, lower in south)	- Failure of infrastructure or foundations	Low	High	- Concerns mitigated through seismic hazard assessment and understanding loading potential - Adequate construction using suitable fill materials, construction practices and qa/qc procedures - Impact of seismicity on structures in permafrost is low

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Engineering Hazard	Hazard Description	Potential Consequences	Risk Factor	Consequence Factor	Mitigation Measures
Flood/ Hydrology	- Although not expected to have significant impact, runoff and water pooling could impact thermal regime. - Significant runoff event exceeds capacity of access road culverts (i.e. icing of culverts or debris reduces capacity)	- Surface water induced thermal degradation leading to thaw settlement or weakening of soils/foundations - Overtopping of roads causing failure and potential downstream sediment issues	Moderate	Low	- Where surface water collection or diversion is required, the thermal impact of runoff must be considered. Ideally, ditches should be avoided wherever possible. Diversion berms are the preferred method of redirecting surface water flows if feasible. If ditches are required, they may have to be created by over-excavation and replacement with thaw stable processed rock fill material and perhaps be lined with geotextile. - Maintain grading and drainage of all areas near infrastructure - Hydrology baseline studies - Over design culvert capacity - Regular monitoring of culverts to identify icing or other debris blockages

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

18.2 Potential Effects of Climate Change on the Project

The Project is situated within the zone of continuous permafrost, which is likely more than 500 m thick across the terrestrial RSA. The thickness of the active layer varies from less than 0.3 m in areas blanketed with organic soils to over 2.0 m in coarse-grained soils. The surficial geology within the terrestrial RSA is variable with the materials encountered consisting of organic soils, alluvium, colluvium, marine and glacio-marine deltaic sediments, glaciofluvial deposits, glaciolacustrine and lacustrine deposits, glacial deposits and highly fractured to competent bedrock outcrops. Soils can be ice-rich, with the amounts of ground ice varying significantly from site to site.

18.2.1 Climate Change Effects on the Main Mine Development Project

The DEIS noted that based on accepted climate change models, it is generally believed that global warming will have little impact on the very cold and deep permafrost conditions in the areas of the Mary River Project Site and associated infrastructure locations over the currently planned life of the main Project.

Geotechnical investigations and studies have been completed to date, to identify areas of concern related to permafrost and potential geo-hazards that could impact the various infrastructure associated with the Project. Although it is Projected that the Mary River Project will remain within the zone of continuous permafrost, it is predicted that the active layer thickness could increase by 50 percent (Arctic Council and the International Arctic Science Committee,2005). Other potential impacts include changes to drainage pattern resulting from subsidence and thermokarst formation, increased sediment loadings and mass wasting on sensitive slopes. In general, the location of infrastructure has been optimized based on the investigations in an attempt to avoid potential problem areas to the maximum extent possible. Additionally, areas where problems cannot be avoided will be constructed with conservatively designed permafrost protection measures and thermal barriers. Thus, the Project is not sensitive to changes in climate-related parameters.

Given that climate change is a phenomenon or trend that is occurring over decades, and the PDW activities will be temporary and short-term, it is expected that climate change trends are unlikely to interact with the PDW in a meaningful way. However, given that some structures (mainly the fuel storage facilities and road upgrades) will exist beyond the PDW time period and for the life of the main Project if it proceeds, the same design measures will be incorporated into the design of these facilities built as part of the PDW.

The following Table 18-5 provides other design measures that may be implemented to protect the PDW Project structures from the impacts of construction, operations and potential changes to the climate. In general, conservative assumptions are used as the way to address potential effects of climate change.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 18-5 Design Measures for Project Structures used to Account for Climate Change

Project Structure	Design Measures
Milne Inlet Tote Road - Upgrades	No specific measures were taken into account for climate change beyond those for construction on permafrost
Milne Inlet Tote Road - Water Crossings	A 1:100 year storm event was used for design of all water crossings
Airstrips and Access Roads	Thermal barrier (non-frost/thaw sensitive fill) thickness increased to account for increases active layer depth
Building foundations	Foundation pads on fuel storage facilities will be thicker

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19. Accidents and Malfunctions

Baffinland has an obligation to identify any foreseeable hazards that may arise from the Mary River Project and to assess the risk of harm arising from the identified hazards. The reasons for this process:

1. Out of concern for the health and safety of employees, contractors and visitors
2. Out of concerns for environmental protection
3. It makes good business sense and is cost effective
4. So that Baffinland's duty of care for its employees and contractors can be undertaken, and so that health, safety and environmental legal requirements can be met.

Knowledge of hazards and the evaluation of associated risks are necessary requirements for establishing health, safety and environmental objectives and targets, and for setting priorities to control the identified risks to employees and others on an ongoing basis. Hazard Identification, risk assessment and control is an on-going process undertaken periodically throughout the Project life cycle. Baffinland's guideline for hazard and risk assessment was presented in Appendix 10A-2 of the DEIS (January 2011). This rigorous approach to hazard identification and risk assessment leads to the development and implementation of mitigation actions and procedures and the development of management plans that ensures on-going control of such risks.

Despite this on-going effort, major accidents and malfunctions can occur due to natural events, breakdown of mitigation measures or human error. Although the likelihood or probability of occurrence of such events is low, accidental events could have severe environmental, health or safety repercussions.

19.1 Identification of Risks and Methodology

A list of potential malfunctions or accidents was developed from the following primary sources:

- Public Concerns: expressed by local communities and other members of the public
- Project personnel: all Project risks, including environment-related risks were identified and assessed as part of Project risk assessment exercises
- Comparative Projects: review of readily available Environmental Assessments issued recently for other large scale mineral development Projects
- Experience of personnel with similar Projects

Only credible malfunctions and accidents that have a reasonable probability of occurring during the Project have been assessed. For the purpose of this assessment, the *likelihood of occurrence* for the accidents and malfunctions is defined as follows:

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 19-1: Likelihood

Likelihood	Description in context of full operating life of the facility	Frequency
Almost Certain	Consequence expected to occur in most circumstances	High frequency of occurrence – occurs more than once per year
Likely	Consequence will probably occur in most circumstances	Event does occur, has a history, occurs once every 1 to 10 years
Possible	Consequence could occur at some time	Occurs once every 10 to 100 years
Unlikely	Consequence may occur at some time	Occurs once every 100 to 1000 years
Rare	Consequence may occur at some time	Occurs once every 1000 to 10 000 years
Refer to DEIS, Appendix 10A-2 Standard for Hazard Identification and Risk Assessment		

Despite the fact that all foreseeable precaution any measures have been implemented to prevent the occurrence of malfunctions and accidental events, the *consequences* associated with an occurrence can result in the loss of human life or severe environmental damage. Table 19-2 presents a list of credible potential accident and malfunction scenarios for the PDW. Risks were assessed based on operational controls implemented on the basis of best management practices as outlined in Baffinland's EHS Management System (refer DEIS, Volume 10, and DEIS Appendix 10A-2 for Hazard and Risk Assessment Methodology) and the application of the various management plans provided as appendices in DEIS Volume 10 and updated in Section 7 of the present document. The EPP (refer to DEIS, Volume 10, Appendix 10B) for the Project will provide a summary of the preventative and operational controls to be implemented.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 19-2: Major Accidents and Malfunctions Risk Summary

Project Sector	Issue of Concern	Consequences	Likelihood	Risk Rating
Milne Port	Diesel spill – ship to shore transfer	Contamination to marine & coastal environment	Possible	Low
	Fire at the camp facilities and infrastructure	Human injuries or fatalities	Possible	Very Low
	Failure of power supply	Human injuries or fatalities	Possible	Very Low
	Failure of WWTP	Human health, environmental contamination	Likely	Very Low
	Contamination or interruption of water supply	Human health	Possible	Very Low
	Congestion at Port	Damage to vessels, possible spills	Likely	Low
	Hazardous material release	Contamination of environment	Possible	Low
	Introduction of invasive species	Harmful consequences to the native ecosystem	Unlikely	Very Low

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Project Sector	Issue of Concern	Consequences	Likelihood	Risk Rating
Tote Road – Transportation of material from Milne Port to Mine Site	Road embankment failure/collapse of water crossing	Human injuries or fatalities	Likely	Low
	Hazardous material release	Contamination of environment	Possible	Low
	Truck accident	Human injuries or production delay	Likely	Low
	Collision with other users	Human injuries or fatalities	Possible	Very Low
	Weather related strandings	Human injuries or fatalities	Likely	Very Low
	Collision with wildlife	Harm to wildlife	Likely	Low
Mine Site	Explosive accidents (accidental detonation of explosives)	Human injuries or fatalities	Unlikely	Very low
	Hazardous material release	Contamination of environment	Possible	Low
	Truck accidents	Human injuries or fatalities	Likely	Low
	Fire at the camp facilities and infrastructure	Human injuries or fatalities	Possible	Very Low
	Failure of power supply	Human injuries or fatalities	Possible	Very Low
	Failure of WWTP	Human health, environmental contamination	Possible	Very Low
	Contamination or interruption of water supply	Human health	Possible	Very Low

© Hatch 2011/09

Project Sector	Issue of Concern	Consequences	Likelihood	Risk Rating
Winter Road and Railway Staging	Weather related strandings	Human injuries or fatalities	Likely	Very Low
	Hazardous material release	Contamination of environment	Possible	Very low
	Collision with human	Harm to human	Likely	Low
	Collision with wildlife	Harm to wildlife	Likely	Very Low
Steensby Port	Diesel spill – ship to shore transfer	Contamination to marine & coastal environment	Possible	Low
	Fire at the camp facilities	Human injuries or fatalities	Possible	Very Low
	Failure of power supply	Human injuries or fatalities	Possible	Very Low
	Failure of WWTP	Human health, environmental contamination	Likely	Very Low
	Contamination or interruption of water supply	Human health	Possible	Very Low
	Congestion at Port	Damage to vessels, possible spills	Likely	Low
	Hazardous material release	Contamination of environment	Possible	Low
	Introduction of invasive species	Harmful consequences to the native ecosystem	Unlikely	Very Low
Air Traffic	Aicraft or helicopter crash	Harm to human life	Possible	Very low

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Project Sector	Issue of Concern	Consequences	Likelihood	Risk Rating
Shipping	Collision with marine mammals	Harm to marine mammals	Unlikely	Very Low
	Engine failure	Delay in shipment	Possible	Very Low
	Ship grounding	Damage to ship, possible harm to aquatic life	Unlikely	Very Low
	Collision with other vessels	Damage to ship, possible harm to aquatic life	Possible	Very Low
	Major diesel spill at sea	Contamination of marine and coastal environment along shipping lane	Unlikely	Very Low
Note: Assessment is based on operational controls implemented on the basis of best management practices as outlined in Baffinland's EHS Management System (refer to DEIS Volume 10, and Appendix 10A-2 for Hazard and Risk Assessment Methodology).				

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.2 Milne and Steensby Ports Ocean Based Activities

For Milne and Steensby Ports, sea lift and shipping will take place during the open water season of 2012. Support activities for the remaining PDW will begin in Q2 2012 and will be completed by Q4 2012.

The most credible and likely accidents related to Milne and Steensby Port activities are:

- Fuel spill during ship-to-shore transfer (discussed in Section 19.2.1)
- Congestion at the port leading to a collision (discussed in Section 19.2.2)
- Introduction of waterborne invasive species (discussed in Section 19.2.3).

For the land based activities at Milne, the most credible accidents and malfunction scenarios are:

- Accidental release of hazardous substances (discussed in Section 19)
- Fire at the accommodation complex (discussed in Section 3.2.6)
- Failure of the power supply (discussed in Section 3.2.7)
- Failure of the wastewater treatment plant (discussed in Section 3.2.8)
- Contamination of the water supply (discussed in Section 3.2.9)

19.2.1 Ship-to-shore Fuel Transfer

At Milne Port fuel will be unloaded by means of flexible hoses from tanker to shore. The distance between the receiving edge of the freight dock and the tanker is about 400 m.

During ship-to-land fuel transfer at the ports (i.e. Milne Port and Steensby Port), minor accidental releases may occur occasionally in water and/or on land. Other oily discharges may also occur from bilge tanks, engines, mechanical parts, and other devices on board. The accumulation of these minor spills may become a cause for concern if they are not contained quickly and prevented from coming into contact with marine or terrestrial environment. Spills on land and ice are more readily contained than those in open water since water can spread the spill quicker and cause immediate impacts to water quality and aquatic life. Snow and ice on the other hand, will act to help contain the spill while clean-up action is implemented. At both port facilities clean up equipment will be made available at all times. An emergency and cleanup response team will implement the spill contingency plan as soon as possible. The shipping contractor will established appropriate loading and off-loading procedures using guidance from legislations such as the *Arctic Waters Pollution Prevention Act*, Arctic Shipping Pollution Prevention Regulation and the Regulation for the Prevention of Pollution from Ships and Dangerous Chemicals to prevent or quickly contain any spills or releases of fuel during ship-to-land transfers.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Both ports are will have Transport Canada-approved Oil Pollution Emergency Plans (OPEPs) as required under the Oil Handling Facilities Regulations of the *Canada Shipping Act*. The *Canada Shipping Act* also requires that every vessel have a Transport Canada-approved Shipboard Oil Pollution Emergency Plan (SOPEP) to address ship-borne accidental releases of fuel. The OPEP for Milne Port is attached in Appendix B.2.

The operations and response structure at the Port facilities have been designed so that a rapid response to a spill incident can be carried out. All equipment and resources are strategically placed near the beach front, directly at the port operation site. Responders, workboats and other support equipment are on standby during all port operations. The deployment of equipment and resources required to contain and control the diesel and the quantity of diesel involved in the incident, up to the minimum spill size of 3.5 m^3 as determined in accordance with section 2 of the Oil Handling Facilities Standards, will be on site and deployed on scene within 1 hour after the discovery of the diesel pollution incident.

In the event of a spill, on water recovery of spilled product will be initiated immediately upon containment of free floating product. The skimming capacities available at the Port facilities are capable of recovery of several times the estimated spill volume.

The Milne bulk fuel storage facilities will be equipped with appropriate spill response equipment which provides *resident capability* for the response to spills in accordance with the scenarios which have been developed under this Oil Pollution Emergency Plan. Containment and recovery equipment inventories exceed the facility category planning standards and are especially appropriate for the potential spill volumes as outlined in the scenarios contained in the OPEP. Furthermore, routing training exercise will be carried out to assess the effectiveness of the spill response procedures prescribed by the OPEP and improvements will be made as required.

Although a fuel spill is **likely** to happen during the PDW, in light of the effort expend in the development and implementation of the OPEP, spills resulting from the ship-to-shore transfer operation will quickly be contained and the environmental effects resulting from such an incident will not be significant. The risk is considered **low**.

19.2.2 Congestion at the Port

A situation could arise where several ships are waiting at Milne Inlet for either unloading cargo. Although planning and logistic will ensure that such events are rare, the probability of occurrence during the PDW is **likely**. The likely accident associated with congestion is a collision, or, grounding of ship, especially during extreme weather events.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

While an **unlikely** event, an accidental fuel spill could hypothetically occur as a result of collision or accident or while transferring fuel between an ocean tanker and shore base. The Milne Port OPEP (Appendix B.2) addresses issues associated with minor spills resulting from the ship-to-shore transfer of fuel. A ship collision could result in a larger spill. Such a scenario is discussed in section 19.9 (Major Diesel Spill at Port or Along the Shipping Lane). The risk is considered **low**.

19.2.3 Introduction of Invasive Species

The following discussion applies to both Milne and Steensby Ports.

19.2.3.1 Water Born Invasive Species

The increased shipping activities could introduce invasive marine species in the northern Baffin Island area. These species could be introduced with ballast water or by physical attachment to ship hulls. The ability of introduced species to establish viable populations is determined in part by the physical and chemical conditions of the exchange site (CSAS, An Ecological and Oceanographical Assessment of the Alternate Ballast Water Exchange Zone in the Hudson Strait Region, 2009).

Climate and water temperatures are currently the main barriers and remain the prevailing barrier to prevent colonization of the Project marine areas by invasive species. However, with climate change and the increase frequency of shipping, there is an increased possibility of introducing a species (biota) that can readily adapt to the prevalent conditions in Steensby Inlet or Minle Inlet. However, such an invasive species would have to originate from a similar climatic region (average annual water temperatures of 2ºC) and could be a serious threat to native aquatic ecosystems. Although the likelihood of occurrence and the significance of the associated effects are impossible to predict, Baffinland will adopt best management practices in terms of ballast water management.

Ballast is water taken on in chambers of vessels mainly to stabilize sea-going vessels by adding weight to the vessels and maintaining a certain draft (the depth a vessel sits in the water). Empty vessels take on much more ballast than a fully laden ship. For icebreakers, ballasting is also used to keep the ice draft of the vessels constant, and to stabilize the ship, thereby optimizing stresses in different loading conditions.

In order to reduce or eliminate the risk of invasive aquatic species and pathogens being introduced into Canadian waters as a result of shipping, all ships will exchange ballast water in accordance with the *Ballast Water Control and Management Regulations* (Transport Canada 2006). The regulations prescribe ships transiting to Canadian ports to exchange ballast water at sea in deep seas away from coastal zones, to limit the potential for foreign harmful aquatic organisms or pathogens to be released in Canadian waters where they may colonize. Ballast water will be exchanged in the mid-north Atlantic Ocean, which is part of the same ocean regime as Steensby Port. Upon arrival at the port, the ships will discharge ballast water to allow for filling the ship with ore. During winter the full ballast is required in the ship to assist in ice breaking and so the entire amount of ballast water will be discharged at the ore

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

dock. During summer, the ships may discharge ballast water along the shipping route before arriving at the dock (in such cases only a partial load of ballast in the order of 70,000 m^3 will be discharged at the ore dock).

Actual Ballast Water Management Plans are specific to individual ships. The Shipping Management Plan (Appendix 10D-10) outlines the major elements and requirements of a plan acceptable to Baffinland. In light of the ballast water management in place, the introduction of invasive species is **unlikely** and the risk is considered **low.**

19.2.3.2 Land Based Invasive Species

The large amount of cargo received has the potential to introduce non-native species to Milne Port and Steensby Port. For the PDW, most cargo and material will originate from southern Canadian ports and will be subjected to standard inspection procedures at source before shipment.

Despite best efforts at source to reduce the risk of introducing invasive species, the potential for the introduction of invasive species remains. Baffinland's Environmental management team will undertake routine inspection of cargo and material delivered throughout the PDW. Should invasive species be detected, responsible regulatory authorities will be contacted and appropriate remedial action will be taken.

19.3 Mine Site

19.3.1 Explosives Accident

Explosives will be used during the PDW. Pre-packaged explosives will be used until the emulsion plant is operational. ANFO and emulsions will be the main explosives used. At the on-set of PDW, a dedicated manufacturing and storage facility will be established on site to facilitate appropriate handling, use and management of explosives according to applicable regulations, including the *Explosives Use Act* and Regulations and the DFO Guidelines for the Use of Explosives in or near Canadian Fisheries Waters.

The components of ANFO and emulsion in isolation are not explosive. Both ANFO and emulsion will explode if mixed in the correct proportions, confined appropriately and detonated with an external device. However, appropriate precautions will be taken to prevent accidental spill or release of the individual components and bulk explosives from accidental detonation. To prevent this from happening, an explosives management plan has been developed which will be adhered to by all workers (Appendix B.10). A blasting operations standard, a site specific blasting plan for Blasting Near Water and Explosives Emergency Response plans will also be developed to prevent or mitigate explosive accidents.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Handling of explosives will be done by licensed personnel only. Other workers will be restricted from access to explosives components, explosives or the explosive facility. These precautions, in addition to adherence to applicable regulatory requirements, appropriate blasting design, monitoring, good housekeeping and management oversight, will reduce the possibilities of explosive incidents.

The potential however exist that accidents or malfunctions can occur during the handling and use of explosives. The concerns associated with potential malfunctions or accidents during explosives handling or use include:

- Hazard to human health – injury or fatality;
- Effect on environment – ammonia run-off, fuel spill, etc.;
- Wildlife and Habitat disturbances; and,
- Damage to property.

Although **unlikely** to happen, Human error or unforeseen occurrences could also lead to accidents or malfunctions. In worst case scenarios where injuries or damage to human, wildlife or property occur, established emergency procedures will be followed according to the explosive management plans mentioned above. With the control measures in place, and, restricting handling of explosives to licensed personnel, the risk rating is considered **very low.**

19.3.2 Accidental Discharge of Hazardous Materials (Fuel Spills)

Material Safety Data Sheet (MSDS) are available and on-site for all hazardous materials transported, handled and stored at all locations of the Project sites. Hazardous materials are stored in appropriate containers placed within a lined/impermeable secondary containment structure. Secondary containments are designed and dimensioned to contain spills and are equipped with sumps for recovery of liquids/runoff or contaminated materials. Detailed operating procedures have been developed for the handling, transportation, use and disposal of hazardous chemicals and wastes (refer to Environmental Protection Plan).

Fuel storages tanks are constructed within the confined of a secondary containment sized to retain 110% of the content of the largest fuel tanks. Double wall iso-containers are used for temporary storage of fuel. Temporary storage and refuelling stations are constructed on impermeable surfaces. The Waste Management Plan (Appendix B.6) describes the procedures in place for the handling of all waste materials while the Emergency and Spill Response Plan (Appendix B.1) details the response procedures to be followed in the event of a spill. The Steensby Port (Appendix B.3) and the Milne Port (Appendix B.2) OPEP details the procedures for fuel handling at the ports.

Despite the mitigation measures and management procedures Baffinland has implemented, a major, uncontrolled land based spills of hazardous materials is unlikely but remains a **possible** event. Should a spill occur due to malfunction or an accident, the spill will be contained within the secondary confinement and cleaned up rapidly. Given the adequate training that the employees will

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

receive and the Emergency and Spill Response Plan (Appendix B.1), as well as the engineered controls, the environmental and safety risks of such an event are considered **very low**.

The above discussion applies to all areas of the Project and PDW where hazardous materials such as fuel and other chemicals are transported, stored and handled (Mine Site, Ports, and transportation).

19.3.3 Traffic Accident

Despite best effort at training of operators, truck and vehicle accidents are likely to occur during the PDW. The accidents may be caused by human errors, mechanical failures and/or extreme weather events. The consequences of a vehicle accident can range from minor to severe depending on the number of fatalities involves and the extent of environmental damage.

Baffinland will ensure that vehicle operators are appropriately trained and that regular maintenance is performed on all road vehicles. The main camp at the Mine will have a medical facility and medical staff to deal with injured personnel. In case of severe injuries, the personnel will be stabilized at the Mine Site clinic and subsequently evacuate off-site for medical treatment (refer to Health Safety Management Plan, Appendix B.11).

Despite best efforts, traffic accidents, collisions with other vehicles or with wildlife are all **likely** events. With the control measures implemented, Baffinland considers the risk of these events resulting in serious human injury or environmental impairment as low.

19.3.4 Fire at the Camp Facilities and Infrastructure

A major fire in or near the camp accommodation complex has been considered. There could be many causes for such a fire including electrical or mechanical malfunction of equipment or infrastructure, the accidental ignition of various flammable/combustible materials that are stored and used throughout the camp, vehicular collisions with camp infrastructure, and accidental detonation of explosives. The causes for such an incident could include some combination of design flaws, systems malfunction, unintentional or irresponsible human behaviour, or improper following of established procedures due to training systems failure.

The design and operational controls in place to reduce the potential for accidental fire include the following:

- Design and construction of camp facilities and infrastructure in accordance to relevant building, fire regulations, and other relevant guidelines and regulations (refer to Section 10-3 Environmental Design Guidelines).
- Materials storage, management, and handling processes and procedures, especially for fuel, hazardous materials, and explosives.
- Regular inspections of all camp facilities and infrastructure for fire code infractions by trained and competent personnel.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Proper training programs for work functions that involve a potential for accidental fire.
- Adequate preventive maintenance programs for equipment, vehicles and camp infrastructure.
- Employee orientation and regular safety meetings that stress the need for fire safety and proper evacuation and response procedures.
- Establishing building facilities that can be heated using fuel oil rather than electrical power that would provide temporary shelter and heat in an emergency.
- Proper signage and fire suppression equipment available where required.
- Emergency response procedures to provide rapid response and evacuation capabilities.
- Employees will be properly monitored for safe and responsible behavior.

The potential for human injury and fatalities is considered to be possible, however the risk rating is considered **very low** in consideration of the engineered design features and the development/implementation of adequate emergency response procedures.

The above discussion applies to all camp sites including camps at Milne Port, Steensby Inlet, and Mine Site where there is a risk of accidental fire.

19.3.5 Failure of the Camp Power Supply

The failure of the camp power supply was considered as a potential scenario for the camp and infrastructure. Such an incident could result in failures to the camp heating systems, potable water treatment plant, wastewater treatment plant, and other key systems. The cause of the failure could be improper design of power generation plant and distribution system, insufficient maintenance, accidental fire, or damage due to human error such as vehicle collision or following procedures improperly. This could result in major inconvenience, discomfort, and health and safety risks to a large number of personnel, especially during colder weather periods.

Design and operational controls will be implemented to minimize this potential occurrence. These include:

- Design and installation of the power supply and distribution system based on relevant electrical codes and regulations, including sufficient and functional backup systems that would be capable of heating key areas of the camp and generating power for necessary services.
- Regular testing of backup systems and inspections of all camp facilities and infrastructure for electrical and fire code infractions by trained and competent personnel.
- Proper training programs for work functions related to power supply and generation.
- Adequate preventive maintenance programs.
- Emergency response procedures to provide rapid response in the event of power failures and building facilities that can be heated using fuel oil rather than electrical power that would provide temporary shelter and heat in an emergency.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The potential for human injury and/or fatalities is considered to be **possible**, however the risk rating is considered **very low** in consideration of the engineered design features/contingencies and the development/implementation of adequate emergency response procedures,

The above discussion applies to all camp sites including camps at Milne Port, Steensby Inlet, and Mine Site where there is a risk of power failure.

19.3.6 Failure of the Wastewater Treatment Plant

The potential for a failure of the wastewater treatment facility (WWTF) was considered. Such a failure would result in effluent that does not meet discharge criteria and is potentially detrimental if released to the receiving environment. If the WWTF does not operate effectively, unsanitary and unhealthy conditions can result and can affect camp occupants. Causes for failure of the WWTF could include camp power failure, frozen discharge line, insufficient capacity in effluent storage ponds, insufficient capacity of system due to design failure, influent upset conditions, or operator error.

Design and operational controls will be implemented to minimize risk associated with this potential scenario. These include:

- Adequate design of the WWTF based on predicted influent characteristics and variability.
- Sufficient volume capacity in effluent discharge ponds to ensure adequate capacity in the event of upset conditions.
- Proper training programs for work functions related to the WWTF.
- Daily monitoring program for early detection of operational problems and preventive maintenance program.
- Adequate electrical power backup systems in the event of power failure.
- Prompt and adequate emergency spill response in the event of effluent or influent spill to the receiving environment.

The potential for human health problems or environmental impairment is considered to be **possible**, however the risk rating is considered **very low** in consideration of the engineered design features/contingencies and the development/implementation of adequate operational controls and emergency response procedures.

The above discussion applies to all camp sites including camps at Milne Port, Steensby Inlet, and Mine Site where there is a risk of WWTF failure.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.3.7 Contamination of the Water Supply

There is the potential for potable water supply to become contaminated at source or during the treatment and distribution process. Potable water contamination can result in adverse health outcomes for camp occupants. Potential for contamination at source (Camp Lake), could result from accidental release of deleterious substances to the lake due to fuel spill or due contamination of the water body from accidental release. Potable water contamination could also result from malfunction of the potable water treatment system or contamination within the distribution system.

Design and operational controls will be implemented to minimize risk associated with these potential scenarios that include:

- The potable water treatment, storage, and distribution system will be adequately designed for the predicted population of the Mine Site camp. Treatment plant processes will include filtration and UV disinfection. Treatment plant operators will be adequately skilled and trained for the work they are performing. Preventative and routine maintenance and inspection programs will be implemented for the potable water treatment and distribution system.
- Camp Lake will be adequately protected from the potential for contamination by ensuring that any upstream retention pond that holds runoff from the waste rock pile is suitably sized to hold the water until tested for appropriate drinking water criteria and released, even under high flow conditions. A treatment plant will be mobilized if necessary to treat water prior to release from the pond. Adequate protection measures including buffer zones around Camp Lake and silt control measures will be implemented and enforced. An alternative potable water supply will be identified and used in the event of a short term water source contamination issue.
- A robust drinking water sampling and monitoring program, modeled after similar programs in Southern Canada, will be conducted that will test both raw and treated water from Camp Lake as well as strategic points within the distribution system. The on-site environmental lab will have sufficient capacity to conduct limited testing for common bacteriological pathogens. This will provide rapid turn-around of results on a routine or emergency basis.
- A potable water emergency plan will be established that could involve a combination of temporary utilization of alternative potable water sources, boiled water orders, and increased frequency of drinking water quality monitoring.
- Adequate electrical power backup systems in the event of power failure.

The potential for human health problems due to contamination of potable water is considered to be **possible**, however the risk rating is considered **very low** in consideration of the engineered design features/contingencies and the development/implementation of adequate operational controls and emergency response procedures,

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.4 Tote Road

19.4.1 Traffic Accidents and Release of Hazardous Materials

See discussion in section 19.3.3.

19.4.2 Collision with Wildlife

Collision with wildlife is also a possible event. Baffinland' s environmental induction program will focus on increasing the awareness of vehicle operators to the presence of wildlife while the Wildlife Mitigation Management Plan (Appendix B.8) outlines the actions implemented to protect wildlife. Although such accidents are deplorable, given the limited number of animals **likely** to be killed by road traffic, the impact of road kill on the herds is considered **very low**.

19.4.3 Road Embankment Failure and/or Collapse of a Water Crossing

A road embankment failure or the collapse of water crossing (bridge or culvert washout) could result from an extreme precipitation event, extreme freshet events and/or the degradation of the ground due to the thawing of the soil/permafrost. Such events are difficult to predict and depending on the timing of occurrence, these events may result in stranding of vehicles and personnel, or, human injuries. Despite the application of best engineering practice for the design of these structures and the routine inspection and maintenance of the roads, such events are **likely** to occur. Given the effort place in design and maintenance, the risk rating is **low.**

19.4.4 Weather Related Strandings

Due to the inclement weather and fast changing difficult to predict conditions for the Project site, there is the potential for personnel to be stranded away from camp infrastructure in vehicles along roadways, along the rail alignment, as well as when working on the land away from roadways. The result of this type of scenario can be injury or fatalities due to exposure. There will be many controls in place to prevent or mitigate against this type of outcome including:

- Focus during employee induction and during safety meetings on the potential for weather related hazards and potential incidents.
- The review of available weather information and predictions prior to working away from camp including satellite weather data available from Environment Canada website and real time weather data available locally from the Mine Site, Milne Port, and Steensby Inlet stations.
- Development and implementation of effective procedures for work away from camp including proper clothing, survival packs, radio and telephone communications, and use of vehicles in proper mechanical condition.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Based on the ambient and extreme weather conditions that occur at the Project site, the scenario of a weather stranding event is predicted to be **likely**. However, based on the robust operational and procedural controls and preventative measures, the overall risk rating for this scenario is considered to be **very low**.

19.5 Steensby Port

For Steensby Inlet, sea lift and shipping will take place only during the open water season of 2012. The remaining land based PDW activities at Steensby Port will extend to Q2 2013.

The most credible and likely accidents related to Steensby Inlet shipping activities are:

- Fuel spill during ship-to-shore transfer
- Congestion at the port leading to a collision
- Introduction of invasive species.

For the land based PDW activities, the most credible and likely accidents and malfunctions are:

- Accidental release of hazardous substances (discussed in section 3.2.4)
- Fire at the accommodation complex (barge camp)
- Failure of the power supply (discussed in section 3.2.7)
- Failure of the wastewater treatment plant (discussed in section 3.2.8)
- Contamination of the water supply (discussed in section 3.2.9).

19.5.1 Ship-to-shore Fuel Transfer

Fuel will be received in 20 ML barges. One barge will be anchored and overwinter in Steensby Inlet. Fuel will be unloaded by means of flexible hoses from tanker to shore. The distance between the receiving edge of the freight dock and the tanker is about 400 m.

During ship-to-land fuel transfer at the ports, minor accidental releases may occur occasionally in water and/or on land. Other oily discharges may also occur from bilge tanks, engines, mechanical parts, and other devices on board. The accumulation of these minor spills may become a cause for concern if they are not contained quickly and prevented from coming into contact with marine or terrestrial environment. Spills on land and ice are more readily contained than those in open water since water can spread the spill quicker and cause immediate impacts to water quality and aquatic life. Snow and ice on the other hand, will act to help contain the spill while clean-up action is implemented. At both port facilities clean up equipment will be made available at all times. An emergency and cleanup response team will implement the spill contingency plan as soon as possible. The shipping contractor will established appropriate loading and off-loading procedures using guidance from legislations such as the *Arctic Waters Pollution Prevention Act*, Arctic Shipping

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Pollution Prevention Regulation and the Regulation for the Prevention of Pollution from Ships and Dangerous Chemicals to prevent or quickly contain any spills or releases of fuel during ship-to-land transfers.

Steensby will have Transport Canada-approved Oil Pollution Emergency Plans (OPEPs) as required under the Oil Handling Facilities Regulations of the *Canada Shipping Act*. The *Canada Shipping Act* also requires that every vessel have a Transport Canada-approved Shipboard Oil Pollution Emergency Plan (SOPEP) to address ship-borne accidental releases of fuel. The OPEP for Steensby Port OPEP is attached in Appendix B.3.

The operations and response structure at the Port facilities have been designed so that a rapid response to a spill incident can be carried out. All equipment and resources are strategically placed near the beach front, directly at the port operation site. Responders, workboats and other support equipment are on standby during all port operations. The deployment of equipment and resources required to contain and control the diesel and the quantity of diesel involved in the incident, up to the minimum spill size of 3.5 m^3 as determined in accordance with section 2 of the Oil Handling Facilities Standards, will be on site and deployed on scene within 1 hour after the discovery of the diesel pollution incident.

In the event of a spill, on water recovery of spilled product will be initiated immediately upon containment of free floating product. The skimming capacities available at the Port facilities are capable of recovery of several times the estimated spill volume.

The land based bulk fuel storage facilities will be equipped with appropriate spill response equipment which provides *resident capability* for the response to spills in accordance with the scenarios which have been developed under this Oil Pollution Emergency Plan. Containment and recovery equipment inventories exceed the facility category planning standards and are especially appropriate for the potential spill volumes as outlined in the scenarios contained in the OPEP. Furthermore, routing training exercise will be carried out to assess the effectiveness of the spill response procedures prescribed by the OPEP and improvements will be made as required.

Although a fuel spill is **likely** to happen during the PDW, in light of the effort expend in the development and implementation of the OPEP, spills resulting from the ship-to-shore transfer operation will quickly be contained and the environmental effects resulting from such an incident will not be significant. The risk is considered **low**.

19.5.2 Congestion at the Port

A situation could arise where several ships are waiting at the Port for either unloading cargo. Although planning and logistic will ensure that such events are rare, the probability of occurrence during the PDW is **likely**. The likely accident associated with congestion is a collision, or, grounding of ship, especially during extreme weather events.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

While an **unlikely** event, an accidental fuel spill could hypothetically occur as a result of collision or accident or while transferring fuel between an ocean tanker and shore base. The OPEP addresses issues associated with minor spills resulting from the ship-to-shore transfer of fuel. A ship collision could result in a larger spill. Such a scenario is discussed in section 3.7 (Major Diesel Spill at Port or Along the Shipping Lane). For the PDW, diesel fuel will be delivered to Steensby Port by 50 ML tankers only during the open water season of 2012. The risk is considered **low**.

19.6 Railway staging related accidents and malfunction

The PDW consist mainly of staging material to the four temporary railway camp locations. Staging requires the construction of four segments of winter road. The potential accidents related to the railway staging operation are:

- Collision with wildlife
- Injuries to traveling hunters (collision with human)
- Accidental release of hazardous material (discussed in section 3.2.4)
- Weather related strandings (discussed in section 3.3.4).

19.6.1 Injury to Passing Hunters at Steensby Inlet

Seasonal hunting of terrestrial and marine wildlife is one of the main land-use activities of Inuit in the Baffin Region. Hunters usually travel by boat or on Snow-mobiles to the Steensby area to hunt for caribou, seals, whale and other wildlife. To prevent accidental injury to passing hunters, community education and awareness programs will be establish to warn hunters of Project activities in the area. If possible, alternative hunting routes and trails will be established by the Project in consultation with the QIA, HTO, etc. Where such alternative routes are not possible or practical, localized exclosures will be developed with appropriate warning signs.

It is still possible, even though **unlikely**, that injuries may be caused to passing hunter(s) by a PDW activity. Where such an injury to a passerby occurs, the on-site emergency response team will be mobilized to assess the injury and implement response action as may be needed as soon as possible. On-site medical services or evacuation to an external medical facility will be provided as required. Family members of the victim(s) will be contacted as soon as possible by appropriate official of the Project to inform them of the incident. Appropriate counselling will be provided when necessary. With these control measures in place, the risk is considered **low**.

19.7 Shipping Related Accidents and Malfunctions

The potential accidents and malfunctions associated with shipping are:

- Collision with marine mammals
- Ship engine failure at sea

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Ship grounding
- Collision with other vessels
- Major diesel spill at sea.

19.7.1 Collision with Marine Mammals

Collision of ships with marine mammals is considered very unlikely. There are very few reported cases of such collisions. The consequence of such a collision would most likely be the death of the animal, which although unfortunate, does not threaten the survival of the species.

For the PDW, shipping is limited to the open water season of 2012. The event is considered **unlikely** and the risk is considered **low**.

19.7.2 Ship Engine Failure at Sea

Ship engine failure may be caused by malfunctioning of the engine system or systems connected to the engine. The quickest and safest way to resolve the problem is to repair the engine. Inability to repair the engine quickly may lead to ship drifting away which may eventually cause ship grounding (discussed below). Before any voyage, the engine system will be inspected to ensure that it is in good working condition. Repair and maintenance tools and equipment will be provided on each ship. Spare parts and if possible spare engines will be kept on board for potential engine failures.

The CGC or an international marine safety organization will be contact for assistance in case of unresolved engine failure at sea.

Although a ship engine failure is a **possible** event, the risk associated with such a failure is considered **very low**.

19.7.3 Cargo Ship Grounding without Fuel Spill

Ship grounding is a marine accident that involves the submerging of ship causing disturbance to seafloor and potential marine habitat, and damage to the entire submerged ship or the part that is submerged. The bottom structure of the ship is often damaged causing water ingress and further damage to the ship. Grounding leads to financial difficulties and may also cause loss of human and marine life.

Some of the main causes of ship grounding include:

- Engine failure
- Deviation from established shipping lanes
- In adequate training of crew
- Malfunction of mechanical parts and/or engine
- Extreme weather conditions

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- Improper functioning of port facility.

The possibility of ship grounding will be prevented or minimized by adherence to established shipping lanes, employment of well trained crew and following ship specific operating procedures. As much as possible port facilities at the Milne and Steensby Inlets will have dedicated personnel who will instruct incoming ship to avoid any potential grounding locations.

Ship ground is a rare occurrence, when ships are designed properly and the ship operating procedures are followed by well trained shipping crew. If grounding occurs, established emergency response for each ship will be followed.

Cargo vessels and fuel tanker have anti-collision devices with alarms and modern radar to ensure that collisions are avoided with other vessels. Furthermore, marine heavy oil (MHO) used for powering the ship is stored within a double tank containment inside the ship (normally toward the stern), away from the hull. MHO storages are unlikely to be damaged by collision or grounding.

While a collision or grounding is **possible**, the subsequent potential release of MHO from the ship in transport or at the dock is not considered to be a credible spill scenario, since fuel is not contained next to the hull and therefore a breach of the integral tank is highly unlikely. The risk associated with such an event is considered **very low**.

19.7.4 Fuel Tanker Grounding or Collision Causing Fuel Spill

Fuel will only be delivered during the open water season. Large spills of diesel fuel may occur when a diesel fuel tanker is grounded. Such incidents are rare, but when they do occur immediate action will be taken to salvage the ship and prevent uncontrolled flow of diesel. Each ship will have a proprietary general emergency plan according to the International Safety Management *Code* (ISM Code) for the Safe Operation of Ships and for Pollution Prevention. The ISM Code is a management systems model designed to encourage safety and pollution prevention. Compliance with the provisions of the code is mandatory for passenger ships and other ships. Emergency plans developed according to the code will be implemented as soon as possible to contain, clean-up and salvage spills. The Canadian Coast Guard (CGC) will be informed as soon as possible and necessary assistance sought in the containment and clean-up exercise. Tankers will maintain a daily reporting routine to CGC when travelling through the north. This daily communication will assist in informing tankers of other vessels in the area, a practice which will prevent or reduce possibilities of collision.

Additionally, all tankers will have anti-collision devices with alarms and modern radar to ensure that collisions are avoided with other vessels. Furthermore, marine heavy oil (MHO) used for powering the ship is stored within a double hulled containment inside the ship.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.7.5 Collision with Other Vessels

Establishing protocols are well established for commercial shipping in the Arctic. In addition, there are a number of small fishing and harvesting vessels that frequent the coastal areas in the vicinity of both Milne and Steensby Ports.

For commercial ships communication protocols and surveillance systems are well established to maintain communication with other vessels and avoid collision. For smaller vessels, the size of the ore carrier and their observation system should be adequate to warn smaller craft of their presence. In addition, the Company will notify local communities when ships are expected to be in the area.

19.8 Air Traffic

Air traffic emergencies were considered as a potential scenario for impacting personnel, aircraft and site infrastructure. The potential for aircraft incidents can occur anytime and anywhere. However, only aerodrome incidents directly affecting the aerodrome were considered. Incidents beyond the aerodrome are covered in the Baffinland Emergency and Spill Response Plan.

Air traffic incidents at the aerodrome could result in failures to aircraft, aerodrome infrastructure and personnel, significantly impacting the operation. The cause of these incidents could be:

- Aircraft incidents & accidents;
- Natural disasters;
- Bomb incidents;
- Hazardous material incidents;
- Aerodrome structural fires; and,
- Failure of power for movement area lighting.

Design and operational controls will be implemented to minimize this potential occurrence:

- Aerodrome design will be based on Transport Canada Standards and Recommended Practices for designated aircraft use at the Mary River Project;
- Installation of visual aids for aircraft navigation;
- Installation and use of electronic and procedural approach aids;
- Adherence to the International Air Transport Association (IATA) standard for the air transportation of dangerous goods;
- Implementation of Mary River Project aerodrome specific standard operating procedures; and,
- Implementation and exercise of Mary River & Steensby aerodrome emergency plans limiting the potential impacts of an incident.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The potential for human injury and/or fatalities is considered to be **possible**, however the risk rating is considered **very low** in consideration of the engineered design features and administrative and operational controls and the development/implementation of adequate aerodrome emergency plan.

The above discussion applies to all Project aerodromes including Mary River, Steensby Port and Milne Port.

19.9 Major Diesel Spill at Port or Along the Shipping Lane

Catastrophic damage could possibly occur to a tanker delivering fuel, or to the fuel storage compartment of a bulk carrier hauling the iron ore sample. The grounding of the tanker/ship within the shipping route is not deemed a credible scenario, as these ships are equipped with advanced navigation systems including sounding alarms. Perhaps more conceivable is a ship collision with an iceberg, which could result in the release of one entire fuel compartment (0.9 ML). However, even this spill scenario is considered very unlikely, given the well-established arctic fuel shipping regime of ship classes and shipping seasons, and other operational safeguards described in the mitigation section.

Ship to shore transfer operations are not causes of major spills. Since these operations are closely monitored, depending on transfer rates, spills rarely exceed 5 m^3, which is the basis for the development of the Milne Port and Steensby Port OPEPs (Appendix B.2 and Appendix B.3). Due to rapid deployment of spill containment equipment, such spills are too small and cannot be used to predict the trajectory of a larger spill that could result from a catastrophic event.

19.9.1 Diesel Spill Modelling

Large diesel spill scenarios for both Milne Inlet and Steensby Inlet were modeled to predict the trajectory of a diesel spill and the coast line that could be impacted by such a spill. The purpose of this modeling was for estimating the marine and coastal areas potentially affected by such an event and the initial weathering fate of the diesel fuel.

19.9.2 Fate of Diesel Fuel – Natural Weathering Processes

Diesel is lighter than water (specific gravity of 0.85 kg/L compared to 1.03 kg/L for seawater) and will initially form a thin layer on the surface of the water if spilled. It will not collect as pooled oil as will crude oil. Diesel fuel undergoes a series of physical and chemical changes when spilled in a marine environment, which together are termed oil weathering (NOAA, 2002):

- **Evaporation**: the conversion of liquid fuel to gaseous fuel that typically occurs in first five days. In 18 hours, 37% of an instantaneous release of approximately 16,000 L of diesel fuel evaporated under conditions of 10 knot winds and a water temperature of 20°C. This process would be slowed in colder water and accelerated in higher winds.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

- **Emulsification**: wave action causes very small water droplets to mix with the fuel, which slows down other mixing processes. This process occurs at any time of vigorous wave conditions.
- **Natural dispersion**: small droplets of fuel are mixed into the water, removing fuel from the water surface (typically occurs during the first five days)
- **Dissolution**: a minor weathering process whereby water soluble components of the fuel are mixed into the water (typically occurs in the first five days)
- **Sedimentation**: fuel adheres to suspended particles in the water column. In turbulent waters having a high sediment load (4,000 mg/L) sedimentation can transfer oil through the water column in hours
- **Biodegradation**: breakdown of fuel by microbes into other compounds, and eventually into water and carbon dioxide. This process occurs over weeks to years, depending on type of oil, temperature, nutrients present, oxygen and quantity of hydrocarbons spilled.

19.9.3 Mitigation Measures

Mitigation to address the potential for fuel spills to the marine environment includes ensuring shippers operate in compliance with the stringent regulations and guidelines established for the transport of fuel in arctic waters north of 60º latitude. The following regulations and guidelines have been established under the *Canadian Shipping Act* and *Arctic Waters Pollution Prevention Act*:

- **Guidelines for the Operation of Tankers and Barges in Canadian Arctic Waters (Interim):** provide an increased standard of protection (above other Canadian waters) from oil spills. The guidelines address the construction of vessels, operation, crew training, required oil cleanup equipment, and the need for an Emergency Response Plan that requires approval by the Canadian Coast Guard (Transport Canada, 1997a).
- **Arctic Waters Oil Transfer Guidelines:** describe the approved procedures for transferring petroleum products in arctic waters, including requirements for safety, fire fighting and emergency equipment, assessment of weather conditions, responsibilities, communication, emergency stop procedures and spill response equipment (Transport Canada, 1997b)
- **Arctic Shipping Pollution Preventions Regulations:** sets out shipping requirements through the arctic, including vessel construction requirements
- **Arctic Waters Pollution Prevention Regulations:** defines equipment standards, inspections transfer operations requirements, and shipboard emergency plans
- **Oil Pollution Prevention Regulations:** indicates liability associated with the deposit of waste in arctic waters
- **Response Organizations and Oil Handling Regulations:** oil tankers must engage a spill response organization if larger than 150 gross registered tonnage

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The vessels must also have on board an Oil Pollution Emergency Plan (SOPEP), and the shipping companies are required to maintain an arrangement with a certified response organization, such as the Eastern Canada Response Corporation for eastern Canada.

19.9.4 Canadian Coast Guard (CCG) Response in the Arctic Region:

The "*Central & Arctic Regional Response Plan (2008)*" and the "*Baffin Region, Nunavut Area Plan*" outline the Canadian Coast Guard's response capability for the Baffin region. This plan is a component of the *Canadian Coast Guard National Response Plan* which is the responsibility of the Director of Safety and Environmental Response Systems, Ottawa. It establishes the framework and the procedures by which Central & Arctic Region will prepare for, assess, respond to and document actions taken in response to pollution incidents in this Region.

Arctic Community Packs (ACPs) are placed in northern communities for rapid (local) initial response. Canadian Coast Guard provides initial response training to members of the communities so that they may effectively deploy equipment in the ACPs in the event of a spill. Access (keys) for the ACPs have been given to an official in each community in most cases.

The inventory for each Canadian Coast Guard Arctic Community Pack location is listed in the Table 3.2. The program received funding under the Health of the Oceans Initiative and placement of ACP's at additional sites took place in 2009. A full review of each community through possible spill scenarios was undertaken and the equipment profiles at the existing Arctic Community Pack sites were changed to reflect characteristics of each community. The inventory at all communities is now "site specific" and coincides with response strategies designed by the ER planning group. The locations of the additional Arctic Community Packs are: Baker Lake, Broughton Island (Qikiqtarjuaq), Chesterfield Inlet, Churchill, Hall Beach, Kimmirut, Iqaluit, Pangnirtung, Tuktoyaktuk and Yellowknife.

Based on the findings of the review, inventories were adjusted by community and additional ACP's were delivered accordingly. For the most part the single sea container approach has now been enhanced to contain 3 modules per community, 1 for boom, one for shoreline clean up and one beach flush kit.

The approach is to provide the community with sufficient materials and training to ensure self help capability for 48 hours and to ensure a timely initial response to spills less than 5 m^3. Following this initial response, should it be necessary, a cascading of resources from other CCG inventories would be initiated. The main base of operations with Environmental Response dedicated personnel is located in Hay River, Northwest Territories. This base is home to a Rapid Air Transportable (RAT) cache of equipment known as the "RAT150". The RAT150T used in conjunction with the "Delta" (Δ) 1000T meets planning standards for a 1000 tonne (T) response. The selection of equipment for the RAT150 meets pumping rates/capacities of 1000T thresholds and be complimentary to the equipment held in the Δ 1000T depots.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The response package, warehoused in Hay River, is maintained in 100% readiness during the shipping season. The equipment is broken down and containerized such that it will fit through the smallest cargo door of any of the selected aircraft. Equipment is TDG compliant, palletized as appropriate, and labeled for ease of selection and loading.

Table 19-3: Canadian Coast Guard Arctic Community Pack Locations

Location	EQUIPMENT SUMMARY			
	Boom (24")	Skimmers	Boats	Storage
Arctic Bay (Ikpiarjuk)	3,650′	TDS-118	16' Aluminum	Open top Tank
Cambridge Bay (Ikaluktutiak)	1,350′	TDS-118	16' Aluminum	Open top Tank
Cape Dorset (Kinngait)	1500′	TDS-118	16' Aluminum	Open top Tank
Clyde River (Kangiqtugaapik)	4,500′	TDS-118	16' Aluminum	Open top Tank
Coppermine (Kugluktuk)	1,350′	TDS-118	16' Aluminum	Open top Tank
Coral Harbour (Salliq)	1,500′	TDS-118	16' Aluminum	Open top Tank
Gjoa Haven (Uqsuqtuuq)	1,350′	TDS-118	16' Aluminum	Open top Tank
Holman (Ulukhaktok)	1,500′	TDS-118	16' Aluminum	Open top Tank
Rankin Inlet (Kangiqsiniq)	2,200′	TDS-118	16' Aluminum	Open top Tank
Resolute (Qausuittuq)	1,350′	TDS-118	16' Aluminum	Open top Tank
Hay River FRU +	1,000′	-	37′ Seatruck 42′ Cutter	-

In combination with the RAT150T, equipment found in the Δ1000T depots will be at a 1000T capacity. Hence, the delta or "Δ" is the difference between the RAT150T and a full 1000T. The Δ1000T depots will have containerized heavier equipment (not suitable for air transport to smaller communities) augmenting the RAT150T to a 1000T capacity, ready to be loaded on deck barge, Canadian Coast Guard icebreaker or freighter. While response personnel cascade in to the spill site pre-identified local, CCG base and available ER personnel will mobilize to the centres and load the equipment on suitable marine transport.

Three Δ1000T depots are strategically located in the northern communities of Tuktoyaktuk (Northwest Territories), Iqaluit (Nunavut), and in Churchill (Manitoba). For the purposes of response in Central & Arctic Region, Churchill is included in the Arctic Zone of operations despite it being south of 60° North Latitude due to the similarities in response characteristics that it shares with locations north of 60° North Latitude.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.9.4.1 CCG expectations of Oil Handling Facilities (OHF) for Response

In most instances when a spill occurs, the initial report will trigger the mobilization of the facility response team. It is normal, in most cases, for the oil handling facility personnel to be the initial responders when a spill occurs.

Small Spills

For the purpose of the OHF plan, a small spill is defined based on the maximum oil transfer rate of the oil handling facility (i.e. what Level it is assigned under the *Canada Shipping Act, 2001),* which directly links to the minimum spill size to which it must be prepared to respond to within one hour. Oil handling facilities are required to have the resources on site to contain a spill of a minimum size within one hour and have the resources required to recover, or where the oil cannot be recovered the resources to control a spill of a minimum spill size within six hours. Response organizations may be called upon to provide additional operational response capability at the discretion of the Polluter.

Large Spills

For the purposes of the OHF plan, any spill above the facility's minimum spill size will be characterized as a large spill. Oil handling facility personnel are still expected to deploy their on-site equipment. Additional resources beyond the capability of the OHF will be requested from CCG, or in the case that CCG deems the OHF unable to adequately respond, they will dispatch resources accordingly.

Arctic Zone – First Response

The highest risk of pollution in the arctic is during a ship fuel transfer to facilities in Canada's northern communities. Should pollution occur, the vessel and oil handling facility have responsibilities to implement their Oil Pollution Emergency Plans (OPEP) that deal with source control. The next step would be for the community to respond using its response plan, protecting the identified priority area(s) and employing the response equipment in an Arctic Community Pack, if so equipped.

Arctic Zone – Escalation

If the pollution is beyond the ship, facility, and community response then the Rapid Air Transportable (RAT) 150T will be the first line Canadian Coast Guard ER response (Arctic icebreakers or Special River Nav-aid Tenders may have been on-scene first). Upon activation of the RAT150T, standing offers with aviation contractors will be called up. Closest ER personnel will be dispatched to the community to assess, plan, assemble (and train) responders, while preparing to stage the in-coming equipment. The Hay River base personnel will transport the pallets to the airport where they will be loaded into the awaiting airframe. Upon arrival the pallets will be unloaded and a trailer tongue and wheels affixed to the pallet to facilitate movement (by ATV if necessary) to a forward

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

staging area and ultimately to a beach site. The timeframe for full forward staged capacity with personnel at any community with suitable runways is under 48 hours.

19.9.4.2 Recent Enhancements to the CCG Response Capability in the Arctic Region

In 2009, CCG – C&A ER received funding under the Health of the Oceans Initiative to proceed with this enhancement to their regional response capability. The equipment profiles at the existing Arctic Community Pack sites were changed to reflect characteristics of the community. The inventories at all communities are "site specific" and coincide with response strategies designed by the ER planning group.

An overlay of the shipping route proposed for both Steensby and Milne ports shows that community packs are now staged at almost all villages along the shipping route. In the Fox Basin, community packs are situated at Hall Beach. Igloolik currently is not supported by a community pack. In Hudson Strait, community packs are staged at Cape Dorset and Kimmurit. The east coast of Baffin Island is supported by CCG with units placed at Pangnirtung, Qikiqtarjuaq and Clyde River. A major 1000T capability is also located at Iqaluit.

The equipment profiles at the existing Arctic Community Pack sites were changed in 2009 to reflect characteristics and specific risks on an individual basis by community. The inventories at all communities are "site specific" and coincide with response strategies designed by the ER planning group.

19.9.4.3 Interaction of CCG with Industry and Potential Polluters

The Canadian Coast Guard is the Lead Agency in responding to marine spills north of 60°. Baffinland initiated discussion with the CCG regarding their current policies and approach in dealing with industry in the region. It is Baffinland's understanding that the CCG's current levels of service in the Foxe Basin/Hudson Strait as well as the east coast of Baffin Island, is adequate for the present and probably also the future needs of the region.

Activity in the context of the Mary River Project would undoubtedly represent an increase of shipping volumes, but CCG sees spill risk centered around the diesel fuel deliveries. From an environmental response standpoint CCG would respond in an efficient manner with current resource levels.

19.9.5 Potential Effects of a Diesel Spill

19.9.5.1 Impacts to Biota - Lower Trophic Levels and Fish

The introduction of diesel fuel into the marine environment could have a harmful effect on plankton, benthos and fish. In open water, toxicology issues would likely focus on acute toxicity within the first few days after a spill. Acute toxicity appears to be related to the WSF of the fuel (McCarthy et al., 1985; Yapa and Shen, 1994) and due to the concentration of aromatic constituents of the fuel, rather

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

than the aliphatic compounds (Doerffer, 1992). Lethal concentrations of WSF vary between species, life cycle stages (eggs and larval stages are most sensitive), and physical environment parameters (water temperature).

In the event of a surface spill during fuel transfer, plankton living in the surface waters at the spill site would be particularly vulnerable because they would be exposed to the highest concentrations of WSF constituents. Organisms or certain life history stages of organisms with no or limited locomotory abilities such as fish eggs, larvae, and benthic invertebrates would also be vulnerable. In contrast, adult fish would be less vulnerable because they are generally able to avoid areas affected by the spill by swimming away.

Craddock (1977) provided a summary of acutely lethal concentration (standardized for a continuous 96 hour exposure) ranges for the water soluble fraction of diesel fuel for a variety of marine biota as follows: fin fish, 5-50 mg/L; larvae and eggs, 0.1-1 mg/L; pelagic crustacean 1-10 mg/L; benthic crustacean 1-10 mg/L; gastropods 10-100 mg/L; bivalves, 5-500 mg/L; other benthic invertebrates, 1-10 mg/L.

From this information, any spill that resulted in WSF concentrations greater than about 0.1 mg/L would be of concern if it occurred at a time when larval fish or eggs were present. This would likely have no acute lethal effects to juvenile and adult fish because it is below the reported lethal range of concentrations (5-50 mg/L) for fin fish. Also, it is highly unlikely that fish would be exposed to that concentration for 96 hours, the duration of exposure at which acute lethal concentrations are determined. Most activity that could result in an accidental introduction of diesel into the marine environment during the bulk sampling program would occur during August, when most fish species are not spawning. Arctic char spawn during fall, but this takes place in freshwater and, consequently, their eggs (the more sensitive stages) would not be exposed to a fuel spill into the marine environment.

There may be some acute lethal effects to some plankton groups in the initial spill area because the expected initial WSF concentration may fall within the reported range of lethal values (1-10 mg/L). However, the WSF concentration is expected to be quickly diluted, resulting in exposure to acutely lethal concentrations for only a short period. Plankton in the initial spill area would quickly re-establish (within perhaps a week – see Silva et al., 1997). It is expected that such a short-term reduction in zooplankton abundance over a small area would not have substantial effects to other ecosystem components. Similarly, the introduction of low concentrations of weathered oil to the sediment over most of the affected area would have little effect to benthic biota.

In addition to toxicity issues, the introduction of diesel or Jet A fuel could negatively impact domestic fisheries by tainting fish that are targeted for human consumption. Arctic char exposed to crude oil in a laboratory setting quickly accumulated an oily off-flavour. This eventually cleared, but at a much slower rate than it was acquired (Lockhart et al., 2002). Results of those experiments suggest that

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

exposure of fish of edible size to concentrations of oil around 3 mg/L for periods of a few hours would be of concern for tainting. However, the small area affected and short duration of exposure to oil at the concentrations described in our example spill indicates that tainting would be a very localized problem. Sport and domestic fishing for Arctic char occurs in the Robertson River entering into Koluktoo Bay, and throughout most coastal areas of Milne Inlet and Eclipse Sound. Fuel from an accidental fuel spill of the size discussed here is expected to disperse over an area within the bulbous head of Milne Inlet and would not reach Koluktoo Bay or areas farther from the head of Milne Inlet. Although anadromous char can move large distances from their overwintering stream while feeding in coastal marine environments, they return to their natal streams during August and September to spawn and access overwintering areas in freshwater areas. Consequently, it is thought that the only char in the immediate vicinity of the Milne Inlet camp during August and September and would be susceptible to tainting in the advent of an accidental oil spill would be those fish that would move into Phillips Creek. The capture of tainted fish in the area could be avoided by closing it to fishing and compensating fishers for loss of opportunity to harvest for the season in which the incident occurred.

19.9.5.2 Impact on Seabirds

Birds are vulnerable to oil exposure through contamination of their plumage and through the ingestion of oil contaminated food. Oiled plumage can result in the loss of insulative capacity leading to hypothermia, or the loss of buoyancy, which in turn could result in drowning. Ingestion of oil can lead to changes in physiology, internal tissue damage, or death. Birds that feed at the water surface, along the shoreline, or dive into the surface waters to feed are all highly vulnerable to exposure in the event of a spill. Colonial nesting species and species that form large feeding aggregations are also highly vulnerable.

Major seabird and waterfowl colonies are located on Bylot Island, but neither large seabird colonies nor large feeding flocks were seen during aerial surveys conducted in the Milne Inlet area during the middle and end of the breeding season in 2006. Only a few individual Thick-billed Murres, as well as Glaucous Gulls, Herring Gulls and Iceland Gulls were seen using the area and two small colonies (less than 20 breeding pairs each) were also located on the cliffs along the inlet's shoreline. An accidental spill would have no effect on birds nesting and feeding in the vicinity of Bylot Island but could have some effect on the small number of seabirds and other birds in the immediate vicinity of Milne Inlet.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.9.5.3 Impact on Marine Mammals

Whales are generally not at great risk to hydrocarbon fuel spills because they rely on a layer of blubber for insulation, and oiling of the skin does not appear to have adverse thermoregulatory effects (Kooyman et al. 1976; 1977; Geraci 1990; St. Aubin 1990). There is a possibility that the baleen of bowhead whales could be contaminated, thereby reducing filtration efficiency, though these effects are expected to be minimal and reversible (Geraci 1990). There is no irrefutable evidence that links hydrocarbon spills with cetacean mortalities.

Seals can be sensitive to exposure to oil at certain times during their life history, particularly during times of natural stress such as during their annual moult or pupping periods (Dickens et al., 1990). A number of sublethal effects to oil exposure or the consumption of oil-contaminated prey have been documented for seals, including changes in behaviour and physiology, but there is little evidence to irrevocably link seal mortalities to oil exposure. Similarly, polar bears can be affected by the consumption of oil-contaminated prey, direct ingestion due to cleaning oil from their fur, of suffer from adverse effect thermal insulation (Dickens et al., 1990).

During August and September, when shipping is expected to occur, narwhal, bowhead, ringed seals, and harp seals are common in the waters of Milne Inlet and Eclipse Sound. Narwhal routinely move to the head of Milne Inlet, but bowheads and harp seals tend to remain in waters north of Koluktoo Bay. Ringed seals are likely present near the head of Milne Inlet through the summer. If it is assumed that the trajectory of a 10,000 L spill is 10 km^2, the area affected would include about a third of the marine area between the head of Milne Inlet and Koluktoo Bay. Under such a scenario, it is doubtful that bowhead or harp seals would be exposed to the slick. Narwhal and ringed seals may be within the area of the slick, but exposure would be short-term in nature because of anticipated rapid dilution of the fuel and because general disturbance associated with the clean-up operations would likely cause animals to leave the area.

19.9.6 Large Spill Modeling - Establishing the size and trajectory of the spill

The starting point for modeling a spill scenario is to establish the type of product spill and a credible volume for the spill. Only two types of fuels will be delivered in bulk, arctic diesel and Jet-A fuel. The spill scenario therefore assumed a total cargo volume of 50 ML (50 million litres or 5,000 m^3) arctic diesel fuel coming through the sea lane and to port.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

For modeling purposes, the total amount of 50 ML spilled is judged to be too large a spill and not a credible amount. Instead, three possible 'modes' of release or of estimating the amount were put forward:

1. for a hypothetical fuel transfer loss at the port. Assuming a 3 ML/h transfer rate (equates to about 16.7 h where the entire offloading might be typically expected to take about 24 h), there would be potential release of 50,000 L/min. Assuming a period of 10 minutes before the spill is stopped this would represent a spill volume of 0.5ML. Clearly the assumed time before spill stoppage is a key factor;
2. if one assumes six or seven tanker compartments and complete loss of one, this would release from 7.1 to 8.3 ML. Again, the number of compartments damaged is a factor; and,
3. historical spill statistics can also be considered. Some research/review (e.g., McKenna and McClintock, 2005) indicates spill amount is best expressed as a proportion of fuel transported, with 5% a most likely estimate, and 10% a conservative one: 10% yields 5 ML

From this workup, it was assumed that an amount on the order of 5 ML was a worst case amount worth carrying forward. It was felt that the Port sites (either Steensby or Milne) were reasonable locations to take for the spill; as it matches scenario a) above and could be considered possible even for b) for a collision and hull damage accident.

The analysis of the open water scenarios was accomplished by making use of a numerical computer model developed by AMEC which predicts the behaviour of fuel on the sea surface and determines probabilistic spill trajectories. The model simulates the two-dimensional motion of a surface slick transported under the joint influence of wind-driven surface currents and residual currents. The processes of evaporation and vertical dispersion are simulated to estimate the volume loss of fuel from the surface slick. Individual trajectories evolve under the influence of a deterministic time-series of winds (hourly) and current vectors until such time as the trajectory terminates ashore or on an external boundary to the model grid, the trajectory has drifted for more than 30 days, or until the slick volume drops to less than 5% of its initial volume.

The advection or transport of spilled fuel on the sea surface was modelled using a *30-year time-series of gridded winds from the* NCEP/NCAR reanalysis Project selected for use. These data are near-surface modelled winds and were determined to be the best comparable winds to the nearby Milne or Steensby met stations from 2006 to 2010. The NCAR/NCEP winds long time-series length provides good statistical reliability in the predicted spill probability distributions. Several wind speed and direction sensitivity runs were also considered to allow for discrepancies between the measured site and 30-year wind distributions.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The results of this modeling are fuel spill distribution probability maps of Milne Inlet and Steensby Inlet developed by superimposing all possible spill trajectories, for a given month, over the 30-year distribution of selected wind data. The results of this modeling are presented in DEIS Appendix 9A for Milne Inlet and DEIS Appendix 9B for Steensby Inlet.

19.9.7 Spill Modelling at Steensby Inlet

The results are fuel spill distribution probability maps of Steensby Inlet developed by superimposing all possible spill trajectories, for a given month, over the 30 year distribution of the selected wind data. The Steensby Inlet is divided into 10 geographical regions and for each monthly spill scenario a comparison st of shore impact statistics are calculated to report the percent of trajectories impacting the shoreline and the earliest times to impact in any of the regions.

The vast majority of trajectories, 86%, reach shore in the port site area, as soon as 15 minutes and on average in two hours. Just over 9% of trajectories end on the western side of Steensby Inlet about 12 to 20 km away. Times to shore are as early as 7 hours, 29 hours on average, and up to 150 hours (6 days), where 54% of the fuel is estimated to be remaining.

Other regions, farther in the inlet are reached, though generally less than 1% of the time. The Rocky East region is reached as soon as six hours, and 56 hours on average. The Coastal Plain West is reached as soon as seven hours, and 29 hours on average. The Inlet Islands are reached as soon as 18 hours, and 56 hours on average. Koch Island, with one trajectory, at the mouth of Steensby Inlet, is reached in just over two days. To the north, the Rocky Northeast region is reached as soon as 34 hours, and 52 hours on average. The Lagoon Complex to the head of the inlet is reached within 52 hours, and 66 hours on average.

The collection of spill probability plots and shore impact statistics presented in the modelling report define the probable distribution of any hypothetical, uncontained, and, unmanaged spill for the Project domain of operations in Steensby Inlet for the open water season.

A qualitative assessment of shoreline fuel retention based on review of the modelling results and understanding of the shoreline habitats in the region has also been prepared. The initial modelling results suggest that the impact to shoreline resources would be comparatively short term (days to weeks) largely because of the volatile nature of diesel fuel. Shorelines close to the port location have fine sediment matrix in the immediate subsurface which will limit fuel penetration and overall retention. Stranded fuel would continue to evaporate on the surface of the beaches.

Key macrobiota on these shorelines include salt marshes and rockweed. Salt marshes are in the upper intertidal and supratidal zones and are vulnerable to fuel contact. Salt marshes substrate is typically fine-grained sediment and organics, which have low permeability so that significant volumetric retention will not be expected. However, diesel does stick to organics so some residual fuel may be incorporated into the organic substrate. It is likely that salt marshes close to the spill site

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

would experience a combination of lethal effects and some sublethal effects. New plants shoots would be expected during the spring melt so it is unlikely that most effects would be limited to a single generation. The estimated duration of impact would be weeks to months with normal growth rates returning the following spring; some marsh areas very close to the spill site could have reduced growth rates for longer periods of time.

Rockweed occurs in the lower intertidal and shallow subtidal. Rockweed would only be exposed during spring tides so it is not vulnerable at any times. There are likely to be a combination of lethal and sublethal affects for rockweed located within 5 km of the spill location. The life stages of rockweed in this region are unknown but the extensive occurrence along the shore probably represents first year growth and the rockweed also occurs offshore where it is vulnerable to contact with sheens. As such, it is likely that effects of a diesel spill on rockweed would be limited to a single generation and that rockweed growth at breakup during the following year would be normal. The effect of a spill on rockweed is likely to be moderate (weeks to months).

19.9.8 Spill Modelling at Milne Inlet

The Milne Inlet is divided into six geographical regions and for each monthly spill scenario a companion set of shore impact statistics are calculated to report the percent of trajectories impacting the shoreline and the earliest times to impact in any of the regions.

It is predicted that the vast majority, 90-97%, of all trajectories, will reach shore in the port site area within about 4 km at the head of Milne Inlet in as soon as 30 minutes and on average in four hours, with an associated small amount of fuel weathering. Between 3 and 10% of the time trajectories might be expected to first contact shore another 6 km farther out in the reach of the inlet leading to Cape Kwaunang. First impacts for shores in Koluktoo Bay, the Bruce Head region on the Borden Peninsula, and the southern tip of Stephens Island are much less likely, occurring less than 1% of the time. Due to the short times to shore for most of the trajectories, weathering of the fuel is correspondingly low. In the Milne Port Area on average about 4 to 5% of fuel are weathered due to evaporation or dispersion into the water column before any fuel reaches shore. This amount increases to 10 to 16% for trajectories reaching Cape Kwaunang and about 15 to 50% for trajectories north of there.

The collection of spill probability plots and shore impact statistics presented define the probable distribution of any hypothetical, uncontained, and unmanaged spill for the Project domain of operations in Milne Inlet for the open water season.

An important observation is that the trajectory model predicts the times and paths taken to first reach a shoreline in the inlet. More detailed characterization of the weathering fate of the spill, slick size, and amounts of fuel remaining on the surface and ashore, e.g., after initial shoreline contact, is better afforded with the OILMAP software. To this end several scenarios for a range of wind conditions likely to be encountered in Milne Inlet are considered.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

19.9.9 Generic Spill Scenario along the Shipping Lane

Arctic diesel fuel and Jet-A fuel will be delivered to Milne Port or Steensby Port by 50 ML tankers during the open water season. For reasons explained in section 19.9.6, a maximum credible volume for a spill is approximately 5 ML (10% of the cargo).

The results of the two spill scenarios that were modeled to assess potential extent of spill impact in Steensby Inlet and in Milne Inlet can be used to infer outcome of potential spill scenarios along the shipping lane. The Steensby and Milne spill scenarios were modeled in OilMap, a widely used spill modeling program. These models assumed spill volumes (5 million L) and release periods, previously measured wind conditions for open-water periods and predicted tidal currents to predict possible fuel spill trajectories.

Evaporation of the spill, dispersal of fuel into the water column and stranding of fuel along shorelines are the primary processes that dissipate the spill. A diesel slick is tracked as part of the modeling process. Plots of individual model runs provide a spatial picture on the extent of the spill at any one time.

The spill is modeled over a wide variety of measured wind conditions to build a stochastic picture of spill probability around the spill site. The spill probability envelopes indicate the potential of spills to reach a certain point.

The modeling results are developed for a specific site and rely on appropriate wind data and tidal current data for that site. As such the predictions and results are specific to a site (wind conditions, currents).

However, there are some aspects of the spill scenario that can be applied to other locations. Diesel is a relatively volatile fuel and weathering is relatively rapid. The overall extent of a spill in open water is limited by nearby shoreline and the drift from the spill site. The following assumptions can thus be used to develop a generic worst case spill description based on the site specific modeling.

DEIS Appendix 9C considers the potential for open water diesel spill associated with fuel shipment to the Project. The assessment examines potential environmental sensitivity associated with the Project shipping routes

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

20. Cumulative Effects Assessment (CEA)

Completion of a cumulative effects assessment was contemplated for this PDW application. Below is a description of the methodology that was employed in the CEA contained in the DEIS, the scope of a CEA for PDW, and the temporal and spatial boundaries of such an assessment, although with Projects that would be included in the CEA for PDW.

The conclusion reached by Baffinland is that the scope and boundaries (spatial and temporal) for a CEA for the PDW would be the same as that completed in the CEA for the main mining Project contemplated in the DEIS. Development of a mine at Deposit No. 1 would rather than being "the Project" assessed along with other known and reasonably foreseeable Projects, enters the assessment as a reasonably foreseeable Project. The outcome is that the assessment remains the same as the CEA in the DEIS, and the conclusions also remain the same.

The text that follows is intended to provide the reader with supporting information to understand why this is the case.

20.1 Methodology

The CEA process adopted for this analysis is in accordance with the methodology put forth by the Canadian Environmental Assessment Agency (CEAA) (Hegman et al., 1999), includes the following.

- Scoping:
  - Identification of Project residual effects and receiving VEC's or VSEC's
  - Identification of other past, present, and future Projects and activities with the potential to interact with residual Project effects
  - Determine where residual Project effects interact with other past, present, and future Projects And activities, resulting in the potential for cumulative effects
- Analysis of cumulative effects
- Identification of mitigation
- Determination of significance
- Identification of monitoring.

A systematic screening method was used to identify and evaluate potential cumulative effects in the DEIS for the full mine development Project. On a VEC or VSEC specific basis, the zone of influence (ZOI) of residual Project effects was compared with the ZOI of other Projects and activities. Cumulative effects were identified where an overlapping interaction in time and space was determined. Where cumulative effects were identified, they were ranked.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

For this assessment, cumulative effects would be assessed when:

- a residual effect of the Project had a demonstrable effect (measured or reasonably expected) on a biophysical or human component
- it was reasonably foreseeable that the residual effect of the Project would interact with the effects of past, present, or future Projects or activities.

For each residual Project effect, the CEA would identify if there was:

- no anticipated interaction with other Projects and activities that could result in cumulative effects
- an anticipated interaction with other Projects or activities, which could result in cumulative effects, and available information allowed for consideration of measurable effects
- an anticipated interaction with other Projects or activities, which could result in cumulative effects, and available information did not allow for consideration of measurable effects
- an interaction with accidents and/or malfunctions of other Projects and activities, which could result in cumulative effects. The effects cannot be assessed, because they are dependent on other Project/activity specific practices for prevention and response to accidents and malfunctions.
- an interaction with accidents and/or malfunctions of other Projects and activities, which could result in cumulative effects. The effects cannot be assessed as a result of the lack of information on the status or trends in the condition of the vc over time. Potential effects are dependent on the adoption and success of regionally based adaptive management practises.

20.2 Scope

The scope of the CEA for PDW includes a subset of the Project components included in the CEA for the main Project, presented in the DEIS, as follows:

- Milne Port
- Milne Inlet Tote Road
- Mine Site (Mary River)
- Railway Steensby Port
- Marine shipping routes within the Nunavut Settlement Area
- Accidents and malfunctions.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

20.3 Temporal Boundaries

Temporal boundaries define the period analyzed within which the Project or Project activities interact with environmental or socioeconomic components. Temporal boundaries were defined in the DEIS for the mine development Project, and temporal boundaries for the pre-development works fit within the overall Project timeline.

The temporal boundaries for PDW are defined as the four year period of 2012 to 2015, with the PDW activities carried out in 2012, and closure activities (if the full Project does not proceed) occurring in 2014 to 2015.

The temporal boundaries of a cumulative effects assessment are expanded to consider the Project's residual effects in the context of the past, present, and future actions of the Project and other actions by others. The temporal boundary for a CEA on PDW would be based on the following considerations:

- Industrial development in the northern Baffin Island area started in the late 1970s with the development of the Nanisivik and Polaris mines, which opened in 1976 and 1980, respectively and were preceded with several years of mineral exploration.
- A Project definition phase of eight years has occurred, from 2004 through 2011, inclusive of all exploration and research programs, as well as the bulk sampling program carried out in 2007 and 2008.
- Pre-development works are scheduled to be carried out in 2012 and be decommissioned/post-closure monitored by the end of 2015.
- To be inclusive of the lifespan of other Projects and activities, where known or reasonably foreseeable.

Included within the last bullet as known or reasonably foreseeable Projects from the perspective of the PDW activities includes the mining development of Deposit No.1 as described in the DEIS, as well as the potential for a doubling of production rate through the development of other deposits. PDW activities are encompassed within the scope of the Deposit No.1 mining development.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

20.4 Spatial Boundaries

Spatial boundaries are determined specifically for each VEC or VSEC on the basis of the following:

- to provide context to assess the magnitude of Project effects as well as interacting effects of other land uses
- overlaps with the expected ZOI likely affected by the Project
- conservative assumptions about the magnitude and probability of the effect
- adoption of an adaptive approach
- large enough to allow meaningful assessment of VECs and VSECs that may be affected by the Project.

Where appropriate, they are different from (i.e., larger than) the boundaries for the corresponding residual Project effects:

- set at a point at which potential cumulative effects become insignificant
- determined based on ecological, and/or sociologically defensible rationale and/or professional judgment.

In the DEIS, a CEA scoping study area was adopted for initial consideration of other Projects and activities that could have the potential to interact with the Project's residual effects. The Nunavut settlement area boundary, encompassing an area of 4,025,445 km^2, was adopted as it represents a sufficiently large scale to be inclusive of any other Project or activity that could reasonably be foreseen to interact with the Project, and it represents NIRB's administrative boundary. The scoping study area for a CEA on the PDW would be the same.

20.5 Other Projects and Activities of Consideration

Projects and activities located within the CEA scoping area have been identified. Other Projects were identified as either certain or reasonably foreseeable based on the following definitions:

- **Certain:** The Project or activity either exists already or there is a high probability the action will proceed. This includes past and ongoing Projects and activities as evidenced by existing disturbance areas and facilities, current land use tenures and activities, and documented land use.
- **Reasonably foreseeable:** the action or Project may proceed but there is some uncertainty about this conclusion. NIRB (2009) defines reasonably foreseeable Projects to be those that are currently under regulatory review, or that will be submitted for regulatory review in the near future, as determined by the existence of a proposed Project description, letter of intent, or any regulatory application filed with an authorizing agency.
- **Induced:** Projects and/or activities which are more likely to occur if the Project proceeds.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

A challenge when evaluating the interactions of current and future Projects and activities was obtaining sufficient data to allow for meaningful analysis. Since future Projects and activities are sometimes only conceptual without formalized development plans, potential effects of many of these Projects could not be accurately determined.

Other Projects and activities that were initially considered in the DEIS for the potential to interact with Project VECs or VSECs identified in the residual effects assessment include:

- Baffinland's previous exploration and bulk sampling programs
- Baffinland's proposed monitoring programs concurrent with the Project
- mining and mineral exploration activities
- operating mines
- decommissioned mines
- induced mining Projects (development of the mary river mine was considered as a Project induced by the pdw activities)
- marine transport/shipping
- naval refuelling station
- dew-line decommissioning
- air transport
- military exercises
- traditional and recreational hunting, fishing, and foraging
- communities
- tourism and commercial recreation activities
- hydroelectric facilities
- climate change.

Where there was a high degree of confidence that the other Project or activity would not interact with any residual effects of the Project, the other Project or activity was removed from further consideration.

Because a CEA for the PDW shares the same scope and boundaries as the CEA completed in the DEIS for the full mine development Project, the list of other Projects potentially also interacting with the same VCs is the same.

On the basis that the scope, boundaries, and Projects that would be included in the cumulative effects assessment are the same as the CEA completed for the DEIS, and the PDW is part of the larger Project, the content and conclusions of a CEA for PDW would remain the same.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

21. Transboundary Effects

21.1 Introduction

Over the past decade and beyond, a variety of international, bilateral and national laws, guidelines and institutions have adopted requirements that a transboundary impact assessment be conducted prior to making decisions on Projects or activities with transboundary implications (Bruch et al., 2007). In Nunavut, consideration of transboundary effects is required by NIRB and the Board provides general direction to proponents regarding transboundary impacts in its minimum EIS Requirements for a Part 5 Review, including Item 10 which states:

Where relevant, an EIS must include an assessment of all significant adverse ecosystemic or socio-economic trans-boundary effects.

Transboundary effects are defined by NIRB in its Guide 2 – Guide to Terminology and Definitions (NIRB, 2007) as:

Environmental effects/ impacts which occur across provincial, territorial, or international boundaries.

21.2 Boundaries

The transboundary effects assessment is intended to consider the extent of effects which may occur outside of the NSA. There are two jurisdictional boundaries that border the Qikiqtani region of Nunavut. To the south of Baffin Island and across Hudson Strait is the Nunavik Inuit Settlement Area, which forms part of northern Quebec. To the east of Baffin Island and across Davis Strait is Greenland.

21.3 Relevant International Agreements

Canada has international agreements in place and joint efforts under way in the following areas that are relevant to development of the Mary River Project:

- Arctic Environment Protection Strategy
- Polar Bear Conservation
- Exchange of Information Related to Energy Project
- Cooperation on Oil Spill Preparedness and Response
- Marine Mammals Conservation and Management.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

21.3.1 Arctic Environment Protection Strategy - 1991

This Strategy represents the culmination of the cooperative efforts of the eight Arctic countries: Canada, Denmark, Finland, Iceland, Norway, Sweden, Union of Soviet Socialist Republics, and United States of America.

The eight Arctic countries were assisted in the preparation of the Strategy by the following observers: Inuit Circumpolar Conference, Nordic Saami Council, USSR Association of Small Peoples of the North, Federal Republic of Germany, Poland, United Kingdom, United Nations Economic Commission for Europe, United Nations Environment Program, and the International Arctic Science Committee.

The objectives of this strategy are to:

- protect the Arctic including human
- provide for the protection, enhancement and restoration of environmental quality and the sustainable utilization of natural resources including their use by the local populations and indigenous people of the Arctic
- recognize to the extent possible, seek to accommodate the traditional and cultural needs, values and practices of the indigenous people as determined by themselves related to the protection of the Arctic
- review regularly the state of the Arctic environment
- identify, reduce, and, as a final goal, eliminate pollution in the Arctic.

The link to the Arctic Council is www.arctic-council.org.

21.3.2 Polar Bear Conservation

A Memorandum of Understanding (MOU 2009) between Canada, Nunavut and Greenland outlines activities aimed at polar bear conservation (http://pbsg.npolar.no/export/sites/pbsg/en/docs/GN-MOU-PB.pdf). The MOU notes the different responsibilities of Nunavut and Government of Canada in the areas of leadership, research, management authority, and, the establishment of protected areas for wildlife species, in Cooperation with territorial and provincial governments and wildlife management Boards in the territories. For example, across the North, there are National Parks, National Wildlife Areas, Migratory Bird Sanctuaries, and provincial and territorial parks that protect some terrestrial habitat.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

21.3.3 Exchange of Information Related to Energy Project - Canada-Greenland Collaboration

This June 2010 Memorandum of Understanding (MOU), based on a marine cooperative agreement between the two countries dating from 1983, call for the participants to exchange information on specific energy Projects; developments in their energy markets; the energy policy context within which they operate; and their respective regulatory requirements, regulatory oversight approaches, regulatory processes, guidelines and best practices.

21.3.4 Collaboration on Oil Spill Preparedness and Spill Response

Since 1983, Canada has had an agreement with the Kingdom of Denmark related to collaboration with regards to oil spill preparedness and spill response in the Arctic (http://www.treaty-accord.gc.ca/text-texte.asp?id=101893&bprint=true).

21.3.5 Canada-Greenland Joint Commission on the Conservation and Management of Narwhal and Beluga

This joint commission provides international oversight on the national management practices affecting these two species. Canada has also Observer Government status at meetings of the North American Marine Mammal Commission (NAMMCO) and the International Whaling Commission (IWC) and contributes to the work of scientific committees of these three marine mammal commissions.

21.4 Definition and Approach

A transboundary environmental effect can occur when animals move across jurisdictional boundaries (e.g. caribou, marine mammals and migratory birds) or when Project activities themselves, or their zone of influence, cross jurisdictional boundaries (e.g. transportation and air quality). The focus of Baffinland's transboundary effects assessment is on the latter, as effects on migratory VECs occurring within Nunavut are considered and fully assessed in the component-specific effects assessments (Sections 13 through 17) as well as the cumulative effect assessment (Section 20).

In accordance with the definition and guidance provided by NIRB, the transboundary effects assessment for the Mary River Project addresses effects from Project activities that occur across provincial, territorial and international boundaries. The Mary River Project, including the proposed Canadian shipping route, is located entirely within the Nunavut Settlement Area (NSA) and therefore little potential exists for the Project to result in effects beyond the NSA. Nevertheless, some residual environmental effects directly linked to the activities associated with the Project, could, as a consequence of a large zone of influence, result in transboundary effects as described below.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

As a general approach, the environmental effects assessment undertaken for each VEC and VSEC, has included a detailed consideration of the full effect of each identified interaction, including any possible instances where the zone of influence associated with the interaction extends beyond the boundary of the NSA. Additionally, the cumulative effects assessment includes a consideration, where applicable, of other Projects or categories of Projects/activities that are located outside of the NSA and which might potentially act in combination with the effects of the Project.

21.5 Assessment

Table 21-1 and Table 21-2 present overviews respectively of the VSECs and VECs that have been considered in this PDW Application. The tables identify potential environmental effects which might have a transboundary component (either direct or cumulative) and identifies where this has been considered within the EIS.

In general, the Project configuration is such that there are few potential transboundary issues. This is not surprising, given the geographic location of the Mary River Project and the limited range of any possible or detectable biophysical effects.

As shown in Table 21-1 and Table 21-2, the existing environmental assessment has already incorporated transboundary considerations into the evaluation. Where assessment boundaries are less than the full range, e.g. of a migratory species, the calculated effect will be conservatively estimated. Where the effects predictions are population- based the reference population is usually far smaller than the total population of the affected species, thus the predictions will over-state any transboundary effect. In cases where species of concern have been considered, the evaluation has included relevant factors affecting the subject population, including transboundary factors. In this manner, the consideration of all such VECs has encompassed transboundary effects assessment. Within the tables, the term “subsumed” has been used to refer to this treatment of a VEC within the PDW Application.

A limited number of interactions require supplemental consideration of transboundary effects. Where such consideration is required, the discussion is presented in this section. A total of five VECs and six VSECs are identified which for transboundary interactions. Two of the VSECs have the potential for direct effects (demographics and substance abuse-transport). The remaining issues are all cumulative in nature. In no case, however is there a potentially significant negative residual environmental effect predicted. Further, within the cumulative effects assessment (Section 20), consideration has been given to significant negative interactions that occur between a VEC and other Projects or activities, including instances where such occur outside Nunavut.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

The discussion presented under each VEC and VSEC assessment section has, for every identified issue, incorporated a consideration of transboundary effects. Additionally, supplemental text has been provided below with respect to three issues:

- shipping
- climate change/air quality
- demographic change.

21.5.1 Shipping

As outlined in the Project Description (Sections 2 through 6), there are two shipping destinations on Baffin Island: Milne Inlet on the east coast; and Steensby Inlet on the west coast. The Milne Inlet site will receive equipment for the Project by way of sealift during the open-water season. Milne Inlet is accessed through Davis Strait, which connects the North Atlantic Ocean with Baffin Bay and is 320 km wide at its narrowest point. Given the width of Davis Strait and Baffin Bay and that shipping along this route will occur infrequently during the open-water period, there are no anticipated transboundary effects from shipping activities within Nunavut.

All shipping to Steensby for PDW will be carried out during the open water. Fuel vessels will also safely overwinter at Steensby Port in accordance with current practices elsewhere in the Canadian arctic by experienced vessel operators. All ships will operate in accordance with the *Canadian Shipping Act* and the *Arctic Waters Pollution Prevention Act*. , thus mitigating transboundary concerns related to sewage, solid waste disposal and ballast water management. In addition, all ships will have prevention and response equipment for accidental spills and will have in place a Shipboard Oil Pollution Emergency Plan.

Ships destined for and leaving from Steensby Port will navigate through Hudson Strait and Foxe Basin. While Foxe Basin is entirely within Nunavut, jurisdiction over development activities in Hudson Strait is divided geographically between Nunavut and the Nunavik Inuit Settlement Area of northern Quebec. The planned shipping route is located entirely on the Nunavut side of Hudson Strait, which is 65 km wide at its narrowest point and up to up 230 km wide in other parts. The central channel of Hudson Strait ranges in depth from 300 to 400 m. The analysis undertaken to predict the zone of influence of the mine development Project`s largest ship to be used was presented in the marine mammal impact assessment in Volume 8 of the DEIS. Given the width of Hudson Strait compared with the zone of influence of Project ships, no transboundary impacts are anticipated from shipping activities within Nunavut.

Baffinland acknowledges that in rare circumstances depending on ice conditions, icebreaking ships may have to navigate Hudson Strait using a more southerly route for safety purposes. Hudson Strait is a well-established shipping route. There are established shipping lanes for community resupply accessing the communities of Hall Beach, Igloolik, Cape Dorset and Kimmirut. In addition, the MV Arctic has been providing winter ore transport through Hudson Strait to support mining operations at

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

the Raglan Mine located at Deception Bay in northern Quebec for a number of years. During that time no adverse effects on marine mammals have been documented. This is consistent with Baffinland's finding that no transboundary impacts will occur from shipping activities in Nunavut through Hudson Strait.

21.5.2 Climate Change/Air Quality

The assessment of effects on air quality is presented in Section 14. The analysis shows that residual effects will not extend beyond 1.5 km from the Project site. As a result and given the location of the Project no transboundary air quality effects are possible.

In addition to local air quality, the Project will emit greenhouse gases into the atmosphere as diesel generators are the only current viable and available source of energy. Greenhouse gas emissions contribute to global warming, which is an issue of global concern that crosses all borders and affects all jurisdictions, particularly circumpolar countries. Baffinland acknowledges that greenhouse gas emissions are a broad scale transboundary issue for which there is presently no viable alternative in Nunavut. During the future mine development Project, Baffinland proposes will report annually on performance indicators, including energy use and greenhouse gas emissions management (DEIS Volume 8, Section 1.5.2). The report will help to show Nunavummiut and other Canadians what the Company's current performance is and how it can be improved. Baffinland will also explore ways of conserving energy as the Project moves through development and will adapt accordingly.

21.5.3 Demographic Change

The potential for adverse residual transboundary socio-economic effects has been considered. While demographic change was identified in the DEIS as a potential residual effect for the mine development Project, the PDW activities are too short in duration to induce demographic changes.

21.6 Conclusion

Baffinland has given due consideration to the potential for transboundary effects associated with the Project. This consideration has included:

- Any residual effects of the Project which have the potential to occur outside of the NSA; and
- Any (cumulative) effects that result from interactions between the Project effects and effects of other Projects located outside Nunavut.

Baffinland has examined each of the VECs and VSECs and assessed the potential for these transboundary effects. Specifically, Baffinland has considered the potential for transboundary effects associated with marine shipping on marine mammals and migratory birds.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

There will be a minor, "*not significant*" negative residual environmental effect of the Project on greenhouse gas emissions. With respect to all the VECs and VSECs examined, Baffinland has determined that there will not be any negative residual transboundary environmental effects.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 21- 1: Summary of Project Transboundary Effects Assessment – VSEC's

VSEC	Potential Effect	Transboundary Relevance	Type of Effect	Assessment Approach
Communities				
Population Demographics	Migration of non-Inuit Project employees into the North Baffin LSA Migration of non-Inuit into North Baffin for indirect jobs Inter-community Inuit migration Out-Migration from the North Baffin	No	n/a	n/a
Education and Training	Improved life skills amongst many LSA residents	No	n/a	n/a
	Incentives related to school attendance and success	No	n/a	n/a
	Opportunities to gain skills	No	n/a	n/a
Human health and well-being, including local food security	Changes in parenting	No	n/a	n/a
	Increase household income and food security	No	n/a	n/a
	Absence from community during work rotation	No	n/a	n/a
Substance Abuse	Transport of substances through Project sites	Yes	Direct	Subsumed
	Affordability of substances	No	n/a	n/a
	Attitudes towards substances and addictions	No	n/a	n/a
Community infrastructure and public service	Competition for skilled workers	Yes	Cumulative	Subsumed
	Labour force capacity	Yes	Cumulative	Subsumed
Governance and leadership	IIBA Agreement with QIA	No	n/a	n/a
Economics and Employment				
Livelihood and employment	Creation of Jobs in the LSA	Yes	Cumulative	Subsumed
	Employment of LSA Residents	Yes	Cumulative	Subsumed
	Job Progression and Career Advancement – New career paths	No	n/a	n/a
Economic development and self-reliance	Land	No	n/a	n/a
	People	No	n/a	n/a
	Community Economy	No	n/a	n/a
	Territorial Economy	Yes	Cumulative	Subsumed
Contracting and business opportunities	Expanded market —business services to Project	Yes	Cumulative	Subsumed
	Expanded market —consumer goods and services		Cumulative	Subsumed

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 21-2: Summary of Project Transboundary Effects Assessment – VEC's

VEC	Potential Effect	Transboundary Relevance	Type of Effect	Assessment Approach
Water Quality				
Surface water freshwater quality	Deterioration of surface runoff - negative effects on receiving water quality	No	n/a	n/a
Treated Effluent Quality	Un treated effluent discharge to freshwater lakes or river	No	n/a	n/a
	Contaminated Runoff, Elevated TSS	No	n/a	n/a
	Spills	No	n/a	n/a
Fish & Fish Habitat				
Freshwater fish, fish habitat and other aquatic organisms	Loss of Habitat (all areas within LSA)	No	n/a	n/a
	Movement (all areas within LSA)			
	Mortality (all areas within LSA)			
	Health (all areas within LSA)			
Vegetation		No	n/a	n/a
Caribou	Loss of Habitat	No	n/a	n/a
	Mortality			
	Movement			
	Health			
Migratory Birds	Direct Habitat Loss	Yes	Cumulative	Subsumed
Peregrine falcons	Indirect Habitat Loss		Cumulative	Subsumed
Snow geese	Indirect Habitat Loss		Cumulative	Subsumed
Common eiders	Indirect Habitat Loss		Cumulative	Subsumed
King eiders	Health & Mortality		Cumulative	Subsumed
Red-throated loons				

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

VEC	Potential Effect	Transboundary Relevance	Type of Effect	Assessment Approach
Marine water and sediment quality	Discharge of runoff	No	n/a	n/a
	Discharge of treated effluent	No	n/a	n/a
	Ship-to-shore spills	No	n/a	n/a
Sea seabed sediments quality	Discharges from Ships	No	n/a	n/a
Invasive Species	Ballast water	Yes	Cumulative	Subsumed
Marine and coastal physical habitat		No	n/a	n/a
Marine fish and invertebrates		No	n/a	n/a
Marine mammals Polar bears, ringed seals, bowhead whales, walrus beluga whales, narwhals	Habitat	Yes	Cumulative	Subsumed
	Movement			
	Mortality			
	Health			

NOTE(S):
1. SUBSUMED = THE TRANSBOUNDARY ASSESSMENT IS INCLUDED WITHIN THE SUBJECT – SPECIFIC EFFECTS ASSESSMENT.

© Hatch 2011/09

22. Water Use and Waste Generated

Table 22-1: Expected 2012 Water Use

Expected 2012 Water Use, m3/day													
	2012										2013		
Location		Q2			Q3			Q4			Q1		
Permitted use													
W.L. 2BB-MRY1114 Type B	385	385	385	385	385	385	385	385	385	385	385	385	385
Allocated Use Under Existing Water License - Exploration/drilling													
Camp use	60	60	60	60	60	60	60	60	60	60	60	60	60
Drilling	325	325	325	325	325	325	325	325	325	325	325	325	325
subtotal	385	385	385	385	385	385	385	385	385	385	385	385	385
PDW Expected Water Use													
Camp use													
Milne	30	30	30	30	30	30	75	75	20	10	10	10	10
Mary River	25	25	60	60	60	60	60	60	60	60	25	25	25
subtotal	55	55	90	90	90	90	135	135	80	70	35	35	35
Industrial Use													
Milne	10	10	10	10	20	20	20	20	20	20	10	10	10
Mary River	10	10	10	10	20	20	20	20	20	20	10	10	10
Steensby						50	50	50	50	50	50	50	50
subtotal	20	20	20	20	40	90	90	90	90	90	70	70	70
Total PDW water	75	75	110	110	130	180	225	225	170	160	105	105	105
Expected Drilling Water Use for 2012			50	150	150	150	150						
Combined Peak Water Demand for 2012, m3													
Peak Daily Water	75	75	160	260	280	330	375	225	170	160	105	105	105
Number of days	31	30	31	30	31	31	30	31	30	31	31	28	30
Monthly Peak	2325	2250	4960	7800	8680	10230	11250	6975	5100	4960	3255	2940	3150
Total water Demand for the PDW period:				**73875**	**m3**		**Average daily peak for PDW:**				**187**	**m3/day**	
Note:													
1. Drilling activities begin in April and concludes by September of each year.													
2. Camp water use at Milne and Mary River include water used existing Mid-Rail camp and existing Steensby 10 person camp													

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 22-2: Waste Generation Breakdown

PDW Waste Breakdown			
Waste	Waste Description	Disposal Method	Est. Total Annual Production (tonnes)
Estimated Domestic Solid Non Hazardous Waste[1]			
Organic	Kitchens	Incinerator	173
Paper	Packaging/Offices	Incinerator/On-site landfill	49
Plastic	Offices/Camps	Incinerator[3]/On-site landfill	35
Cardboard	Packaging/Camps	Incinerator	38
Cloth	Camps	Incinerator	11
Multi-Material	Packaging/Camps	Incinerator/On-site landfill	8
Metal	Packaging	On-site landfill	5
Glass	Camps	On-site landfill	5
Wood	Packaging	Incinerator	3
Estimated Hazardous Waste [2]			
Waste oils and fluids	Maintenance	Shipped off Site	150
Batteries	Maintenance	Shipped off Site	15
Spent activated carbon	Domestic	Shipped off Site	15
Human Waste	Domestic	Shipped off Site	10
Aerosol containers	Misc.	Shipped off Site	9
Empty compressed gas cylinders	Misc.	Shipped off Site	minimal
Kitchen grease	Kitchen	Shipped off Site	65
Crushed drums / plastic pails	Misc.	Shipped off Site	30
Spoiled CaCl	Drilling	Shipped off Site	5
Contaminated Soils or Snow to Landfarm			
Soils contaminated with Hydrocarbon	Fuel spill	On-site treatment (landfarm)	-
Water/ice/snow contaminated with HC	Fuel spill	On-site treatment (landfarm)	-

Note(s):

1. Composition based in part on 2011 Mary River Waste Audit results (Aug 27 - Aug 29).
2. Composition based on Canutuec Hazardous Waste Shipment Manifest from Mary River Project 2011.
3. Poly-chlorinated plastics will be sorted out of waste stream and sent to landfill and will not be incinerated.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 22-3: Waste Generation Estimate

Time Period	On Site Personnel	Total Waste Generated (excluding sludge and ash)[1]	Total Domestic Related Waste Generated	Total Construction Related Waste Generated	Total Waste Expected to be Generated On Site[4]	Incineration Waste		Inert Landfill Waste			
						33% of Waste Stream - Suitable for Incineration	Total Waste Incinerated	66% of Waste Stream - Suitable for Landfill[6]	Inert Wastes[3]	Ash[2]	Total
		(tonnes)							(m^3)		
Pre-development Work											
Daily (avg)	100	0.6	0.3	0.3	0.6	0.2	0.2	0.4	0.9	0.2	1.1
Total[7]	36300	203	94	110	203	68	68	136	339	68	407
Daily (avg)	300	1.7	0.8	0.9	0.9	N/A[5]	N/A[5]	0.9	2.3	N/A[5]	2.3
Total[7]	67500	378	174	204	204	N/A[5]	N/A[5]	204	510	N/A[5]	510
Daily (avg)	50	0.3	0.1	0.2	0.3	0.1	0.1	0.2	0.5	0.1	0.6
Total[7]	23400	131	60	71	131	44	44	87	218	44	262
		712	**328**	**385**	**538**	**269**	**269**	**359**	**1068**	**111**	**1179**

Note(s):

1. Disposal Rate of 5.6 kg/day - Cold Region Utilities Monograph, 3rd edition, pg 14-16 1996.
2. Estimated ash density was assumed as 1.0 tonnes/m^3 - AMEC Earth & Environmental. Victor Diamond Mine Project Comprehensive Study. Waste Management Addendum Jan 18 2005.
3. Estimated ash density was assumed as 0.4 tonnes/m^3 for moderately compacted solid waste - AMEC Earth & Environmental. Victor Diamond Mine Project Comprehensive Study. Waste Management Addendum Jan 18 2005.
4. Assumed no domestic waste will come up ashore at Steensby Inlet.
5. No waste appropriate for incineration will be brought or left on-shore at Steensby Inlet.
6. All waste at Steensby brought on site will be disposed of in landfill.
7. Total amount of people days on site during PDW.

© Hatch 2011/09

23. List of Contributors

The DEIS was prepared for Baffinland by a large team of companies and consultants, with Knight Piesold Ltd. As lead environmental consultant (Table 23-2: List of Contributors for the DEIS).

Since the DEIS was submitted in January 2011, Baffinland made the decision to proceed with a definitive feasibility study for the Project and in March 2011, Baffinland retained Hatch as its prime EPCM contractor. The Project execution strategy is currently being developed by Hatch. Therefore, for the PDW submission and necessary permit applications, Hatch provided the engineering support.

The PDW-EIS is largely a subset of the Mary River Project DEIS. Baffinland personnel took the lead in the preparation of this PDW-EIS and requested assistance from various experts and environmental consultant as necessary. The list of key contributors for preparation of the PDW-EIS is presented in Table 23-1.

Table 23-1 List of Contributors for DEIS

Person	Role	Contact Details
Erik Madsen V.P. Sustainability	Review and approval	Baffinland Iron Mines Corporation erik.madsen@baffinland.com
Jim Millard Environmental Superintendent	Review and management plans	Baffinland Iron Mines Corporation jim.millard@baffinland.com
Fernand Beaulac	PDW-EIS preparation and organization	FPB Management Services fernand.beaulac@baffinland.com
Oliver Curran	Effects Assessment – Terrestrial Environment	Sustainable Results Inc. oliver.curran@baffinland .com
Bevin LeDrew	Effects Assessment - Freshwater Environment and Marine Environment	Sikumiut Environmental Management Ltd bevin.ledrew@sikumiut.ca
Richard Cook	Baseline Summaries, EIS Methodology, Cummulative Effects Assessment, Transboundary Effects Assessment	Knight Piesold Ltd. rcook@knightpiesold.com
Doug Brubacher	Effects assessment for the human environment	Brubacher Development Strategies Inc. dougbrubacher@gmail.com
Michael Settington	Effects Assessment – Terrestrial Environment	EDI Environmental Dynamics Inc. msetterington@edynamics.com
John Binns	Engineering Support and Management Plan for PDW	jbinns@hatch.ca
Michael Hall	Engineering Support	mhall@hatch.ca

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Table 23-2: List of Contributors for the DEIS

Person	Role	Contact Details
Project Management		
W.A. (Bill) Napier, M.Sc.	Client review	Baffinland Iron Mines Corporation[3] bill.napier@baffinland.com
Matthew Pickard, MBA, P.Geo, CCEP, CRSP	Client review, Project management	Baffinland Iron Mines Corporation[3] matthew.pickard@baffinland.com
David McCann, P.Eng.	Client review of EHS Management System and Project Definition	Baffinland Iron Mines Corporation[3] david.mccann@baffinland.com
James (Jim) Millard, M.Sc., P.Geo.	Client review of geochemistry, EHS Management System	Baffinland Iron Mines Corporation[3] jim.millard@baffinland.com
Linda Chepyha	Administrative assistance, document preparation	Baffinland Iron Mines Corporation[3] linda.chepyha@baffinland.com
Oliver Curran	Review of baseline studies	Sustainable Results, Inc.[22] oliver.curran@sustainableresults.ca
Fernand Beaulac	Environmental Management System and management plans; accidents and malfunctions, senior review	FPB Management Services[21] fernand.beaulac@gmail.com
Richard Cook	EA preparation manager; Project description; Inuit knowledge study manager; regulatory lead, senior/technical review	Knight Piésold Ltd.[1] rcook@knightpiesold.com
Ken Embree, P.Eng.	Senior review, company principal	Knight Piésold Ltd.[1] kembree@knightpiesold.com
Steve Aiken, P.Eng.	Senior review	Knight Piésold Ltd.[1] saiken@knightpiesold.com
Barb McCord	Technical editor	Doyle Resources 2000 Ltd.[10] bemccord@shaw.ca
Andy Phillips, P.Eng.	EA document control manager	Knight Piésold Ltd. [1] aphillips@knightpiesold.com
Caroline Duval	Administrative assistance; document preparation	Knight Piésold Ltd.[1] cduval@knightpiesold.com
Amanda Daigle	Administrative assistance; document preparation	Knight Piésold Ltd.[1] adaigle@knightpiesold.com
Amanda Moore	Drafting lead	Knight Piésold Ltd.[1] amoore@knightpiesold.com

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Person	Role	Contact Details
Project Description		
Carole Burnham	Updated Project description; cultural resources baseline summary and effects assessment	Carole Burnham Consulting[11] cburnham@allstream.net
Steve Walker	Geochemistry and water quality runoff estimates	AMEC Americas Ltd.[4] Steve.Walker@amec.com
Socio-Economic		
Doug Brubacher	Socio-economic baseline and effects assessment	Brubacher Development Strategies Inc.[9] dougbrubacher@gmail.com
Jason Prno	Inuit knowledge studies	Knight Piésold Ltd[1] jprno@trailheadconsulting.ca
Shelly Elverum	Inuit knowledge studies	Knight Piésold Ltd[1]
Anna Potoczna	Land use baseline update and effects assessment	Knight Piésold Ltd[1] apotoczna@knightpiesold.com
Claude Pinard	Archaeological surveys (2008 and 2010); cultural resources effects assessment	Claude Pinard[14] pinardc@videotron.ca
Atmospheric		
Alain Carrière	Project Manager - climate, air quality and noise baseline and effects assessments	RWDI AIR Inc.[5] alain.carriere@rwdi.com
Ahammad Ali	Air quality modeling	RWDI AIR Inc.[5] ahammad.ali@rwdi.com
Kyle Hellewell	Noise baseline and effects assessment	RWDI AIR Inc.[5] kyle.hellewell@rwdi.com
Mike Lepage	Senior air quality review	RWDI AIR Inc.[5] mike.lepage@rwdi.com
Sharon Schajnoha	Air quality baseline and effects assessment	RWDI AIR Inc.[5] sharon.schajnoha@rwdi.com
Terrestrial		
Kevin Hawton, P.Eng.	Geotechnical investigations	Knight Piésold Ltd[1] khawton@knightpiesold.com
Rob Mercer, Ph.D., P.Eng.	Geomechanical investigations and hazard assessment, including pit slope, deep thermistor and tunnels	Knight Piésold Ltd[1] rmercer@knightpiesold.com
Charlotte Dubec	Landforms, soil and permafrost effects assessment	Knight Piésold Ltd[1] cdubec@knightpiesold.com

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Person	Role	Contact Details
Kevin Jones, P.Eng.	Specialist permafrost geotechnical input	EBA Engineering Consultants Ltd.[17] kjones@eba.ca
Page Burt	Vegetation baseline study and effects assessment	Outcrop Ltd.[15] page@outcrop.com
Michael Setterington, R.P.Bio.	Terrestrial mammal baseline and effects assessment	EDI Environmental Dynamics Inc.[16] msetterington@edynamics.com
Matt Evans, Ph.D.	Terrestrial bird baseline and effects assessment	AMEC Americas Ltd.[4] Matt.Evans@amec.com
Graeme Pelchat, M.Sc.	Terrestrial mammal baseline and effects assessment	EDI Environmental Dynamics Inc.[16] gpelchat@edynamics.com
Shannon Stotyn, M.Sc.	Terrestrial mammal baseline	EDI Environmental Dynamics Inc.[16] sstotyn@edynamics.com
Sophie Czetwertynski, Ph.D.	Terrestrial mammal baseline	EDI Environmental Dynamics Inc.[16] sczetwertynski@edynamics.com
Matthew Power, AScT	Terrestrial mammal baseline	EDI Environmental Dynamics Inc.[16] mpower@edynamics.com
Robert Elliot	Terrestrial mammal habitat suitability modelling	LGL Ltd.[7] telliot@lgl.com
Peter Quinby, Ph.D.	Terrestrial bird habitat suitability modelling	Knight Piésold Ltd[1] pquinby@knightpiesold.com
Freshwater		
Ryan Stinson	Water quality effects assessment	Knight Piésold Ltd[2] rstinson@knightpiesold.com
Kyle Terry	Hydrology baseline study and effects assessment	Knight Piésold Ltd[2] kterry@knightpiesold.com
Shannon Roach	Water and sediment quality baseline study	Knight Piésold Ltd[1] sroach@knightpiesold.com
Megan Cooley, M.Sc., P.Biol.	Freshwater fish and fish habitat baseline and effects assessment	North/South Consultants Inc.[13] mcooley@nscons.ca
Karl Kroeker, R.P. Bio., P. Biol.	No Net Loss Planning; freshwater fish and fish habitat baseline and effects assessment	North/South Consultants Inc.[13] kkroeker@nscons.ca
Richard Remnant, M.N.R.M.	Freshwater fish and fish habitat baseline and effects assessment	North/South Consultants Inc.[13] rremnant@nscons.ca

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Person	Role	Contact Details
Leanne Zrum, M.Sc., R.P. Bio., P. Biol.	Freshwater fish and fish habitat baseline and effects assessment	North/South Consultants Inc.[13] lzrum@nscons.ca
Michael Johnson, M.Sc.	Freshwater fish and fish habitat baseline reporting	North/South Consultants Inc.[13] mjohnson@nscons.ca
Gaylen Eaton, M.N.R.M.	Freshwater fish and fish habitat baseline reporting	North/South Consultants Inc.[13] geaton@nscons.ca
Marine		
Warren Bernhardt	Marine mammal baseline studies and effects assessment	North/South Consultants Inc.[13] wbernhardt@nscons.ca
Kathleen Dawson	Marine baseline studies (Oceanography, Marine mammals)	North/South Consultants Inc.[13] kdawson@nscons.ca
Brianna Wyn	Marine water and sediment baseline study and effects assessment	North/South Consultants Inc.[13] bwyn@nscons.ca
Stacy Hnatiuk	Marine water and sediment baseline study and effects assessment	North/South Consultants Inc.[13] shnatiuk@nscons.ca
Micheal Lawrence	Senior review and advice	North/South Consultants Inc.[13] mlawrence@nscons.ca
Robert Elliott	Marine mammal baseline studies and effects assessment	LGL Ltd.[7] telliot@lgl.com
Val Moulton	Marine mammal effects assessment	LGL Ltd. [6] vmoulton@lgl.com
Rolph Davis, Ph.D.	Senior review	LGL Ltd.[7] rdavis@lgl.com
Meike Holst	Marine mammal effects assessment	LGL Ltd. [18] mholst@lgl.com
Nathalie Patenaude, Ph.D.	Marine mammal baseline report lead	LGL Ltd.[7] npatenaude@lgl.com
Patrick Abgrall, Ph.D.	Marine mammal baseline report	LGL Ltd.[7] pabgrall@lgl.com
Mark Fitzgerald	GIS-map preparation	LGL Ltd.[7] mfitzgerald@lgl.com
Rolph Davis, Ph.D.	Senior review and advice	LGL Ltd.[7] radavis@lgl.com
William Cross	Senior review	LGL Ltd.[7] wecross@lgl.com
W. John Richardson, Ph.D.	Senior advice	LGL Ltd.[7]

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Person	Role	Contact Details
		wjr@lgl.com
Charles Greene, Jr., Ph.D.	Senior review and advice	Greeneridge Sciences,[19] cgreene@greeneridge.com
Mikhail Zykov	Acoustic modelling lead	Jasco Applied Sciences[20] Mikhail.Zykov@jasco.com
Marie-Noel Matthews	Acoustic modelling	Jasco Applied Sciences[20] Marie-Noel.Matthews@jasco.com
Matt Evans, Ph.D.	Marine bird baseline report	AMEC Americas Ltd.[4] matt.evans@amec.com
Bevin LeDrew	Senior review	Sikumiut Environmental Management Ltd.[12] Bevin.LeDrew@sikumiut.ca
Cumulative Effects and Other Assessments		
Tobin Seagal, MEDes, R.P.Bio.	Cumulative effects assessment	Knight Piésold Ltd.[2] tseagal@knightpiesold.com
Heather Lindsay, M.Sc., P. Eng.	Preparation of preliminary closure plan	AMEC Americas Ltd.[4] heather.lindsay@amec.com
Todd Mitchell	Oil handling facility plans and spill response planning	Navenco Marine Inc.[8] todd@navenco.com

Note(s)

1. Knight piésold ltd., 1650 main street w., north bay, ontario p1b 8g5; tel (705) 476-2165.
2. Knight piésold ltd., suite 1400 - 750 west pender, vancouver, british columbia v6c 2t8 ; tel (604) 685-0543.
3. Baffinland iron mines corporation, 120 adelaide street w., toronto, ontario m5h 4t4; tel (416) 364-8820.
4. Amec earth and environmental a division of amec americas ltd. 160 traders blvd. East, suite 110. Mississauga, ontario l4z 3k7; tel (905) 568-2929.
5. Rwdi air inc., 650 woodlawn road west, guelph ontario n1k 1b8; tel (519) 823-1311.
6. Lgl ltd. P.o. box 13248 station a, 388 kenmount road., st. John's, newfoundland a1b 4a5; tel (709) 754-1992.
7. Lgl ltd. P.o. box 280, 22 fisher st., king city, ontario l7b 1a6; tel (905) 833-1244.
8. Navenco marine inc. 350 boul. Ford, suite 130., chateauguay, quebec j6j 4z2; tel (450) 698-2810.
9. Brubacher development strategies inc. 105 caroline ave., ottawa, ontario k1y 0t1; tel (613) 715-9708.
10. Doyle resources 2000 ltd., 40 silver ridge crt. Nw., calgary, alberta t3b 4v5; tel (403) 547-1619.
11. Carole burnham consulting. 26 plateau cres., north york, ontario m3c 1m8; tel (416) 445-0500.
12. Sikumiut environmental management ltd. P.o. box 39089 175 hamlyn rd. St. John's newfoundland a1e 5y7; tel (709) 754-0499.
13. North/south consultants inc. 83 scurfield blvd., winnipeg, manitoba r3y 1g4; tel (204) 282-3366.
14. Claude pinard. 12524 odette oligny, montreal, quebec h4j 2r4; tel (514) 334-3618.
15. Outcrop ltd. 800-4920 52 st., yellowknife, nunavut x1a 3t1; tel (867) 766-6700.
16. Edi environmental dynamics inc. Suite 780 - 1100 melville st., vancouver, british columbia v6e 4a6; tel (604) 633-1891.
17. Eba engineering consultants ltd. 14940 - 123 ave., edmonton, alberta tsv 1b4; tel (780) 451-2121.
18. Lgl ltd., 9768 second street, sidney, british columbia v8l 3y8; tel (250) 656-0127.
19. Greeneridge sciences 6160 - c wallace becknell road, santa barb4ara, california 93117; tel (805) 967-7720.
20. Jasco applied sciences 432 - 1496 lower water street, halifax, nova scotia, b3j 1r9; tel (902) 405-3336.
21. Fpb management services, 1000 english bluff road, delta, b.c., v4m 2n6; tel: (604) 948 2165.
22. Sustainable results, inc., 144 pinegate road, port perry, on, l9l 1b5; tel (416) 577-5829.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

24. References

It must be noted that the environmental effects assessment of the PDW was an integral part of the Mary River Project DEIS submitted in January 2011. The PDW-EIS must be viewed as a subset of the much larger Mary River Project DEIS and most technical references for baseline information and effects assessment refers to documents and studies presented in support of the DEIS. For this reason, and to enable rapid and convenient cross-referencing for the readers and reviewers, the electronic submission of this PDW application includes a copy of the DEIS and its Addendum.

1. Baffinland Iron Mines Corporation, Draft Environmental Impact Assessment, January 2011
2. Baffinland Iron Mines Corporation, Addendum to Draft Environmental Impact Assessment, January 2011
3. Brubacher Development Strategies. 2009. ***Jericho Diamond Mine: 2007 Socio-Economic Monitoring Report***. Prepared for the Kitikmeot Socio-Economic Monitoring Committee. 80 p.
4. Human Resources and Skills Development Canada (HRSDC). 2006. ***National Occupational Classification Matrix 2006***. Available online at: http://www5.hrsdc.gc.ca/noc/english/noc/2006/pdf/Matrix.pdf.
5. Sivummut Economic Development Strategy Group. 2003. ***Nunavut Economic Development Strategy: Building a Foundation for the Future***. Available online at Nunavut Economic Forum: http://www.nunavuteconomicforum.ca/public/files/strategy/NUNAVUTE.PDF.

© Hatch 2011/09
Safety • Quality • Sustainability • Innovation

Appendix A:
Permit Applications in Support of PDW
Provided in Electronic Format

© Hatch 2011/09

Appendix A.1:
QIA – 2012 Work Plan: Work on Inuit Owned Land
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix A.2:
NWB – Application for Amendment to Water License
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix A.3:
AANDC – Crown Land Lease for Steensby Site
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix A.4:
AANDC – Quarry Lease for Steensby Site
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix A.5:
DFO – Request for Steam Crossing Authorization at Steensby
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B:
Management Plans
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.1:
Emergency Response and Spill Contingency Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.2:
Oil Pollution (OP) EP for Milne Port
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.3:
OPEP for Steensby Port
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.4:
Site Surface Water and Aquatic Ecosystem Management Plan
Provided in Electronic Format

© Hatch 2011/09

Appendix B.5:
Wastewater Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.6:
Waste Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.7:
Quarry Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.8:
Wildlife Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.9:
Shipping Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.10:
Explosives Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.11:
Health and Safety Management Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix B.12:
Abandonment and Reclamation Plan
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix C:
Drawings in Support of Pre-Development Work

© Hatch 2011/09

Appendix C .1:
Drawing List

© Hatch 2011/09

Appendix C.2: Drawings

© Hatch 2011/09

Appendix D:
Model Graphics / Photographic Views in Support of Pre-Development Work

© Hatch 2011/09

Appendix E:
Technical Documents
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix E .1:
Technical Document List
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix E .2:
Design Criteria, Design Basis, Technical Specifications
Provided in Electronic Format

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Appendix F:
Details Construction Equipment List
Provided in Electronic Format

© Hatch 2011/09

Appendix G:
Definitions

© Hatch 2011/09

Safety • Quality • Sustainability • Innovation

Definitions

Adaptive Management Plans	A systematic, rigorous approach for deliberately learning from management actions with the intent to improve subsequent management policy or practice.
Agreement-in-Principle	A non-legally enforceable agreement, subject to final ratification or signing by parties to a future agreement.
Air Quality Modelling	To predict the potential fate and transport of Project-related air emissions at Milne Port (including ore haulage traffic), the Mine Site, and Steensby Port (including railway operations).
Ballast Water Dispersion Modelling	To understand the physical aspects of ore carriers discharging large volumes of ballast water while at dock at Milne and Steensby Ports.
Baseline	Environmental settings in the Project area as they exist naturally or pre-development, against which changes in the environment from a Project can be assessed.
Best Practice Methods	A technique, method, process, or activity which conventional wisdom regards as most effective at delivering a particular outcome.
Bulk Sample	A large ore sample extracted as a test for the purpose of demonstrating the quality of an ore and/or the economic viability of mining the ore.
Certainty	The level of confidence in the knowledge or analysis that supports the prediction, in particular with respect to limitations in overall understanding of the ecosystem, and limitations in the ability to foresee future events or conditions.
Closure and Post-Closure Phase	Considered the period required for decommissioning and/or removing Project infrastructure.
Community Liaison Office	A first point of contact for communities in terms of obtaining or exchanging information on the Project and employment.
Construction Phase	Defined by the length of the construction phase of the railway.
Consultation	Information exchange.

© Hatch 2011/09

Crown Land	Land owned by the Federal Government, administered by Indian and Northern Affairs Canada within Nunavut.
Cumulative Effects	Refers to effects that result from incremental changes caused by interactions between the Project and other past, present, or reasonably foreseeable future Projects or activities.
Definition Phase	Inclusive of all exploration and research programs, as well as the bulk sampling program carried out in 2007 and 2008.
Direct Effects	Refers to changes in the VC that result from direct interactions between Project activities and the environment.
Direction and Nature (of an Effect)	The ultimate long-term trend of an environmental effect - positive, neutral, or negative.
Duration	The period over which an effect will occur.
Ecological Land Classification	To predict the distribution and relative quality of terrestrial wildlife habitat and specific plant species.
Ecological/Socio-Economic Context/Value	The general characteristics of the area in which the Project is located, as indicated by existing levels of human activity and associated types of disturbance. Interpreted to mean the basis for assigning "value" to the particular VEC.
Economic Impact Modelling	To estimate the monetary flows generated and induced by Project expenditures.
Ecosystemic	Relating to the complex of a natural community of living organisms and its environment functioning as an ecological unit in nature.
Effects Assessment	An assessment of the environmental and socio-economic effects of a Project, using accepted methodologies.
Environmental Components	Human, atmospheric, terrestrial, freshwater, and marine.
Environmental Effect	A positive or negative change in the biophysical and/or socioeconomic environment caused by or directly related to a proposed activity.
Environmental Impact Statement	A statement of an evaluation of the predicted environmental and socio-economic effects of a proposed undertaking or Project.

© Hatch 2011/09

Environmental Sensitivity	Refers to areas of heightened sensitivity that will be identified where applicable in relation to the Project (i.e., areas sensitive to spills; caribou calving areas).
Equity	Considers whether those experiencing an effect have made a choice to engage in the Project.
Extent (of an Effect)	The geographic area over which the interaction will occur.
Federal Claims	Mining claims registered with the Federal Government Mining Recorders Office at Indian and Northern Affairs Canada.
Frequency (of an Effect)	The number of times during a Project or a Project phase that an interaction or environmental effect can be expected to occur.
Geographical Extent	Identifies whether the effect will be experienced in the smaller communities, in Iqaluit, or in both these areas.
Igloolingmiut	Residents of Igloolik.
Impact Significance	Based on comparing the predicted state of the environment with and without the Project, and expressing a judgment as to the importance of the changes identified.
Indirect Effects	Refers to effects on the environment that are not a direct result of the Project.
Information	Flow from the company to stakeholder.
Interaction	Relating key Project activities with valued components and key indicators.
Inuit Qaujimajatuqangit	Traditional, current and evolving body of Inuit values, beliefs, experience, perceptions and knowledge regarding the environment, including land, water, wildlife and people, to the extent that people are part of the environment.
Inuit Qaujimaningit	(a) Inuit traditional knowledge and variations of Inuit Traditional Knowledge; (b) Inuit epistemology relating to: Inuit Societal values (including the legal obligations set out in the NLCA regarding Inuit Participation, Inuit employment and training, etc.); and Inuit knowledge (both contemporary and traditional).

© Hatch 2011/09

Inuit-Owned Land	Land identified in the Nunavut Land Claims Agreement (NLCA) as being held by a designated Inuit Organization. May include ownership of surface rights only or both surface and sub-surface (i.e. mineral) rights.
Inuktitut	Dominant language in Nunavut.
Invited Persons	Individuals invited to participant in consultation based on their particular community status (Elders and youth), knowledge (health and social services), or skill set in a particular field (economic development).
Kajjuqtikkut Workshop	A five-day workshop held in Arctic Bay on March 10-14, 2008, attended by members of the five Inuit Knowledge Study working groups. The key themes of transportation (marine and rail), caribou, marine mammals, and socio-economic issues were discussed and minutes recorded.
Key Indicators or Environmental Indicators	Subsets of VECs or VSECs used to communicate information about the environmental effects of the Project. The use of indicators is a pragmatic approach to conducting environmental effects assessment, where evaluating every potential effects on the receiving environment is not practical.
Key Issues	Interactions that are of substantial public interest and/or of potentially high environmental importance or consequence and, consequently require rigorous investigation and analysis in the EIS.
Level of Confidence	Related to limitations in the overall understanding of the ecosystem and limitations in accurately foreseeing future events or conditions.
Likelihood	A parameter is assigned both a probability dimension as well as a level of certainty, to qualify significance rankings relative to the likelihood that the predicted effects will actually occur.
Local Study Area	The study area that describes areas within and directly adjacent to the Project footprint, and that may be subject to direct and indirect effects. See Regional Study Area.
Magnitude (of an Effect)	The amount or degree of change in a measurable parameter or variable relative to existing conditions (the exposed population).

© Hatch 2011/09

Management Required	Active intervention is required to bring the effect to an acceptable level.
Marine Ecology	Includes marine mammals, marine fish and lower trophic levels, physical and chemical oceanography, and marine and shoreline habitats.
Marine Spill Modelling	To estimate the potential trajectory of a catastrophic spill of diesel fuel in the marine environment.
Mary River Project Components	The main Project development areas including Milne Port, Milne Inlet Tote Road, Mine Site, Railway, and Steensby Port.
Measurable Parameters	Clearly defined aspects of an indicator (VEC/VSEC) that can be quantified and compared against a baseline value or condition; has an associated performance level or standard that can establish an effect magnitude or indicate compliance with formal standards.
Mitigation Measures	Management actions or strategies applied to minimize or eliminate negative environmental effects. They are also used to reduce or eliminate the potential residual effects of the Project and are identified in each of the effects assessments, along with potential residual effects of the Project.
Monitoring	Systems that will be put into place to document the adequacy of each mitigating action in reducing impacts to insignificant levels.
Negotiation	Face-to-face discussions with the intent of reaching agreement.
Noise Modelling	To predict the noise generated at Milne Port, the Mine Site, and Steensby Port.
Non-Reversible	Effect will not be reversed.
Operations Phase	Includes the 3 Mt/a road haulage operation and open-water shipping from Milne Inlet, and the 18 Mt/a railway operation and year-round shipping from Steensby Port.
Oral Tradition	Written materials are of secondary importance as a communication tool in the communities, as many people do not have the ability or the comprehension level with reading.

© Hatch 2011/09

Overall Significance (of an Effect)	Derived from the experience and professional judgment of the environmental practitioners who prepared the assessment, considering the rankings of the contributing attributes of significance.
Participation	Active interaction and more intensive form of consultation.
Permafrost Depth Modelling	Extrapolation of deep thermistor data to establish a basement depth of permafrost.
Physical Environment	Includes climate, air, noise, water, waste rock characterization, soils, and the physical aspects of archaeology.
Pit Lake Quality Modelling	To predict the long-term quality and ecological risk posed by the post-closure pit configuration.
Point-of-Hire Locations	Communities where the company currently operates and plans to operate direct flights to and from the Project sites.
Potential Development Areas	A boundary established to encompass a Project component, where future development is expected to occur.
Potentially Affected Communities	A community or communities with the potential to be impacted, either positively or negatively, by a proposed Project or development. Such communities may be defined physical entities or comprised of dispersed populations in the area of influence of a development or Project.
Probability	The likelihood that an interaction and a consequent effect will, in fact occur.
Qualitative Analysis	A non-numerical estimation of the magnitude of an effect.
Quantitative Analysis	Use of numbers to estimate the magnitude of an effect.
Research Agreement	Agreement negotiated between Baffinland and each working group that articulates the agreed-on study approach and intended use of the information.
Residual Impacts	Impacts after mitigation have been applied.
Residual Projects Effects	Refer to the environmental effects identified for the Project, post-mitigation.

© Hatch 2011/09

Resource Selection Function	To predict the probability of caribou occurrence throughout the RSA based on recent collar data.
Reversibility	The likelihood that a VEC/VSEC or Indicator will recover from an environmental effect, including consideration of active management techniques. Reversibility is considered for biological VECs at the population level. Therefore, although an effect like mortality is irreversible, the effect at the population level might be reversible.
Significance Evaluation	An evaluation of the "significance" of environmental effects.
Social Extent	Identifies the specific groups or social units most likely to experience an effect.
Socio-Economics	Includes demographics, workforce experience, health, social services, youth, education, economic development, opinions, perceptions, and the spiritual aspects of archaeology.
Spatial Boundaries	The anticipated zone of influence of Project effects.
Spontaneously Reversible	Effect reverses with no intervention within an acceptable time frame.
Stakeholder Engagement	Activities that engage stakeholders in the Project, or in the review of the Project.
Stakeholders	The Inuit communities proximate to the Project sites the public, local and regional Inuit organizations, the Government of Nunavut, and federal agencies with a mandate relevant to the Project.
Subjects of Note	Interactions are those that are less likely to be of notable environmental importance or consequence.
Temporal Boundaries	The period analyzed within which the Project or Project activities interact with environmental or socioeconomic components.
Terrestrial Ecology	Includes terrestrial wildlife and wildlife habitat (e.g., caribou and carnivores), birds (e.g., raptors, geese, loons, shorebirds and songbirds), freshwater fish and fish habitat, vegetation, habitats, and biodiversity.
Thresholds	Limits of acceptable change determined from regulated guidelines or by professional opinion.

© Hatch 2011/09

Timing	The Project Phase within which the environmental effect will occur.
Value	The value attached to the affected VEC or VSEC by those who identified them. An environmental or socio-economic component was identified as "valued" and was addressed in the EIS if it was found to have a high value to communities.
Valued Components (VCs)	VCs identify key species or topics to focus the effects assessment. NIRB (2007) distinguishes between valued ecosystem components (VECs) as the VCs of the biophysical environment, and "valued socio-economic components" (VSECs) relating to the human, economic, and spiritual environment.
Valued Ecosystem Component (VECs)	Environmental attributes or components perceived to be locally important based on local ecological, social, cultural, and/or economic reasons.
Valued Socio-Economic Components (VSECs)	Environmental attributes or components perceived to be locally important based on local social, cultural, and/or economic reasons.
Water Quality Modelling	To estimate the quality of water that contacts and runs off waste rock and ore stockpiles.
Working Groups	The working groups have provided valuable insights into community and cultural values, priorities, fears, and hopes, and helped researchers prepare culturally sensitive and appropriate research methodologies and plans. Additionally, the presence of working groups facilitates information flow between the company and the communities.

© Hatch 2011/09

Sheridan Science and Technology Park, 2800 Speakman Drive
Mississauga, Ontario, Canada L5K 2R7
Tel 905 855 7600 ◆Fax 905 855 8270 ◆ www.hatch.ca