AGNICO EAGLE

MELIADINE GOLD MINE

Shipping Management Plan

MARCH 2019

VERSION 8

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FIGURES AND TABLES

DOCUMENT CONTROL

Version	Date	Section	Page	Revision	Author
1	December 2012			First draft of the Shipping Management Plan	John Witteman, Env. Consultant, AEM
2	March 2013			DEIS re-submission; rebranding	
3	April 2014	1.1 1.2 3 4 4.2	1 4 10-11 14 16	Anticipated increased shipping traffic Updated Figure 1-1 Added details on AWPPA and regs. and Shipping Safety Control Zone Mention of marine birds and ship track data Distance of release from Itivia Spill vs marine wildlife	John Witteman, Env. Consultant, AEM
4	January 2016	1.1 1.3.3 2.3 2.4 4.1 4.2 4.3 9.2 10 A-B A-D A-E	1 6 7 8 13-14 14-15 15-16 23 24	Decrease in shipping traffic Added details for cyanide Update spill support Added details to SOPEP Reference to Spill Risk Assessment Updated mitigation and reference to MEMP and MMSO program in accordance with Project Certificate conditions. Updated monitoring activities and reference to MEMP and MMSO program. Removed last paragraph Update to safety Added Revised Marine Baseline Assessment Added Marine Environmental Management Plan (MEMP) Added Revised Spill Risk Assessment	Phil Rouget, Golder Associates Ltd.
5	August 2016	1.3.3 Table 3-1	6 12	Up to date Safety Bulletin in relation to vessels Added that ammonium nitrate is listed under schedule 1 of the Environmental Emergency Regulations. Update to Navigation Protection Act.	Katelyn Zottenberg, Golder Associates Ltd.

				Added Section 36(3) of the *Fisheries Act.*	
		4.2	15	Updated wording "Subject to safe navigation…" Footnote added to include how vessel wake was assessed in the FEIS. Updated to wording around marine mammal mitigation. (changed to 500 m buffer zones).	
		Appendix D	2.2.1.2	Added Government of Nunavut as lead management responsibility for polar bears.	
		Appendix D	Table D-4	Changed wording regarding the handling of birds during a spill.	
		Appendix D Appendix B Figure B3	 1.0	Updating wording to state the intent of the MMSO program. Revised	
6	February 2017	Appendix D	2.1.3	Updated to include more detailed protocols for marine mammal and seabird surveys/observations (specifically the ECSAS protocols for seabirds as request by ECCC)	Katelyn Zottenberg, Golder Associates Ltd.
		Figure 1-1 Executive Summary Sections 1.0, 4.0, 11, 12 and 13	4 vi 1, 14, 26, 30, 28	Updated text to reflect comments received from dry cargo shipping contractor (Desgagnes Transarktic). Key edits related to shipping of dry cargo shipping operations included (description of lightering operations, potential anchor location (dry cargo vessels only), number of vessel, and potential nighttime operations).	
6	March 2017	Throughout the Shipping Management Plan		Minor wording updates to the text to reflect comments received from dry cargo shipping contractor (Desgagnes Transarktic).	Katelyn Zottenberg, Golder Associates Ltd.
7	March 2019	Throughout the Shipping Management Plan		Updated wording to reflect current management status.	Dan Gorton
		Section 4.3	17	Updated to address NIRB condition 127.	

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ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐸᕐᓇᐅᑎ ᐱᓕᕆᐊᖑᓚᐅᖅᑐᖅ ᒪᓕᒃᓱᒋᑦ ᑲᓇᑕᐅᑉ ᒪᓕᒐᖏᑦ, ᐱᓗᐊᖅᑐᒥᑦ *ᑲᓇᑕᒥᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᐱᕐᔪᖅ ᐊᒻᒪᓗ ᐅᑭᐅᖅᑕᖅᑐᒥᑦ ᐃᒪᕐᓂᒃ ᐱᐅᖏᑦᑐᖃᓕᖅᑎᑦᑎᑦᑕᐃᓕᒪᓂᕐᒧᑦ ᐱᕐᔪᖅ*, ᐊᒻᒪᓗ ᑕᒪᒃᑯᓄᙵ ᒪᓕᒐᕋᓛᑦ. ᐃᓕᑕᖅᓯᓯᒪᖕᒥᔪᖅ ᓄᓇᕐᔪᐊᕐᒥᑦ ᑲᒪᔾᔪᐃᔪᓂᒃ ᐊᒻᒪᓗ ᒪᓕᒃᑕᐅᔪᓂᒃ ᐊᑎᓕᖅᑕᐅᓯᒪᔪᑦ ᑲᓇᑕᒧᑦ. ᐊᓐᓂᑯᒃᑯᑦ ᑐᓂᓯᖃᑦᑕᖅᑐᑦ ᐱᔭᕆᐊᖃᖅᑐᓂᒃ ᐃᓄᖕᓄᑦ, ᐊᑐᖅᑕᐅᔪᓄᑦ ᐊᒻᒪᓗ ᑰᓇᐅᔾᔭᕐᕕᐅᔫᓂᒃ ᑎᑭᐅᑎᓂᐊᕐᓗᑎᒃ ᐅᕝᕙᓘᓐᓃᑦ ᐅᖓᑕᐅᑦᑎᓗᑎᒃ ᐱᔭᕆᐊᖃᖅᑐᓄᑦ ᑲᒪᓂᓘᖕᒐᔪᓂᒃ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᓘᖕᒐᔪᓂᒃ. ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᑳᓐᑐᕌᒃᖃᖅᑐᑦ ᑕᐃᒪᓐᓇᐃᓕᐅᕐᑯᔭᐅᓚᐅᖅᑐᑦᑕᐅᖅ. ᐊᓐᓂᑯᒃᑯᑦ ᐊᒻᒪᓗ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᑳᓐᑐᕌᒃᖃᖅᑐᑦ ᐃᓚᒋᔭᐅᔪᓂᒃ ᐱᔭᒃᓴᐅᑎᖃᕐᓂᕐᒧᑦ ᓇᓪᓕᐅᒃᑯᒫᖃᖅᑐᑦ.

ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᐅᔪᓗᒃᑖᑦ ᐱᓕᕆᐊᖑᔪᑦ ᐊᐅᔭᐅᑎᓪᓗᒍ ᐊᒻᒪᓗ ᒪᓕᒃᓱᑎᒃ ᐅᑐᕐᑯᔭᐅᔪᓂᒃ ᐊᑦᔨᑎᓂᒃ ᒦᓇᐅᔪᖅ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᓂᒃ ᐊᕐᕌᒍᑕᒦᖅ ᐅᒥᐊᕐᔪᐊᒃᑯᑦ ᑎᑭᑎᑕᐅᔪᓂᒃ ᑲᖏᖅᖠᓂᕐᒧᑦ ᐊᓯᖏᓐᓄᓪᓗ ᑭᕙᓪᓕᕐᒥᑦ ᓄᓇᓕᖕᓂᑦ. ᓯᑯᒥᒃ ᓯᕐᑯᑎᓇᓂᖃᑦᑕᙱᑦᑐᑦ ᐅᐃᒍᕆᐊᖅᓯᓂᐊᕐᓗᑎᒃ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᐅᔪᒥᒃ.

ᑎᑭᒃᑳᙵᓚ ᑲᖏᖅᖠᓂᕐᒧᑦ, ᐅᒥᐊᕐᔪᐊᓗᒃᑖᑦ ᑭᓴᖃᑦᑕᖅᑐᑦ ᐃᑎᕝᕙ ᓯᓚᑖᓂᓘᓐᓃᑦ ᐃᑎᕝᕙᐊᓂᓘᓐᓃᑦ. ᐸᓂᖅᑐᑦ ᐅᓯᔭᐅᔪᑦ ᓯᑲᐅᓄᐊᖅᑕᐅᖃᑦᑕᖅᑐᑦ ᐊᓯᖅᑕᐅᐸᓗᑎᒃ ᐊᕐᑯᑕᐅᔪᒃᑯᑦ ᐊᑐᖅᓱᑎᒃ ᐅᒥᐊᕐᓂᒃ. ᓯᑲᐅᒃᑯᑦ ᐊᓯᖅᑕᐅᓕᖅᓱᑎᒃ ᐸᓂᖅᑐᑦ ᐅᓯᔭᐅᔪᑦ ᓯᑲᐅᒃᑯᑦ ᑐᓚᒃᑾᖕᒧᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᑲᖏᖅᖠᓂᐅᐸ H ᐋᓪᓚᒃᑯᖏᓐᓄᑦ ᐊᕐᕌᒍᑕᒦᖅ ᐱᕐᑰᑦ ᑎᑭᐸᓪᓕᐊᔪᓄᑦ ᓄᓇᓕᖕᒧᑦ. ᐊᖏᔪᑦ ᐅᖅᓯᐊᓘᓯᕚᑦ ᑐᓚᖃᑦᑕᖅᑐᑦ ᓯᓚᑖᓂᑦ ᐃᑎᕝᕙᐊᑉ. ᓅᑎᓇᓂᖅ ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᐅᒥᐊᕐᔪᐊᕐᒧᑦ ᓯᕗᓪᓕᖅᐹᖑᔪᖅ ᐃᑎᕝᕙᐊᓂᑦ ᐅᖅᓯᐊᓘᓯᕙᖕᓄᐊᕐᓂᐊᕐᓗᒋᑦ ᐅᖅᓯᖅ. ᒥᑭᓂᖅᓴᐃᑦ ᐅᖅᓯᓂᒃ ᐅᓯᔪᑦ ᑭᓴᖅᓱᑎᒃ ᐃᑎᕝᕙᐊᓂᑦ ᐅᒥᐊᕐᔪᐊᖅ ᓅᑎᓪᓗᓂ ᐳᒃᑖᖅᑐᒥᑦ ᓱᐸᓗᓕᒃᑯᑦ ᐅᖅᓯᐊᓘᓯᕙᖕᓄᑦ.

ᐊᓐᓂᑯᒃᑯᑦ ᓯᕗᓪᓕᖅᐸᐅᑎᓂᐊᖅᑕᖏᓐᓂᒃ ᐱᔭᖃᖃᑦᑕᖅᑐᑦ ᐊᐸᖅᑎᒃᑯᑦ ᐊᓪᔭᖅᑐᐃᓂᕐᒥᒃ ᐅᓗᕆᐊᓇᖅᑐᓂᒃ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᓂᒃ, ᐃᓚᐅᐸᓗᑎᒃ ᖄᖅᑕᖅᑐᑦ ᐃᓚᖏᓪᓗ, ᑕᓯᕐᔪᐊᕐᒧᑦ ᑕᐃᒪᓐᓇᐃᑦᑐᓂᒃ ᐅᓯᔭᐅᔪᓂᒃ ᑐᖅᑐᖅᓯᒪᕐᑯᙱᖕᓗᒋᑦ ᐃᑎᕝᕙᐊᓂᑦ. ᐊᓯᖏᑦ ᓂᕈᐅᓇᙱᑦᑐᓕᕆᓃᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᐃᓚᐅᔪᑦ ᑯᕙᔪᖃᖅᐸᑦ ᓂᕈᐅᓇᙱᑦᑐᒃᑯᑦ ᐸᕐᓇᐅᑎ, ᐅᓗᕆᐊᓇᖅᑐᓕᕆᓂᕐᒧᑦ ᐊᐅᓚᑦᑎᓂᖅ ᐊᒻᒪᓗ ᑐᐊᕕᓇᖅᑐᓄᑦ ᐅᐸᓗᐊᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ, ᐊᒻᒪᓗ ᐅᖅᓯᓂᒃ ᑐᐊᕕᓇᖅᑐᓕᕆᓂᕐᒧᑦ ᐸᕐᓇᐅᑎ (OPEP). ᐅᓗᕆᐊᓇᖅᑐᓂᒃ ᐊᒻᒪᓗ ᐋᓂᖅᑎᑦᑎᔾᔭᓇᖅᑐᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ ᑕᕆᐅᕐᒥᑦ ᐅᐸᓗᐊᓂᕐᓘᖕᒐᔪᑦ ᐱᓕᕆᐊᖑᖃᑦᑕᖅᑐᑦ ᐃᓚᒋᔭᐅᐸᓗᓂ ᐊᔪᕈᓐᓃᖅᓴᐃᓂᕐᒥᒃ ᑐᐊᕕᓇᖅᑐᖃᖅᐸᑦ ᐅᐸᓗᐊᔩᓂᒃ (ERT).

ᐊᓐᓂᑯᒃᑯᓐᓄᑦ ᐱᓕᕆᔩᑦ ᐊᒻᒪᓗ ᐊᖓᔪᖅᑳᖑᔪᖅ ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᐱᔭᒃᓴᐅᑎᖃᖅᑐᑦ ᒥᐊᓂᕆᔭᐅᔪᓕᕆᓂᕐᓂᒃ ᐱᔾᔪᑎᖃᖅᑐᓂᒃ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᓘᖕᒐᔪᓂᒃ. ᓂᕈᐅᒋᔭᐅᑎᓪᓗᒍ ᐳᑭᖅᑖᓪᓚᑦ ᐃᓚᐅᑎᑕᐅᔾᔮᙱᓐᓂᖏᓐᓄᑦ ᒥᐊᓂᖅᓯᓂᕐᓘᖕᒐᔪᓂᒃ, ᐱᕋᔭᖕᓂᓗᒃᑖᑦ ᐅᕝᕙᓘᓐᓃᑦ ᓇᒻᒪᙱᑦᑐᓕᓐᓂᑦ (ᓈᕐᓗ, ᑎᓪᓕᖕᓂᐅᔪᑦ) ᑐᓂᐅᑕᐅᓂᐊᖅᑐᑦ ᐳᑭᖅᑕᓕᖕᓄᑦ ᑲᖏᖅᖠᓂᕐᒥᑦ. ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᓘᖕᒐᔪᑦ ᑎᓪᓕᖕᓂᖅᑕᖃᖅᑕᐃᓕᑎᑦᑎᓂᕐᒧᑦ ᑕᐃᒪᐅᔪᑦ. ᐊᖏᓗᐊᖏᒋᐊᖅᑎᑦᑎᓂᕐᓘᖕᒐᔪᑦ ᐊᑐᖅᑕᐅᖃᑦᑕᕐᒥᔪᑦ ᒥᑭᓖᒃᑰᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᐱᐅᖏᑦᑐᑦ ᐃᓄᐃᑦ-ᐱᕈᖅᐸᓪᓕᐊᓂᖏᓐᓄᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒥᑦ ᐱᔪᓂᒃ; ᐱᐅᔪᑦ ᐃᓄᐃᑦ-ᐱᕈᖅᐸᓪᓕᐊᓂᖏᓐᓄᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᓂᕈᐅᒋᔭᐅᔪᑦ.

ᐃᖏᕐᕋᔭᖕᓂᖅ ᐹᐳᕋᑐᐊ ᑕᓇᐅᖏᑦᑎᒍᑦ, Hudson Strait ᐊᒻᒪᓗ ᑕᓯᐅᔭᕐᔪᐊᒃᑯᑦ ᐊᒃᓱᕈᕐᓇᖅᑑᖏᑦᑐᖅ ᐊᐅᔭᒃᑯᑦ. ᐊᖏᔪᓂᒃ ᐋᓂᕈᑕᐅᔪᖕᓇᖅᑐᓂᒃ ᖃᐅᔨᓐᓇᖅᑐᖃᓚᐅᖏᑦᑐᑦ ᐊᕐᑯᑎᒋᔭᐅᔪᓂᑦ ᐅᒥᐊᒃᑯᑦ-ᓯᑲᐅᒃᑯᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᓯᓚ ᖃᐅᔨᓴᐃᖏᑎᓪᓗᒍ. ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᖅ ᐱᓕᕆᐊᖑᔪᖕᓇᖅᑐᖅ ᖃᐅᔨᓴᖅᑎᖃᙱᓪᓗᑎᒃ ᐊᕐᑯᑎᒋᔭᐅᔪᑦ ᒥᑭᔪᒥᒃ ᐋᓂᖅᑎᑦᑎᓂᕐᒧᑦ ᒥᒃᓵᓂᐊᖅᑎᑦᑎᓂᖃᕐᓗᐊᖏᓪᒪᑕ ᐅᒥᐊᕐᔪᐊᖅ ᐅᓗᕆᐊᓇᖅᑐᖃᕐᓂᐊᖏᓪᓗᓂ.

ᐅᒥᐊᕐᔪᐊᓗᒃᑖᑦ, ᓯᑲᐅᑦ ᐊᒻᒪᓗ ᐅᖅᓱᓂᑦ ᐅᓯᖃᑦᑕᖅᑐᑦ ᐊᑐᖃᑦᑕᖅᑐᑦ ᑲᐸᔾᔨᓅᖅᑐᓂᒃ ᐊᓯᖏᓐᓂᓪᓗ ᑲᐸᔾᔨᓅᖅᑐᓂᒃ ᐃᖏᕐᕋᔭᖕᓂᕐᒧᑦ ᐃᑲᔪᖅᑐᓂᒃ ᐅᓗᕆᐊᓇᙱᑦᑐᒃᑯᑦ ᐃᖏᕐᕋᔪᖕᓇᕐᓂᐊᕐᓗᑎᒃ, ᒥᒃᓵᒋᐊᖅᓯᔪᖅ ᐱᓂᕐᓗᐊᕿᓂᐅᔪᕐᓇᖅᑐᓂᒃ, ᐊᒻᒪᓗ ᐊᑉᖁᑎᒋᔭᕆᐊᖃᖅᑕᖏᓐᓂᒃ ᐊᑐᐃᓐᓇᕐᓗᑎᒃ. ᐃᖏᕐᕋᔭᒃᑐᑦ ᐊᑉᖁᑎᒃᑯᑦ ᑐᑭᒧᐊᒃᑎᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᖅᑐᑦ ᐃᓱᐃᓐᓂᒃᑰᖁᓇᒋᑦ, ᐊᒻᒪᓗ ᓇᑭᖅᓴᕐᓂᖏᑦ ᓱᑲᐃᓕᕆᐊᖅᓱᑎᒃ ᐅᓗᕆᐊᓇᖅᑐᖃᖁᓇᒍ. ᐊᖏᕐᕋᒃᑰᖅᑎᓐᓂᐊᕐᓗᒍ ᐅᓗᕆᐊᓇᖅᑐᖃᙱᓐᓂᖅ ᐃᓄᖕᓄᑦ ᐃᖏᕐᕋᔭᒃᑐᑦ ᐅᒥᐊᒃᑯᑦ ᖃᓂᑕᖕᒪᓂᑦ ᖃᖏᖅᓯᓂᐅᑉ ᐊᑉᖁᑕᐅᔪᓂᑦ, ᐊᓪᓃᑯᒃᑯᑦ ᑐᓴᐅᒪᑎᑦᑎᖃᑦᑕᖅᑐᑦ ᓄᓇᓕᖕᒥᐅᓂᒃ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓂᒃ, ᖃᐅᔨᒪᑎᑦᑎᐸᓗᑎᒃ ᖃᓄᐃᓕᐅᕐᓂᖃᕐᑲᐊᖅᑎᑦᑎᐸᓗᑎᒃ ᐅᒥᐊᕐᔪᐊᓂᒃ ᐊᒻᒪᓗ ᒥᑭᔪᓂᒃ ᐅᒥᐊᕐᓂᒃ ᑕᑯᖃᑦᑕᐅᑎᓂᐊᕐᓗᑎᒃ, ᐊᒻᒪᓗ, ᓄᓇᓕᖕᒧᑦ ᑲᒪᓂᕐᒥᒃ ᑲᑎᒪᔨᐊᑳᒃᑯᑦ, ᐃᒪᓐᓈᖅᑐᐃᖃᑦᑕᖅᑐᑦ ᒥᑭᑦᑐᓂᒃ ᐅᒥᐊᕐᓂᒃ ᐊᑐᖅᑐᓗᒃᑖᑦ ᐳᒃᑖᕈᑐᓂᒃ ᐱᖅᑯᐸᓗᒋᑦ.

ᐅᒥᐊᕐᓂᑦ ᐊᒃᑕᑯᓂᑦ ᐊᐅᓚᑦᑎᓂᖅ (ᓯᑎᔪᓂᒃ ᐊᒻᒪᓗ ᐋᓂᕈᑕᐅᔪᕐᓇᖅᑐᑦ ᐊᒃᑕᑯᐃᑦ, ᖁᕐᕕᖕᒥᙶᖅᑐᑦ) ᐱᔭᒃᓴᐅᑎᒋᔭᖕᖓᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᑳᓐᑐᕌᒃᖃᖅᑐᑦ. ᐊᓪᓃᑯᒃᑯᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᑳᓐᑐᕌᒃᖃᖅᑐᓂᒃ ᒪᓕᒋᐊᖃᖅᑎᑦᑎᔪᑦ *ᐃᒪᖅ ᐃᖏᕈᓕᒃᑐᓂᑦ ᐊᐅᓚᓗᐊᖅᑕᐃᓕᔾᔩᑦ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᒪᓕᒐᕿᓂᒃ*, ᒥᒃᓵᒋᐊᖅᑎᑦᑎᓇᔭᖅᑐᖅ ᐋᓂᖅᓯᓂᖅ ᑎᑭᐅᑎᔪᓂᒃ ᓂᕐᔪᑎᓂᒃ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒥᒃ ᐱᔪᓂᒃ. ᐊᓪᓃᑯᒃᑯᑦ ᑳᓐᑐᕌᒃᑎᑦᑎᔪᒪᔪᑦ ᑎᑭᐅᑎᓯᒪᔪᓂᒃ ᐊᑐᕆᐊᓕᖕᓂᒃ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᐱᔭᕆᐊᖅᑐᓂᒃ ᐃᓕᒋᓗᒍ ᐊᑐᖅᑕᐅᔪᕐᓇᕐᓂᖕᖓᑦ ᐊᒻᒪᓗ ᐱᐅᔪᒥᒃ ᐅᓗᕆᐊᓇᖅᑐᖅᑕᐃᓕᓂᕐᒧᑦ ᖃᐅᔨᒪᔪᐅᓂᖏᓄᑦ.

ᑲᒪᑦᑎᐊᖃᑦᑕᖅᑐᑦ ᐊᔪᙱᓐᓂᓕᒫᖏᓐᓄᑦ ᐃᓱᐃᓵᓇᓂᐊᖏᓪᓗᑎᒃ ᑕᓇᐅᕐᒥᐅᑕᓂᒃ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᐊᑉᖁᑎᒋᔭᐅᔪᓂᑦ. ᐃᓕᕆᔭᐅᐸᓗᓂ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᑲᓪᐸᓃᑦ ᐊᑐᖃᑦᑕᖅᑕᖏᓐᓄᑦ, ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᐱᓕᕆᔪᑦ ᖃᐅᔨᓴᐃᖃᑦᑕᖅᑐᑦ ᐃᖏᕐᕋᑎᓪᓗᒋᑦ ᓂᕐᔪᑎᑕᖃᕐᓇᐊᒃᓯᙵᓂᑦ Hudson Strait-ᒥᑦ ᑲᖏᖅᖢᓂᕐᒧᑦ. ᐊᖏᓗᐊᖏᕿᐊᖅᑎᑦᑎᓂᕐᒨᖓᔪᑦ ᐃᒪᓐᓇᐃᑦᑐᖕᓇᖅᑐᑦ, ᐅᓗᕆᐊᓇᙱᑉᐸᑦ ᑕᐃᒪᓐᓇᐃᓐᓂᐊᕐᓗᓂ, ᓯᑲᐃᓕᕆᐊᕐᓗᒍ ᐅᒥᐊᕐᔪᐊᖅ ᐊᒻᒪᓗ ᐅᖓᓯᒋᐊᕐᓗᒋᑦ ᓂᕐᔪᑏᑦ.

ᐅᒥᐊᕐᔪᐊᑦ ᑳᓐᑐᕌᒃᑕᐅᔪᑦ ᐊᓪᓃᑯᒃᑯᓄᑦ ᓈᒻᒪᒋᔭᐅᔪᒥᒃ ᐱᓯᒪᖁᔭᐅᔪᑦ ᐅᒥᐊᕐᔪᐊᕐᒥᐅᑕᖅ ᐅᖅᓯᐊᓗᖕᒥᑦ ᑐᐊᕕᓇᖅᑐᑎᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥᒃ (SOPEP). ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᑐᐊᕕᓇᖅᑐᖃᔭᖅᐸᑦ ᐃᖏᕐᕋᑎᓪᓗᒋᑦ, SOPEP ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ. ᑲᒪᑦᑎᐊᖃᑎᒌᖕᓂᖏᑦ ᐊᓪᓃᑯᒃᑯᑦ ᐅᒥᐊᕐᔪᐊᕐᒥᑦ ᐃᓯᒪᑕᓇᔭᐅᔪᑦ ᐱᕆᐊᖅᑎᑦᑎᔪᕐᓇᖅᑐᑦ ᐊᓪᓃᑯᒃᑯᑦ ᑐᐊᕕᓇᖅᑐᒧᑦ ᐅᐸᓗᐊᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᙳᓐᓂᒃ ᐊᒻᒪᓗ OPEP-ᒥᒃ ᐃᑲᔪᕐᓂᐊᕐᓗᑎᒃ ᐅᒥᐊᕐᔪᐊᕐᒥᑦ. ᐱᓂᕐᓗᐊᕿᓃᑦ ᐊᔪᓕᖅᑐᓘᓐᓃᑦ ᐃᖏᕐᕋᑎᓪᓗᒋᑦ ᐅᖃᐅᓯᐅᓂᐊᖅᑐᑦ ᑲᓇᑕᒥᑦ ᐃᖏᕐᕋᔭᒃᑐᓕᕆᔨᒃᑯᓄᑦ, ᒪᓕᒃᓗᒋᑦ ᒪᓕᒐᐃᑦ ᐃᓗᐊᓃᑦᑐᑦ *ᑲᓇᑕᒥᑦ ᐊᐅᓪᓚᖅᑎᑦᑎᖃᑦᑕᕐᓂᕐᒧᑦ ᐱᖁᔭᖏᑦ* (CSA 2001) ᐊᒻᒪᓗ ᒪᓕᒐᓇᔭᐅᔪᑦ. ᑯᕕᔪᑦ ᐅᖃᐅᓯᐅᓂᐊᕐᒥᔪᑦ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᑐᐊᕕᓇᖅᑐᓕᕆᔨᓄᑦ 24 ᐃᑲᕐᕋᐃᑦ ᐅᒃᑯᐃᖓᔪᑦ ᐅᖃᓗᒃᕙᐅᔪᕐᓇᖅᑐᓄᑦ ᐊᒻᒪᓗ, ᐱᔭᕆᐊᖃᖅᐸᑦ, ᐅᖃᐅᔾᔭᐅᔪᒪᓇᔭᖅᑐᑦ ᐊᕙᒃᑐᖅᓯᒪᔪᒥᑦ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ ᑐᐊᕕᓇᖅᑐᓕᕆᔨᓂᑦ (REET). ᐃᑲᔪᖅᑕᐅᔪᒪᓂᐊᖅᑐᑦ ᖃᓂᑦᑐᓂᑦ ᐅᒥᐊᕐᔪᐊᓂᑦ ᐊᒻᒪᓗ ᑲᓇᑕᒥᑦ ᐃᒫᓂᑦ ᐊᓇᒃᑐᐃᔪᓕᕆᔨᒃᑯᓂᑦ (CCG).

EXECUTIVE SUMMARY

The Shipping Management Plan was developed in accordance with federal legislation, notably the *Canada Shipping Act* and the *Arctic Waters Pollution Prevention Act,* and associated regulations. It also recognizes the international conventions and protocols signed by Canada. Agnico Eagle provides the necessary human, material and financial resources to meet or exceed the legal requirements attributable to the company that arise from shipping-related activities. Shipping contractors are encouraged to do the same. Agnico Eagle and its shipping contractors carry third party liability insurance.

All shipping is carried out during the open water season and follows the recommended shipping routes that are presently in use for the annual sea lift to Rankin Inlet and other Kivalliq communities. Ice breaking is not conducted to extend the shipping season.

Upon arrival at Rankin Inlet, all vessels anchor either outside or inside Melvin Bay. Dry cargo is lightered onto barges for transport through the access passage using tugs. The barges then transport the dry cargo by barge to the existing gravel ramp used by the hamlet of Rankin Inlet during the annual sealift to dock. Large fuel tankers anchor outside of Melvin Bay. Ship-to-ship fuel transfer is the first step in moving the fuel to the Itivia tank farm. The small tanker navigates the access passage and anchors off Itivia where a ship-to-shore floating hose transfers the fuel to the tank farm.

It is Agnico Eagle's intent to prioritize the road transport of hazardous materials, including explosive-related materials, to the Meliadine site to avoid having such cargo remain in storage at the Itivia laydown yard. Other contingency measures associated with shipping-related activities include the Spill Contingency Plan, Risk Management and Emergency Response Plan, and the Oil Pollution Emergency Plan (OPEP). Risk and hazard assessments of shore-based marine response activities are undertaken as part of training the Emergency Response Team (ERT).

Agnico Eagle personnel and the Master of the ship are responsible for security matters related to the shipping-related activities. While it is anticipated that the RCMP will not be involved in security matters, all criminal activities or matters of a grave nature (e.g., smuggling) will be referred to the RCMP in Rankin Inlet. Mitigation measures to prevent smuggling are in place. Mitigation measures are also employed to minimize potential negative socio-economic effects from shipping-related activities; positive socio-economic impacts are anticipated.

Navigation through the Labrador Sea, Hudson Strait and Hudson Bay is not challenging during the open water season. No major hazards were identified along the shipping and tug-barge routes under normal conditions. Shipping can be carried out without pilotage as the shipping routes entail minor hazards not significantly reducing ship safety.

All ships, tugs and tankers use electronic charts and other electronic navigational aids to provide safety in transit, reduce the risk of accidents, and remain within the recommended shipping routes.

Traffic through the access passage is coordinated to avoid shipping conflicts, and speed is reduced to ensure safety. To maximize the safety of the persons travelling in boats near the Rankin Inlet access passage, Agnico Eagle informs the community of the shipping activities, promotes actions that will allow the ship and the small boats to see one another, and, through the Community Liaison Committee, recommends that all those in small boats wear personal floatation devices.

On board waste management (solid and hazardous wastes, sewage) is the responsibility of shipping contractors. Agnico Eagle requires the shipping contractors to conform to the *Ballast Management Control and Management Regulations*, which should reduce the risk of invasive species being introduced as a result of shipping activities. Agnico Eagle expects to contract vessels that meet applicable environmental requirements in addition to being reliable and having a superior safety record.

Care is taken to avoid disturbing marine mammals within the shipping routes as much as possible. As part of shipping companies' standard operating procedures, ship crew monitors the shipping routes for marine mammals from the Hudson Strait to Rankin Inlet. Mitigation measures may comprise, if safe to do so, slowing the ship and stay at distance from marine mammals.

Vessels contracted by Agnico Eagle are required to have an approved Shipboard Oil Pollution Emergency Plan (SOPEP). If an environmental emergency occurs along the shipping routes, the SOPEP is activated. Close coordination is maintained with Agnico Eagle's shore-based supervisors who can activate Agnico Eagle Emergency Response Plan and OPEP to provide assistance to a vessel. Accidents or malfunctions during transit will be reported to Transport Canada, in accordance with provisions under the *Canada Shipping Act* (CSA 2001) and subsequent regulations. Spills would also be reported to the Environmental Emergencies 24-Hour Report Line and, if necessary, advice would be requested from the Regional Environmental Emergencies Team (REET). Assistance could be sought from nearby ships and the Canadian Coast Guard (CCG).

ACRONYMS

Agnico Eagle	Agnico Eagle Mines Limited
BWMP	Ballast Water Management Plan
CCG	Canadian Coast Guard
ECCC	Environment and Climate Change Canada
EIA	Environmental Impact Assessment
ERP	Emergency Response Plan
ERT	Emergency Response Team
IMO	International Marine Organization
MARPOL	International Convention for the Prevention of Pollution from Ships
MEMP	Marine Environmental Management Plan
MMSO	Marine Mammal and Seabird Observer
OHF	Oil Handling Facility
OPEP	Oil Pollution Emergency Plan
RCMP	Royal Canadian Mounted Police
REET	Regional Environmental Emergencies Team
SOLAS	International Convention for the Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
TEU	Twenty-foot Equivalent Unit, a measure used for capacity in container transportation (sea can)
TK	Traditional Knowledge
WSCC	Workers' Safety Compensation Commission

SECTION 1 • INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) gained extensive experience in shipping fuel and dry cargo to the Meadowbank Gold Mine (Meadowbank) since its construction began in 2008 and commercial production in 2010. Similar shipping, lightering and ship-to-shore fuel transfer procedures developed and in use for Meadowbank are employed for the Meliadine Gold Mine in Rankin Inlet.

Dry cargo barges undergo lightering operations at the existing gravel ramp used by the hamlet during the annual sealift in Itivia Harbour[1]. A tank farm, sea can storage and a laydown yard is also located at Itivia (Figure 1-1).

1.1 Shipping Needs

A total of approximately 40,000 tonnes of dry cargo (equipment and supplies) and 50 million litres of diesel fuel is required annually for the operations of the Meliadine Mine. To meet these needs, approximately 8 vessels annually deliver dry goods and up to 6 tankers will annually deliver diesel fuel. At this time, dry cargo shipping operations have been contracted to Desgagnes Transarktic.

All shipping is carried out during the open water season (typically from early July to late October) and follow the recommended shipping routes presently in use for the annual sea lift to Rankin Inlet and other Kivalliq communities. There will not be any ice breaking to extend the shipping season.

The priorities in shipping dry cargo and fuel are:

- The protection of the crew and others in small boats that the ship may come across;
- The protection of the marine environment; and
- The preservation of the ship and its cargo.

All ships, tugs and tankers are equipped with electronic navigational aids. Ships are not serviced in Rankin Inlet and arrive with enough fuel for the return voyage south.

The Meliadine Mine is anticipated to contribute to shipping in Hudson Strait and Hudson Bay by about 14 ships during construction and 8 to 12 ships during operations. This represents an increase in ship traffic in Hudson Strait, Hudson Bay and to Rankin Inlet, and extra care is required in regards to marine safety. This includes ensuring there is adequate spill response equipment on the ships and at the Itivia

[1] The current plan is to lighter cargo using the existing gravel ramp in Itivia Harbour. This ramp is currently used by the Hamlet of Rankin Inlet during the annual sealift. The assessment of potential effects related to the use of this ramp are consistent with those discussed in Section 8.3.4 of the FEIS (e.g., propeller wash from nearshore Mine vessels berthing at the landing ramp may result in adverse effects to marine water quality with associated indirect effects on marine wildlife). The conclusions of the assessment remain the same.

Oil Handling Facility. Spill response personnel need to have adequate training and equipment to effectively respond to a spill in the marine environment[2].

1.2 Shipping Routes

The marine transport of dry cargo is comprised of four main segments, all within the recommended shipping routes:

- Bécancour, Québec on the St. Lawrence River, along the coast of Labrador to the Hudson Strait;
- Through Hudson Strait to Hudson Bay (see Appendix A for marine hydrographic charts showing the shipping routes);
- Across Hudson Bay to Marble Island, this being approximately 45 km offshore Rankin Inlet; and
- From Marble Island to the barrier islands, through the islands to an anchoring point either inside or outside of Melvin Bay and Itivia. Access to anchoring locations inside Melvin Bay occurs through the access passage (Figure 1-1).

Dry cargo and transport barges are loaded onto ocean-going container ships in eastern ports, almost exclusively Bécancour, and delivered directly to Rankin Inlet[3]. The first vessels of the year normally arrive in Rankin Inlet in early July or August. This first container ship includes two (2) transport barges to transport dry cargo to shore, and two (2) tugs.

Up to twelve (12) container ships arrive throughout the open water shipping season delivering dry cargo[4]. All ships follow the recommended shipping routes and are equipped with complete electronic navigation aids for navigation in restricted waters.

The port of departure for transporting fuel is different from that for dry cargo. The first leg of the voyage is from an east coast refinery along the coast of Labrador to the Hudson Strait with the remainder of the voyage being the same as for the ships carrying dry goods.

1.3 Lightering Procedures

1.3.1 Dry Cargo

Sea cans, large equipment, machinery, general cargo and vehicles are lightered onto the barges (that arrived during the first dry cargo trip) for transport to shore using tugs and then lightered to shore using the existing gravel ramp in Itivia Harbour. During lightering operations, attention is directed to

[2] Oil Pollution Emergency Plan details spill response at the Itivia Oil Handling Facility.
[3] Agnico Eagle's shipping routes within Nunavut are non-compulsory pilotage areas during the ice free shipping season.
[4] To this point there are no alternative routes under consideration, however future routing may include Churchill to Rankin Inlet on occasion.

stabilizing the barges at the gravel ramp, with due consideration being given to the prevailing and expected wind, weather, and tide conditions.

Most dry cargo is transported in marine shipping containers (TEUs; Twenty-foot Equivalent Unit) of general cargo vessels fitted with cranes. Most materials arrive in sea cans, which are stacked in the Itivia laydown yard or moved immediately to site. The use of sea cans provides secondary protection against spills and facilitates rapid transfer from ship to shore.

The tug-barge used to ferry the dry cargo to shore is highly manoeuvrable and capable of transiting the access passage with its changing current patterns. The tidal current in the area is half a knot (0.93 km/h). Navigation proceeds at a slow speed in periods of low visibility. Traffic through the access passage is coordinated through communication between the tugs to avoid shipping conflicts and to ensure safety.

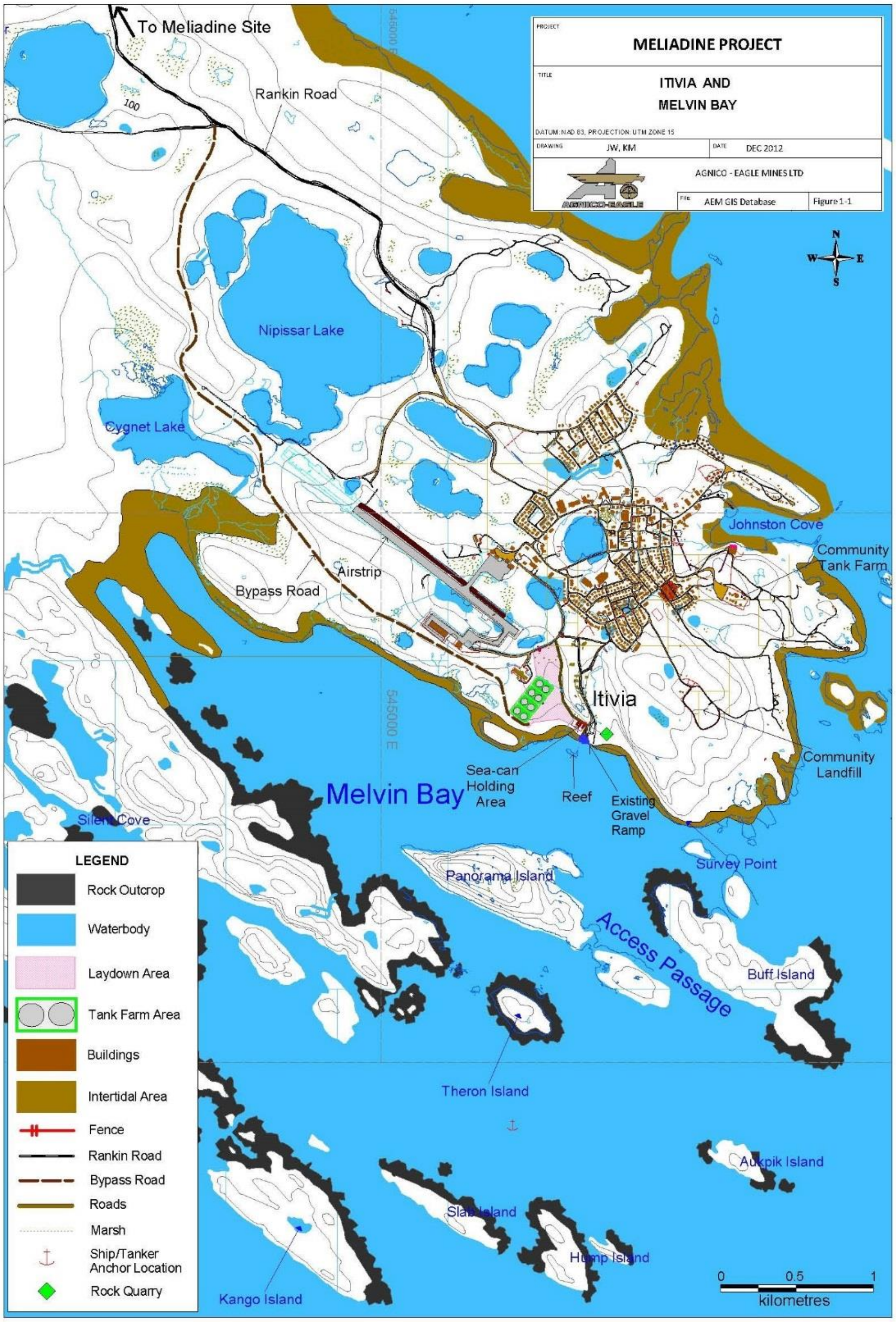

Figure 1.1 Itivia and Melvin Bay

Masters of tugs, large and small tankers, and dry cargo ships are responsible for their vessels at all times – for the safe navigation of their vessels from the port of departure to Rankin Inlet. For tugs this also includes responsibility for the barge they are towing or pushing. When a barge is laid alongside a dry cargo vessel for lightering containers or equipment from the cargo ship to the barge, a loading supervisor on the ship takes charge of the barge. When a cargo barge is stabilized at the gravel ramp for lightering to shore, a shore supervisor takes charge of the cargo barge.

The shore crew then conducts a "roll-on/ roll-off' operation using wheel loaders equipped with forks, trucks and trailers to unload the cargo from the barges. Cargo is stockpiled on the laydown area before being transported to the Meliadine Mine.

For the majority of the shipping season, outgoing cargo is loaded onto lightering barges and subsequent container ships for the return trip to southern ports. Outgoing cargo could include construction equipment being demobilized following the completion of construction and/or hazardous or other waste being sent to a certified waste management facility for treatment, recycling and/or disposal in another provincial or territorial jurisdiction. No barges, fuel vessels or tugs remain at Rankin Inlet over the winter; all return to southern ports.

1.3.2 Diesel Fuel

Large tankers delivering diesel fuel anchor in the same general location as the dry cargo vessels (Figure 1-1). Ship-to-ship transfer of fuel occurs at this location from the larger tanker to a smaller tanker that can navigate the access passage. The carrying capacity of the small tanker will be either 7,300 m^3 or 10,500 m^3. The one selected at any one time is subject to its availability when a large fuel tanker is set to deliver fuel to Agnico Eagle. The smaller tankers are able to navigate the access passage into Melvin Bay while the large tanker cannot. The small tanker anchors opposite Itivia[5]. From there a floating hose of some 300-500 m is connected to a shore-based pipeline for transfer of fuel to the tank farm. Contingency measures related to the transfer of fuel are described in the Oil Pollution Emergency Plan.

1.3.3 Explosives and Hazardous Materials

Part of the dry cargo received each year is ammonium nitrate, which is used on site to manufacture explosives. Bulk ammonium nitrate is shipped as prill, which is inert and does not require special handling during transit. The ammonium nitrate remains in sea cans at the mine site until needed[6]. Other needed raw materials and blasting related products arrive in sea cans and are stored in secure locations at the mine site. Ammonium Nitrate (to be used as an explosive) is also listed in schedule 1 of the *Environmental Emergency Regulations* under the *Canadian Environmental Protection Act*. Further information related to transport of ammonium nitrate is provided in the Explosives

[5] The anchoring location will vary based on a number of factors such as tide, wind and draught of the small tanker.
[6] An on-site Emulsion Plant has been constructed for the manufacturing of explosives. More details on that subject are available in the Explosives Management Plan.

Management Plan (Agnico Eagle 2018). Agnico Eagle notified Environment and Climate Change Canada of the expected quantity of ammonium nitrate to be shipped by barge and stored on site, and received a response from ECCC indicating that Agnico Eagle has met the requirements of the E2 registration.[7]

It is Agnico Eagle's intent to prioritize the road transport of hazardous materials, including explosive-related materials, to the Meliadine site to avoid having such cargo remain in storage at the Itivia laydown yard. Sensitive products such as explosives, boosters and caps are transported directly to the Meliadine Mine. However, in the eventuality of a delay in their transit to the mine site, these products will be temporarily stored in Rankin Inlet according to applicable regulations which include locked storage under constant surveillance. All handling, transport, storage, manufacture and use of explosives are subject to federal approval under the *Explosives Act*, and the *Nunavut Mine Health and Safety Act*. In addition, the latest Ship Safety Bulletin issued by Transport Canada's Marine Safety Directorate is followed when loading and unloading explosives.

Sodium cyanide is used to optimize gold recovery from the ore. This product is used at the Meliadine site. Due to transportation restrictions, normally a full year's supply of sodium cyanide is transported and stored on site. The product is transported, stored, handled, transferred and used in compliance with appropriate legislation and applicable Best Management Practices. Agnico Eagle is a signatory to the International Cyanide Management Code.

Hazardous waste and contaminated soil is managed on a yearly basis; consequently there will be little to no accumulation of such wastes at the mine site during operations, subject to seasonal shipping considerations. Hazardous waste that cannot be managed on site is appropriately packaged for transport in sea cans and sent via a dry cargo vessel to a certified hazardous waste management facility for treatment, recycling and/or disposal in another provincial or territorial jurisdiction. Agnico Eagle contracts shipping companies that are certified under the IMDG code (International Maritime Dangerous Goods).

Itivia is presently connected to the hamlet by a municipal road and a private bypass road, which is used for the transport of all its dry cargo and fuel around the community. This includes explosives, cyanides and dangerous goods.

[7] E-mail submitted by Martin Theriault of Agnico Eagle to ECCC on September 13, 2018 and an e-mail received by Martin Theriault of Agnico Eagle from Christina Firth of ECCC, September 13, 2018.

SECTION 2 • RELATED DOCUMENTS

The Shipping Management Plan covers the scope of shipping activities for the Meliadine Mine. It is part of the Environmental Management and Protection Plan.

Management and monitoring plans for the Meliadine Mine that provided input to the Shipping Management Plan include the following:

- Spill Contingency Plan;
- Risk Management and Emergency Response Plan;
- Oil Pollution Emergency Plan;
- Shipboard Oil Pollution Emergency Plan (shipping companies); and
- Occupational Health and Safety Plan.

2.1 Spill Contingency Plan

The cornerstone of spill contingency planning for Agnico Eagle is the Spill Contingency Plan covering all spills on land, water and ice. It forms part of the Environmental Management and Protection Plan. The Spill Contingency Plan, coupled with the Risk Management and Emergency Response Plan, describes the processes to be followed when responding to a spill to the environment.

2.2 Risk Management and Emergency Response Plan

The Risk Management and Emergency Response Plan focuses on responding to all emergencies in a timely and adequate manner. It commits Agnico Eagle to being prepared for and providing adequate resources - qualified personnel and equipment - to handle a wide variety of emergency situations.

Risk and hazard assessments of shore-based marine response activities are undertaken as part of training for Emergency Response Team (ERT).

2.3 Oil Pollution Emergency Plan (OPEP)

The Oil Pollution Emergency Plan complements the Spill Contingency Plan and should not be construed as superseding it. The OPEP only provides contingency planning for the Oil Handling Facility (OHF) at Itivia.

The OPEP complies with the requirements for procedures, equipment and resources as set out in the *Canada Shipping Act* (s.s. 660.2(4)) specific to the fuel handling facility, the bulk incoming transfer of fuel from ship-to-shore and spill scenarios directly relating to this operation. Further, the OPEP provides direction to Agnico Eagle personnel and/or contractors and to Agnico Eagle's ERT in emergency spill response situations. It also contributes in developing oil pollution scenarios, defining the roles and responsibilities of management and responders, and outlining the measures taken to prevent spills. The OPEP seeks to minimize potential health and safety hazards, environmental damage and cleanup costs.

Spills resulting from ship-to-ship fuel transfer will be the responsibility of the ships contracted by Agnico Eagle and ship's Master. Agnico Eagle will provide assistance wherever possible in these instances.

2.4 Shipboard Oil Pollution Emergency Plan

The Shipboard Oil Pollution Emergency Plan (SOPEP)[8] contains all information and operational instructions as required by the International Marine Organization's "*Guidelines for the Development of the Shipboard Marine Pollution Emergency Plan*". Vessels contracted by Agnico Eagle will be required to have an approved SOPEP. The preparation of the SOPEP is the responsibility of the shipping company and is maintained by the vessel's Master. However, close coordination is maintained with Agnico Eagle's shore-based Itivia supervisors who can activate the Emergency Response Plan (ERP) and OPEP in providing assistance to a vessel in the near-shore area. These two plans have close links to the SOPEP and, as required, include training exercises at regular intervals to ensure ship and shore can cooperate in responding to any spill of fuel or any other hazardous product in the immediate vicinity of Itivia. SOPEP(s) arerequired to include how vessel contractor(s) maintain spill equipment and the frequency and framework for training vessel personnel in vessel-based spill response. This includes, but is not limited to:

- Spill equipment audits;
- Maintaining posted list of spill equipment;
- Requirements for spill response drills; and
- On-going training refreshers (e.g. annual renewals).

Accidents or malfunctions during transit will be reported to Transport Canada, in accordance with CSA 2001 and subsequent regulations. If the accident involves the loss of fuel or chemicals, the SOPEP would be activated and on-board spill response materials and equipment put to use. Spills would also be reported to the Government of Nunavut Spill Line and to the Environmental Emergencies 24-Hour Report Line and, if necessary, advice would be requested from the Regional Environmental Emergencies Team. Assistance could be sought from nearby ships and the Canadian Coast Guard (CCG). Spill response resources such as those maintained by the Canadian Coast Guard at select locations along the Kivalliq coast could be dispatched to the spill site. A sea can with spill response materials is maintained by the CCG in Rankin Inlet. Permission to use this material will have to be obtained from CCG before usage.

Outside help could be requested for major accidents such as accidental grounding/stranding of a vessel. Under these circumstances, the safety of the crew and maintaining the integrity of the vessel would be the first priority.

[8] Spills and their effect on Marine Wildlife are addressed in Oil Pollution Emergency Plan.

2.5 Occupational Health and Safety

All activities carried out by Agnico Eagle must consider the attendant risks and be carried out with safety first in mind. Agnico Eagle will conduct all activities in accordance with the Workers' Safety and Compensation Commission (WSCC) Occupational Health and Safety legislation.

SECTION 3 • APPLICABLE FEDERAL ACTS, REGULATIONS AND GUIDELINES

The Plan was prepared in accordance with federal legislation outlined in Table 3-1. Numerous regulations exist under the *Canada Shipping Act* and these can be found at www.tc.gc.ca and www.canada.ca The regulations included here are most relevant to the environment and the Shipping Management Plan.

Table 3-2 lists international conventions and protocols signed by Canada. Canada is a signatory to International Marine Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) and International Convention for the Safety of Life at Sea (SOLAS). As such, Canadian marine laws, regulations and guidelines rules are a reflection of these international conventions, protocols and agreements.

At this time, Agnico Eagle has contracted Desgagnes Transarktic to ship to Rankin Inlet. Even so, the shipping companies could change over the construction, operation and closure phases of the Meliadine Mine. Shipping contractors used by Agnico Eagle will abide by Canadian laws and regulations, applicable MARPOL 73/70 annexes, and international conventions. Inspections carried out by federal inspectors will ensure that all applicable statutes are followed. This could include the review of required plans (SOPEP), an audit of the emergency response equipment carried by the vessel, and the means to prevent the discharge of any oil, oily water or other hazardous waste in Arctic waters. Agnico Eagle will notify Transport Canada if contracted shipping companies change.

All vessels transiting through and operating in Canadian Arctic waters are required to comply with the *Arctic Waters Pollution Prevention Act* (AWPPA), the *Canada Shipping Act* 2001 (CSA 2001), the *Marine Transportation Security Act* (MTSA), the Marine Transportation Security Regulations (MTSR), the *Marine Liability Act* (MLA), and all associated regulations, including requirements for vessel construction and operations (see Table 3-1). While the provisions of the CSA 2001 apply in all Canadian waters, vessels in Arctic waters north of 60°N and out to the 200 nautical mile limit of Canada‘s Exclusive Economic Zone are also subject to the provisions of the AWPPA. The AWPPA prohibits discharges of oil, chemicals, garbage and other wastes generated onboard vessels. It does allow for the discharge of untreated sewage[9]. The *Marine Liability Act* sets out a regime that requires vessels operating in Canadian jurisdiction, including Arctic waters, to carry insurance to pay for damages from oil spills.

Two vessel control systems are established under the *Arctic Shipping Pollution Prevention Regulations* – the Zone/Date System and the Arctic Ice Regime Shipping System, which provide for operational safety by taking into account the vessel‘s capability to operate safely by virtue of ice strengthening, and the ice conditions it will encounter[10].

[9] Ships are to only discharge gray water and treated sewage when the ship is at least 50 km from Rankin Inlet.
[10] Agnico Eagle will only ship dry goods and fuel during the open water season.

Vessels servicing the Mine will be required to comply with the AWPPA and regulations while in a Shipping Safety Control Zone[11].

Shipping companies contracted by Agnico Eagle must have an approved SOPEP, and verify that equipment and operating procedures are consistent with Canadian Marine laws, regulations and guidelines, and with IMO agreements to which Canada is a signatory. It is the responsibility of the Master of the ship to ensure safe passage through Canadian waters and to maintain up-to-date charts and publications[12].

Agnico Eagle will provide the necessary human, material and financial resources to meet or exceed the legal requirements attributable to the company that arise from shipping. The marine equipment used on the Meliadine Mine will meet task specifications for reliability, safety and capability of meeting or exceeding environmental requirements and guidelines. Shipping contractors will be encouraged to do the same.

Table 3-1 Applicable Acts, Regulation and Guidelines

Acts	Regulations	Guidelines
Federal Legislation		
Canada Shipping Act, 2001 (S.C. 2001, c. 26) [An Oil Pollution Emergency Plan is required under the Act (168(1)d)]	*Response Organizations and Oil Handling Facilities Regulations* (SOR/95-405) *Pollutant Discharge Reporting Regulations*, 1995 (SOR/95-351) *Environmental Response Arrangements Regulations* (SOR/2008-275) *Ballast Water Control and Management Regulations* (SOR/2006-129) *Vessel Pollution and Dangerous Chemicals Regulations*	Oil Handling Facilities Standards – TP12402 Environmental Prevention and Response National Preparedness Plan 2008 – TP13585 Guidelines for Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants – TP9834E 2009 Arctic Waters Oil Transfer Guidelines, 1997 - TP10783E Response Organizations Standards – TP 12401E 1995 Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction (TP 13617)
Canadian Transportation Accident Investigation and Safety Board Act (S.C. 1989, c. 3)	*Transportation Safety Board Regulations* (SOR/92-446)	
Marine Liability Act (S.C. 2001, c. 6)	*Marine Liability Regulations* (SOR/2002-307)	
Arctic Waters Pollution Prevention Act (R.S.C., 1985, c. A-12)	*Arctic Waters Pollution Prevention Regulations* (C.R.C., c. 354) *Arctic Shipping Pollution Prevention Regulations* (C.R.C., c. 353)	

[11] Rankin Inlet is in Zone 16.
[12] Transport Canada is not the source to provide up-to-date information on changing sea levels or on emergence of new reefs or shoals.

Acts	Regulations	Guidelines
Transportation of Dangerous Goods Act (1992, c.34)	*Transportation of Dangerous Goods Regulations* (SOR/2001-286)	
Marine Transportation Security Act (1994, C.40)	*Marine Transportation Security Regulations* (SOR/2004-144)	
Safe Containers Convention Act (R.C.C. 1985, c. S-1)		
Oceans Act (S.C. 1996, c. 31)		
Navigation Protection Act (R.S. 1985 c. N-22)		
Canada Water Act (1985 c.11)		
Fisheries Act (R.S.C. c. F-14)	*Marine Mammal Regulations* (SOR/93-56) *Marine Mammal Regulations* (SOR/93-56) Prohibition of Depositing Deleterious Substances (Section 36[3])	
Species at Risk Act (2002 c.29)		Species at Risk Policies
Canadian Environmental Protection Act (1999 c.33)	*Environmental Emergency Regulations* (SOR/2003-307) *Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations* (SOR/2002-301) *Release and Environmental Emergency Notification Regulations* *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations* (SOR/2008-197	

Table 3-2 International Conventions and Protocols Signed by Canada

Conventions	
International Convention for the Prevention of Pollution from Ships MARPOL 73/78 Annexes	
	Objective of Annex is to Prevent Pollution from:
Annex 1	Oil from ships
Annex 2	Noxious liquid substances carried in bulk
Annex 3	Harmful substances carried by ships in packaged form
Annex 4	Sewage treatment and disposal
Annex 5	Garbage handling
Annex 6	Air Pollution from Ships
International Maritime Dangerous Goods Code	
International Convention for the Safety of Life at Sea, 1974, SOLAS 74	

SECTION 4 • MARINE WILDLIFE

Marine mammals have been the basis of the Inuit economy for over 4,000 years. They provide meat, fat, oil, leather, tools and materials for fabrication of arts and crafts. The top layers of the skin yield "muktuk", which is still highly prized as a food rich in vitamin C and high in energy content. *(Fisheries and Oceans Canada http://www.dfo-mpo.gc.ca/Science/publications/uww-msm/articles/beluga-eng.htm)*

The reaction of marine wildlife to vessel traffic is predicted to not be significant and, providing mitigation measures are employed, should not lead to any residual effects (see Volume 8, Marine Environment and Impact Assessment). The effects of vessel traffic on marine mammals and birds were assessed in the Environmental Impact Assessment (EIA). This included a Traditional Knowledge (TK) study of the marine environment between Chesterfield Inlet and Whale Cove. Together, scientific and traditional knowledge were used to develop mitigation measures to eliminate potential residual effects. Of greatest interest in the TK study was the distance vessels remained from Marble Island, this being an important area for whales, seals, marine birds, and, on occasion, walruses.

Agnico Eagle includes in its contracts that ships must remain mindful of marine areas having a high density of marine mammals and birds and stay within the recommended shipping route, wherever possible[13]. Agnico Eagle requests that ships provide their ship track data for inclusion in annual reporting.

4.1 Interactions and Potential Effects

Vessel discharges (sewage, solid wastes, ballast water), the sight of the vessels and their movement, vessel noise, as well as accidental spills and releases have the potential to interact with and disturb marine wildlife and affect life cycle activities. Possible interactions between shipping and marine wildlife can have the following potential effects:

- Marine mammals may retreat to the water should a vessel pass too close to an island or reef where they have pulled themselves out of the water;
- The foraging of marine birds and mammals may be interrupted when vessels approach and pass them in the shipping route;
- The improper treatment and release of ballast water, grey water and bilge water could alter the water quality and contaminate the food supply;
- Marine mammal mortalities or injuries may result from collisions with the ship;

[13] Frobisher Bay and Button Islands key marine habitat sites overlap with the proposed shipping route at their southern and northern boundaries, respectively. This overlap is unavoidable as these two sites almost completely cover the entrance to Hudson Strait from the Atlantic Ocean (see Volume 8 for more details).

- Marine bird mortalities or injuries may result from collisions with the ship; and
- Fuel and/or oil spills could result in mortalities and, for marine birds, could lead to the loss of foraging and brood rearing habitat. A Spill Risk Assessment is provided in Appendix E.

4.2 Mitigation Measures

As part of shipping companies' standard operating procedures, ship crews monitor the shipping route for marine mammals from Hudson Strait to Rankin Inlet. In addition, a vessel-based Marine Mammal and Seabird Observer (MMSO) program has been implemented during all routine shipping activities in the Regional Study Area (RSA). Protocol for the MMSO program is provided in the Marine Environmental Management Plan (MEMP) in Appendix D. The MEMP is based upon the most current marine mammal and seabird baseline information available for the area impacted by shipping for the Meliadine Mine, as documented in the revised marine baseline report (Appendix B). The ship's Master will be notified if there is a concern of the ship striking a marine mammal. Ship personnel will make a decision if actions are required to avoid a possible collision. This may include, if safe to do so, slowing the ship until the animal has travelled clear of the ship's course. Subject to safe navigation and emergency response, ship personnel shall take every precaution to avoid disturbance, harassment, injury or mortality of marine wildlife by implementation of the following mitigation measures:

- Adherence to monitoring requirements as outlined in the vessel-based MMSO program (Appendix D);
- Ships will, when possible, maintain a straight course and constant speed, and avoid erratic behaviour;
- Marine mammals will be given right of away as safe navigation allows. Under no circumstances, other than in the case of an emergency, will ships approach within 300 m of a walrus or polar bear observed on sea ice[14];
- Ships will remain at least 2 km from Marble Island to avoid disturbing seals, walrus and marine birds that might be in the vicinity. This would significantly reduce interactions between marine wildlife and vessels, and also reduce the noise in near-shore areas;
- Ships will look out for marine mammals and avoid them as possible. If marine mammals are encountered, and remain in the area, effort will be made to avoid them by maintaining a 500 m buffer zone;
- Ships will maintain a minimum distance of 500 m from marine mammals engaged in feeding activities;
- Ships will avoid accelerating within 500 m of a marine mammals;
- If it is not possible for the ship to move away from or detour around a stationary marine mammal or group of marine mammals, the ship will reduce its speed and wait until the animal(s) move to the side and remain at least 500 m from the ship prior to resuming speed;

[14] As all shipping will occur during the open water season, collision with young seals in liars will not happen.

- When marine mammals appear to be trapped or disturbed by ship movements, the ship will implement appropriate measures to mitigate disturbance, including stoppage of movement until the marine mammal has moved away from the immediate area;
- The ship will not be operated in such a way as to separate an individual member(s) of a group of marine mammals from other members of the group. When weather conditions require, such as when visibility decreases, the ship will adjust its speed accordingly to avoid the likelihood of the ship striking an animal;
- Subject to ship and human safety considerations, the following mitigation techniques will be implemented to avoid impacts to migratory birds nests in low lying shoreline habitats:
    - Barge-tug or shipping vessels will travel at a slow speed (2 knots or less) when transiting through the near shore islands and reefs to reduce wake[15];
    - Barge-tug or shipping vessels would only travel through the near shore islands and reefs when there is good visibility or adjust their speed according to the conditions;
- Implementation of monitoring and reporting procedures for ship-bird collisions. Any incidents of bird mortalities associated with near-shore lighting and infrastructure, intertidal construction activities, and ship operations are to be recorded and reported to Environment Canada (Canadian Wildlife Services) as outlined in Appendix D;
- Ballast water will only be released in designated areas and if there is no marine wildlife in the area; and
- Bilge water, grey water and sewage will be properly treated and only released in areas where no marine wildlife is present and at least 50 km from Itivia.

Spills from ships in transit could affect marine wildlife coming in contact with any petroleum product spilled. In the event of a spill, the ship personnel will discourage marine wildlife from coming in contact with the spilled material. The product most likely to be spilled would be diesel fuel, which floats on the water surface and has a high rate of evaporation. However, these occurrences are expected to be rare and the activation of the SOPEP would significantly reduce their impact. Preventive and contingency measures already in place substantially reduce the risk to marine wildlife from spills.

Adaptive management will allow mitigation measures to be modified in response to new information arising from monitoring carried out by the vessel crews and from traditional knowledge. Appendix D summarizes how and when adaptive management will be implemented during shipping activities for the Meliadine Mine.

[15] Vessel wakes from nearshore Mine vessels engaged in transportation activities were assessed as a minor linkage in the FEIS. Potential effects assessed included shoreline erosion. The conclusion of the FEIS was that any wake effects from Mine related barges are expected to be within the normal variation experienced during tidal cycles and storms within Melvin Bay (see Section 8.3.4.3 of the FEIS for additional details).

4.3 Monitoring and Reporting

Agnico Eagle will discuss with contracted vessel operators the monitoring of marine wildlife. Contracted vessels by Agnico Eagle will be requested to collect incidental monitoring data during their voyage and to report it to Agnico Eagle. In addition, a vessel-based MMSO program will be implemented during routine shipping activities in the RSA. This program will be executed by trained observers stationed on-board vessel(s). A proposed protocol for this program is provided in the MEMP in Appendix D.

The MMSO program includes protocols on data collection and reporting requirements. Agnico Eagle will share the data with Inuit organizations and/or government agencies for their information. If effects monitoring identifies potential for effects on marine mammal populations along the shipping route, Agnico Eagle will provide updates and identify adaptive management measures in consultation with the Kivalliq Inuit Association and the Hunters and Trappers Organizations of the Kivalliq communities.

SECTION 5 • SAFETY OF PERSONS USING SMALL BOATS IN THE SHIPPING ROUTE

The most likely areas where interactions may occur between small boats and barges-tugs and/or ships or vessels are:

1. Melvin Bay, particularly in the access passage;
2. Where the ship is transiting through the near shore islands and reefs; and
3. The area between Marble Island and the near shore islands.

Subject to ship and human safety considerations, mitigation measures to safeguard the safety of those in small boats will include the following:

- Agnico Eagle will consult with the community members mooring or beaching their boats in Melvin Bay on the shipping activities that can be expected over the ice free shipping season. Protocols will be developed to minimize the interaction between barge-tug or ship and small boats;
- Barge-tug or ship will travel at a slow speed (2 knots or less) when transiting through the near shore islands and reefs to reduce the wake and not compromise the safety of people travelling in small boats along the shipping route. The slower speed will reduce the wake of the ship;
- Barge-tugs or ships would only travel through the near shore islands and reefs when there is good visibility or adjust their speed according to the conditions. This would allow the ship and the small boats to be in visual contact;
- Barge-tugs or ships will restrict themselves to the recommended shipping route thereby not surprising any small boat travelling outside the shipping route;
- The ship will sound its horn if a small boat seems unaware of its presence; and
- Agnico Eagle, through the Community Liaison Committee, will recommend that all those in small boats wear personal floatation devices.

SECTION 6 • SMUGGLING PREVENTION AND POLICE SERVICES

Smuggling, particularly alcohol and prohibited substances, could have negative socio-economic effects on the community. It is Agnico Eagle's intent to avoid or minimize all negative socio-economic effects.

Measures to prevent smuggling will include:

- The crew of the ship will not be allowed to take any alcohol ashore;
- Any crew member under the influence of alcohol, or attempting to take alcohol ashore will be disciplined by the ship's Master; and
- Agnico Eagle security will send any crew member having alcohol back to the ship for disciplinary action, or refer the matter to the Royal Canadian Mounted Police (RCMP) if prohibited substances are involved.

While it is anticipated that the RCMP will not be involved in security matters, all criminal activities or matters of a grave nature will be referred to the RCMP in Rankin Inlet.

SECTION 7 • IDENTIFIABLE THIRD PARTY LIABILITIES

Agnico Eagle and its shipping contractors will carry third party liability insurance. Identifiable third party liabilities related to shipping include but are not limited to:

- Hamlet of Rankin Inlet, in the event of spill in Melvin Bay that adversely impacts the marine environment;
- Hunters and trappers, should a ship or tanker run aground and adversely impact the marine environment by spilling fuel or other chemicals into the marine environment;
- Small boat owners, should a ship or tanker collide with a small boat in the shipping route; and
- Hunters and trappers, should a vessel collide with a large marine mammal such as a whale along a shipping route.

Mitigations for possible third party liabilities are identified in Section 11 of this Plan (Hazard Identification Analysis of Marine Routes).

SECTION 8 • ON BOARD WASTE MANAGEMENT

The six (6) annexes of MARPOL promote the elimination of deliberate, negligent or accidental discharge of ship-source pollutants into the marine environment (see also Transport Canada 2009). The list of harmful ship-source discharges includes: oil, noxious liquid substances and dangerous chemicals, sewage, garbage and air pollution. Canadian laws and regulations mirror the MARPOL annexes and conventions.

Agnico Eagle will contract vessels that meet applicable environmental requirements in addition to being reliable and having a superior safety record.

8.1 Sewage

Vessels are to have an approved sewage treatment plant meeting Canadian standards[16]. Holding tanks with the capacity for all grey and treated sewage while in port are expected to be part of the ship's infrastructure. Agnico Eagle will advise ships that disposal of waste water into the environment is to be avoided within 50 km of Rankin Inlet.

Sewage sludge from the sewage treatment plant can be incinerated in the on-board incinerator.

8.2 Solid Waste

Solid waste materials are to be incinerated on board, not disposed of in the marine environment. Modern incinerators operating at very high combustion temperatures are expected on all vessels. These will be capable of incinerating food and other domestic waste, residual oil separated from bilge water, waste oil and sludge. Ash from incineration will remain on board and be taken south for treatment, recycling and/or disposal in a certified waste management facility. By incinerating waste on board, the risk of introducing invasive non-aquatic species to the Rankin Inlet area is reduced. This would not be the case if the waste was transferred onshore for incineration/disposal.

The design and operation of shipboard incinerators in Canada are specified under the International Marine Organization, Marine Environmental Pollution Committee 76 (40), Annex V. Standard specifications for shipboard incinerators allow for the incineration of solid wastes approximating in composition to household waste and liquid wastes arising from the operation of the ship, e.g., domestic waste, cargo-associated waste, maintenance waste, operational waste, cargo residues, and fishing gear. Operating temperatures are similar to those for the incinerator at the Meliadine site, and flue gases are cooled rapidly to limit the *in vivo* formation of dioxins.

[16] If all sewage is to be incinerated, there will not be any need for sewage treatment.

Tugs will remain on site for the duration of the shipping season. Their waste will be incinerated with the ash stored in containers, which will be shipped south at the end of the shipping season for treatment, recycling and/or disposal in a certified waste management facility.

Hazardous waste will not be incinerated but returned south for treatment, recycling and/or disposal in a certified waste management facility.

SECTION 9 • BALLAST WATER MANAGEMENT

Ballast water is essential to control trim, list, draught, stability, and/or stresses on a vessel. Ballast water control and management regulations protect waters under Canadian jurisdiction from non-indigenous aquatic organisms and pathogens that can be harmful to ecosystems. Agnico Eagle recognises that when a new organism is introduced to an ecosystem, negative and irreversible changes may result, including a change in biodiversity. The *Ballast Management Control and Management Regulations* are intended to minimize the probability of introduction of harmful aquatic organisms and pathogens from vessels' ballast water while also protecting the safety of vessels (Transport Canada 2007).

While an exemption exists in the regulations for vessels operating exclusively in waters under Canadian jurisdiction or certain adjacent waters, any Canadian vessel that has operated outside these waters may carry harmful aquatic organisms or pathogens in their residual ballast and, as such, is not eligible to exemption.

Agnico Eagle expects to use vessels largely active in the coasting trade that operate almost exclusively in waters under Canadian jurisdiction. However, these vessels do on occasion venture into waters outside Canadian jurisdiction and, as such, will require a Ballast Water Management Plan (BWMP). The regulations require the preparation and carriage of a BWMP for each vessel, and for copies to be submitted to Transport Canada. The BWMP will be specific to the vessel.

If Agnico Eagle were to contract vessels originating from waters outside the jurisdiction of Canada, a BWMP would be required. All BWMP (reviewed by the National Administration) carried on ships of foreign origin would be based on the following international guidelines and guiding principles:

- IMO Resolution A.868(20): *Guidelines for the Control and Management of Ships Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens*, in particular Section 7.1;
- The *Model Ballast Water Management Plan* developed by the International Chamber of Shipping and the International Association of Independent Tanker Owners;
- Regulation B-1 of the IMO's *Regulations for the Control and Management of Ships' Ballast Water and Sediments*; and
- Part B of the Annex to Resolution MEPC.127 (53): *Guidelines for Ballast Water Management and Development of Ballast Water Management Plans*.

Agnico Eagle will require contracted vessels not eligible for exemption to have a BWMP and provide Agnico Eagle with a copy.

9.1 Ballast Water Exchange

It is recognised by the IMO that the exchange of ballast water in deep ocean areas or open seas offers a means of limiting the probability that harmful aquatic organisms and pathogens be transferred from/in vessels ballast water. If it is necessary to take on and discharge ballast water in the same port to facilitate safe cargo operations, care should be taken to avoid unnecessary discharge of ballast water that has been taken up in another port as this could introduce harmful aquatic organisms. In particular, sediment found in the vessel's ballast tanks should be disposed of at sea in areas outside 200 nautical miles (370 km) from land and in water depths exceeding 2,000 m.

Vessels take on ballast water in segregated chambers for the main purpose of stabilizing the vessels by adding the weight of the water and maintaining a specified draught. Vessels laden with dry cargo or fuel will take on less ballast water than empty vessels. As all ships on the inward voyage to Rankin Inlet will be laden, they will have a minimum of ballast water. However, on the outward journey, these vessels will take on ballast water.

In the event that a ship is contracted from waters outside jurisdiction of Canada, ballast exchange is to occur before entering Canadian waters. The ballast exchange and documentations needs to be made according to the *Ballast Management Control and Management Regulations* (Transport Canada 2007).

In the case of non-transoceanic navigation, and where ballast water is taken on-board outside waters of Canadian jurisdiction, the water is to be exchanged before entering Canadian waters at a location at least 50 nautical miles offshore, in water at least 500 m deep. If this is not possible due to safety or other reasons, the ballast water exchange can occur in the alternate designated area in Hudson Strait, east of 70°west longitude, where the water is over 300 m deep.

All coastal trade vessels will in all likelihood not venture more than 200 nautical miles from shore and will not exchange ballast water outside waters of Canadian jurisdiction. All the same, ballast water exchanges for all vessels operating in waters under Canadian jurisdiction are expected to meet the provisions of the Regulations, and to follow Part A of the IMO *Guidelines for Ballast Water Management and Development of Ballast Water Management Plans*, and the IMO *Guidelines for Ballast Water Exchange*.

SECTION 10 • SAFETY

Safety is a top priority for Agnico Eagle. It begins with all personnel (Agnico Eagle, contracted employees and contractors) wearing the appropriate personal protection equipment suitable for the task at hand and for the weather conditions at the time. Secondly, personnel must understand the hazards associated with the task, the safe procedures in carrying it out, and how not to place oneself in harm's way. Accident prevention will be supported by a proactive program to identify and correct potential hazards before an accident occurs.

Agnico Eagle or contracted supervisors will ensure that the interactions between ship and shore are carried out with the safety and the health of the employees first in mind.

SECTION 11 • HAZARD IDENTIFICATION ANALYSIS OF MARINE ROUTES

Hazard: Anything that has the potential to cause harm.

Likelihood: The probability/chance of harm occurring as a result of exposure to a hazard.

Severity: The level of harm that may occur as a result of exposure to or contact with a hazard.

Risk: The likelihood of harm occurring combined with the potential severity to produce a level of risk or risk rating.

Navigation through the Labrador Sea, Hudson Strait and Hudson Bay is not challenging during the open water season[17]. No major hazards were identified along the shipping and tug-barge routes under normal conditions. Electronic charts combined with electronic navigation aids for the shipping routes ensure the vessel remains on course where bathymetry and physical hazards are known.

Subject to ship and human safety considerations, the average speed of the vessels in open waters is expected to be less than 14 knots (26 km/h). Once ships approach the offshore islands and reefs off Rankin Inlet, and subject to ship and human safety considerations, the ship's speed will be slowed to 2 knots or less (3.7 km/h) to navigate the shipping route through the islands to their anchor point outside Melvin Bay. Shipping can be carried out without pilotage as the shipping routes entail minor hazards that do not significantly reduce ship safety. Any actions required by the crews of the ships and tugs are expected to be well within their capabilities.

At the anchor point, cargo will be lightered from the ships onto barges which will travel to the lightering location via the access passage. The tugs-barges will be highly manoeuvrable and capable of transiting the access passage with its changing currents and will not require pilotage. The tidal current in the access passage can be half a knot (0.93 km/h). Navigation will proceed at a slow speed in periods of low visibility. Traffic through the access passage will be coordinated to avoid shipping conflicts and to ensure safety.

However, out of the ordinary events have been identified that could increase the level of hazard and necessitate associated mitigation measures:

- Mechanical failure occurring on the ship or tug thereby placing it in jeopardy in the shipping route;
- Tug-barge or ship running aground due to a navigational error or mechanical failure;

[17] Agnico Eagle's shipping routes within Nunavut are non-compulsory pilotage areas during the ice free shipping season

- Loss or damage to sea cans in heavy seas;
- Barge tow line breaking in heavy seas;
- Collision of tug-barge or ship carrying dry cargo and fuel to Itivia through the access passage;
- Tug-barge or ship sinking upon hitting ice; and
- Tug-barge or ship colliding with a small boat.

The access passage deserves special attention as:

- Dry cargo for Agnico Eagle and the hamlet and fuel for Agnico Eagle could all be unloaded at the same time; and
- The access passage is 150 m wide at its narrowest point and, although two-way traffic is theoretically possible, it raises the risk of collisions and groundings. To reduce the risk, it is best that a single tug-barge or ship be in the access passage at any one time.

SECTION 12 • RISK ANALYSIS OF MARINE ROUTES

All ships, tugs and tankers use electronic charts and other electronic navigational aids to provide safety in transit, reduce the risk of accidents, and remain within the recommended shipping route presently in use for the annual sea lift to Rankin Inlet and other Kivalliq communities. For an extra measure of safety, weather warnings are updated regularly. Also, shipping companies likely to be employed by Agnico Eagle commonly sail in Hudson Bay and to Rankin Inlet and are aware of its marine hazards.

The potential severity of shipping hazards[18] cannot be changed in most circumstances, what can be reduced is their likelihood. This is possible through the application of mitigation measures. And the level of risk can be defined as the likelihood of harm posed by a hazard combined with its potential severity. The objective is, through the use of mitigation measures, to reduce the risk as low as practically possible. Residual risk is what remains after mitigation measures have been applied. And those having the highest potential residual risk would be aggressively managed.

Mitigation reduces the probability of occurrence and increases safety. The following mitigation/safety measures will be implemented subject to ship and human safety considerations:

- Where available, electronic navigation aids be used in all instances;
- Ship speeds in open water remain less than 14 knots in the absence of marine mammals, and once within the barrier islands and reefs near Rankin Inlet, 2 knots or less;
- Shipping is only carried out during the ice free season. Should ice be encountered, the vessel will either sail around it at a reduced speed or proceed slowly through the ice;
- Tug-barge or ship will remain within recommended shipping routes ;
- Fuel tankers and the fuel tanker barges will be double hulled;
- Tug-barge operations will proceed when there is good visibility from the anchor point of the ships to the barge at Itivia and/or adjust their speed according to the conditions;
- Traffic through the access passage will be coordinated to avoid conflicts and ensure safety. Communication between tugs will coordinate movement through the access passage;
- Agnico Eagle will provide emergency response equipment and materials as outlined in the OPEP if necessary. Tug or ship will also provide their own emergency response equipment.
- Crews will follow standard operating procedures and adherence to these will be monitored; and
- Tug-barge or ship crews are to be trained for responses to hazards that can normally be expected in northern waters.

[18] One hazard that can be reduced is shipping when ice is present. Agnico Eagle has opted to only ship during the ice-free season thereby greatly reducing this hazard.

Appendix C outlines the methodology used in the risk analysis of the transportation routes and how various mitigation measures reduced the risk level.

SECTION 13 • SOCIO-ECONOMIC IMPACT OF SHIPPING

Agnico Eagle does not believe that shipping activities related to the Meliadine Mine will result in an increased demand on local public service providers (i.e., fire, police, ambulance, medical, and maintenance) in Rankin Inlet. In most circumstances, any emergency response will be undertaken by Agnico Eagle personnel and/or the ship's crew. Agnico Eagle personnel and the Master of the ship will be responsible for security matters related to the shipping-related activities.

Shipping may impact socio-economic activities in Rankin Inlet. Itivia will be jointly used by the hamlet and Agnico Eagle during the ice free shipping season, which will require coordination. Mitigation measures will be employed to minimize negative socio-economic effects:

- Communication between tugs will coordinate movement through the access passage and use of the Designated Hamlet Landing Beach during lightering operations to avoid conflicts and ensure safety;
- Agnico Eagle has a separate storage area from the community.

The mitigation of negative socio-economic effects in smuggling alcohol and prohibitive substances into the community were described earlier.

Positive socio-economic effects will arise from the increased number of dry cargo and fuel tankers coming to the community. The crews of these ships will in all likelihood come ashore when the boat is anchored and contribute to the local economy through the:

- Use of restaurants, hotels and stores in the community;
- Purchase of local Inuit art; and
- Guided tours to the barrens for fishing and wildlife experiences.

SECTION 14 • PUBLIC AND MEDIA COMMUNICATIONS

When an environmental emergency occurs, the public will be provided with timely and accurate information as to the nature of the incident, the steps being taken to correct the problem, and, if necessary, what citizens should do to protect themselves. This information is intended to protect the overall community well being, including human health, to provide timely information amongst the public, to ensure cooperation from all interested parties, and to reduce the spread of concern or alarm through the dissemination of inaccurate information.

Each agency involved in a major spill event may provide its own media communications, and may designate spokespersons for such; however, from the Arctic REET's (Regional Environmental Emergencies Team) perspective, a coordinated response is preferable. To that end, the government lead Agency is expected to act as the official spokesperson for the response, with support provided by personnel within the Arctic REET, as required.

Transport Canada guidelines will be followed to ensure proper authorities are informed without delay so that appropriate action may be taken when:

- Any incident occurs involving the loss, or likely loss, of dangerous goods into the marine environment; or
- Any incident occurs giving rise to pollution or threat of pollution to the marine environment; or
- Any oil pollution incident occurs involving the loading or unloading of oil to or from tanker-to-tanker and from tanker to the OHF.

REFERENCES

Agnico Eagle Limited. 2015. Risk Management and Emergency Response Plan. Submitted in support of the Type A Water Licence Application to the Nunavut Water Board, May 2015.

Transport Canada. 2007. A Guide to Canada's Ballast Water Control and Management Regulations. Guideline TP 13617E

Transport Canada. 2009. Reporting Incidents Involving Dangerous Goods, Harmful Substances and/or Marine Pollutants. Guideline TP 9834E.

APPENDIX A • MARINE HYDROGRAPHIC CHARTS

Chart 5002 Hudson Bay and Hudson Strait

Chart 5629 Marble Island to Rankin Inlet

Chart 5628 Rankin Inlet including Melvin Bay and Prairie Bay

Fisheries and Oceans Canada / Pêches et Océans Canada
Canada
5002
INT 406

INTERNATIONAL CHART SERIES

SÉRIE DE CARTES INTERNATIONALES

CANADA

HUDSON BAY AND STRAIT
BAIE ET DÉTROIT D'HUDSON

Scale 1:3 500 000 (22°30'N) Échelle

Projection : Mercator

DEPTHS are in metres.

ELEVATIONS, spot elevations and clearances are in metres.

SOURCES: Compiled by the Canadian Hydrographic Service from information to 1973.

For Symbols and Abbreviations, see Chart No. 1.

DOUBTFUL DATA
Reported but unconfirmed Depths or Dangers are indicated by an encircling dotted line.

Magnetic Variation Curves are for the 2015 epoch. Figures in parentheses indicate the annual change.

LES PROFONDEURS sont en mètres.

LES ALTITUDES, les points cotés et les hauteurs libres sont en mètres.

SOURCES : Compilé par le Service hydrographique du Canada de l'information de 1973.

Pour les signes conventionnels et les abréviations, consulter la Carte nº 1.

DONNÉES DOUTEUSES
Des profondeurs ou des dangers signalés mais non confirmés sont encerclés d'une ligne pointillée.

Les courbes de déclinaison magnétique correspondent à l'époque 2015. Les chiffres entre parenthèses représentent la valeur de la variation annuelle.

PREVIOUS EDITIONS / ÉDITIONS ANTÉRIEURES 1975
NEW EDITION / NOUVELLE ÉDITION MAY/MAI 29 2015
Corrected to NOTICES TO MARINERS / Corrigée jusqu'à l'AVIS AUX NAVIGATEURS :
See Notices to Mariners for subsequent corrections on this chart and Notices to Shipping in force for hazards or changes essential for the safety of navigation. / Voir les Avis aux navigateurs pour les corrections subséquentes sur cette carte et les Avis à la navigation en vigueur pour les dangers ou les changements essentiels pour la sécurité de la navigation.

PUBLISHED BY THE CANADIAN HYDROGRAPHIC SERVICE
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Nautical Charts Protect Lives, Property and the Marine Environment
Les cartes marines protègent la vie, la propriété et l'environnement marin

METRIC/MÉTRIQUE

NEW CHART / CARTE NOUVELLE OCT 27 2000
NOTICES TO MARINERS / AVIS AUX NAVIGATEURS 2004-06-18

PUBLISHED BY THE CANADIAN HYDROGRAPHIC SERVICE
PUBLIÉE PAR LE SERVICE HYDROGRAPHIQUE DU CANADA

Nautical Charts Protect Lives, Property and the Marine Environment
Les cartes marines protègent la vie, la propriété et l'environnement marin

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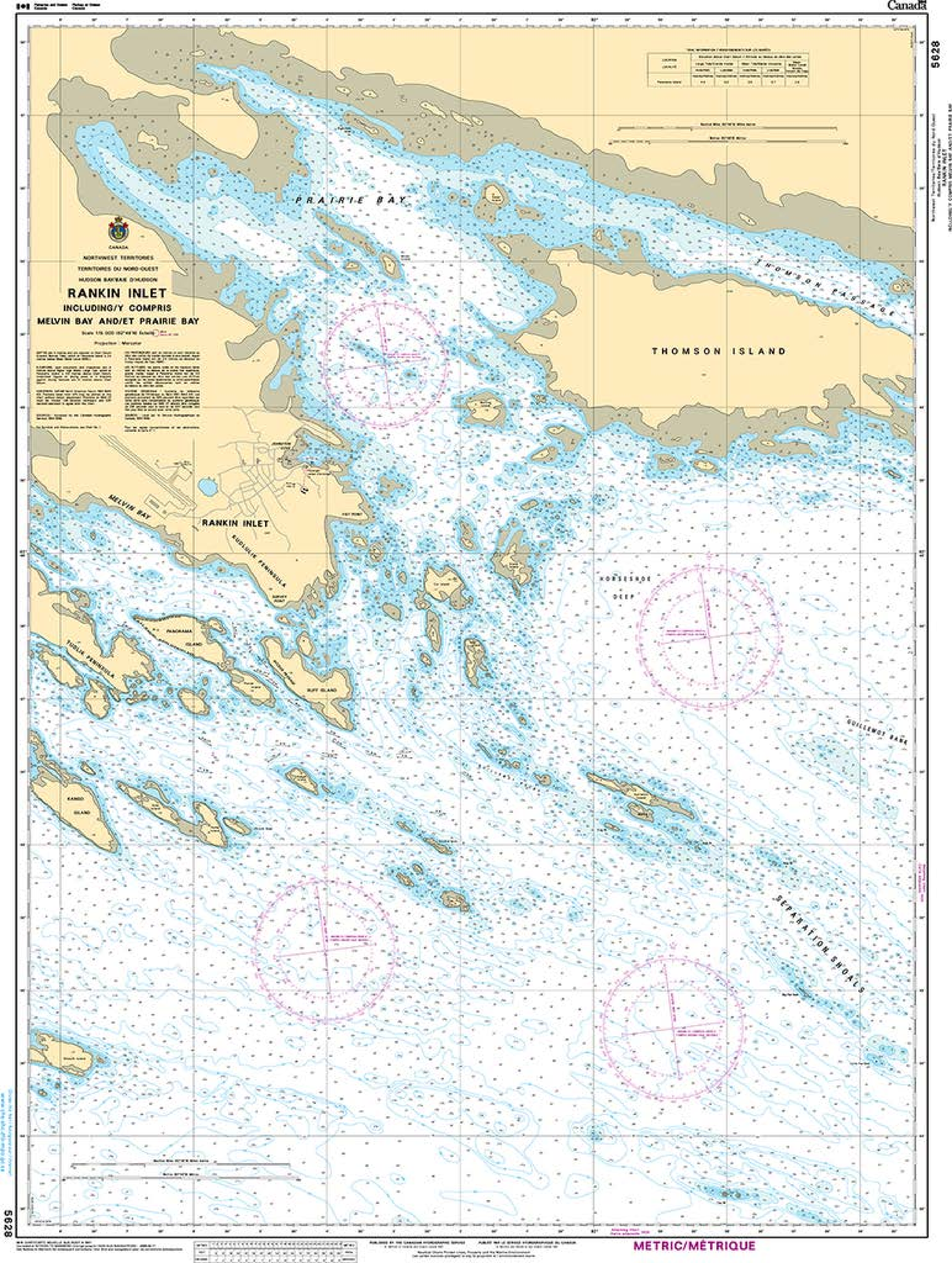

Canada
5628
PRAIRIE BAY
THOMSON PASSAGE
THOMSON ISLAND
CANADA
NORTHWEST TERRITORIES
TERRITOIRES DU NORD-OUEST
HUDSON BAY/BAIE D'HUDSON
RANKIN INLET
INCLUDING/Y COMPRIS
MELVIN BAY AND/ET PRAIRIE BAY
Projection : Mercator
MELVIN BAY
RANKIN INLET
KUDLULIK PENINSULA
PANORAMA ISLAND
BUFF ISLAND
TUDLIK PENINSULA
KAMIGO ISLAND
HORSESHOE DEEP
GUILLEMOT BANK
SEPARATION SHOALS
5628
METRIC/MÉTRIQUE

APPENDIX B • REVISED MARINE ENVIRONMENTAL BASELINE

August 10, 2016

REVISED MARINE ENVIRONMENTAL BASELINE REPORT

Appendix B

Submitted to:
Agnico Ealge Mines Limited
10200, Route de Preissac
Rouyn-Noranda QC
Stephane Robert, Manager Regulatory Affairs

REPORT

Report Number:

Distribution:

1 copy - Agnico Ealge Mines Limited
2 copies - Golder Associates Ltd.

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FIGURES

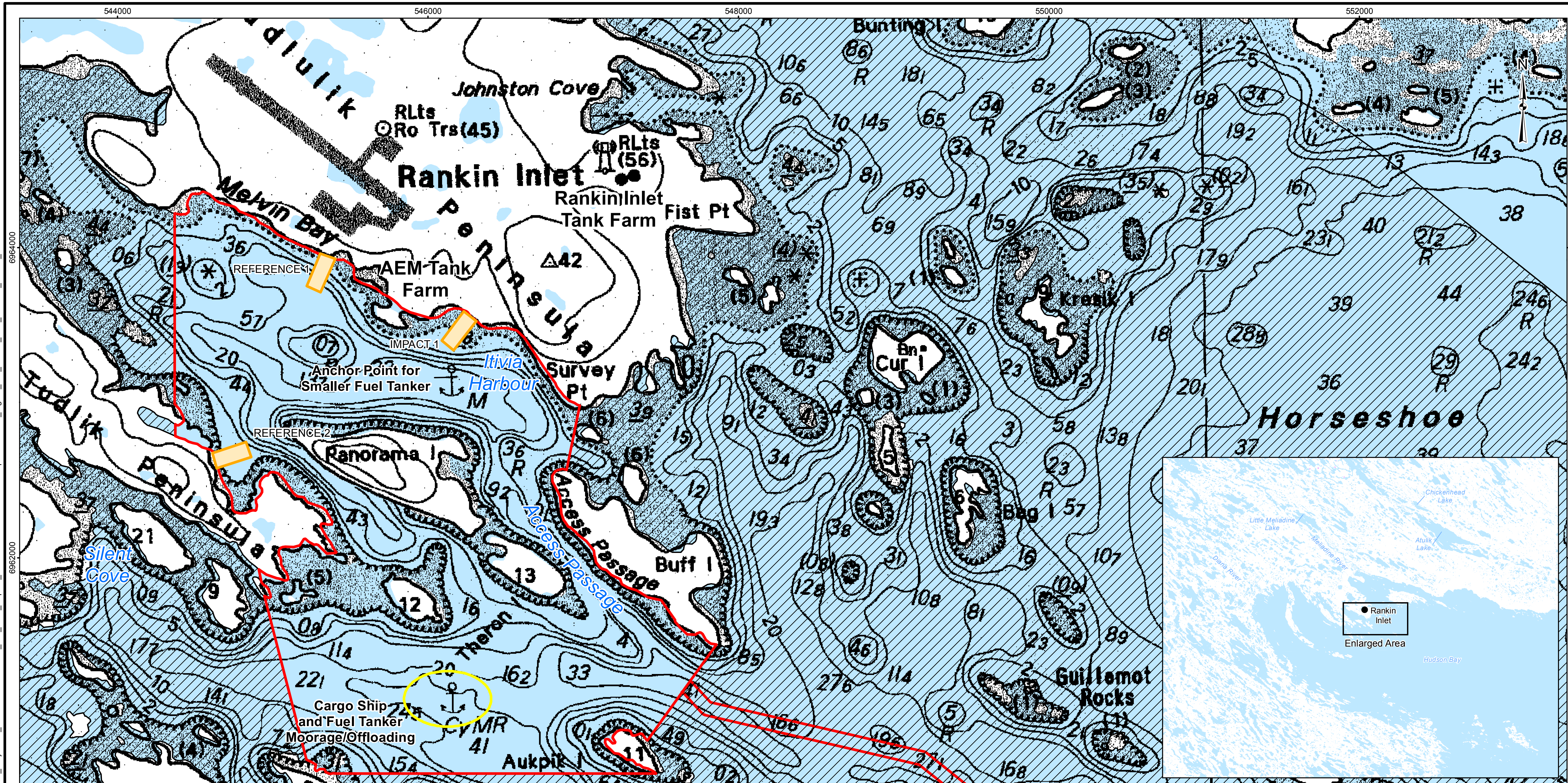
1.0 MARINE ENVIRONMENT REVISED BASELINE

1.1 Purpose and Scope

This report represents an update to the marine baseline information originally presented in Agnico Eagle's Final Environmental Impact Statement (FEIS). These revisions have been undertaken in accordance with Meliadine Gold Project (Project) Certificate Condition 79, which states the following:

"Prior to any Project-related shipping, the Proponent will update its marine baseline information to ensure that it includes the most recent information on marine wildlife abundance and distribution, carefully considers seasonal distribution patterns of marine wildlife, and incorporates western scientific and Inuit Qaujimajatuqangit knowledge sources. The updated marine baseline should be made available to appropriate authorities for feedback, then incorporated into the Proponent's Shipping Management Plan (SMP), with continued updates on a regular basis as new information becomes available."

This report was updated with new environmental information now available in the public domain (as of January 2016), as well as information provided through consultation with regulators and as a result of technical responses prepared by the proponent in response to information requirements (IRs) submitted as part of the FEIS review process. The majority of the new information provided relates specifically to the abundance and distribution of marine wildlife species in the Local Study Area (LSA) and Regional Study Area (RSA) (Figure B-1 and Figure B-2) and incorporates best available science with Inuit Qaujimajatuqangit. Information presented in this report should be reviewed in conjunction with the Marine Environmental Management Plan (MEMP) (Appendix D) and the Spill Risk Assessment (Appendix E), to inform monitoring, mitigation and adaptive management strategies for the Project.



LEGEND

- BASELINE SAMPLING AREA
- MOORAGE AND OFFLOADING
- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- BATHYMETRIC DEPTH CONTOUR
- WATERBODY

REFERENCE

BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED (AEM). BASELINE SAMPLING OBTAINED FROM NUNAMI STANTEC ON BEHALF OF AGNICO EAGLE MINES LIMITED (AEM). ATLAS OF CANADA DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. COUNTRY BACKGROUND DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: UTM ZONE 15

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METRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
MARINE LOCAL STUDY AREA

PROJECT NO.		1535029	FILE No.
DESIGN	AK	25 Jul. 2012	SCALE AS SHOWN REV. 0
GIS	MH	15 Mar. 2018	
CHECK	PR	18 Jan. 2013	FIGURE B-1
REVIEW	DW	18 Jan. 2013	

Golder Associates

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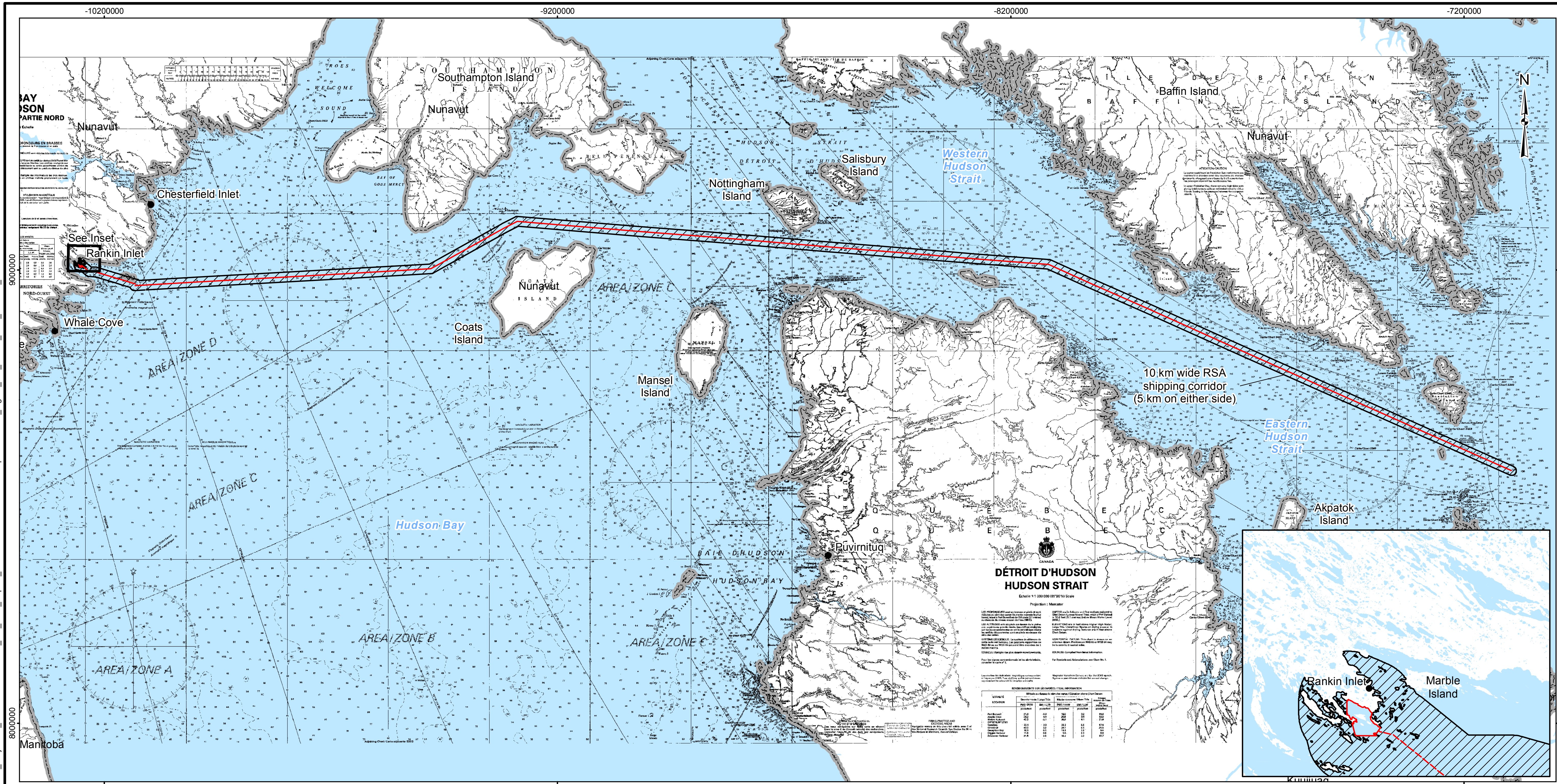

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA) (SEE INSET)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- COMMUNITY
- WATERBODY

REFERENCE

BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED (AEM).
CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: WGS 84 PROJECTION: WORLD MERCATOR

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
MARINE REGIONAL STUDY AREA

Golder Associates

PROJECT NO.		1535029	FILE No.	
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GIS	DSC	18 Jul. 2012		
CHECK	PR	18 Jan. 2013	FIGURE B-2	
REVIEW	DW	18 Jan. 2013		

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1.2 Existing Environment in Melvin Bay / Itivia Harbour

In August 2011, a field program was conducted by Nunami Stantec at Itivia and at two nearby reference sites in Melvin Bay (Figure B-1). The objective of the field program was to collect physical and biological baseline information in the marine LSA (Figure B-1), with a focus on the Project footprint corresponding with the proposed floating dock facility (landing barge). The field program investigated bathymetry, water and sediment chemistry, aquatic lower-trophic organisms (phytoplankton, zooplankton, and benthic invertebrates) and fish and fish habitat. Results from Nunami Stantec's field program are provided in detail in Appendix 8.2-A of the FEIS, with a general summary provided below for bathymetry, water, and sediment chemistry (Agnico Eagle 2014).

1.2.1 Physical Environment

Depth soundings were collected along shore-perpendicular transects in the LSA. Water depths at Itivia and in Melvin Bay were determined to be shallow, with maximum depths in the Project footprint reaching 6.6 metres (m). A large rocky reef is present approximately 125 m offshore of the high water mark near the proposed landing barge facility. Cobble and gravel were the dominant substrates in the nearshore environment of the Project footprint (Figure B-3).

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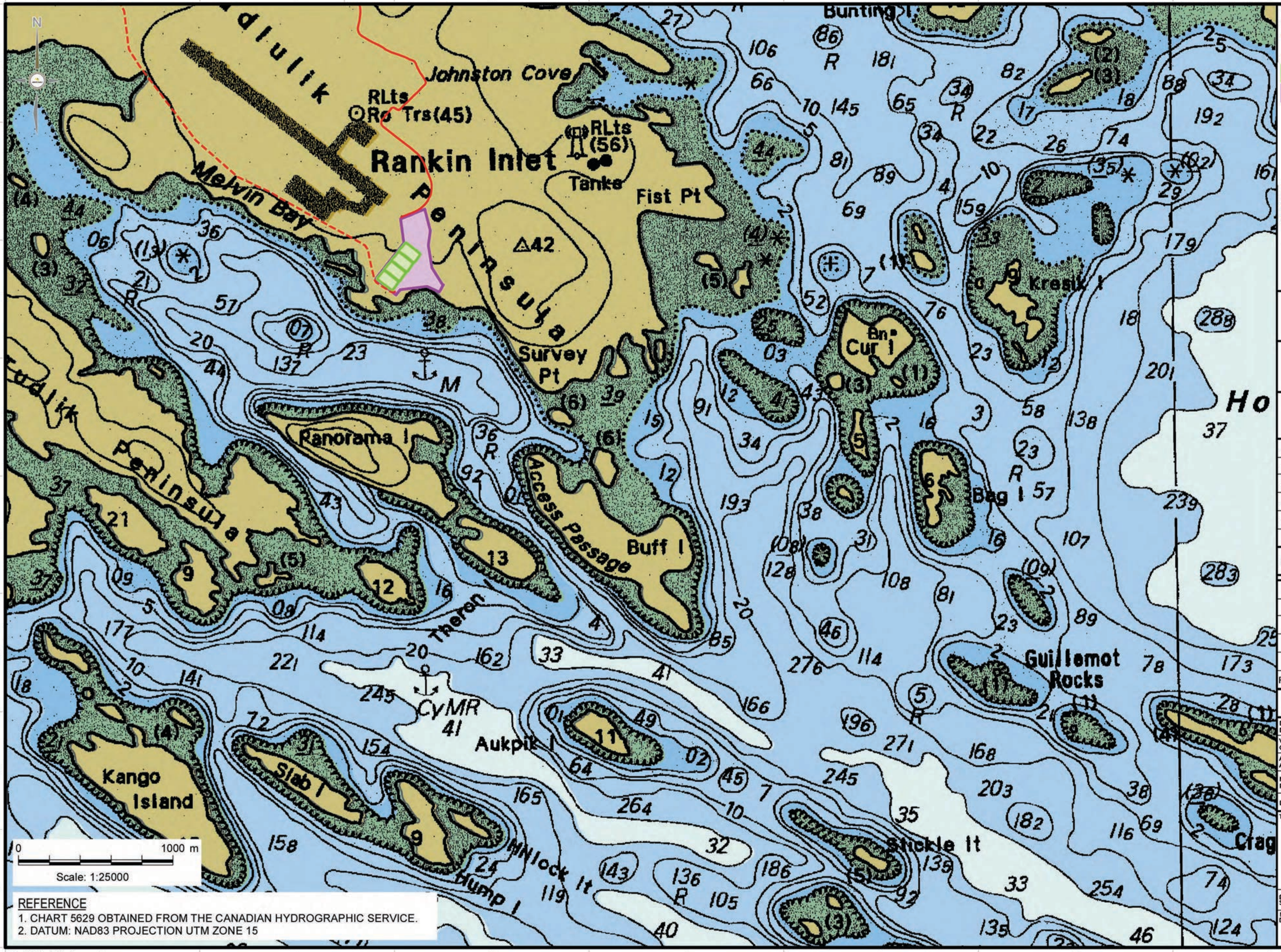

LEGEND

- RANKIN ROAD
- BYPASS ROAD
- TANK FARM AREA
- LAYDOWN AREA
- SHIP/TANKER ANCHOR LOCATION
- M MUD
- Cy CLAY
- R ROCK, ROCKY
- LOW WATER LINE
- ROCKY AREA, WHICH COVERS AND UNCOVERS

AGNICO EAGLE

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REVISIONS

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APPROUVÉ PAR / APPROVED BY	LY	09-08-2016
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DATE	–	

TITRE / TITLE

AGNICO EAGLE – MELIADINE DIVISION
FIGURE B3 SHORELINE TYPES
IN ITIVIA HARBOUR AND MELVIN BAY

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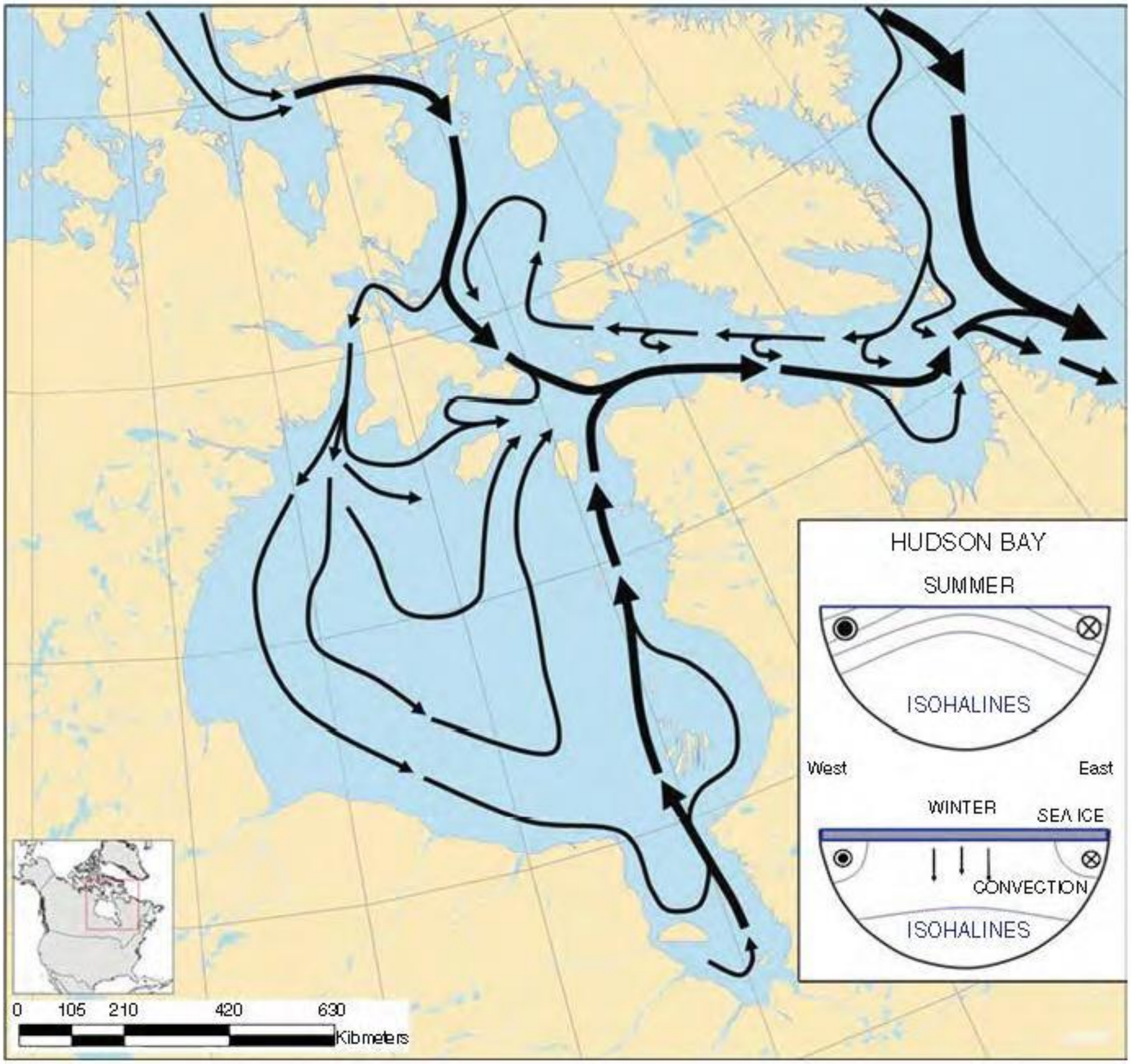

Figure B-4: Summer circulation of water in the Hudson Bay Complex (extracted from Stewart and Barber 2010; inset after Ingram and Prinsenberg 1998)

Water quality profiles were collected at one location in the LSA with an YSI 600QS multi-meter. Parameters measured included temperature, conductivity, pH, dissolved oxygen, salinity, and oxidation-reduction potential. Mean surface water temperature (at 1 m depth) in the harbour was 8.86 ± 0.52 degrees Celsius (°C), with a salinity of 29.32 ± 0.03 ppt, and a pH of 8.08 ± 0.03. Bottom water was slightly colder than surface water at 8.49 ± 0.57°C; with similar salinity and pH values. No thermal stratification was observed. The pH was near constant across the LSA (range from 8.05 to 8.10) and throughout the water column (range from 8.05 to 8.10).

Mean conductivity ranged from 45.6 ± 0.1 mS/cm at the surface to 45.7 ± 0.1 mS/cm at the bottom. Dissolved oxygen ranged from 114.5 ± 1.0% at the surface to 114.1 ± 1.2% at the bottom.

Water samples were collected for chemistry analysis at one location in the LSA using a Van Dorn sampler deployed at mid-depth. Parameters analyzed included major anions, alkalinity, total suspended solids, total dissolved solids, pH, conductivity, total metals, total Kjeldahl nitrogen, ammonia, nitrate and nitrite, total phosphate, and total organic carbon. Results were compared to Canadian Council of Ministers of the Environment (CCME) guidelines (maximum levels) for Protection of Marine Aquatic Life (PMAL). Total alkalinity in the marine LSA ranged from 142 to 144 milligrams per litre (mg/L), with bicarbonate (HCO3-) as the major representative ion. Nitrate, nitrite, total Kjeldahl nitrogen, dissolved orthophosphate, and total phosphorus were below detection limits (typically <0.050 mg/L). Total organic carbon values were low (ranging from 2.8 to 3.6 mg/L). Approximately 78% of all analyzed metals (33 of 42) were below detection limits. All sample parameters for which CCME PMAL guidelines exist were within acceptable limits.

Sediment samples were collected for chemistry analysis at 3 locations in the marine LSA footprint using a petite ponar grab. Metal concentrations were compared to CCME Interim Sediment Quality Guidelines (ISQG). Sediment chemistry was near constant across the LSA. Metal concentrations were variable and ranged from below analytical detection limits to exceeding CCME ISQCs. Chromium slightly exceeded the CCME ISQG of 52.3 milligrams per kilogram (mg/kg) at all sample stations, with average (±SD) concentrations in the marine LSA footprint measured at 55.8 ± 5.89 mg/kg. The precision analyses (CV) indicate some heterogeneity of marine sediments in the study area.

1.2.2 Biological Environment

Plankton

Phytoplankton abundance, richness, and diversity were similar across all sites within the marine LSA, and a total of 33 taxa were recorded. Dinoflagellates were the dominant taxa at all sites and included Peridinium/Gonyaulax spp. and Dinophysis spp. The ciliate *Tintinnida* was present at low percentages at 2 of the sites.

Zooplankton abundance, richness, and diversity differed between sites, and a total of 44 taxa were recorded. An unidentified rotifer species, possibly Notommatidae, was identified as the dominant taxa at all sites. Calanoid copepods were also present at all 3 sites.

Benthic Invertebrates

Benthic invertebrate abundance, richness, and diversity differed amongst sites. Polychaetes were the dominant taxa at all sites and included Polychaeta: Sedentaria (burrowing or tube-dwelling), Capitellidae, and Cirratulidae and/or Paraonidae. Polychaeta: Errantia (free-swimming) were the next dominant taxa and included Nephtyidae, Syllidae, and Pholoidae. Also present was nematode subclass Hoplonemertea, the Myidae and Tellinidae clams, the amphipod families of Ischyroceridae, Oedicerotidae, and Zopfiaceae, as well as 11 additional polychaete families. At 1 site, a single sponge (*Porifera*), 2 hydrozoan taxa, 1 flatworm (*Playhelminthes*), Terebellidae and Opheliidae polychaetes, 3 gastropod, and 3 bivalve taxa, several crustaceans (copepod, amphipod, decapods), and one sea squirt (*Urochordata*) were also identified.

Benthic species are not thought to occupy the intertidal zone in Hudson Bay on a permanent basis; rather, they occur seasonally when the habitat is not influenced by ice (Stewart and Lockhart 2005). Baseline studies completed in the LSA support this assumption (Nunami Stantec Ltd. 2012). Few invertebrate species were observed in the nearshore habitat, and abundance was low. Most of the individuals observed were less than 1 cm, suggesting a low biomass. Nearshore macrophyte coverage was found to be equally sparse (ranging from 2 to 5% coverage).

Fishes

Six species of marine fish (n=156) were identified during gill net and beach seine sampling in the marine LSA, including Greenland cod (*Gadus ogac*) (52%), slender eelblenny (*Lumpenus fabricii*) (27%), fourhorn sculpin (kanayok in Inuktitut) (*Myoxocephalus quadricornis1*[1]) (15%), unidentified sculpin (possibly juvenile; 3%), Arctic staghorn sculpin (*Gymnocanthus tricuspis*) (2%), and Arctic sculpin (*Myoxocephalus scorpioides*) (1%). The range of total lengths of the dominant fish taxa were 118 to 520 mm for Greenland cod, 180 to 210 mm for slender eelblenny, and 205 to 315 mm for fourhorn sculpin species. Arctic char were not observed during the baseline field study but were reported to be in the area at the time of the field study (west of Melvin Bay near the Barrier Islands).

Marine Birds

A black guillemot (*Cepphus grylle*) and a pair of sandhill cranes (*Grus canadensis*) were identified in the LSA during the baseline field program.

Marine Mammals

No marine mammals were observed in the LSA during the baseline field program.

1.3 Existing Environment within Hudson Bay / Hudson Strait Shipping Corridor

Golder conducted a comprehensive literature review to characterize the physical and biological environment in the proposed shipping corridor in Hudson Bay and Hudson Strait (Figure B-2). The following information sources were reviewed:

- available records of consultation with regulatory agencies, public stakeholders, and Inuit communities;
- available scientific literature / data reports;
- DFO Integrated Fisheries Management Plans;
- DFO Stock Status Reports;
- DFO's Mapster database;
- DFO's Ocean Data Inventory;

[1] Referenced by it's European (Triglopsis quadricornis) name in Appendix 8.2-A of the FEIS - Nunami Stantec Marine Baseline Report for Itivia Harbour, Rankin Inlet, NU

- Environment Canada's Key Marine Habitat for Migratory Birds;
- Fisheries and Oceans Canada's (DFO) Mapster database;
- governmental and non-governmental environmental resources including:
- Important Bird Areas (IBAs) spatial database;
- Marine Baseline Report - Itivia and Melvin Bay, Rankin Inlet, NU produced by Nunami Stantec Ltd. (2012);
- NIRB Guidelines for the Preparation of an Environmental Impact Statement for the Agnico Eagle Mines Ltd. Meliadine Project (NIRB File No. 11MN034) (NIRB 2012);
- Nunavut Planning Commission web resources including the Nunavut Wildlife Resource and Habitat Values final report (2008);
- Nunavut Wildlife Management Board Reports / Guidance Documents;
- OBIS-Seamap database (Duke University);
- previous marine-based environmental impact statements completed in the Project area (e.g., AREVA and others as available);
- regional fisheries catch statistics (e.g., DFO annual catch data);
- federal Species at Risk Act (SARA) database;
- The Canadian Circumpolar Institute and the Tungavik Federation of Nunavut, Nunavut Atlas (1992); and
- Inuit Qaujimajatuqangit (IQ) collected for local coastal areas.

1.3.1 Physical Environment

Hudson Bay is one of the world's largest inland seas, with a total surface area of approximately 830,000 square kilometres (km^2) (Prinsenberg 1984). It is connected to the Atlantic Ocean by Hudson Strait and the Labrador Sea; and to the Arctic Ocean by the Foxe Basin, Fury and Hecla Strait. Hudson Bay is a relatively shallow waterbody, with an average depth of approximately 100 m. The oceanographic regime in Hudson Bay is complex and manifests all the features of an Arctic system (Macdonald and Kuzyk 2011). It is highly influenced by the influx of cold saline waters (between approximately 32.5 and 33.5 ppt) from the Arctic Ocean and Baffin Bay, through Foxe Basin and Hudson Strait, by wind-stress during both the open-water and ice-cover season, by powerful tides (Stewart and Barber 2010), and by a large freshwater input from both runoff and ice melt (Stewart and Lockhart 2005; Ingram and Prinsenberg 1998). Less saline surface outflows occur along the eastern shores of James Bay and Hudson Bay north to Hudson Strait. In Hudson Bay, estimates of average residence time of water range from 1.0 to 6.6 years (Ingram and Prinsenberg 1998).

Water in the region freezes over each winter and becomes ice-free each summer, with sea-ice first forming in late October and continuing to expand until a maximum ice cover is reached by the end of April. In winter and early spring, the ice floes that cover most of Hudson Bay are kept in constant motion by wind forces. A shore lead system develops along the land-fast ice that forms from the coast of Hudson Bay as a result of wind blowing seaward (Barber and Massom 2007). Major polynyas (stretches of open-water surrounded by sea ice) are found in the northwest sector (including Foxe Basin) and in the vicinity of the Belcher Islands in Eastern Hudson Bay. The northwestern region of Hudson Bay, encompassing part of the Project LSA and RSA, is an area where there is a large and persistent reoccurring polynya (Saucier et al. 2004).

Waters in the Hudson Bay region are characterized by moderate to strong semidiurnal tides of Atlantic origin, a marked summer pycnocline, and greater mixing inshore than offshore (Stewart and Lockhart 2005; Ingram and Prinsenberg 1998). Although marine productivity in Hudson Bay proper is low in comparison with other oceans of similar latitudes, productivity in Hudson Strait is typically twice higher than in other oceans of similar latitudes because of the sustained nutrient availability supplied by tidal mixing throughout an extended ice-free season (Ferland et al. 2011; Sibert et al. 2011).

The southern James Bay region is shallower and influenced to a much greater extent by freshwater runoff, thus supporting a wider variety of temperate-water species that are rare or absent elsewhere in Canada’s Eastern Arctic waters (Stewart and Lockhart 2004). Seasonal ice cover also occurs in James Bay, with ice beginning to recede in late May, and the area becoming ice-free by the end of July. Polynyas are found predominantly along both coasts of James Bay during winter.

The Hudson Bay marine ecosystem is abnormally cold relative to other regions of the same latitude, and its climate is characterized by long and cold winters and cool summers (Stewart and Lockhart 2004). The entire area exhibits extreme temporal (seasonal and annual) and spatial variations in the range of average temperatures and average precipitation. Northwestern Hudson Bay experiences the greatest influence of cold Arctic air masses and has the harshest climate, with typical strong winds and persistent low temperatures. Other areas of the bay have less extreme conditions affected by moderate southern or marine influences. There is also a strong average precipitation gradient across the region, from less than 200 millimetres (mm) per year in the northwest to over 800 mm per year in the southeast (Stewart and Lockhart 2004). The upper air circulation of weather systems over Hudson Bay water is mainly related to the persistent, counter-clockwise air flow around a low pressure vortex that is situated over Baffin Island in winter, but weakens and retreats northward in summer (Stewart and Barber 2010).

There is considerable seasonal variation in Hudson Bay with respect to water circulation. In summer, surface water in Hudson Bay moves cyclonically (counter clockwise), influenced by cold saline Arctic water from Foxe Basin that enters in the northwest via Roes Welcome Sound (Prinsenberg 1986a; Tan and Strain 1996). During the transit, surface water is diluted by meltwater and runoff from the land, warmed by the sun, and mixed by the wind as it circulates, thus generating strong vertical stratification of the water column. Most of the river runoff water remains in the nearshore coastal regime in summer, with limited exchange into the interior of the Bay (Granskog et al. 2011). These water masses move eastward along the southern coast and are subsequently deflected northward and exit to the northeast into Hudson Strait (Figure B-2). About half of the freshwater transport from Hudson Bay to Labrador Sea is the result of water pulses associated with anticyclonic, surface-trapped eddies that propagate through Hudson Strait as a result of storms and/or local instability processes (Sutherland et al. 2011).Deep water in Hudson Bay moves in the same general direction as surface water, although it is influenced by bottom topography (Ingram and Prinsenberg 1998; Wang et al. 1994). Intermittent flow of this dense water (approximately 34.1 ppt) over the sill that separates Foxe Channel from Hudson Bay likely maintains the homogeneous bottom layer in Hudson Bay (Stewart and Barber 2010). The incursion of

Arctic waters creates Arctic oceanographic conditions in Hudson Bay, which extend farther south than elsewhere in North America and serve as the main driver of the Hudson Bay ecosystem (Stewart and Lockhart 2004).

The residual currents in Hudson Bay that are independent of tides are wind-driven and density-driven. Monthly mean current velocities are in the range of 4 to 6 centimetres per second, with stronger currents occurring in summer than in winter and more variability occurring at the surface than at depth (Prinsenberg 1986b). Winds are generally weaker and more variable in summer than in fall when strong northwesterly winds occur. The density-driven component is stronger in early summer when surface freshwater input from runoff and ice melt is highest (Prinsenberg 1982), and weakest in late winter/early spring when surface runoff input is lowest, local salinity is offset by salt excreted by the growing sea-ice, and wind-driven mixing of surface waters is not possible due to ice cover.

The tidal regime in Hudson Bay is influenced by powerful tides from the Atlantic Ocean that surge twice a day via Hudson Strait (Stewart and Barber 2010). These tides move as a Kelvin wave and propagate counter clockwise around Hudson and James Bay following the shoreline contour and overshadowing local tides and the Arctic tidal influence (Freeman and Murty 1976). In general, both tidal amplitude and range decreases as one moves counter-clockwise along the coast. The semidiurnal tidal amplitude ranges from 1.50 m along the western shore at Churchill to 0.10 m along the eastern shore near Inukjuak (Prinsenberg and Freeman 1986; Prinsenberg 1988a). The range in height between high and low water also varies, ranging from 0.5 m at Inukjuak (Inoucdjouac) and 2 m along the east side of James Bay to as high as 4.6 m along the west coast of Hudson Bay (Dohler 1968).

Hudson Bay is nearly entirely covered by ice in winter and is free of ice in summer. Depending on the weather, timing of sea ice formation or breakup may occur earlier or later by up to a month, but the general patterns remain similar. The ice formation in Hudson Bay usually begins in the north-western part (Repulse Bay) in October and spreads rapidly southward along the western coast during November (Cohen et al. 1994). By mid-December, from 90 to 100% of Hudson and James bays are covered with ice. Maximum ice cover usually occurs in April and May, and maximum ice thickness can occur between late February and early June and can reach 285 centimetres (cm) (Loucks and Smith 1989). The ice breakup begins in June in southern James Bay and Chesterfield Inlet and the region is usually entirely ice free in the first week of August (Stewart and Lockhart 2004; Cohen et al. 1994). Ice cover is an important feature of the Hudson Bay marine ecosystem. Ice distribution determines the distribution of marine biota and affects marine ecological processes in the water column and near the ice edge (Melnikov 1980). During ice formation, most of the seawater salt is expelled from the ice. This increases the salinity of the surface water, thereby increasing its density and deepening its layer (up to 100 m) and enhancing mixing of the water column (Prinsenberg 1988b). Formation of dense deep water is facilitated in the shore lead polynya system within which increased brine rejection is able to overcome buoyancy in the surface layer. This provides a mechanism to shunt approximately 6 to 16% of river runoff inputs into deeper waters that have an apparent residence time of about 4 to 14 years (Granskog et al. 2011).

As the pack-ice forms in northwestern Hudson Bay, predominant northwest winds continuously push it to southeastern Hudson Bay. The pack-ice forms rafts and ridges and increases in overall ice thickness, which increases freshwater input in this area in the spring (Prinsenberg 1988b). In northwest Hudson Bay, in contrast, the ice is constantly formed and removed continuing the salt input into the water column. This constant removal of the ice by northwest winds and tidal mixing develops leads and recurring polynyas. There are several polynyas that form close to shore, such as in Roes Welcome Sound, at the northern tip of Coats Island, and at

Akimiski Island, which is one of the most southerly polynyas in Canadian waters. These polynyas provide important habitat for various species of marine birds, such as the Hudson Bay eider, which overwinters in this region (Martini and Protz 1981; Nakashima 1988).

The Hudson Bay marine ecosystem is characterized by strong vertical stratification of the water column in spring and summer, particularly offshore (Roff and Legendre 1986; Anderson and Roff 1980; Prinsenberg 1986a). The vertical stratification is caused by a dilution of cold Arctic saline surface water by freshwater runoff and sea-ice melt, which is subsequently warmed by the sun, and mixed by the wind. The stratification results in a strong vertical density gradient between fresh, warm water at the surface and cold, saline deeper water. The vertical density gradient impedes vertical mixing, thereby limiting nutrient input to surface waters and lowering biological productivity. A strong summer pycnocline can be observed at depths between 15 and 25 m (Anderson and Roff 1980; Prinsenberg 1986a; Ferland et al. 2011). Heating of the surface layer and freshwater input decrease as summer progresses. This increases the depth of the pycnocline. In winter, the vertical stratification is the weakest due to the increase in density of surface water and, therefore, there is an increase in vertical mixing.

Physical conditions that promote large-scale mixing or upwelling in the region during spring and summer remain limited, but ice edges along the well-developed shore lead system (where the coastal fast ice and mobile pack ice meet) correspond with areas of upwelling and associated stimulation of nutrient fluxes and primary production (Stewart and Barber 2010). In the area where the shore lead prevails (nearshore), the isotopic composition of phytoplankton during summer suggests the presence of an open system influenced by the upwelling of deep waters and related nutrient replenishment (Kuzyk et al. 2010). Another key process that supports the re-injection of nutrients in surface waters in Hudson Bay is the vertical mixing driven by tidal currents (Sibert et al. 2011). Tides in the region are known to enhance marine productivity (Stewart and Barber 2010) and to contribute to the development of local biological hotspots that are used by marine mammals as summer habitats, such as in the northwest region of the Bay (Higdon and Ferguson 2010).

At a deep-water station in southeastern Hudson Bay, surface salinity ranged from 24 ppt in August to 28 ppt in April, and surface temperature ranged from -1.5°C in April to 8°C in August (Figure B-5). At depths below 50 m, water temperature and salinity were relatively stable throughout the year. As water depth increased, water temperature progressively decreased as salinity increased, with mean water temperature below -1.4°C and salinity greater than 33 ppt at approximately 100 m water depth (Ingram and Prinsenberg 1998).

Freshwater runoff, wind-driven mixing, and tidal influence have great effects on water column characteristics in the Hudson Bay ecosystem. Vertical stratification near large river plumes varies seasonally and spatially. It is usually directly related to the runoff volume and inversely related to the tidal kinetic energy (Freeman et al. 1982). The water column stratification is stronger during freshet and weaker with distance from the river mouth. The salinity and temperature gradients are usually weaker when wind-driven mixing and tidal energy are strongest. The volume of the freshwater runoff in the region is high, with a mean discharge rate of 30 900 cubic metres per second for all rivers combined (The Canadian Encyclopaedia). These high runoff volumes determine oceanographic conditions in the area by creating very low surface salinities and strong vertical density gradients.

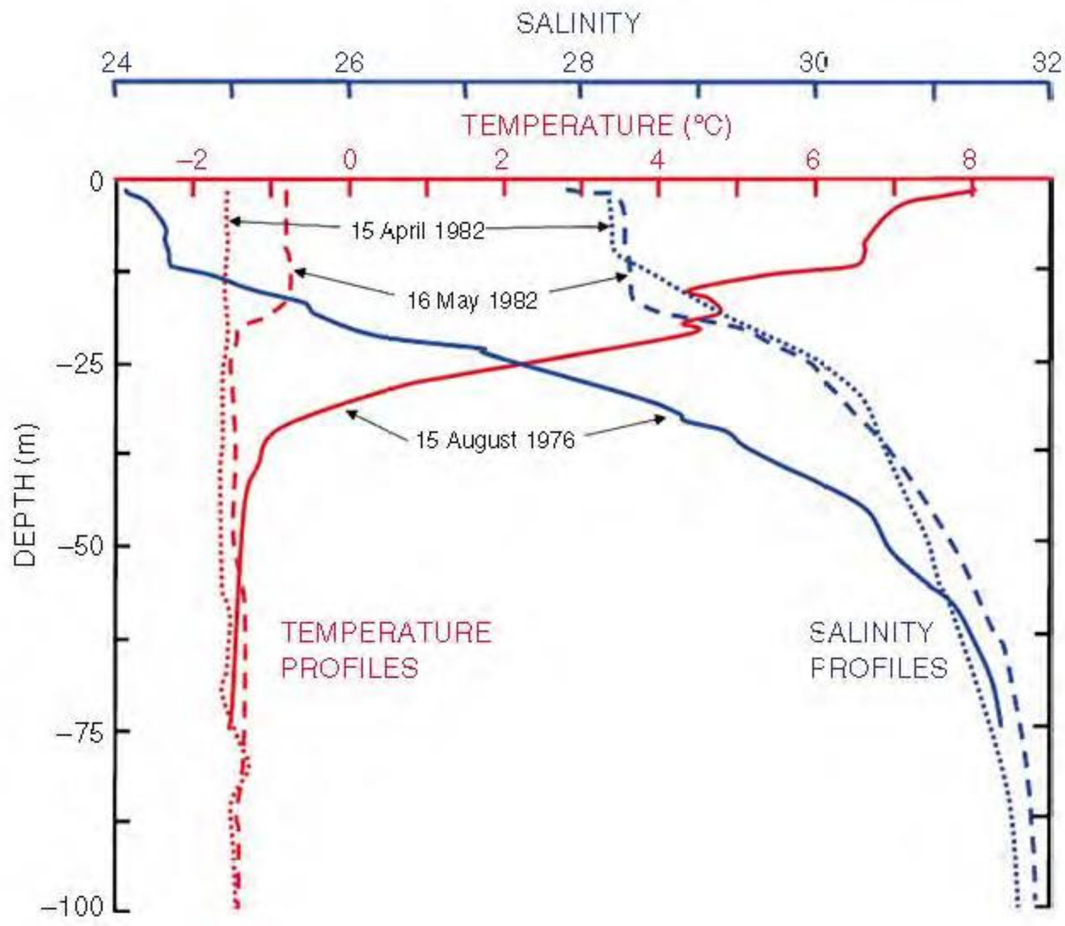

Figure B-5: Representative Vertical Profiles of Temperature and Salinity in Southeastern Hudson Bay in April (dashed line), May (dashed-dotted line), and August (solid line) (extracted from Stewart and Barber 2010; Redrawn from Ingram and Prinsenberg 1998)

High freshwater runoff volumes are also partly responsible for the difference between inshore and offshore oceanographic conditions in Hudson Bay during summer. In general, salinity and temperature in Hudson Bay increases with distance from shore (during summer). For example, surface salinity in Hudson Bay ranged from 10 ppt near major rivers to 30 ppt in offshore locations of the bay, and surface temperature ranged from 4°C in nearshore areas to 11°C in offshore locations (Anderson and Roff 1980; Prinsenberg 1986a). Lower salinities in the inshore region are due to dilution effects, whereas lower nearshore temperatures in western Hudson Bay are due to strong northwesterly wind effects causing upwelling of colder deep water to the surface (Figure B-6). In southern Hudson Bay, lower temperatures are a result of pack-ice, which lingers along the shore well into summer. Higher temperatures offshore cause stronger vertical stratification. During periods with low water temperatures (−1.75°C to 1.25°C), considerably higher rates in both bedload and suspended sediment transport are observed along the shore in comparison with a summer situation (9°C to 17°C), with similar wave heights and current velocities (Héquette and Tremblay 2009). The winter increase in suspended sediment transport is likely due to lower sediment settling velocities resulting from significant increases in fluid kinematic viscosity at low temperature. Hudson Strait is a wide, deep-water channel (on average 150 km wide, 750 km long, and

400 m deep) that connects Hudson Bay and Foxe Basin with the Labrador Sea and Davis Strait (Harvey et al. 2001). It acts as a transition zone between brackish waters in Hudson Bay and more oceanic waters of the Labrador Sea. Hudson Strait is covered with ice from mid-December to July (Hudon et al. 1993). The oceanographic regime in Hudson Strait is affected by strong tidal currents (up to 2 to 3 m/s) and high tidal elevations (tidal amplitudes are 6 to 9.5 m). These tides cause intensive vertical mixing in the water column, disrupting vertical density stratification and, therefore, enhancing biological productivity by increasing nutrient availability in the surface layer (Drinkwater and Jones 1987; Drinkwater 1986, 1990; Harvey et al. 2001).

The physical processes in Hudson Bay and Hudson Strait have a strong influence on the oceanographic and biological processes over the Labrador Shelf, affecting the water temperature and salinity characteristics in the area (Drinkwater and Harding 2001). At the eastern entrance of Hudson Strait, low salinity waters from Hudson Bay and Foxe Basin flowing eastward converge with cold Baffin Land Current waters from the north and warmer deep West Greenland Current waters. The Hudson Strait strong tidal currents result in intensive vertical mixing of these waters and the residual current carries the resulting mixture eastward onto the Labrador Shelf (Drinkwater and Jones 1987). This results in increased mixing over the Labrador Shelf, with reduced vertical density stratification relative to the Baffin Island Shelf to the north (Lazier 1982). Primary productivity is subsequently enhanced by elevated surface nutrient concentrations in eastern Hudson Strait (Drinkwater and Jones 1987) and on the northern Labrador Shelf (Kollmeyer et al. 1967).

Since 2005, recurrent expeditions of the CCGS Amundsen in Hudson Bay (Arcticnet 2014) have supported the collection of ambient noise and acoustic backscattering data. The primary dataset is composed of records obtained with a SIMRAD EK60 3-frequency split-beam echosounder that was operated continuously during the field campaigns (Polar Data Catalogue 2014). In parallel, AURAL-M2 (Autonomous Underwater Recorder for Acoustic Listening-Model 2) passive hydrophones were attached on mooring arrays deployed nearby Churchill and Great Whale River to document the seasonality of underwater sound, including marine mammal vocalizations and ambient noise (Polar Data Catalogue 2014).

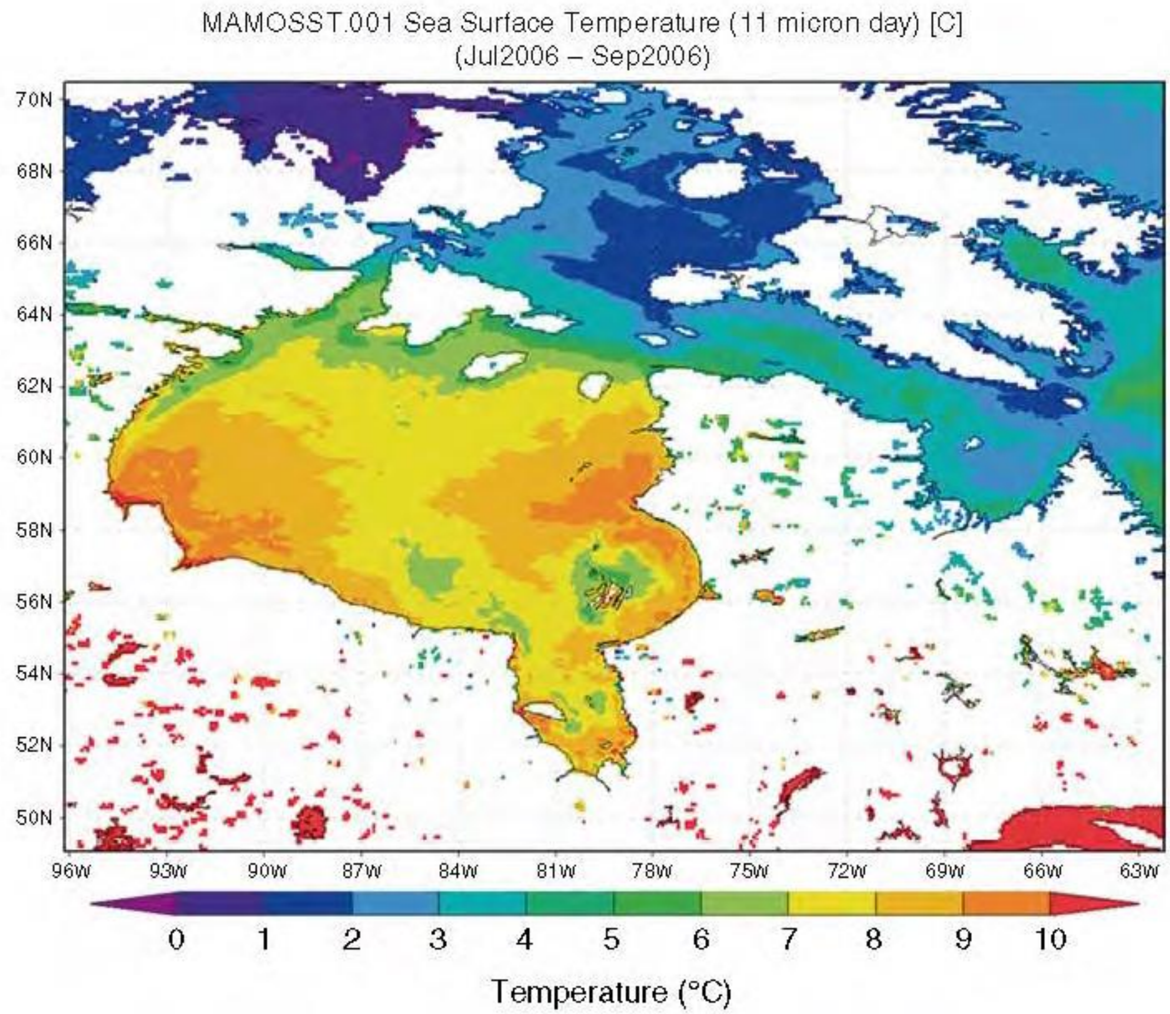

Figure B-6: Summer (July to September) sea surface temperature in 2006 (Stewart and Barber 2010)

1.3.2 Biological Environment

The marine ecosystem of Hudson Bay encompasses a large geographical area that includes James Bay, Hudson Bay, Fox Basin, and Hudson Strait. Four important features characterize this unique ecosystem:

1) an extreme southerly penetration of Arctic marine water from the north;

2) a very large volume of freshwater runoff that enters the Hudson Bay watershed each year from land;

3) seasonal coverage of sea-ice; and

4) the dynamic coastal geomorphology of the coastal zone where exposure of new shoreline (made up of coastal salt marshes and wide tidal flats) presently occurs at a rate of up to 15 m/year (horizontal) as part of an isostatic rebound of the land from the weight of the Laurentide Ice Sheet, which once covered this entire region (Stewart and Lockhart 2004).

These key features combine to form critical habitat areas for many species of marine fauna including anadromous fish and large concentrations of migratory species including shorebirds, waterfowl, seabirds, and marine mammals. The following section provides an overview of the biological characteristics of each taxa (by key species) potentially impacted by shipping activities in the RSA.

1.3.2.1 Fishes

Approximately 60 species of fish are known to inhabit estuarine waters of Hudson Bay and James Bay (CARC 1991). Fewer species are present in the northern limits of the RSA, where arctic species predominate. Arctic char, Arctic cod, and other species contribute directly to the domestic fishery, and indirectly to the food chain of marine and terrestrial mammals and birds. Fish species considered important to the local commercial, recreational, and subsistence fisheries are identified in Table B-1. An overview on the biology of these species is provided below.

Table B-1: Overview of Marine Fish Species Found within the Local and Regional Study Areas

Common Name	Species	Inuktitut Name	Habitat	*SARA* Status[(a)]	COSEWIC Status[(b)]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Arctic char	*Salvelinus alpinus*	ᐃᖃᓗᒃ ᐱᒃ / ᑕᑎᐅᕐ ᒥᐅᑕᖅ	Anadromous (Riede 2004). In the marine environment, they are found in coastal areas in waters 30 to 70 m deep (Billard 1997).	No status	Not assessed	Yes	✔	✔
Greenland cod	*Gadus ogac*	ᐆᒐᖅ	Demersal[(c)]. Coastal waters up to 400 m deep (Coad and Reist 2004; Cohen et al. 1990).	No status	Not assessed	Yes	✔	✔
Polar cod	*Arctogadus glacialis*	ᐆᒐᖅ	Cryopelagic[(d)] or epontic[(e)] (Coad and Reist 2004). Marine waters down to 1,000 m; Mainly found in the shallower areas of the water column (Scott and Scott 1988).	No status	Not assessed	Yes	✔	✔
Arctic cod	*Boreogadus saida*	ᐆᒐᖅ	Cryopelagic or epontic. Marine waters down to approximately 1400 m. Favour coastal areas during the summer and winter months (Coad and Reist 2004). Spawning occurs under the Arctic ice (DFO 2011b).	No status	Not assessed	Yes	✔	✔
Fourhorn sculpin (marine form)	*Myoxocephalus quadricornis*	ᑲᓇᔪᖅ	Benthic. Shallow coastal estuarine environments (Morrow 1980). In spring, they move to deeper waters for the summer and are generally found in waters 45 m to 100 m deep (Muus 1999).	No status	Not at Risk	Yes	✔	✔
Arctic staghorn sculpin	*Gymnocanthus tricuspis*	ᑲᓇᔪᖅ	Benthic. Prefers sandy bottoms (Fedorov 1986; Coad and Reist 2004). Coastal areas, close to shore (ArcOD 2011).	No status	Not assessed	Yes	✔	✔
Arctic sculpin	*Myoxocephalus scorpioides*	ᑲᓇᔪᖅ	Benthic. Shallow marine environments up to 275 m (Coad and Reist 2004).	No status	Not assessed	Yes	✔	✔
Slender eel blenny	*Lumpenus fabricii*	ᒪᓯ ᖃᖕᒋ ᑐᑦ	Sandy to rocky habitats. Seem to prefer seagrass and algae, where they spawn (Mecklenburg and Sheiko 2004).	No status	Not assessed	No	✔	✔
Greenland halibut	*Reinhardtius hippoglossoides*	ᖃᓕᕋᓕᒃ	Epibenthic. Surface to deep waters down to 2000 m (Coad and Reist 2004).	No status	Not assessed	Yes	✔	✔

(a) SARA.The *Act* is a key federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of their biological diversity (extracted from *SARA* 2012).

(b) COSEWIC (Committee on the Status of Endangered Wildlife in Canada) is a committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada. It is up to Government to legally protect wildlife species designated by COSEWIC. The potential impacts of legal listing are for Government to analyse, and the SARA applies only to wildlife species on the SARA legal list (extracted from COSEWIC 2012).

(c) live on or near the seafloor.

(d) cold, deep marine environments.

(e) associated with the lower interface of the sea ice.

Arctic char (*Salvelinus alpinus*)

Arctic char exhibit anadromous and land-locked life history types (DFO 2006c). The anadromous forms of this species spend a large portion of its life cycle in the coastal marine environment (Riede 2004; Billard 1997). Spawning occurs in freshwater rivers, with annual migrations to marine waters occurring in the spring after the first 2-6 years of life (DFO 2006c). During autumn, adults migrate back to freshwater habitats to overwinter (Richardson et al. 2001). Arctic char feed on crustacean and other fish including capelin (Mallotus villosus), sand lance (Ammodytes spp.), Arctic cod, and juvenile Greenland cod (Richardson et al. 2001; Coad and Reist 2004).

In the RSA, Arctic char can be found along the western and northern coast of Hudson Bay and coastal areas of Hudson Strait (Coad and Reist 2004), with high abundances identified near Arviat, Chesterfield Inlet, Cape Dorset, and Kimmirut (NPC 2008) (Figure B-7). Arctic char are harvested commercially, recreationally, and for subsistence use (Canadian Circumpolar Institute 1992; Heather and usher 2004). Kangiqliniq Hunter and Trappers Association consider Arctic char an important food fish species for the residents of Rankin Inlet (Nunami Stantec Ltd. 2012).

Greenland cod (*Gadus ogac*)

Greenland cod are a demersal[2] fish found most commonly in coastal waters up to 400 m deep (Coad and Reist 2004; Cohen et al. 1990). They feed on crustaceans, molluscs, sea stars, worms, and other fish including capelin, polar cod juvenile Greenland cod and Greenland halibut (Coad and Reist 2004). Greenland cod spawn at the mouths of freshwater rivers during spring (DFO 2006a). Their habitat range overlaps with the RSA, primarily occupying inlets and estuaries along both coasts of Hudson Bay extending south to Arviat along the west coast and to the Eastmain River estuary in James Bay along the east coast (Coad and Reist 2004; Ochman and Dodson 1982; Hunter et al. 1984).

Polar cod (*Arctogadus glacialis*)

The habitat range of polar cod includes offshore continental shelf waters of the RSA in Hudson Bay and Hudson Strait (Cohen et al. 1990; NPC 2008). They exhibit cryopelagic[3] or epontic[4] life history types (Coad and Reist 2004), although they frequent primarily the upper surface waters in Hudson Bay (Scott and Scott 1988). Polar cod are closely associated with sea-ice and spawn underneath the ice during winter (Bradstreet et al. 1986; Craig et al. 1982). Prey species include other fish and crustaceans; predators include seabirds, seals, whales, and other fish (Bradstreet 1982).

Arctic cod (*Boreogadus saida*)

Arctic cod are a key species in the arctic marine ecosystem (DFO 2011b). Like polar cod, Arctic cod exhibit cryopelagic or epontic life history types and have a short life span (Coad and Reist 2004). They live in marine waters down to 1,400 m (Coad and Reist 2004) and inhabit coastal areas during the summer and winter months (Cohen et al. 1990). Arctic cod feed on epibenthic mysids, amphipods, copepods, and other fish (Coad and Reist 2004). Spawning is thought to occur in late autumn and winter under the sea-ice. Arctic cod are a main food source for marine mammal and seabirds, particularly narwhals and murres (DFO 2011b).

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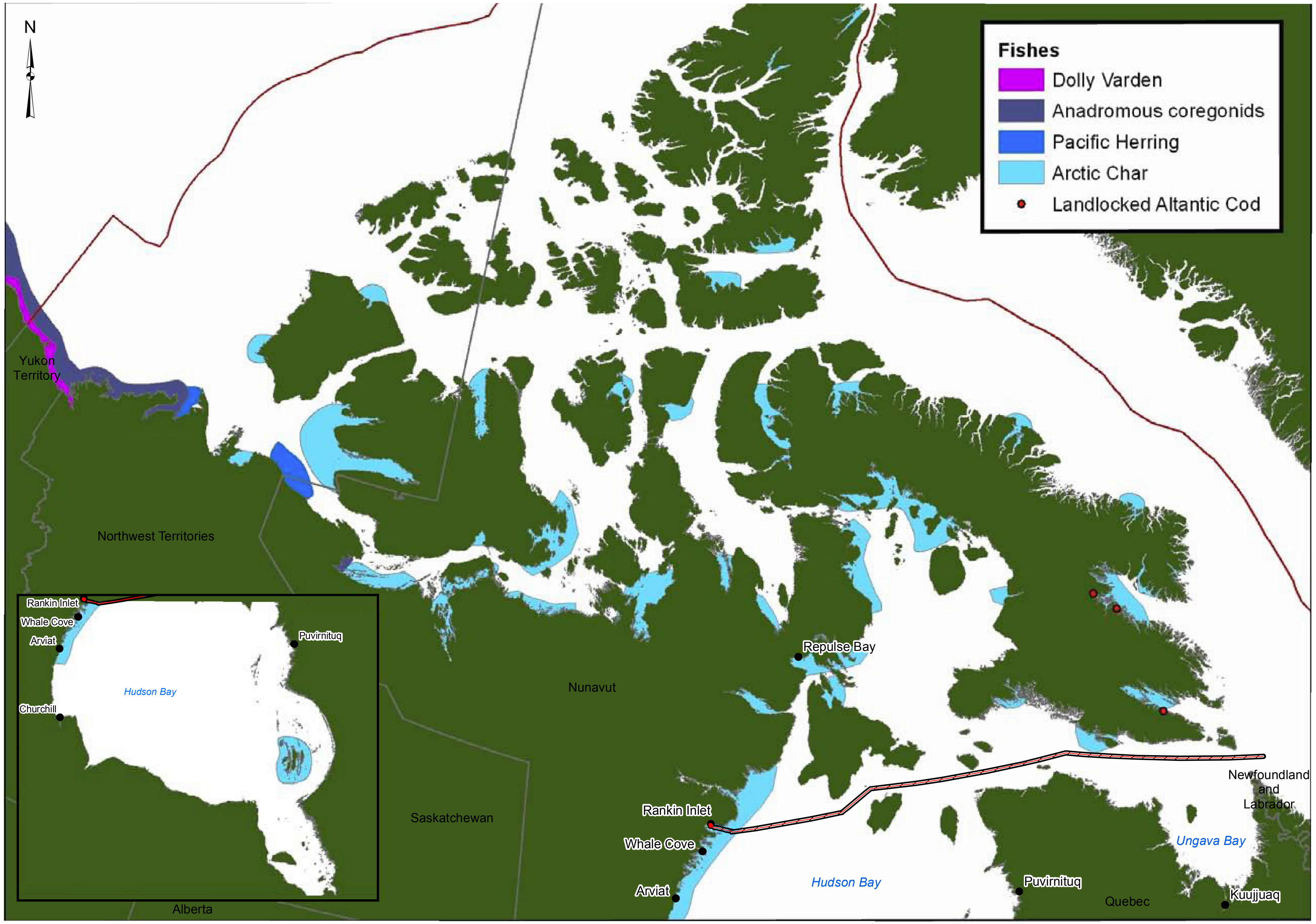
[2] live on or near the seafloor

[3] associated with cold, deep marine environments

[4] associated with the lower interface of the sea ice



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

POVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF ARCTIC CHAR (*Salvelinus alpines*) AND OTHER SELECTED FISH SPECIES IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	20 Jul. 2012		
CHECK	PR	18 Jan. 2013	**FIGURE B-7**	
REVIEW	DW	18 Jan. 2013		

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Meliadine_Gold_Project\99_PROJECTS\1535029_WL_Tech_Sup\02_PRODUCTION\5000\MXD\Report\1535029_Figure_B-7_Distribution_of_Arctic_Char.mxd

There is no commercial harvest of Arctic cod in the Canadian Arctic (DFO 2011b). Subsistence fishery records indicate that Arctic cod have been traditionally harvested in Arviat, Whale Cove, Coral Harbour, Cape Dorset, Kimmirut (Canadian Circumpolar Institute 1992; Heather and Usher 2004). Their habitat range overlaps with that of the RSA and extends into the Hudson Bay and Hudson Strait (Coad and Reist 2004).

Fourhorn sculpin (*Myoxocephalus quadricornis*)

Fourhorn sculpins are a benthic species (Coad and Reist 2004) and are generally found in shallow coastal estuarine waters (Morrow 1980). In the spring, this species migrates to deeper waters for the summer months where they are typically found in waters 45 to 100 m in depth (Muus 1999). They feed on crustaceans, molluscs, and fish (Coad and Reist 2004). Spawning occurs in shallow waters where pairing and egg laying occur in gravel substrate (Muus 1999). This species is distributed throughout Hudson Bay and Hudson Strait (Coad and Reist 2004). Fourhorn sculpins have been traditionally harvested in Arviat, Whale Cove, Coal Harbour, Cape Dorset, and Kimmirut (Canadian Circumpolar Institute 1992; Heather and Usher 2004).

Arctic staghorn sculpin (*Gymnocanthus tricuspis*)

The Arctic staghorn sculpin are a benthic species preferring sandy bottom types but also frequenting mud, gravel, and rocky habitats (Fedorov 1986; Coad and Reist 2004). This species tends to inhabit near-shore areas (ArcOD 2011). Spawning occurs in late autumn and winter (ArcOD 2011). Artic staghorn sculpin feed primarily on benthic amphipods and worms (Fedorov 1986). They are not a commercially harvested species and do not represent a major target species of the subsistence fishery.

Arctic sculpin (*Myoxocephalus scorpioides*)

Arctic sculpin are known to occur in the RSA, with a regional distribution extending from James Bay and the Straits of Belle Isle to Greenland (Fishbase 2012). They are a benthic species found primarily in shallow marine environments up to 275 m in depth (Coad and Reist 2004). Spawning occurs during autumn (Coad and Reist 2004). Prey items include mainly crustaceans (Coad and Reist 2004). They are not a commercially harvested species and do not represent a major target species of the subsistence fishery.

Slender eelblenny (*Lumpenus fabricii*)

The slender eel blenny can be found in a variety of marine environments from sandy bottoms to rocky habitats but are rarely found in intertidal areas (Coad and Reist 2004; Mecklenburg and Sheiko 2004). They are closely associated with seagrass and macroalgae in the nearshore where they spawn during autumn (Mecklenburg and Sheiko 2004). This species feeds on crustaceans, worms, clams, and other fish eggs (Coad and Reist 2004). Its habitat range includes both Hudson Strait and Hudson Bay (Coad and Reist 2004). They are not a commercially harvested species and do not represent a major target species of the subsistence fishery.

Greenland halibut (*Reinhardtius hippoglossoides*)

The Greenland halibut is an epibenthic species and can be found at the surface to waters down to 2,000 m (Coad and Reist 2004). This species feeds on other fishes, crustaceans and squids (Coad and Reist 2004). Its habitat range includes the Hudson Strait (Coad and Reist 2004). The Greenland halibut has become increasingly important in developing commercial fisheries in the eastern Arctic (Coad and Reist 2004); however, they do not represent a major target species of the subsistence fishery.

Hearing Abilities of Marine Fish

It is well known that fish use sound for communication, detection of predators and prey, and learning about their environment (Popper and Fay 1999; Zelick et al. 1999; Fay and Popper 2000; Popper et al. 2003). All fish species can hear with varying degrees of sensitivity within the frequency range of sound produced by seismic sources and other industrial sound sources (Popper and Fay 1973; Fay 1988; Popper and Fay 1993; Fay 2000). The hearing range for most fish is believed to be in the frequency range of 100 to 1000 hertz (Hz) (Fay 1988). A smaller number of species can detect sounds to over 3,000 Hz, while a very few can detect sounds to well over 100 kHz. Because of wide differences in hearing capability and morphologies among fish species, behavioural responses and the susceptibility of fish to auditory trauma varies greatly. There is considerable anatomical and physiological variation amongst fish with respect to hearing structures, suggesting that various species may detect and process sound in different ways (Popper and Fay 1993). Fish can be divided into 2 broad categories: hearing generalists and hearing specialists (Popper et al. 2003; Ladich and Popper 2004). Hearing generalists are fish species without any auditory system specializations. They have poor auditory sensitivity characterized by a narrow bandwidth of hearing, typically detecting sounds from below 50 Hz up to 1 or 1.5 kHz (Popper et al. 2003). This includes most bottom-dwelling species such as Greenland halibut (Popper et al. 2003). The majority of fish species that fall into this category generally do not hear frequencies much above 1 kHz, with peak sensitivities around 300 to 500 Hz (Ladich and Popper 2004). The sound pressure detection threshold can be as high as 120 dB re 1 µPa at 1 m at the most sensitive frequency (Nedwell et al. 2004). Hearing specialists have specialized auditory structures connected to well-developed pressure sensitive organs (Popper and Fay 1993). These morphological adaptations allow hearing specialists to detect sound pressure with greater sensitivity (i.e., lowering their hearing threshold) and in a wider bandwidth than “generalists”, and makes hearing specialists more sensitive to high-amplitude sound introduced into the marine environment.

Hearing thresholds for many Arctic species of fish are largely unknown. Underwater noise generated by vessel engines and cavitation can affect fish behaviour. Behavioural changes may cause disruption to migration patterns or spawning events and movement away from valuable food sources and have the potential to cause population-level effects. Fish are particularly sensitive if these changes occur over a critical period when they have a short window of opportunity to complete an activity.

Over 60 species of marine fish may be found in the LSA and RSA including: Greenland cod (*Gadus ogac*), slender eelblenny (*Lumpenus fabricii*), fourhorn sculpin (*Triglopsis quadricornis*), Arctic staghorn sculpin (*Gymnocanthus tricuspis*) and Arctic sculpin (*Myoxocephalus scorpioides*), Arctic char (*Salvelinus alpinus*), Arctic cod (*Boreogadus saida*), and polar cod (*Arctogadus glacialis).* Polar cod and Arctic cod are both hearing specialist species and are likely to be present in the RSA. Cod fish can detect both sound acceleration and sound pressure over a substantial frequency range; 20 to 150 KHz. Sound pressure thresholds in cod fish in the frequency range 60 to 300 Hz lie in the range 80 to 90 dB re 1 µPa at 1 m. Although hearing thresholds for most of these fish species are largely unknown, hearing thresholds for closely related species such as the walleye pollock

(*Theragra chalcogramma*) and the Atlantic cod (*Gadus morhua L.)* are known and may be used as surrogates for Greenland cod. The hearing ability of walleye pollock, from three different age groups (corresponding to size-classes), was determined from auditory evoked potentials by Mann et al. 2009. Walleye pollock hearing was most sensitive between 100 and 200 Hz, with thresholds around 75 dB re: 1 µPa (Mann et.al 2009). Hearing sensitivity decreased as frequency increased up to 450 Hz. The three age groups of walleye pollock did not show a difference in hearing sensitivity, although there was a noticeable interaction between frequency and age as well as a trend with older fish having a slightly lower mean threshold level. Water temperature appears to have an effect on the hearing thresholds at 350 Hz for walleye pollock. Each degree of temperature increase (from 8 to 12°C) resulted in an 8.3-dB decrease in hearing threshold, with hearing being largely changed by local temperature over their natural range of occurrence. However, walleye pollock are generally found in the marine environment at temperatures less than those used during the Mann et al. 2009 laboratory experiments. In the Bering Sea, walleye pollock are generally found in 3–6°C waters and avoid temperatures less than 0°C (Kotwicki et al. 2005). They may be found in temperatures as warm as 10–12°C (Bailey et al. 1999). Based on the above results, Mann et al. 2009 suggests that the hearing thresholds of walleye pollock are generally similar to those of other gadid fishes.

Hearing studies on Atlantic cod demonstrated that this species is sensitive to pure tones in the frequency range of 30 to 470 Hz. Greatest sensitivity was observed between 60 to 310 Hz and the hearing threshold ranged from 78 to 117 dB re: 1 μPa (Chapman and Hawkins 1973). Changes in levels of ambient sea noise caused variation in thresholds in most frequency bands. In calm sea conditions, unmasked thresholds can be obtained. Thresholds were largely independent of the sound source distance within 1.7 to 50 m, suggesting that cod are sensitive to acoustic pressure (Chapman and Hawkins 1973).

1.3.2.2 Marine Birds

The Hudson Bay marine ecosystem provides resources of critical importance to resident and migrant marine birds throughout the year. At least 43 species of seabirds, shorebirds, waterfowl, and marine-associated raptors frequent offshore, inshore, intertidal, or salt marsh habitats of the Hudson Bay marine ecosystem (Table B-2). Few of these species are year-round residents. Most pass through the area during summer for staging, moulting, nesting, and brooding purposes (Canadian Circumpolar Institute 1992) prior to transiting to their traditional wintering grounds in the south, many of which fall outside the NSA (e.g., Arctic terns, red-necked phalaropes). Thus, impacts to certain long-range migratory species have the potential for transboundary effects. Marine bird species present year-round in Hudson Bay / Hudson Strait are limited to common eider, king eiders, black guillemot, dovekie, and ivory gull. These species have adapted to accessing prey in polynyas, where current and tidal action keep waters ice-free throughout the winter. FigureB- 8 and Figure B-9 provide an overview of marine bird distribution in the RSA based on historical sightings, current scientific knowledge, and IQ.

Table B-2: Overview of Seabird Species Potentially Present within the Local and Regional Study Areas

Common Name	Species	Seasonal Occurrence	Distribution	Other Relevant Information	SARA Status[a]	COSEWIC Status[b]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Black guillemot	*Cepphus grylle*	year-round	coastal / offshore	Harvested for subsistence. Nests in small colonies on steep shores on Southampton and Coats islands.	No status	Not assessed	Yes	✔	✔
Thick-billed murre	*Uria lomvia*	summer	coastal / offshore	Large breeding colony (520 000 pairs) on Akpatok Island in Hudson Strait. Traditional knowledge suggests that murres winter in large numbers in area of open water west of the Belcher Islands in southeast Hudson Bay. Moulting adult birds with their young complete swimming migration in August from a number of known bird colonies in Hudson Bay through the Hudson Strait to offshore areas of Newfoundland and Labrador (Mallory and Fontaine 2004).	No status	Not assessed	Yes	✔	✔
King eider	*Somateria spectabilis*	year-round	coastal	Widely distributed in James Bay and Hudson Bay.	No status	Not assessed	Yes	✔	✔
Common eider	*Somateria mollissima*	year-round	coastal / offshore	Hudson Bay subspecies overwinter in areas where open water and shallow depth coincide. Breeds along rocky coasts or tundra throughout Hudson Bay. Present along ice edge and at polynyas. Feed exclusively on blue mussel.	No status	Not assessed	Yes	✔	✔
Northern fulmar	*Fulmarus glacialis*	summer / fall	coastal / offshore	Rare visitor to James Bay in late fall. Observed at Coats Island.	No status	Not assessed	No	✔	✔
Black-legged kittiwake	*Rissa tridactyla*	summer	coastal / offshore	Occurs on the open waters of northern Hudson Bay in July and August, and occasionally at Churchill in early summer.	No status	Not assessed	No	✔	✔
Dovekie	*Alle alle*	year-round	coastal / offshore	Winter offshore in Hudson Bay, Hudson Strait and Gulf of St. Lawrence.	No status	Not assessed	No	✔	✔

Table B-2: Overview of Seabird Species Potentially Present within the Local and Regional Study Areas

Common Name	Species	Seasonal Occurrence	Distribution	Other Relevant Information	SARA Status[a]	COSEWIC Status[b]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Long-tailed duck	*Clangula hyemalis*	May-Oct	coastal	Occur in large numbers close to shore in Hudson and James Bay. Some individuals also overwinter on open water of James Bay.	No status	Not assessed	No	✔	✔
Canada goose	*Branta canadensis*	summer and fall	coastal	Spring and fall transient. Breeds in large numbers along the coasts (McConnell River Migratory Bird Sanctuary) and on the islands of Hudson Bay and James Bay (e.g., Southampton Island).	No status	Not assessed	Yes	✔	✔
Lesser snow goose	*Anser caerulescens*	May – Sept	coastal	Migratory species. Breeding colonies occur along the coasts (McConnell River Migratory Bird Sanctuary) and on the islands of Hudson Bay (e.g., Southampton Island). Hudson Bay supports over 50% of the eastern Arctic breeding population.	No status	Not assessed	Yes	✔	✔
Atlantic Brant	*Branta bernicla*	April to October	coastal	Migratory species. Breed on Southampton Island. During the fall migration, > 50% of the population frequents eelgrass habitat in James Bay.	No status	Not assessed	No	✔	✔
Glaucous gull	*Larus hyperboreus*	summer	coastal / offshore	Breed along the northern coasts of Hudson Bay, the Belchers, and widely throughout the Canadian Arctic.	No status	Not assessed	No	✔	✔
Herring gull	*Larus argentatus*	April-Nov	coastal / offshore	Migratory species. Breed along the coasts of Hudson Bay and James Bay in summer and in the Belchers.	No status	Not assessed	No	✔	✔
Ross's gull	*Rhodostethia rosea*	spring and autumn	coastal / offshore	Established nesting areas near Churchill, McConnell River Migratory Bird Sanctuary, and in the Canadian High Arctic (Devon Island). May overwinter in polynyas.	TH (Schedule 1)	TH	No	✔	✔
Ivory gull	*Pagophila eburnean*	year-round	coastal / offshore	Occur in Hudson Bay during both summer and winter, but breed in the	EN (Schedule 1)	EN	No	✔	✔

Table B-2: Overview of Seabird Species Potentially Present within the Local and Regional Study Areas

Common Name	Species	Seasonal Occurrence	Distribution	Other Relevant Information	SARA Status[(a)]	COSEWIC Status[(b)]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
				Canadian High Arctic.					
Sabine's gull	*Xema sabini*	summer	coastal / offshore	Migratory species. Breeds on colonies along the northern coasts of Hudson Bay. Pelagic outside breeding season.	No status	Not assessed	No	✔	✔
Thayer's gull	*Larus thayeri*	summer	coastal / offshore	Migratory species. Breeds along the coasts of northern Hudson Bay during summer including Coats and Southampton islands.	No status	Not assessed	No	✔	✔
Arctic tern	*Sterna paradisaea*	summer	coastal / offshore	Migratory species that breeds throughout the Hudson Bay and Hudson Strait.	No status	Not assessed	No	✔	✔
Pacific loon	*Gavia pacifica*	summer	coastal	Migratory species. Arctic breeding species common and numerous along the mainland and island coasts of the Hudson Bay coast.	No status	Not assessed	No	✔	✔
Red-throated loon	*Gavia stellata*	summer	coastal	Migratory species. Arctic breeding species common and numerous along the mainland and island coasts of the Hudson Bay coast.	No status	Not assessed	No	✔	✔
Common loon	*Gavia immer*	summer	coastal	Migratory species. Common in southeastern Hudson Bay and James Bay.	No status	Not at risk	No	✔	✔
Black scoter	*Melanitta americana*	summer	coastal	Migratory species. Common on the Belchers and along the coast from southeastern Hudson Bay west to Churchill. May overwinter in small numbers in James Bay.	No status	Not assessed	No	✔	✔
Red-breasted merganser	*Mergus serrator*	summer	coastal	Migratory species. Common along the coasts of James Bay and southwestern Hudson Bay. Males and non-breeding birds frequent coastal marine waters.	No status	Not assessed	No	✔	✔
Red-necked phalarope	*Phalaropus lobatus*	summer	coastal / offshore	Migratory species. Breeds widely across the Arctic and throughout Nunavut.	No status	Not assessed	No	✔	✔

Table B-2: Overview of Seabird Species Potentially Present within the Local and Regional Study Areas

Common Name	Species	Seasonal Occurrence	Distribution	Other Relevant Information	SARA Status[(a)]	COSEWIC Status[(b)]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Red phalarope	*Phalaropus fulcarius*	summer	coastal / offshore	Migratory species. Breeds along the west coast of the Hudson Bay, on the Ungava Penninsula and on the southern end of Baffin Island in Nunavut.	No status	Not assessed	No	✔	✔
Parasitic jaeger	*Stercorarius parasiticus*	summer	coastal / offshore	Migratory species. Breed along the coast and islands of Hudson Bay.	No status	Not assessed	No	✔	✔
Long-tailed jaeger	*Stercorarius longicaudus*	summer	coastal / offshore	Migratory species. Breeds along the Quebec coast of Hudson Bay, on Southampton Island, and along the Kivalliq coast.	No status	Not assessed	No	✔	✔
Pomarine jaeger	*Stercorarius pomarinus*	summer	coastal / offshore	Migratory species. Breeds along the Quebec coast of Hudson Bay and on Southampton Island.	No status	Not assessed	No	✔	✔
Sandhill crane	*Grus canadensis*	summer	coastal	Migratory species. Summer visitors to the southern and western coasts of James Bay and Hudson Bay, from Boatswain west and north. Also reported on the Belchers and Southampton islands.	No status	Not at risk	No	✔	
Dunlin	*Calidris alpina*	summer	coastal	Migratory species. Breeds along the west coast of the Hudson Bay, on Southampton and Coats Island and on the southern end of Baffin Island in Nunavut.	No status	Not assessed	No	✔	
Semi-palmated sandpiper	*Calidris pusilla*	summer	coastal	Migratory species. Breeds in in the Hudson Bay including Southampton Island, Coats Island and the southern end of Baffin Island.	No status	Not assessed	No	✔	

Table B-2: Overview of Seabird Species Potentially Present within the Local and Regional Study Areas

Common Name	Species	Seasonal Occurrence	Distribution	Other Relevant Information	SARA Status[a]	COSEWIC Status[b]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Least sandpiper	*Calidris minutilla*	summer	coastal	Migratory species. Common breeder on the mainland shores of Hudson Bay south of Chesterfield Inlet in the west and Inukjuak in the east	No status	Not assessed	No	✔	
White-rumped sandpiper	*Calidris fuscicollis*	summer	coastal	Migratory species that breeds on the southern tip of Baffin Island and on the northwestern side of the Hudson Bay.	No status	Not assessed	No	✔	
Baird's sandpiper	*Calidris bairdii*	summer	coastal	Migratory species that breeds on the northern end of Baffin Island and in the coastal areas of the northern Foxe Basin.	No status	Not assessed	No	✔	
Pectoral sandpiper	*Calidris melanotos*	summer	Coastal	Migratory species that breeds along the northwest coast of the Hudson Bay, on Southampton and Coats islands in Nunavut.	No status	Not assessed	No	✔	
American golden plover	*Pluvialis dominica*	summer	Coastal	Migratory species that breed along the shores of Hudson Bay and James Bay and Southampton Island.	No status	Not assessed	No	✔	
Semi-palmated plover	*Charadrius semipalmatus*	summer	Coastal	Migratory species that breed along the shores of Hudson Bay and James Bay.	No status	Not assessed	No	✔	
Black-bellied plover	*Pluvialis squatarola*	summer	Coastal	Migratory species that breeds on the shores of northern Hudson Bay and Southampton Island.	No status	Not assessed	No	✔	
Ruddy turnstone	*Arenaria interpres*	summer	Coastal	Migratory species that breeds on the southern end of Baffin Island, along the coastal areas of the northern Foxe Basin and on Southampton Island and Coats Island.	No status	Not assessed	No	✔	

Table B-2: Overview of Seabird Species Potentially Present within the Local and Regional Study Areas

Common Name	Species	Seasonal Occurrence	Distribution	Other Relevant Information	SARA Status[a]	COSEWIC Status[b]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Sanderling	*Calidris alba*	spring / summer	Coastal	Migratory species. Common spring migrant along the coast near Churchill en-route to its breeding grounds in the Arctic.	No status	Not assessed	No	✔	
Red knot	*Calidris canutus*	summer	Coastal	Migratory species. Hudson Bay ecosystem provides critical resources for this species.	EN-*rufa ssp*. (schedule 1) SC-*islandica ssp*. (schedule 1)	EN-*rufa ssp*. SC-*islandica ssp*.	No	✔	
Peregrine falcon	*Falco peregrinus tundrius*	summer	coastal	Breed and hunt along the coasts of Hudson Bay and James Bay in summer. Breed in areas with high to moderate relief along the Hudson Bay coast of Manitoba, Nunavut, and northern Quebec and on Southampton, Coats and the Belcher and Nastapoka islands	SC (Schedule 1)	SC	No	✔	
Snowy owl	*Bubo scandiacus*	summer	coastal	Breed and forage along the coasts of Hudson Bay and James Bay	No status	Not at risk	No	✔	

(a) SARA (Species at Risk Act). The Act is a key federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of their biological diversity (extracted from SARA 2012).

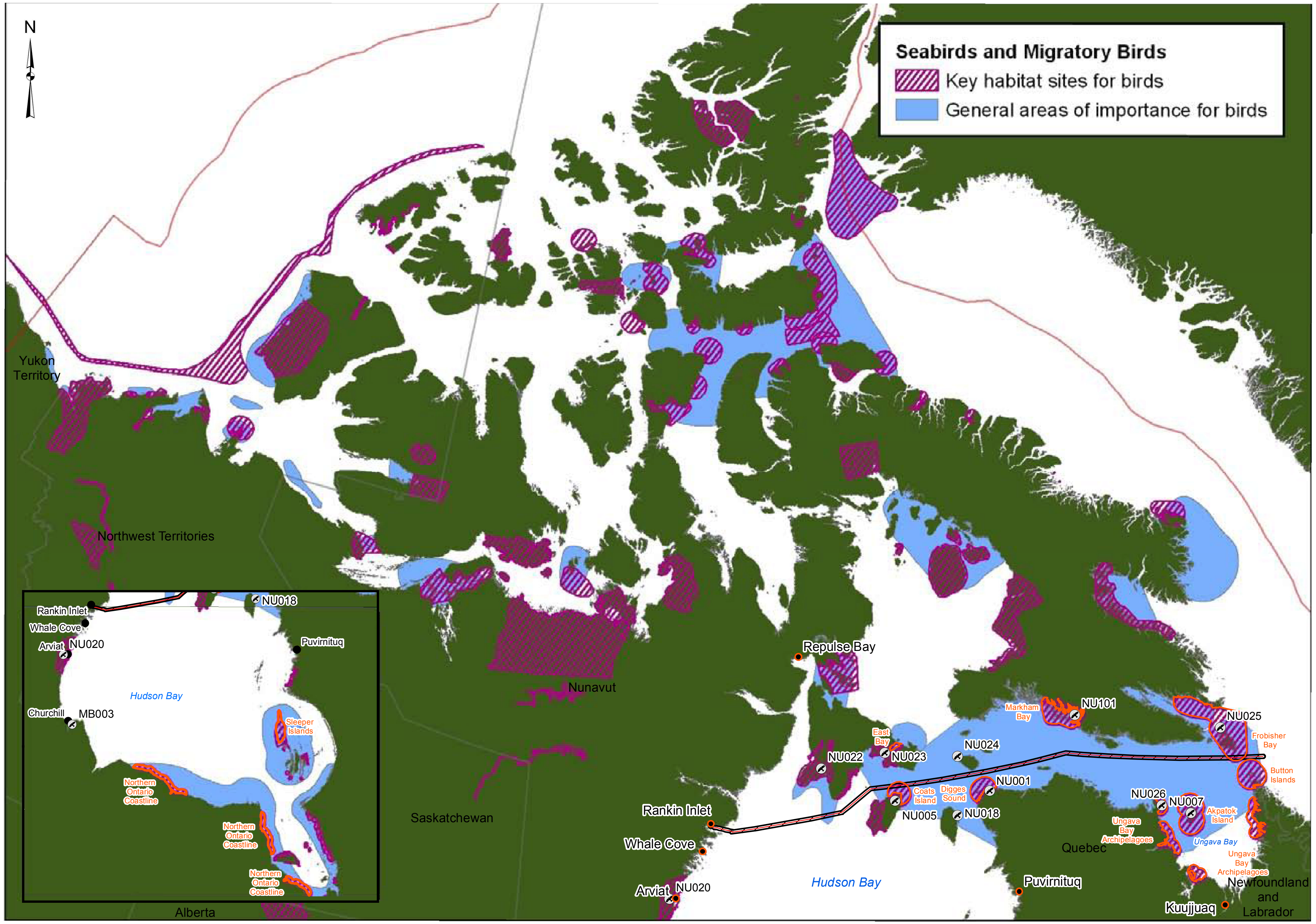
(b) COSEWIC (Committee on the Status of Endangered Wildlife in Canada) is a committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada. It is up to Government to legally protect wildlife species designated by COSEWIC. The potential impacts of legal listing are for Government to analyse, and the *Species at Risk Act* (SARA) applies only to wildlife species on the SARA legal list (extracted from COSEWIC 2012).

EN=Endangered, TH=Threatened, SC = Special Concern

LEGEND

- IMPORTANT BIRD AREAS
- COMMUNITY
- KEY MARINE HABITAT AREAS FOR MIGRATORY BIRD
- MARINE REGIONAL STUDY AREA (MARINE RSA)

ID#	Important Bird Areas
NU022	Harry Gibbons Migratory Bird Sanctuary (federal)
MB003	Wapusk National Park (federal)
NU005	Cape Pembroke
MB013	Seal River Estuary Heritage River (federal)
NU020	McConnell River Migratory Bird Sanctuary (federal) & Ramsar Site
NU023	East Bay Migratory Bird Sanctuary (federal)
NU024	Fraser Island
NU001	Digges Sound
NU101	Markham Bay Eider Colony
NU026	Eider Islands
NU007	Akpatok Island
NU018	Mansel Island
NU025	Hantzsch Island



REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010, IBA 2012
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240
KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

KEY HABITAT AREAS FOR MARINE BIRDS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	KZ	06 Feb. 2014	SCALE AS SHOWN	REV. 0
GIS	MH	06 Feb. 2014		
CHECK	KZ	16 Feb. 2014	**FIGURE B-8**	
REVIEW	DRW	16 Feb. 2014		

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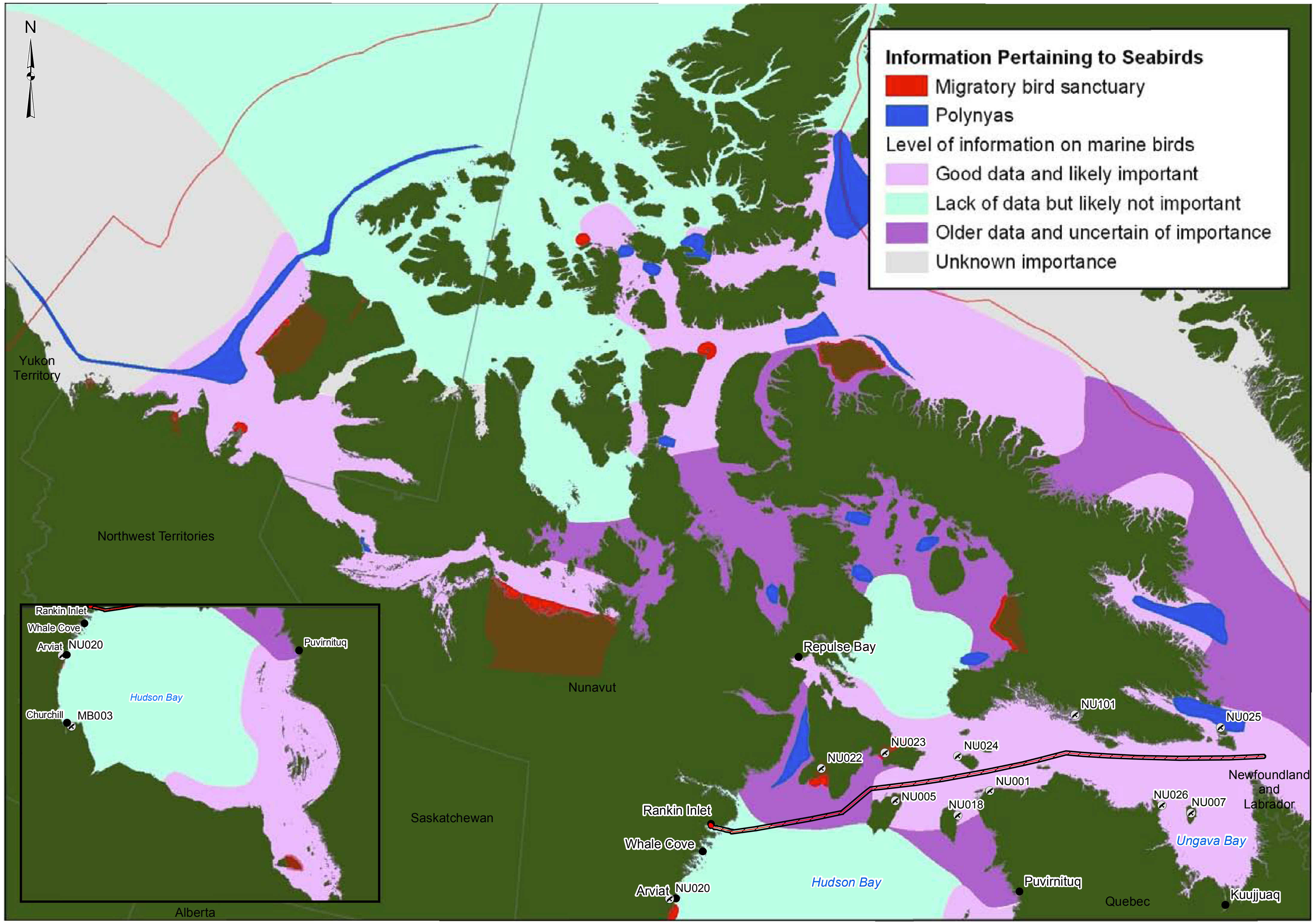


LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

ID#	Important Bird Areas
NU022	Harry Gibbons Migratory Bird Sanctuary (federal)
MB003	Wapusk National Park (federal)
NU005	Cape Pembroke
MB013	Seal River Estuary Heritage River (federal)
NU020	McConnell River Migratory Bird Sanctuary (federal) & Ramsar Site
NU023	East Bay Migratory Bird Sanctuary (federal)
NU024	Fraser Island
NU001	Digges Sound
NU101	Markham Bay Eider Colony
NU026	Eider Islands
NU007	Akpatok Island
NU018	Mansel Island
NU025	Hantzsch Island

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010, IBA 2012
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240
KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF MARINE BIRDS AND BIRD HABITAT IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	24 Jul. 2012		
CHECK	PR	18 Jan. 2013	**FIGURE B-9**	
REVIEW	DW	18 Jan. 2013		

Hudson Bay / Hudson Strait provides key breeding habitat for numerous species, including many birds that are primarily Arctic breeders and others that are rarely seen in breeding condition outside the Arctic Islands. The only species listed under the SARA with the potential to occur in the RSA are the Ross's gull and the ivory gull (listed as Threatened and Endangered under Schedule 1 of SARA, respectively) (Table B-2). Those bird species identified as having special ecological or cultural importance, or holding special conservation status, with home ranges overlapping with the RSA are identified in Table B-2.

Three designated migratory bird sanctuaries occur along the shorelines of Hudson Bay / Hudson Strait: one south of Arviat in western Hudson Bay (McConnell River), and 2 on Southampton Island in northern Hudson Bay (Harry Gibbons and East Bay). Although these sites are generally a fair distance from the proposed shipping route, birds do forage offshore to considerable distances and may be vulnerable to impacts associated with shipping activities. For instance, hundreds of thousands of thick-billed murre fledglings migrate with molting adults from colonies in Hudson Strait (Hantzsch Island and Digges Sound) to Newfoundland by swimming, while those that nest on Akpatok Island overwinter west of the Belcher Islands.

Approximate densities of seabirds in the RSA during late summer / early fall have been identified by means of vessel-based seabird surveys undertaken in Hudson Bay and Hudson Strait in 2005 as part of the 2005 ArcticNet expedition (McKinnon et al. 2009). Mean seabird density indices were highest in Hudson strait (8.3 ± 1.9 birds/km^2) and lowest in southern Hudson Bay (0.36 ± 0.2 birds/km^2). Where mean density indices were high, sightings were dominated by northern fulmars or dovekies (or both). The results suggest that several seabird populations that migrate eastward through Hudson Strait converge at the eastern mouth of the Hudson Strait, thus representing a major staging area for migrant seabirds during September and October, particularly for northern fulmar, dovekie, and thick-billed murre.

In Hudson Strait, the mean density index of seabirds sighted within transects (both sitting on the sea and in flight) was 8.3 ± 1.9 birds/km^2. The species most commonly documented sitting on the sea were northern fulmar (65.8% of sightings) and dovekie (14.2%). The species most commonly documented in flight were Dovekie (48.3% of sightings) and northern fulmar (38.7%). Other species sighted (sitting on the sea and in flight) included, in order of abundance, thick-billed murre, black-legged kittiwake, glaucous gull, common eider and black guillemot (McKinnon et al. 2009).

In Hudson Bay, the mean density index of seabirds within transects (both sitting on the sea and flying) was 0.36 ± 0.2 birds/km^2. Species sighted sitting on the sea included thick-billed murre, herring gull, and glaucous gull. The species most commonly documented in flight were Canada goose (36.4% of sightings) and herring gull (23.6%). Other species sighted in flight included, in order of abundance, thick-billed murre, northern fulmar, black guillemot, black-legged kittiwake, glaucous gull, common eider, and long-tailed duck (McKinnon et al. 2009).

1.3.2.3 Marine Mammals

There are 11 species of marine mammals potentially present within the RSA for variable periods of time and at different times throughout the year (Table B-3). This includes 4 species of cetaceans (3 toothed whales and one baleen whale), 6 species of pinnipeds (seals and walrus), and the polar bear. Narwhal (*Monodon monoceros*), beluga (*Delphinapterus leucas*), and bowhead whales (*Balaena mysticetus*) are known to overwinter in Hudson Strait and in polynyas within Hudson Bay. Atlantic walrus (*Odobenus rosmarus rosmarus*), bearded seal (*Erignathus barbatus*), ringed seal (*Phoca hispida*), and harbour seal (*Phoca vitulina concolor*) are year-round residents to at least portions of Hudson Bay. Polar bears are also common in the RSA, entering the pack-ice in early November following their denning season but retreat to coastal areas during the summer ice-free season. The remainder of marine mammals identified in Hudson Bay / Hudson Strait are migratory and seasonal visitors, limited largely by the presence of solid land-fast ice throughout the winter and spring. There is a pronounced geographic bias on the distribution of several species within Hudson Bay; for example, belugas are strongly associated with the western part of Hudson Bay with substantial attraction to estuaries such as the Churchill River. Table B-4 provides a summary of marine mammal species harvested throughout the year by Coastal Inuit communities in Nunavut. An overview on the biology of each marine mammal species potentially present in, or in the vicinity of, the RSA is provided below.

Table B-3: Overview of Marine Mammal Species Found within the LSA and RSA

Common Name	Species	Seasonal Occurrence	Habitat	SARA Status[(a)]	COSEWIC Status[(b)]	Of Cultural, Economic or Subsistence Importance	LSA	RSA
Ringed seal	*Pusa hispida*	Year-round	Shore-fast ice and pack-ice	No Status	Not at Risk	Yes	✔	✔
Harp seal	*Pagophilus groenlandica*	Open-water season (July-Sept)	Pack-ice	No Status	Not assessed	Yes	✔	✔
Bearded seal	*Erignathus barbatus*	Year-round	Pack-ice	No Status	DD	Yes	✔	✔
Harbour seal	*Phoca vitulina concolor*	Year-round	Coastal terrestrial areas and edge of shore-fast ice	No Status	Not assessed	Yes	✔	✔
Hooded seal	*Cystophora cristata*	Open-water season (July-Sept)	Pack-ice	No Status	Not assessed	Yes	✔	
Atlantic walrus	*Odobenus rosmarus*	Year-round	Pack-ice or coastal waters during summer; floe-edge / polynyas during winter	No Status	SC	Yes	✔	✔
Polar bear	*Ursus maritimus*	Year-round	Spring: shore-fast ice; Summer: coastal areas and inland; and Winter: shore fast-ice and coastal areas for denning	SC (Schedule 1)	SC	Yes	✔	✔
Beluga whale	*Delphinapterus leucas*	Winter (Nov-May) and Summer	Spring: ice-edges/leads; Summer: shallow coastal areas (around Southampton Island and western Hudson Bay); Fall: deep water (foraging); Winter: offshore pack-ice (Hudson Strait)	No Status	EN	Yes	✔	✔
Narwhal	*Monodon monoceros*	Year-round	Winter: deep water / edge of banks; Summer: fjords / coastal waters	No Status	SC	Yes	✔	✔
Bowhead whale	*Balaena mysticetus*	Winter (Feb-Jun)	Spring : along the ice-edge; Summer: open-water /pack-ice; Winter: heavy pack-ice	No Status	SC	Yes	✔	✔
Killer whale	*Orcinus orca*	Jun-Aug	Coastal / offshore	No Status	SC	No	✔	✔

(a) SARA (*Species at Risk Act*). The Act is a key federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of their biological diversity (extracted from SARA 2012).

(b) COSEWIC (Committee on the Status of Endangered Wildlife in Canada) is a committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada. It is up to Government to legally protect wildlife species designated by COSEWIC. The potential impacts of legal listing are for Government to analyse, and the Species at Risk Act (SARA) applies only to wildlife species on the SARA legal list (extracted from COSEWIC 2012).

EN=Endangered, SC=Special Concern, DD=Data Deficient

Table B-4: Marine Mammal Species Harvested Throughout the Year by Coastal Inuit Communities in Nunavut

Target Species	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Ringed seal	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Bearded seal	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Harp seal	✔			✔		✔	✔	✔	✔	✔	✔	
Hooded seal							✔	✔	✔	✔	✔	✔
Harbour seal							✔	✔	✔	✔	✔	
Walrus	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Beluga	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Narwhal	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Bowhead								✔				
Polar bear	✔	✔	✔	✔	✔					✔	✔	✔

Source: Priest and Usher (2004)

Ringed seal (*Phoca hispida*)

The ringed seal has a circumpolar distribution that is closely associated with the distribution of land-fast ice. This species occurs at the southern limit of their range in Hudson Bay where it is present year-round (Mansfield 1967; Stewart and Lockhart 2005). Ringed seals are the most abundant and widespread seal in the Arctic; however, their numbers in western Hudson Bay declined between 1995 and 2010 based on annual aerial surveys conducted during spring/summer (Lunn et al. 2000; Vincent-Chambellant 2010; Ferguson and Young 2011). The results of two DFO aerial surveys in 2007 and 2008 indicate the relative density of ringed seals in western Hudson Bay falls in the range estimated in previous years and is consistent with estimates derived from surveys conducted in other Arctic areas (DFO 2009). In western Hudson Bay, density estimates for ringed seals varied greatly from year to year and there is inter-annual variation widely reported in the literature for the density of ringed seals hauled-out on the ice (DFO 2009). In 2007 and 2008, ringed seal relative densities in western Hudson Bay were estimated at 0.92 ±0.07 seal/km^2 and 0.44±0.05 seal/km^2 respectively with an abundance of 73170±5440 and 33701±3704 individuals respectively (DFO 2009)... Several factors, in addition to an actual change of seal abundance, could contribute to inter-annual variation including: ice type and conditions, water depth, temperature, wind speed and cloud cover, and time of the day and year could potentially affect ringed seal presence, haul-out activity and detectability (DFO 2009). DFO (2009) notes that many ringed seals may not have been available for detection in 2008 relative to 2007, and a declining population might not be an accurate interpretation of results.

The ability of ringed seals to maintain breathing holes in the land-fast ice enables them to occupy large areas that are inaccessible to other marine mammals except during the summer. During winter, their preferred habitat consists of ice leads and polynyas where breathing holes are easiest to maintain. In spring, breeding adults occur in highest densities in areas of stable land-fast ice with good snow cover where they maintain birth lairs for pup rearing (Hamill and Smith 1991), whereas non-breeders occur at the floe edge or in the moving pack-ice (Stewart and Lockhart 2005). Pups are born in early spring (March/April) and weaned prior to break-up of the sea-ice in late June (Evans and Raga 2001). Pups will remain in subnivean[5] dens during a 5 to 8 week lactation

[5] situated or occurring under the snow

period to avoid detection from predators such as polar bears (Evans and Raga 2001). During the open-water season (July-Sept), ringed seals are commonly observed hauled-out on the sea-ice in large numbers. Juveniles may move offshore at this time, but adults remain around islands and within the bays and fiords (McLaren 1958a; Dunbar and Moore 1980). As such, seals are unlikely to occur in large numbers in the proposed offshore shipping corridor during summer.

Figure B-10 provides an overview of ringed seal distribution in the RSA based on historical sightings, current scientific knowledge, and IQ.

Ringed seals are considered a keystone species[6] (Ferguson et al. 2005), as both adults and pups are an important food source for polar bears (Smith et al. 1991). Other predators include Arctic fox, walrus, wolves, humans, and dogs (Hammill and Smith 1991). Juvenile ringed seals prey mainly on crustaceans under the ice, whereas adults prey on crustaceans and small fish (e.g., Arctic cod) (Richard 2001). This species serves as the main target of the Coastal Inuit subsistence hunt, with all communities in Nunavut (28 out of 28) actively harvesting this species (Priest and Usher 2004). The number of ringed seals harvested in Rankin Inlet is variable, ranging from 55 to 356 animals over a 5 year period (Priest and Usher 2004). The meat is considered a staple of the local diet, and seal hides are used for clothing and sold commercially. Concerns have been raised over possible declines in ringed seal abundance in western Hudson Bay, as indicated by Inuit traditional knowledge, due to reduced pregnancy rate (Stirling 2005), reduced pup survival and recruitment (Holst et al. 1999; Ferguson et al. 2005), later age of maturation and older age structure (Vincent-Chambellant 2010), and increased number of polar bears (Regehr et al. 2007).

Bearded seal (*Erignathus barbatus*)

Bearded seals are large, solitary seals, which have a circumpolar distribution in Arctic and sub-Arctic waters (Mansfield 1967). This species is sparsely distributed throughout their range, and are most abundant in areas where they have access to sea-ice upon which to haul-out, and in shallow water depths where they can access the seafloor (typically <200 m; Kingsley et al. 1985) to feed on crustaceans, molluscs, and fish (e.g., Arctic cod, polar cod, sculpin) (Burns and Frost 1979; Finley and Evans 1983). They are commonly found along continental shelf areas associated with high benthic productivity.

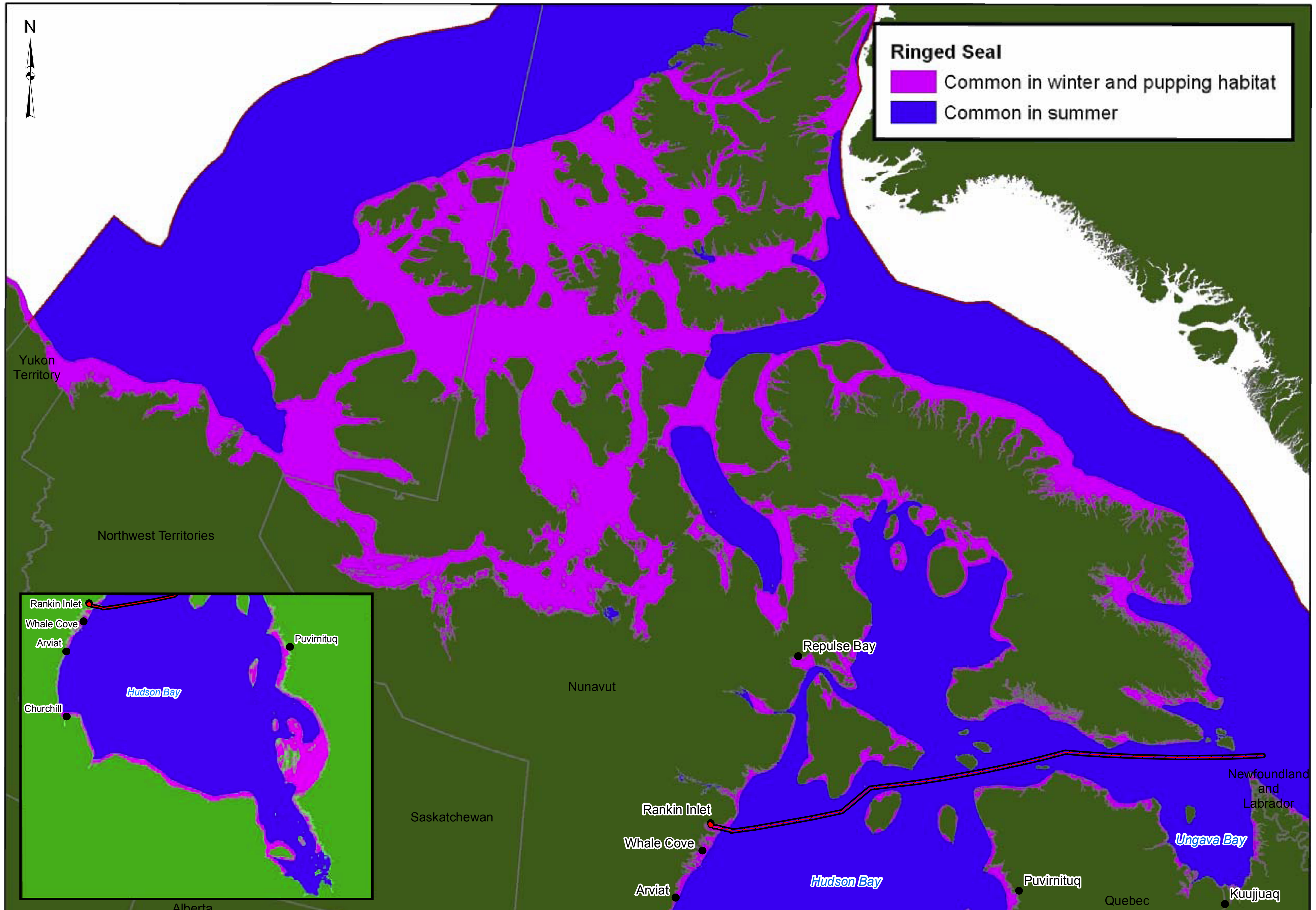
Since this species has only a limited capability to maintain breathing holes in solid ice, they are generally excluded from areas of land-fast ice during much of the year (e.g., High Arctic Archipelago) and are mostly found amongst the pack-ice where the surface is always accessible (Burns et al. 1981). As such, bearded seals move with the receding and forming ice, often travelling considerable distances to the north (seawards) in the summer and back south in the winter (Gilchrist and Robertson 2000). Studies of their general distribution have led to adopt the 250 m benthic contour interval as a measure to delineate the area in which bearded seals are commonly seen (Stephenson and Hartwig 2010). Figure B-11 provides an overview of bearded seal distribution in the RSA based on historical sightings, current scientific knowledge, and IQ.

[6] a keystone species is a species that plays a critical role in maintaining the structure of an ecological community and whose impact on the community is greater than would be expected based on its relative abundance or total biomass

LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)



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PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
DISTRIBUTION OF RINGED SEAL (*Phoca hispida*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	19 Jul. 2012	FIGURE B-10	
CHECK	PR	18 Jan. 2013		
REVIEW	DW	18 Jan. 2013		

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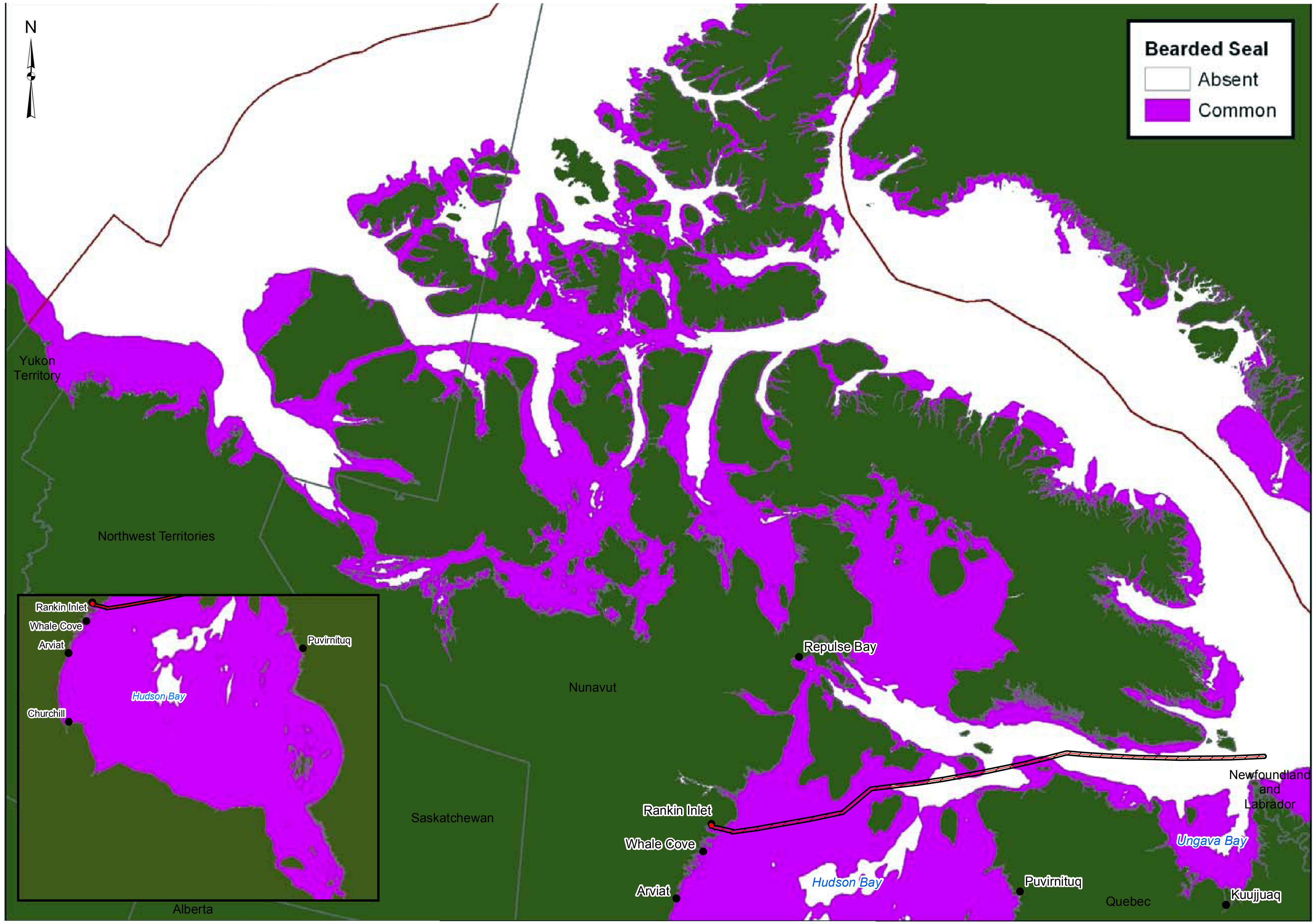

LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

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BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF BEARDED SEAL (*Erignathus barbatus*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	23 Jul. 2012	FIGURE B-11	
CHECK	PR	18 Jan. 2013		
REVIEW	DW	18 Jan. 2013		

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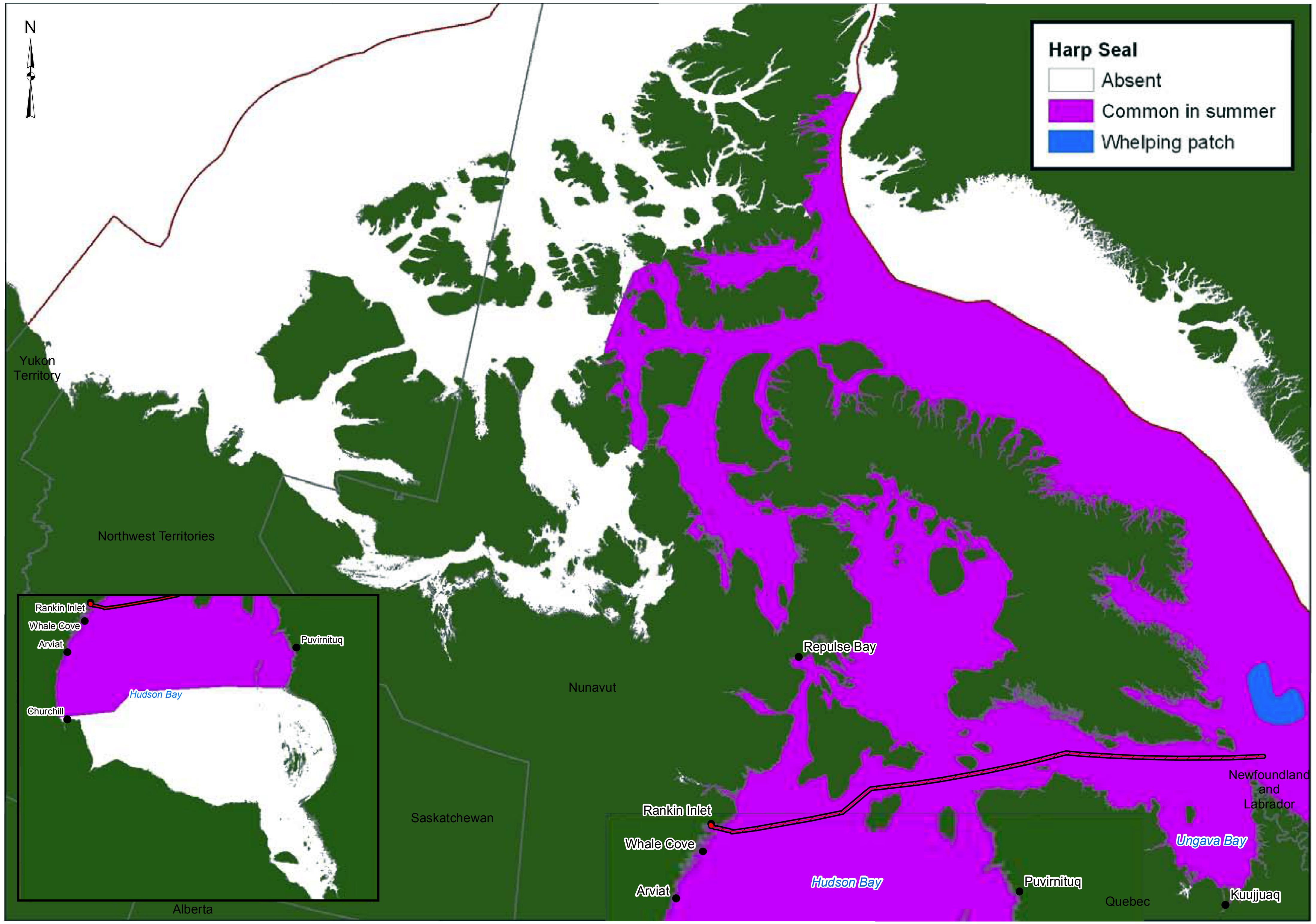
Bearded seal pups are born in late April on the ice, weaned approximately 12 to 18 days later, and then abandoned (Evans and Raga 2001). Mating occurs in the water shortly after weaning, and involves a 2-month delayed uterine implantation period. Both males and females mature around 6 years of age and reproduce biannually until 20 to 30 years of age (Evans and Raga 2001). Males actively vocalize underwater during the breeding season, with calling behaviour associated with territorial or mating displays (Richardson et al. 1995a). Bearded seals are estimated to number approximately 100 000 in the Canadian Arctic, and are especially abundant in Hudson Strait, Foxe Basin, and along the west coast of Hudson Bay (Mansfield 1967; Davis et al. 1980). The main predators of the bearded seal are polar bears and humans. This species is harvested throughout the year by virtually all coastal Inuit communities in Nunavut (27 of 28) (Furgal et al. 2002; Hovelsrud et al. 2008; Priest and Usher 2004), with hunting taking place from July to October. The meat is consumed and the tough flexible hide is used for harpoon lines, dog harnesses, whips, boot soles, and to cover boats called Umiak (Richard 2001). No Total Allowable Catch (TAC) limits exist for bearded seal in Nunavut. Population trends are listed as unknown by DFO (DFO 2015) and COSEWIC defines the status of bearded seals as ‘Data Deficient’ (DFO 2015)

Harp seal (*Pagophilus groenlandicus*)

The harp seal is a widespread species found in the northern Atlantic and Arctic oceans (Sergeant 1976). Their range includes northern Hudson Bay, Foxe Basin, Baffin Island, Davis Strait, Gulf of St Lawrence, Newfoundland, southern Greenland, Iceland, northern Norway, the White Sea, the Barents Sea, and the Kara Sea. Three distinct genetic populations are recognized: the Northwest Atlantic stock, the Greenland Sea stock, and the White Sea stock. Genetic evidence demonstrates that little gene flow occurs between the 3 stocks (Perry et al. 2000). Harp seals in Hudson Bay / Hudson Strait belong to the Northwest Atlantic stock and are only present in the RSA from ice break-up in early June until just before freeze-up (early October), at which point they migrate east outside the NSA and into the Gulf of St. Lawrence. Thus, impacts to harp seals due to the Project have the potential for transboundary effects. Harp seals are less common than ringed or bearded seals, but may have been more numerous and widespread in the past and may be re-occupying their former range (Stewart and Lockhart 2004). Figure B-12 provides an overview of harp seal distribution in the RSA based on historical sightings, current scientific knowledge, and IQ.

During spring (late February to April), female harp seals aggregate on the pack-ice along the southeast coast of Labrador (‘Front’) and in the Gulf of St. Lawrence where they form dense and highly-synchronized “whelping herds” and give birth to a single pup. Pups are nursed for 12 days, after which they remain fasting on the pack-ice for approximately 2 weeks before entering the water to feed (Lavigne and Kovacs 1988; Lydersen and Kovacs 1996). Adult females attain sexual maturity at 4 to 6 years of age (Frie et al. 2003). Reproductive maturity occurs in males at about 8 years of age. Towards the end of lactation, females come into estrus and mate (Lavigne and Kovacs 1988). Gestation lasts about one year, including a 3 to 4 month period of delayed implantation (Stewart et al. 1989). The life span of harp seals is approximately 20 to 30 years. Both males and females are sexually active until the ends of their lives, showing no evidence of reproductive senescence (Ronald and Healey 1981).



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF HARP SEAL (*Pagophilus groenlandica*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN REV. 0
GIS	DSC	23 Jul. 2012	
CHECK	PR	18 Jan. 2013	**FIGURE B-12**
REVIEW	DW	18 Jan. 2013	

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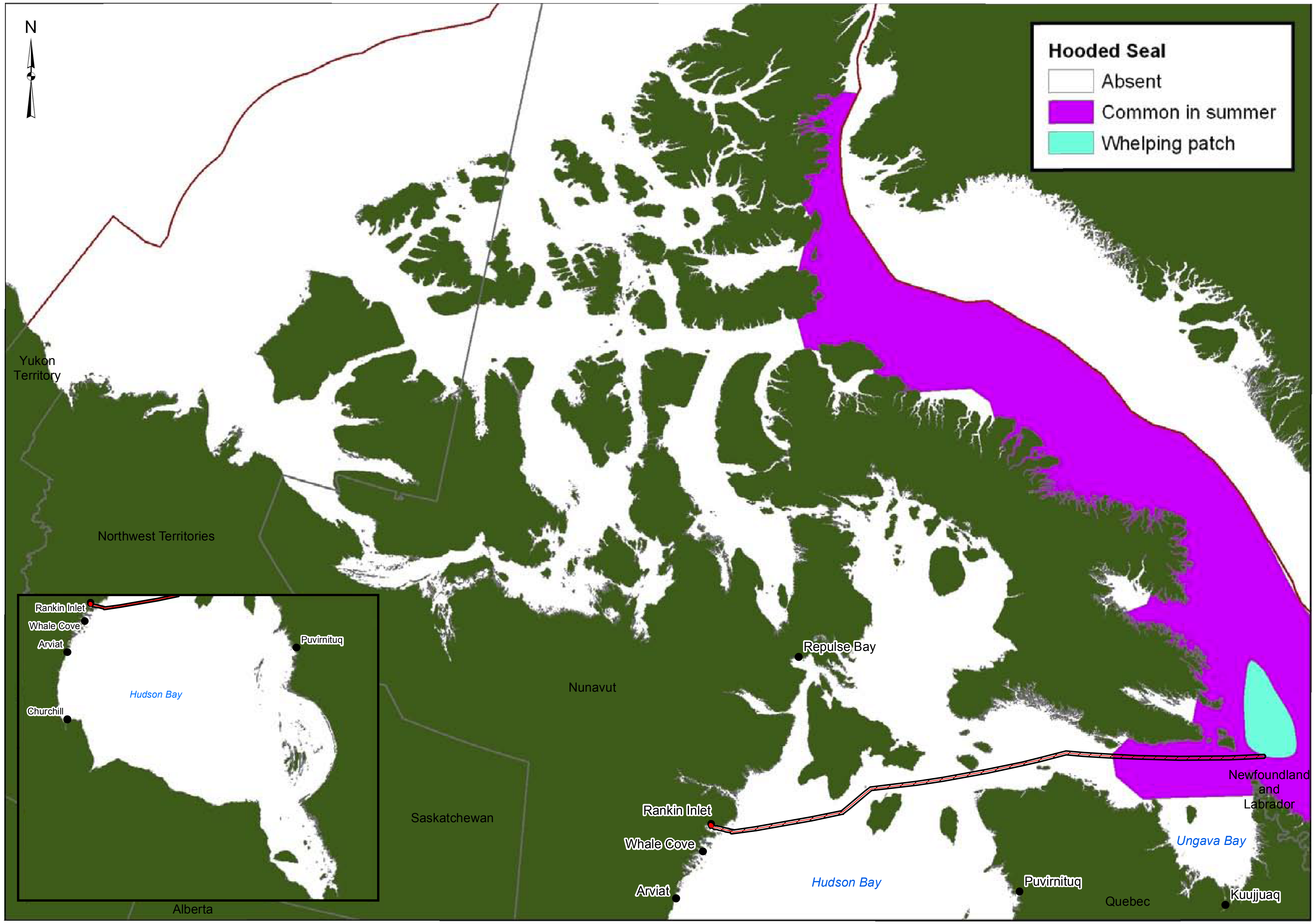
Harp seals undergo a moult in the post-breeding months, from early April to early May (Lavigne and Kovacs 1988). They are a highly social species that travel and forage in groups. The Northwest Atlantic population is highly migratory; after breeding, individuals follow the pack-ice up the coast of Labrador and spend the summer feeding in Baffin Bay, with small numbers entering Hudson Bay and Hudson Strait around Baffin Island before returning south to the Gulf of St. Lawrence during autumn, resulting in an annual migration of over 5000 km (Lavigne and Kovacs 1988). Natural predators of harp seals include polar bears, killer whales, Greenland shark, and humans (Lavigne and Kovacs 1988). Harp seals consume a wide range of fish and invertebrate prey that varies along their migration route (Lavigne 2002). Fish prey includes capelin, Arctic cod, Atlantic cod (Gadus morhua), Atlantic herring (Clupea herringus), and redfish (Sebastes sp.) (Lawson et al.1995). Pups and juveniles prey primarily on crustaceans, particularly euphausiids and amphipods (Haug et al. 2000; Nilssen et al. 2001).

The harp seal global population is presently estimated at 8 million individuals, with pup production at 1.4 million pups per year (Stenson et al. 2003; Potelov et al. 2003; Haug et al. 2006). The Northwest Atlantic stock is estimated to number 5.9 million individuals (DFO 2005a). This is a marked recovery from an estimated low of around 1.8 million recorded in the early 1970s (Sergeant 1976) linked to a population crash from overharvesting. This led to the near cessation of hunting and the gradual recovery of this stock. Catch levels have increased repeatedly during the last decade, with the Canadian and Greenland hunt now presently the largest marine mammal harvest in the world (DFO 2007). As of 2011, the Northwest Atlantic harp seal population was at the highest levels observed since monitoring began almost 60 years ago. Pup production in 2008 was on the order of 1.63 million animals with a total population size of around 8.0 to 8.7 million animals increasing to 8.6 to 9.6 million animals in 2010 (Hammill and Stenson 2011).According to Hammill and Stenson (2011) the likelihood that the population is no longer growing exponentially needs to be considered further, particularly within the context of levels of carrying capacity (K) to understand the dynamics of the population. It is important to note however, there is some uncertainty associated with reproductive rates and how density dependence is expressed in the models used to predict these population trends (DFO 2012). The 2010 assessment assumed that reproductive rates would remain high, predicting a population between 8.61 to 9.55 million animal (95% CI 7.80 to 10.80 million; DFO 2012). However, since 2008 reproductive rates have declined resulting in a 2012 population estimate of 7,700,000 (95% CI=6,900,000-8,400,000). The current population of Northwest Atlantic harp seals is estimated to have declined slightly since 2008; nevertheless it is near its highest level since the mid-19th Century (DFO 2012).

This species is hunted throughout Nunavut primarily during the months of June through September (Priest and Usher 2004), with pups representing the majority of the harvest. Both meat and blubber are consumed, and the pelts are sold commercially. Subsistence harvests are currently not regulated, but the commercial harvest is regulated by the 2011 to 2015 Integrated Fisheries Management Plan for Atlantic Seals. Seals are also caught incidentally in fishing gear (DFO 2012). DFO sets TACs within a 3-year period for the Northwest Atlantic population. In addition to Canada’s commercial harvest, some harp seals are still taken in subsistence hunts in Labrador, Newfoundland, northern Quebec, and in Nunavut. Aboriginal peoples and non-Aboriginal coastal residents who reside north of latitude 53 degrees can hunt seals for subsistence purposes without a permit (DFO 2006b). Between 1983 and 1995, Canadian catches of Northwest Atlantic harp seals averaged approximately 52,000 seals per year, with catches increasing significantly to a range of 226,000 to 366,000 between 1996 and 2006 (DFO 2012). Since 2007 Canadian catches have declined significantly with DFO (2012) reporting a catch of 40,370 in 2011. Catches in the Canadian Arctic remains low at under 1,000 Northwest Atlantic harp seals per year (DFO 2012).

Hooded seal (*Cystophora cristata*)

The hooded seal occurs throughout much of the North Atlantic and Arctic Oceans (King 1983) preferring deeper water and occurring farther offshore than harp seals (Sergeant 1976; Campbell 1987; Lavigne and Kovacs 1988; Hammill and Stenson 2006). They are a highly migratory species, and are considered a rare visitor to Hudson Bay / Hudson Strait (Stewart and Lockhart 2004). Thus, impacts to hooded seals due to the Project have the potential for transboundary effects. As primarily deep-water feeders, the 200 m bathymetric contour interval has been adopted to estimate the offshore distribution boundary of this species (Stephenson and Hartwig 2010). Figure B-13 provides an overview of hooded seal distribution in the RSA based on historical sightings, current scientific knowledge, and IQ. They are generally associated with heavy pack ice, and their presence would extend until ice break-up (Sergeant 1974).



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240
KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF HOODED SEAL (*Cystophora cristata*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	23 Jul. 2012	**FIGURE B-13**	
CHECK	PR	18 Jan. 2013		
REVIEW	DW	18 Jan. 2013		

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Hooded seals of the Western North Atlantic stock breed synchronously during mid to late March in heavy pack-ice areas off the coast of eastern Canada and around Greenland. Breeding of this population is divided into 4 whelping areas. The “Front” herd (largest of the 4) breeds off the coast of Newfoundland and Labrador, the “Gulf” herd breeds in the Gulf of St. Lawrence, the “Davis Strait” herd breeds between Baffin Island and western Greenland, and the “West Ice” herd breeds in the Greenland Sea near the island of Jan Mayen (Sergeant 1974, 1976; Folkow et al. 1996). These breeding herds are considered to belong to 2 recognized populations (Hammill and Stenson 2006). Seals whelping near Jan Mayen are thought to constitute the Northeast Atlantic population, while hooded seals whelping and breeding in Davis Strait, the Gulf and at the Front are all thought to belong to the Northwest Atlantic population (Hammill and Stenson 2006). The breeding season for this polygamous species is brief lasting only 2 to 3 weeks, with mating taking place in the water (Boness et al. 1988; Kovacs 1990). This species has the shortest lactation period for any mammal, with most pups being weaned in 4 days (Bowen et al. 1987). Hooded seals moult in July, with each breeding stock congregating at separate traditional sites away from the whelping areas. Many seals are reported to migrate to the pack-ice east of Greenland in Denmark Strait at this time (Sergeant 1974, 1976; Folkow et al. 1996). Hooded seals form loose aggregations in specific areas during the breeding and moulting season and generally remain solitary outside this period. Hooded seal life span is approximately 25 to 30 years (Kovacs 2002).

The Northwest Atlantic population has been estimated at approximately 600 000 animals (593 500, +67 200 SE, Hammill and Stenson 2006), of which 90% are estimated to whelp at the Front (Stenson et al. 2006). The DFO 2011 to 2015 Integrated Fisheries Management Plan for Atlantic Seals still estimates the hooded seal herd in the northwest Atlantic to have increased from 478,000 in 1965, to approximately 600,000 animals currently (DFO 2011c). The Northeast Atlantic population is estimated at between 70 000 and 90 000 animals, although there is considerable uncertainty around these estimates due to scarcity of data and limited understanding of the relationships between whelping areas (ICES 2006). Hooded Seals are annually harvested by coastal Inuit of Greenland and Canada for subsistence purposes (Kovacs 2002) and have been commercially hunted at the Front since the late 1800s (Kovacs 2008b). Harvesting occurs primarily during the months of July through December (Table B-5). For the Canadian harvest, the TAC has been set at 10 000 seals per year since 1998 (ICES 2006). For the period 2000-2004, the total estimated catch of hooded seals was 48 188 (Kovacs 2008b). By-catch of hooded seals in coastal net fisheries has been reported from the United States, from trawl fisheries off Norway and Newfoundland, and salmon drift nets used off Greenland (Woodley and Lavigne 1991; Reeves et al. 1992; Waring et al. 2005).

Harbour seal (*Phoca vitulina concolor*)

The harbour seal is the most widely-distributed of all pinnipeds, inhabiting temperate, sub-Arctic and Arctic coastal areas on both sides of the North Atlantic and North Pacific Oceans. As this species does not maintain breathing holes in the ice, their distribution in the RSA is limited to locations where currents maintain open water year-round, typically in freshwater or estuarine rapids, in small coastal polynyas, or at the ice floe edge (Mansfield 1967). Harbour seals are not typically found in offshore waters exceeding 50 m depth (COSEWIC 2007). This depth limitation is supported by radio telemetry studies that have indicated that the 50 m benthic contour line may be used to demarcate their offshore limit of distribution (Stephenson and Hartwig 2010). Figure B-14 provides an overview of their distribution in the RSA based on historical sightings, current scientific knowledge, and IQ. Adults tend to be solitary in the water but haul out in small sedentary groups on rocky shores, where pupping occurs. Harbour seals are harvested by coastal Inuit communities primarily during the period from July through October (Table B-4).

LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF HARBOUR SEAL (*Phoca vitulina concolor*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	23 Jul. 2012		
CHECK	PR	18 Jan. 2013	**FIGURE B-14**	
REVIEW	DW	18 Jan. 2013		

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Atlantic walrus (Odobenus rosmarus rosmarus)

The walrus (*Odobenus rosmarus*) has a circumpolar distribution and is the largest pinniped occurring in the Canadian Arctic. Individuals inhabiting coastal areas of the RSA belong to the Atlantic stock, 1 of 2 subspecies recognised. Walrus in the Canadian Arctic include two genetic populations, with seven different stocks (DFO 2013). The Baffin Bay (BB), west Jones Sound (WJS) and Penny Strait-Lancaster Sound (PS-LS) stocks comprise the high Arctic population. The central Arctic population is composed of the north and central Foxe Basin (N-FB and C-FB) and Hudson Bay-Davis Strait (HB-DS) stocks (DFO 2013). According to DFO (2013), the relationship between these six stocks and walrus distributed in south and east Hudson Bay (S&E-HB) is currently unknown. Recent aerial and satellite telemetry studies have been used to develop abundance estimates for six of the walrus stocks that make up the high Arctic and central Arctic populations in Canada. Based on those estimates, total allowable removals (TARs) were calculated for each stock using the Potential Biological Removal method (PBR) (DFO 2013). The aerial surveys of walrus haul outs conducted in 2007 to 2011 provided data to enable the calculation of abundance estimates for all stocks, with the exception of the S&E-HB stock (DFO 2013). However, it is likely that individual stock abundance estimates were underestimated due to incomplete survey coverage, inter-annual variability in distribution, and unfavourable weather and ice conditions (DFO 2013).

According to DFO (2013) stock estimates and associated TARs for walrus belonging to the high Arctic population are as follows:

- Baffin Bay stock was estimated at approximately 1,250 walrus in 2009 (based on a count of 571) resulting in an annual TAR of 10 to11 walruses;
- West Jones Sound stock was estimated at 503 (coefficient of variation (CV) = 0.07) walruses in 2008, (based on a count of 404) resulting in an annual TAR of seven or eight walrus; and
- Penny Strait-Lancaster Sound stock was estimated at between 661 (CV = 2.08) and 727 (CV = 0.07) walrus in 2009 (based on a count of 557) resulting in an annual TAR of 10to12 walrus.

However, dividing the harvest of the three stocks that make up the high Arctic population was not possible (DFO 2013). The average annual Canadian reported harvest (reported over 25 years) was approximately 14, less than the combined annual TAR of 27 to 31 walrus (DFO 2013).

The combined population estimates for the north and central Foxe Basin stocks in 2011 ranged from 8,153 (CV = 0.07) to 13,452 (CV = 0.43) animals and was based on counts of 6,043 and 4,484, respectively, using different survey dates and different adjustment factors (DFO 2013). The annual TARs is currently 106 to166 walruses and with a yearly harvest level of approximately 185 animals (DFO 2013). Further investigation into walrus movements within Foxe Basin and exchange with the larger Hudson Bay-Davis Strait stock is required to better understand how and if these stocks interact (DFO 2013).

Walruses from the Hudson Bay-Davis Strait stock summer in the Hoare Bay area on southeast Baffin Island. Population estimates were between 1,420 (CV = 0.07) and 2,533 individuals (CV = 0.17) in 2007 (based on a count of 1,056 animals; DFO 2013). The calculated annual TARs for the Hudson Bay-Davis Strait stock is currently 18 to 38 with local annual harvests of approximately 36 walruses (DFO 2013).

According to DFO (2013), the central Arctic population lacks sufficient data for a meaningful population estimate. Changes in the abundance of the Atlantic walrus population during the past 45 years remain unclear (COSEWIC 2006). Modelling indicates that populations in the Eastern Canadian Arctic have been in steady decline (Witting and Born 2005). The current total abundance of the Atlantic walrus is poorly known, the most recent information suggests a population size of 18,000 to 20,000 individuals (COSEWIC 2006). The population status of Atlantic walrus was recently upgraded to “Special Concern” (COSEWIC 2006). Walruses are harvested year-round by coastal Inuit communities in the Nunavut region (Table B-4; Priest and Usher 2004). Between 1996 and 2001, hunters reported an average annual walrus catch (landed) of 2/year from Arviat, 3/year from Chesterfield Inlet, 5/year from Rankin Inlet and none for the communities of Baker Lake or Whale Cove during that same period (NWMB 2004). Walrus hunting is subject to the terms of the Nunavut Land Claims Agreement and is legislated under the Marine Mammal Regulations of the *Fisheries Act*.

Walrus require large areas of shallow water (<80 m) with substrate that supports a productive bivalve community, the reliable presence of open water over these feeding areas, and suitable ice or land nearby upon which to haul out (Evans and Raga 2001). Atlantic walrus are highly gregarious and are associated with moving pack-ice for most of the year. In Hudson Bay, the paucity of sea-ice during summer forces walrus to haul-out in predictable locations on land. The main concentration of walruses in southern Hudson Bay is in the Belcher Islands (Sanikiluaq) (Figure B-15; DFO 2002). The main concentration of walruses in northern Hudson Bay resides on the northeast side of Coats Island and in Coral Harbour on the southeast side of Southampton Island (Figure B-15; DFO 2002). Walrus in both areas are present year-round with an estimated summer population of 2000 animals. The main concentration of walruses in Hudson Strait resides at Cape Dorset on the Foxe Peninsula (Figure B-15; DFO 2002). Walruses may occasionally haul out at the East Bay Bird Sanctuary on Southampton Island and the Bowman Bay Wildlife Sanctuary on Baffin Island (COSEWIC 2006).The general distribution of walrus and their preference for shallow near shore areas substantially reduces the potential for interaction of walrus with Project vessels in the shipping corridor (RSA). Figure B-16 provides a summary of distribution of haul-outs and areas of known important habitat for Atlantic Walrus in the Marine RSA and Adjacent Arctic Waters.

Walrus are characterized by a highly polygamous mating system, with breeding herds forming in January - April. They are long-lived animals (approximately 40 years) with a low reproductive rate. Females attain reproductive maturity at approximately 5 to 7 years of age, with a typical calving interval of 3 years (Garlich-Miller and Stewart 1999). Males reach sexual maturity at 6 to 10 years of age, although likely cannot successfully compete for females until they are older. Mating takes place in the water, usually from January to April, and pregnancy lasts 15 to 16 months. Females, therefore, can only give birth a maximum of once every 2 years, though it is more commonly 3 years between calves. This results in a pregnancy rate that is much lower than that of other pinnipeds. Walrus calves are born on land or on the pack-ice between late April and early June. The nursing period typically lasts for 2 years, with weaning occurring gradually over this time.

Behavioral responses of walrus to man-made noise are shown to be variable (DFO2002). Aircraft noise has been correlated with evidence of stampedes, with attendant mortality, as well as partial habituation to the noise (Born et al. 1995). Some individuals at haul outs may allow ships to approach quite close while others will react to ships 2 km away (Born et al. 1995). Displacement from haul outs for up to 9 hours has been noted as a result of in-air noise, with females and calves being the most susceptible to this type of disturbance (Salter 1979, Miller 1982). Suitable walrus habitat has been shown to be decreasing as human activities in the north expand

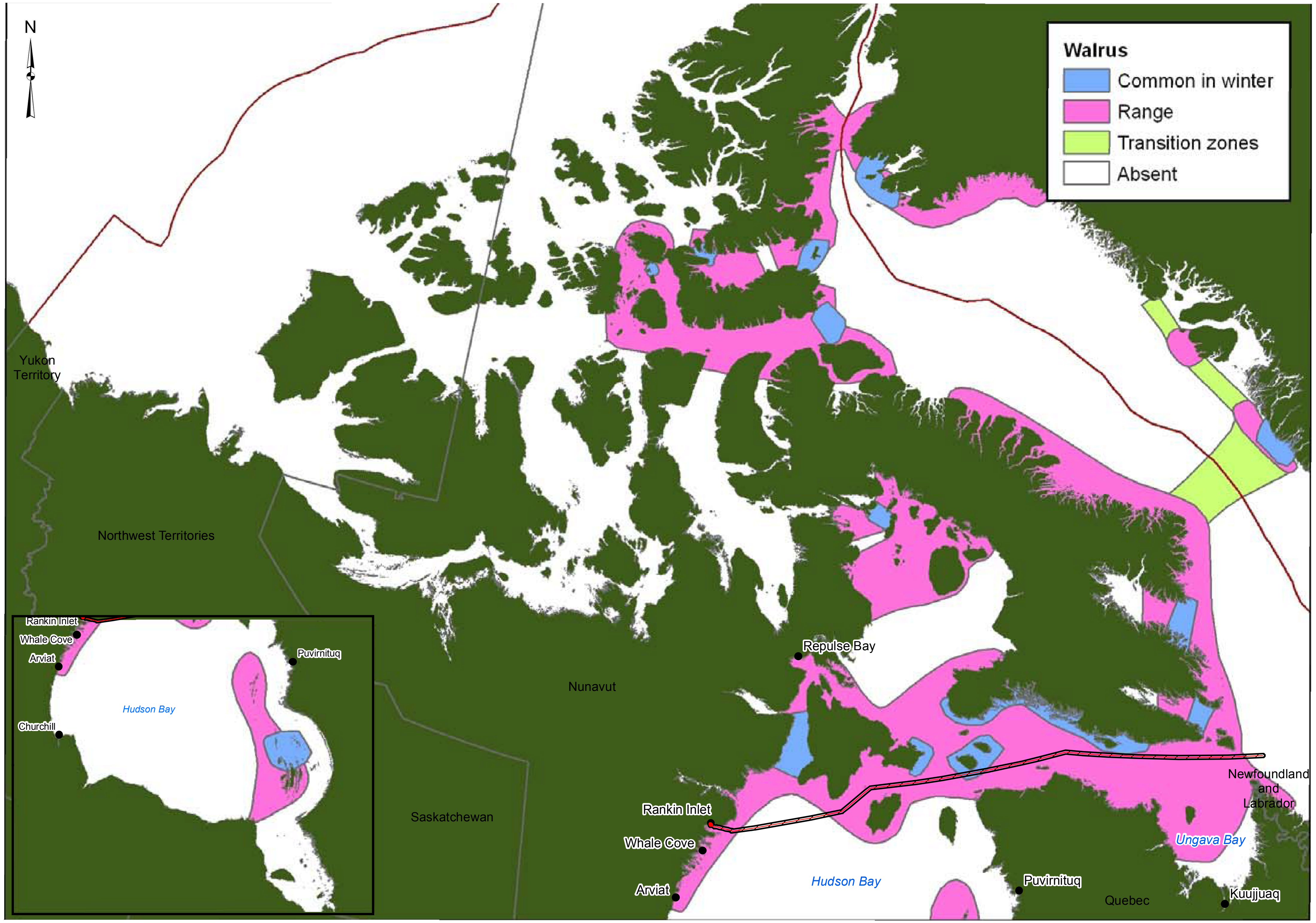
(COSEWIC 2006). Noise disturbance caused by motorized transportation and hunting have caused herds to abandon haul out near communities in favour of less accessible islands and shores (Born et al. 1995).

Interviews were conducted with Inuit hunters from Coral Harbour and Cape Dorset to document their knowledge regarding the seasonal distribution and abundance of walruses in northern Hudson Bay and western Hudson Strait (Orr and Rebizant 1987). Harvesters for Coral Harbour noted that during the winter, walruses were found along the floe edge from Leyson Point to Hut Point, with sightings of usually less than 100 walruses (Orr and Rebizant 1987). At the floe edge of Ruin Point, as many as 1,000 walruses have been noted, although usually sightings were around 500 individuals. Reports of sightings of 500 walrus at South Bay were also shared (Orr and Rebizant 1987). In the spring walrus were primarily noted in the area of South Bay, between Native Point and Ruin Point, with most sightings consisting of groups less than 100 individuals. The highest concentrations of walrus, up to 500, appeared to be at the floe edge near Renny Point. As ice breaks up in late spring, greater numbers of walrus (>500) are found near Leyson Point (Orr and Rebizant 1987). During the summer greater numbers of walrus were reported, with sightings common from Sea Horse Point, west along Bell Peninsula, to Ruin Point. Walrus Island, Bencas Island, the north and eastside of Coats Island and Evans Strait are all areas reported to have high concentrations (>1000) of walrus by hunters (Orr and Rebizant 1987). Harvesters noted that there appears to be a localized migration in the early fall, from the Coats Island and Walrus Island area, across to Evans Strait (Orr and Rebizant 1987). Harvesters reported more than 1,000 walrus hauled out or swimming in the area of Cape Pembroke (Orr and Rebizant 1987).

Cape Dorset hunters noted that during the winter months, walrus are sporadically distributed along the coast of Foxe Peninsula from Cape Dorchester to Chamberlain Island, with the largest number of walruses around Cape Dorchester (Orr and Rebizant 1987). Salisbury Island and Nottingham Island reported as many as 500 walruses in the area between the two islands. Most sightings documented were in groups from 20 to 50 individuals during the winter months (Orr and Rebizant 1987). Cape Enavolik, Shuke Island and Sakkiak Island were all noted to support as many as 1,000 walruses, with most individuals observed either swimming or hauled out on floating pack ice near the floe edge. During the spring, walruses can be found from Cape Dorchester to Dorset Island, commonly in groups of ~1,000 animals along the coast, while the groups from around the tip of Salisbury Island and the southeast side of Nottingham Island were similar to the winter numbers of approximately 500 individuals. In the spring, walrus were most commonly observed hauled out on floating pack ice (Orr and Rebizant 1987). In the summer months, walrus numbers decline in the vicinity of Cape Dorset; hunters suggested that walrus prefer the area along the west coast of Foxe Peninsula, from Lloyd Point to the group of islands north of Cape Dorchester during this time (Orr and Rebizant 1987). Walruses are known to travel around the islands of Mills, Salisbury and Nottingham in late summer, but hunting usually occurs along the west coast of Foxe Peninsula. Large groups of walrus of 500 to1000 individuals have been noted in the summer along the south, west and north coast of Salisbury Island and along the southeast coast of Nottingham Island (Orr and Rebizant 1987). In July and August, concentrations of over 1,000 walruses were reported around Cape Dorchester. During the fall, reports by hunters are similar to those made during the summer, with a slight decrease in the numbers along the northwest coast of Foxe Peninsula. This may be due to a seasonal migration of these animals to islands in Hudson Strait with noted increases in the number of animals observed around Nottingham and Salisbury Islands during this time (Orr and Rebizant 1987).

The main changes in seasonal distribution of the Northern Hudson Bay-Davis Strait walrus population occurred in the early to mid-1900 (COSEWIC 2006). This included the abandonment of haul outs along the west coast of Hudson Bay north to Chesterfield Inlet, Digges Island, Cumberland Sound, and on the Gyrfalcon Islands (Born et al. 1995). During this time, walruses were rare in western Hudson Bay, but were moving northward where the coastline offered more suitable haul out (COSEWIC 2006). Walruses were numerous at islands near the community of Whale Cove from 1942 to 1945, but are uncommon in this area now (Fleming and Newton 2003). Small groups are sometimes seen at the floe edge south of Whale Cove (Gamble 1988; Fleming and Newton 2003). Inuit report that walruses were more numerous in the Chesterfield Inlet area in the early 1990s than in times previous (Fleming and Newton 2003). Some haul out in western Hudson Bay have been abandoned, but walrus have been noted to be hauled out (Figure B-16) in small numbers in summer at:

- Bibby Island (61°53'N, 93°05'W);
- Term Point (62°08'N, 92°28'W);
- “Little Walrus Island” in Mistake Bay;
- Sentry Island (61°10'N, 93°51'W);
- Wag Island (63°23'N, 90°38'W);
- Marble Island (62°41'N, 91°08'W); and
- Fairway Island (63°15'N, 90°33'W;Low 1906; Degerbøl and Freuchen 1935; Loughrey 1959; Reeves 1978; Born et al. 1995; DFO 2000; Fleming and Newton 2003).



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF ATLANTIC WALRUS (*Odobenus rosmarus rosmarus*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN REV. 0
GIS	DSC	23 Jul. 2012	
CHECK	PR	18 Jan. 2013	FIGURE B-15
REVIEW	DW	18 Jan. 2013	

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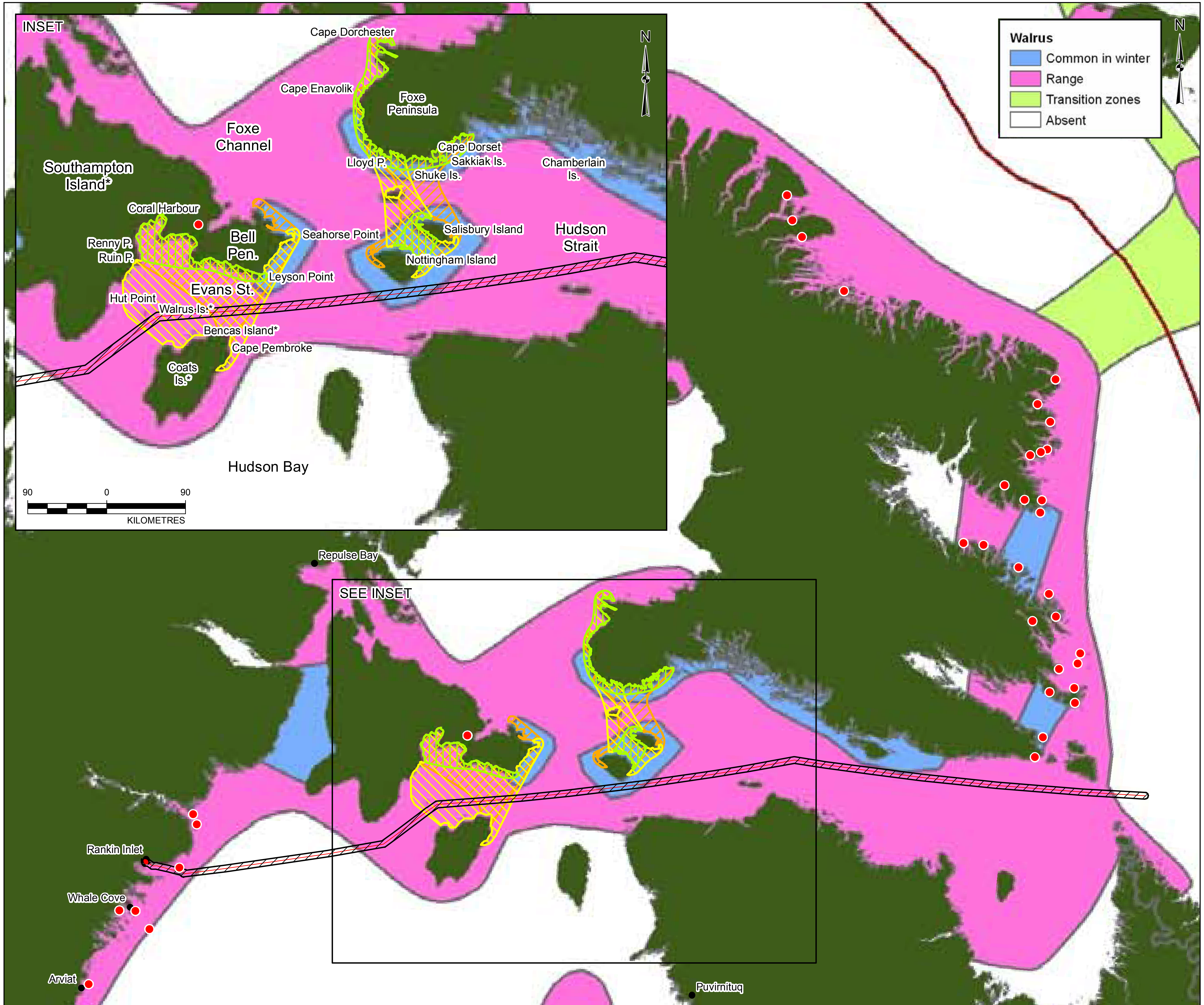

LEGEND

- KNOWN WALRUS HAUL OUT
- WALRUS DISTRIBUTION (SPRING)
- WALRUS DISTRIBUTION (SUMMER)
- WALRUS DISTRIBUTION (FALL)
- LOCAL STUDY AREA (LSA)
- MARINE REGIONAL STUDY AREA (MARINE RSA)

* HAUL OUTS AND MAIN CONCENTRATION AREAS

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
KNOWN WALRUS HAUL OUT LOCATIONS FROM STEWART ET AL. 2014; LOW 1906; DEGERBØL AND FREUCHEN 1935; LOUGHREY 1959; REEVES 1978; BORN ET AL. 1995; DFO 2000; FLEMING AND NEWTON 2003.
SPRING/SUMMER/FALL WALRUS DISTRIBUTION FROM ORR AND REBIZANT, 1987.
*HAUL OUTS AND MAIN CONCENTRATION AREAS FROM DFO, 2002.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010.
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

120 0 120
KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF HAUL OUTS AND IMPORTANT HABITAT ATLANTIC WALRUS IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	EL	12 Jan. 2016	SCALE AS SHOWN	REV. 0
GIS	CDB	12 Jan. 2016		
CHECK	KZ	15 Jan. 2016	FIGURE B-16	
REVIEW	PR	15 Jan. 2016		

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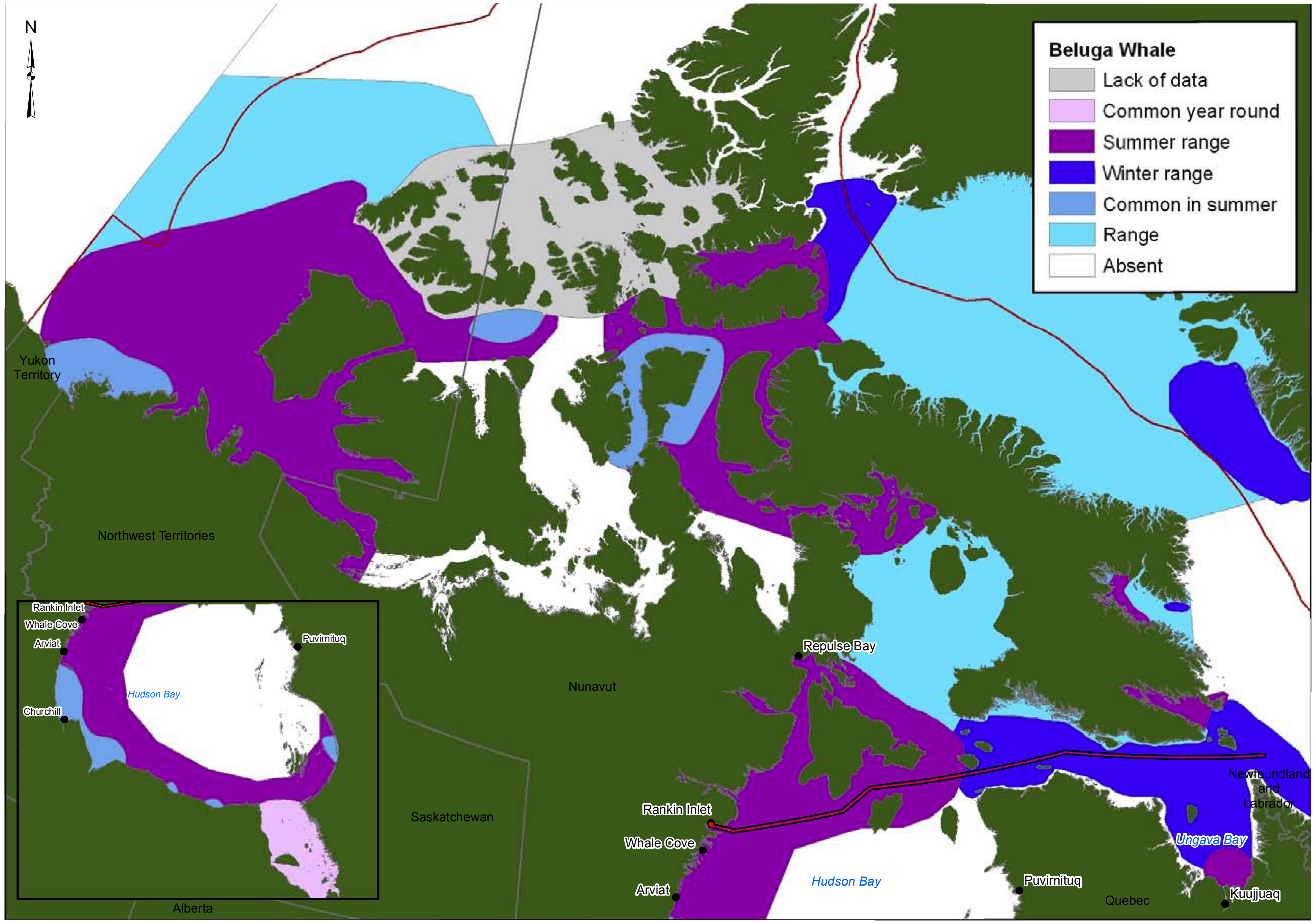
Beluga whale (Delphinapterus leucas)

Beluga whales are circumpolar in distribution, typically occurring in warm shallow estuaries during summer and migrating south during autumn to over-winter in the pack-ice, at established polynyas, or along prominent ice leads where open water conditions prevail (Doidge and Finley 1993; NAMMCO 2005). Beluga whales in the Canadian Arctic are sub-divided into 7 populations based on summer distribution and genetic differences (COSEWIC 2004a). The highest concentrations of belugas in the Canadian Arctic occur in the Hudson Bay region (Stephenson and Hartwig 2010), where animals during summer are observed in concentrated groups along both eastern and western coasts, as well as in James Bay and in nearby Ungava Bay (Gosselin et al. 2013). Each spring and fall, Hudson Strait is considered an important migration route for over 60,000 beluga whales from the Eastern and Western Hudson Bay populations (Gosselin et al., 2013; Richard 2005, 2010). Estuaries serve as important feeding and calving grounds for beluga whales, with their first arrival in these areas timed with the initial ice breakup in late June and their abundance increasing into the summer. Molecular genetic studies indicate at least two populations in Hudson Bay: a western Hudson Bay (WHB) stock and an eastern Hudson Bay (EHB) stock (Brennin et al. 1997; Brown Gladden et al. 1997; De March and Postma 2003). The WHB stock numbers about 57 000 individuals (Richard 2005). Genetic studies (Turgeon et al. 2012) and satellite telemetry (Bailleul et al. 2012) have shown that the two stocks overwinter together, where interbreeding likely occurs. Beluga whales in James Bay appear to constitute a distinct breeding population (Postma et al. 2012).

Most beluga whales present during summer in the Hudson Bay region belong to the WHB stock and occur in shallow coastal waters along western Hudson Bay (Martin et al. 2001), concentrating in the Churchill, Nelson, and Seal River estuaries (Stephenson and Hartwig 2010). The most recent population estimate for the WHB population was estimated at approximately 57,300 animals (95% C.I.: 37,700 to 87,100) (Richard 2005), making this stock of beluga the most abundant cetacean species in the region. Individuals from the EHB stock occur during summer along the shores of eastern Hudson Bay, including the Nastapoka River and the Little Whale River estuaries in northeastern Nunavik (Quebec's Arctic region) (Stephenson and Hartwig 2010). The EHB stock, currently listed as endangered by COSEWIC, was depleted by intensive commercial hunting between the 1860s and the early 1900s and has decreased from an estimated pristine population size of 12,500 to about 3,000 individuals in 2009 (Hammill et al. 2009). Aerial line transect surveys conducted in 2011 provided revised abundance estimates of the EHB stock at 3,351 animals (CV 48.9%; 95% CI: 1552 to 7855), which included correction factors for submerged animals and an additional 354 individuals counted during dedicated surveys in Little Whale River estuary (Gosselin et al. 2013). An uncorrected density estimate of 0.02 individuals / km^2 (CV 47.1%) was reported for EHB beluga whales in the eastern Hudson Bay survey area (Gosselin et al. 2013). The 2011 EHB abundance estimate is higher than that of 2008 (2,646 individuals; Gosselin et al. 2009), lower than that of 2004 (4,274 individuals; Gosselin 2005), and in line with model predictions of the stock abundance for 2011 (Doniol-Valcroze et al. 2011).

Belugas have been observed in many areas of Hudson Strait during the summer months (July and August), and even throughout the fall from September to November (Lewis et al. 2009). Migration is believed to begin northward along the coast of Hudson Bay during late August / early September (COSEWIC 2004a). In early August, satellite tagging studies and aerial surveys indicate a behavioural shift with beluga starting to migrate from southwestern Hudson Bay estuaries (e.g., Seal, Churchill and Nelson rivers; Sergent 1973; Smith 2007). Most beluga have left Hudson Bay by early September, with some following the west coast of Hudson Bay northward into Rankin inlet, while others mover eastward along the southern coast of Hudson Bay then northward along the Nunavik coastline or crossing Hudson Bay via offshore waters (Smith 2007). In late

September, beluga whales tagged in eastern Hudson Bay begin migrating northward along the coast and move through Hudson strait in the months of October and November (Lewis et al., 2009). Although some beluga whales have been reported to overwinter in polynyas in northwest Hudson Bay and in James Bay, in general, beluga whales over-winter in highly productive areas in Hudson Strait, Davis Strait, and Baffin Bay (Gosselin et al. 2009; Hammill and Lesage 2009; Hammill et al. 2009; DFO 2010a; Stephenson and Hartwig 2010). Smith (2000) suggests that it appears that the Western Hudson Bay, Eastern Hudson Bay, Ungava Bay and possibly James Bay stocks join together to winter in Hudson Strait. Figure B-17 provides an overview of beluga whale distribution in the RSA based on historical sightings, current scientific knowledge, and IQ. The presence of beluga whales along the shipping corridor is thought to be low, given their general distribution pattern and preference for shallow nearshore waters.



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF BELUGA WHALES (*Delphinapterus leucas*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN REV. 0
GIS	DSC	24 Jul. 2012	
CHECK	PR	18 Jan. 2013	**FIGURE B-17**
REVIEW	DRW	18 Jan. 2013	

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Meliadine_Gold_Project\99_PROJECTS\1535029_WL_Tech_Sup\02_PRODUCTION\5000\MXD\Report\1535029_Figure_B-17_Distribution_of_Beluga_Whales.mxd

Beluga whales are harvested year-round by most coastal Inuit communities (20 out of 28) (Table B-4) (Priest and Usher 2004). During summer, they are mostly hunted along the western coast of Hudson Bay up to 35 km offshore (Canadian Circumpolar Institute 1992) from Arviat to Cape Fullerton. They are hunted primarily for their tusks and their meat. The meat is eaten or fed to dogs.with (Born *et al.* 1995).

Over the 5-year period from 1996 to 2001, the total annual mean number of beluga whales taken through hunting was approximately 1,339 for all of Nunavut, whereas annual rates of belugas harvested from the community of Rankin Inlet ranged from 22 in 1998 to 1999 to 116 in 1999 to 2000 (Priest and Usher 2004). Subsistence harvest of beluga whales by Nunavik Inuit communities is directed towards a mixture of the WHB and EHB stocks, with the reported 2010 harvest consisting of 45 beluga whales taken near Sanikiluaq (Belcher Islands), 16 in the eastern Hudson Bay area, 15 in Ungava Bay, 146 in Hudson Strait in the spring and 58 in the fall (Doniol-Valcroze et al. 2011).

Narwhal (*Monodon monoceros*)

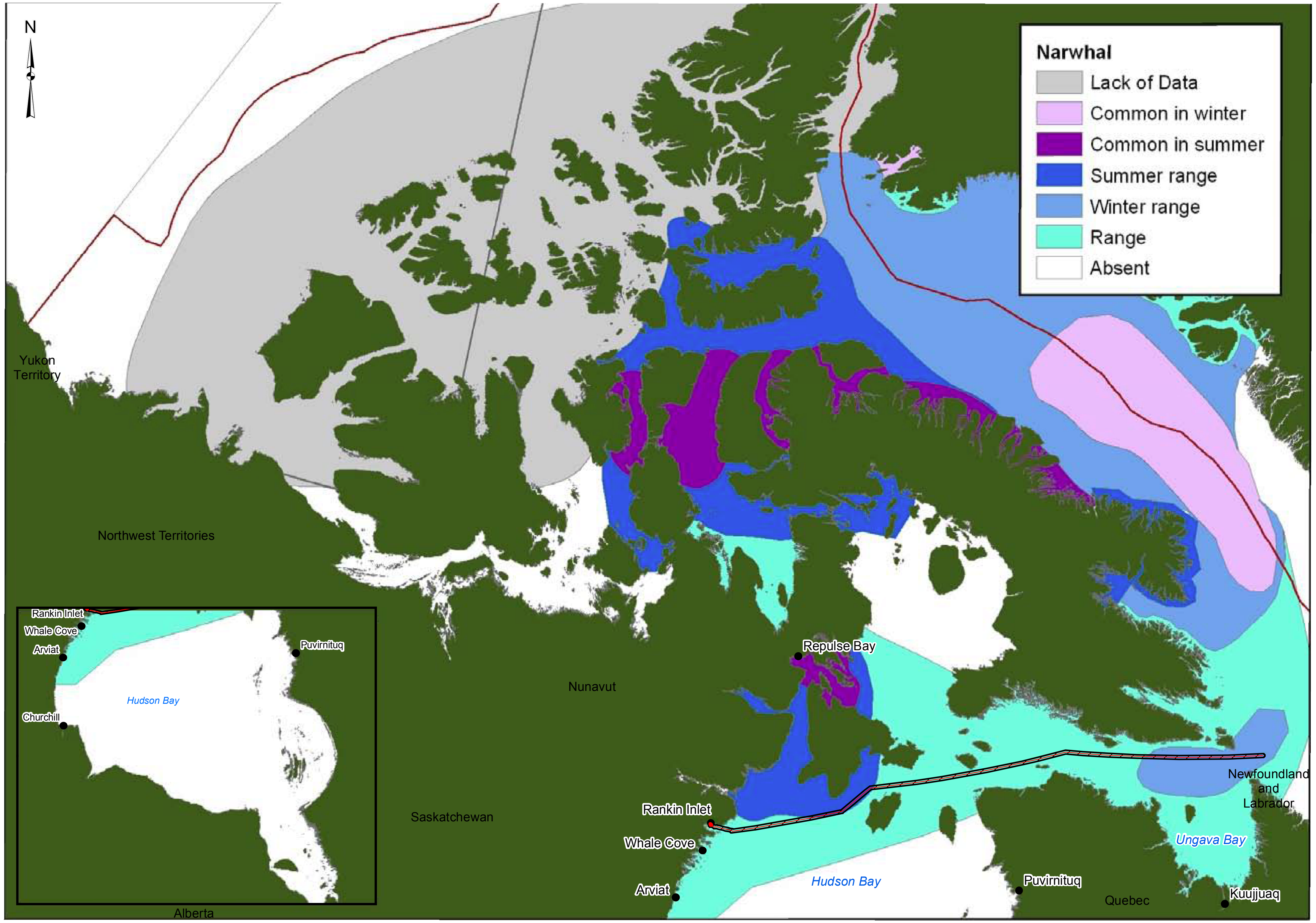
Two of 3 recognized populations of narwhals occur in the Canadian Arctic (Baffin Bay and Hudson Bay), with the third stock residing in East Greenland (COSEWIC 2004b). The populations are distinguished by means of their summer distribution, although the degree of genetic interchange between the 3 stocks is poorly known. The summer range of northern Hudson Bay narwhals includes the waters surrounding Southampton Island, with the larger aggregations in Repulse Bay, Frozen Strait, Western Foxe Channel, and Lyon Inlet (Figure B-18). Most narwhal are assumed to winter in eastern Hudson Strait and range over an area of roughly 250 000 km² (COSEWIC 2004b), while some occur in open leads and polynyas in northern Hudson Bay and western Hudson Strait. The core summering areas potentially overlap with the proposed open-water shipping route between Rankin Inlet and eastern Hudson Strait (Figure B-18).

Little information is known on narwhal habitat requirements. Throughout the year, they appear to be closely associated with the Arctic pack-ice, following the distribution of the ice and moving towards coastal areas when these are ice free. In summer, they appear to prefer coastal areas and ice-free shallow bays. During freeze-up, the coastal areas are abandoned, and the narwhals move offshore (Heide-Jørgensen 2002). During their fall migrations, and later while wintering in the pack ice, narwhals tend to prefer deep fjords and the continental slope, where depths range from -1000 to -1500 m and upwelling zones may increase biological productivity. The quality of sea-ice habitat, particularly the presence of leads in fast-ice and the density of broken pack-ice, appears to highly influence habitat selection (COSEWIC 2004b). Given that narwhal are an ice-associated species, it is likely that potential effects of climate change will result in changes to their habitats, prey availability, and increased natural mortality and may lead to changes in abundance, distribution and stock structure (Laidre and Heide Jorgensen 2005, Laidre et al. 2008). Narwhals generally travel in small groups in summer (<10 individuals), but gather in concentrations of many hundreds of animals during migrations in the spring and fall.

In Nunavut, local residents and scientists have observed killer whales feeding and hunting on marine mammals including narwhals (Steltner et al. 1984; Campbell et al. 1988; Stewart et al. 1995; Laidre et al. 2002; Higdon and Ferguson, 2009). Killer whales may be an important predator of narwhals, as indicated by their evasive behavioural responses when killer whales are nearby (Campbell et al. 1988; Laidre et al. 2002). This evasive behaviour may lead to more narwhals being available to hunters as narwhals tend to seek protection near shorelines, in bays or in inlets when killer whales are present. DFO is working with Nunavut HTOs to gather information on killer whale abundance and distribution in Nunavut, to evaluate their impact on their prey (Ferguson et al. 2012, 2011, Higdon et al. 2011).

Mating in narwhals occurs between March and May, and calving occurs in July and August. Since the lactation period exceeds 12 months, the interval between successive conceptions is usually 3 years, but about 20% of females conceive at the first breeding season following birth of their calves (Heide-Jorgensesn 2002). The basic life history features of the narwhal are similar to those of other medium-sized toothed whales (Hay 1985), with long life spans and sexual maturity estimated to be 6 to 7 years for females and 9 years for males (Garde et al. 2007). Narwhals feed heavily during migrations, but very little during the open water season (Hay and Mansfield 1989). Fish, squid, and shrimp make up the narwhal diet, particularly Arctic cod and polar cod (Heide-Jorgensen 2002). Their main predators are killer whales, polar bears, and humans, and possibly occasionally Greenland sharks and walruses (Hay and Mansfield 1989). Narwhal are harvested by coastal Inuit communities in Nunavut throughout the year under a quota system. The blubber is highly prized by the Inuit for food and is consumed locally or traded to other Inuit communities. The meat is also consumed as food. Narwhal tusks are a valuable economic commodity. Coral Harbour, Chesterfield Inlet, Rankin Inlet, Cape Dorset, Whale Cove, Kimmirut, Arviat, Baker Lake, and Hall Beach.

In 2008, DFO conducted a survey of the summer aggregation area for the Northern Hudson Bay narwhal population. Given apparent defects in the 2008 survey and uncertainty in the results, including the estimation of sustainable catches, a new survey was recommended (DFO 2012a,b). In August 2011, DFO conducted additional aerial surveys of the Northern Hudson Bay summer aggregation area. The 2011 surveys of the summering aggregations of Northern Hudson Bay narwhals produced a population estimate of 12,485 (95% CI: 7,515 to 20,743) (DFO 2012a). On the basis of this survey, an annual Total Allowable Landed Catch (TALC) of 157 narwhals for the Northern Hudson Bay population was allocated (DFO 2012a). In northern Hudson Bay, the harvest quota is to be shared among hunters in Repulse Bay, Coral Harbour, Chesterfield Inlet, Rankin Inlet, Cape Dorset, Whale Cove, Kimmirut, Arviat, Baker Lake, and Hall Beach (DFO 2012b). COSEWIC (2004b) currently recognizes narwhal in the Canadian Eastern Arctic as a species of “Special Concern”.



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF NARWHAL (*Monodon monoceros*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

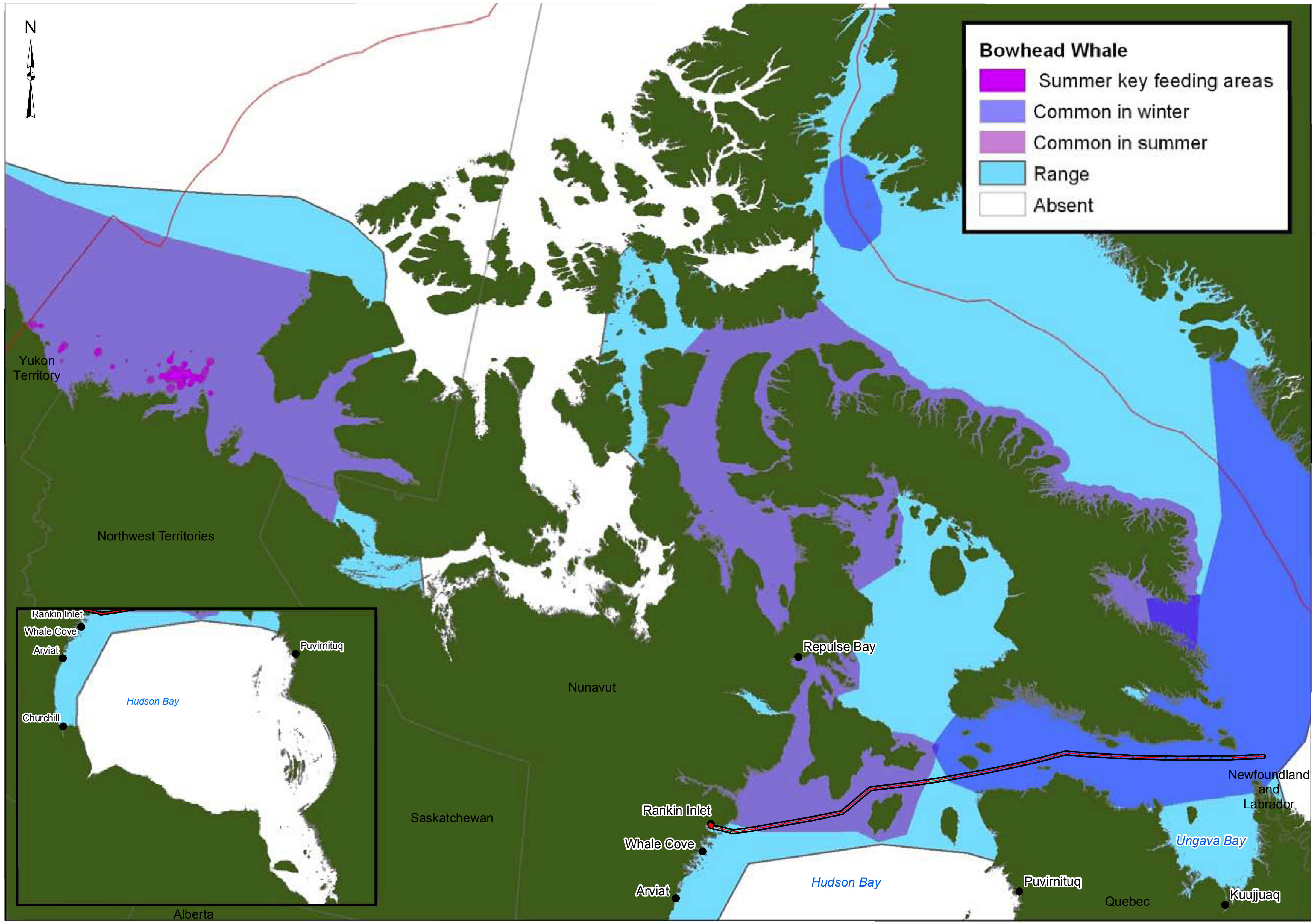
PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	24 Jul. 2012		
CHECK	PR	18 Jan. 2013	**FIGURE B-18**	
REVIEW	DW	18 Jan. 2013		

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Meliadine_Gold_Project\99_PROJECTS\1535029_WL_Tech_Sup\02_PRODUCTION\5000\MXD\Report\1535029_Figure_B-18_Distribution_of_Narwhal.mxd

Bowhead whales (*Balaena mysticetus*)

The bowhead whale is the only baleen whale that occurs in circumpolar Arctic waters year-round. This species is especially well adapted to life in seasonally ice-covered seas by having no dorsal fin, a thick blubber layer, a low surface area to volume body ratio, and an enlarged head that they use to break through thick sea-ice (Montague 1993). Males tend to be smaller than females and reach sexual maturity at 12 to 13 m body length (Koski et al. 1993). Females reach sexual maturity at 12 to 14 m (Koski et al. 1993), which corresponds to >25 years in age (Rosa et al. 2004). There is evidence that the lifespan of bowhead whales can exceed 150 years (DFO 1999). Mating is believed to occur in February or March, with calves born from April to early June. Calves remain with their mothers for nearly a year (Koski et al. 1993).

Bowhead whales that occur in Hudson Bay/Hudson Strait belong to the Eastern Canadian Arctic-West Greenland (EC-WG) population, 1 of 4 populations present in Arctic waters. This population has a home range of approximately one million square kilometres, with summering grounds occurring in western Baffin Bay, the Canadian High Arctic, northern Foxe Basin, and northwestern Hudson Bay (COSEWIC 2009). Thus, impacts to the EC-WG bowhead whale population due to the Project have the potential for transboundary effects. Studies indicate that EC-WG bowhead whales travel large distances (Dueck et al. 2006; Ferguson et al. 2010a), may be spread over thousands of kilometres, and may segregate by size, sex, or reproductive status (Finley 2001). In the Hudson Bay region there are important areas of aggregation including the spring nursery area in northern Foxe Basin, northwest Hudson Bay for summering locations and Hudson Strait for wintering habitat in (Higdon and Ferguson 2010). Historic bowhead concentration areas, including possible nursery areas, include Roes Welcome Sound and around Rankin inlet (Reeves and Cosens 2003). The fall migration occurs over 2 to 3 months starting in late August/September. Wintering grounds are located in areas of unconsolidated pack-ice, such as northern Hudson Bay, Hudson Strait, central Davis Strait, southern Baffin Bay, and off West Greenland. These areas provide shelter and protection from their main predator killer whales. During spring, whales from southeastern Baffin Island travel to summering areas in Prince Regent Inlet and Gulf of Boothia by either a southern route via Hudson Strait and Fury and Hecla Strait, or a northern route via Lancaster Sound. In April and May, some bowheads move west transiting through Hudson Strait to their summer aggregation areas in northwest Hudson Bay (Reeves and Mitchell 1990) and also to northern Foxe Basin (NWMB 2000). Bowhead cow-calf pairs have been observed using the flow edge as a nursery area in northern Foxe Basin (Cosens and Blouw 2003). Figure B-19 provides an overview of bowhead whale distribution in the RSA based on historical sightings, current scientific knowledge, and IQ. Seasonal migration and general distribution patterns of EC-WG bowhead whales are thought to be largely dictated by ice conditions (Ferguson et al. 2010a), water depth and temperature (Thomson et al. 1986; Finley 2001; Harwood et al. 2010), predators (NWMB 2000; Finley 2001; Laidre et al. 2008; Ferguson et al. 2010b), and abundance and distribution of their main prey species including euphausiids, copepods, and epibenthic organisms (mysids and gammariid amphipods) (Thomson et al. 1986; LGL 1987; Finley 2001; Harwood and Smith 2002; COSEWIC 2009).



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240

KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF EASTERN CANADIAN ARCTIC / WEST GREENLAND BOWHEAD WHALES (*Balaena mysticetus*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

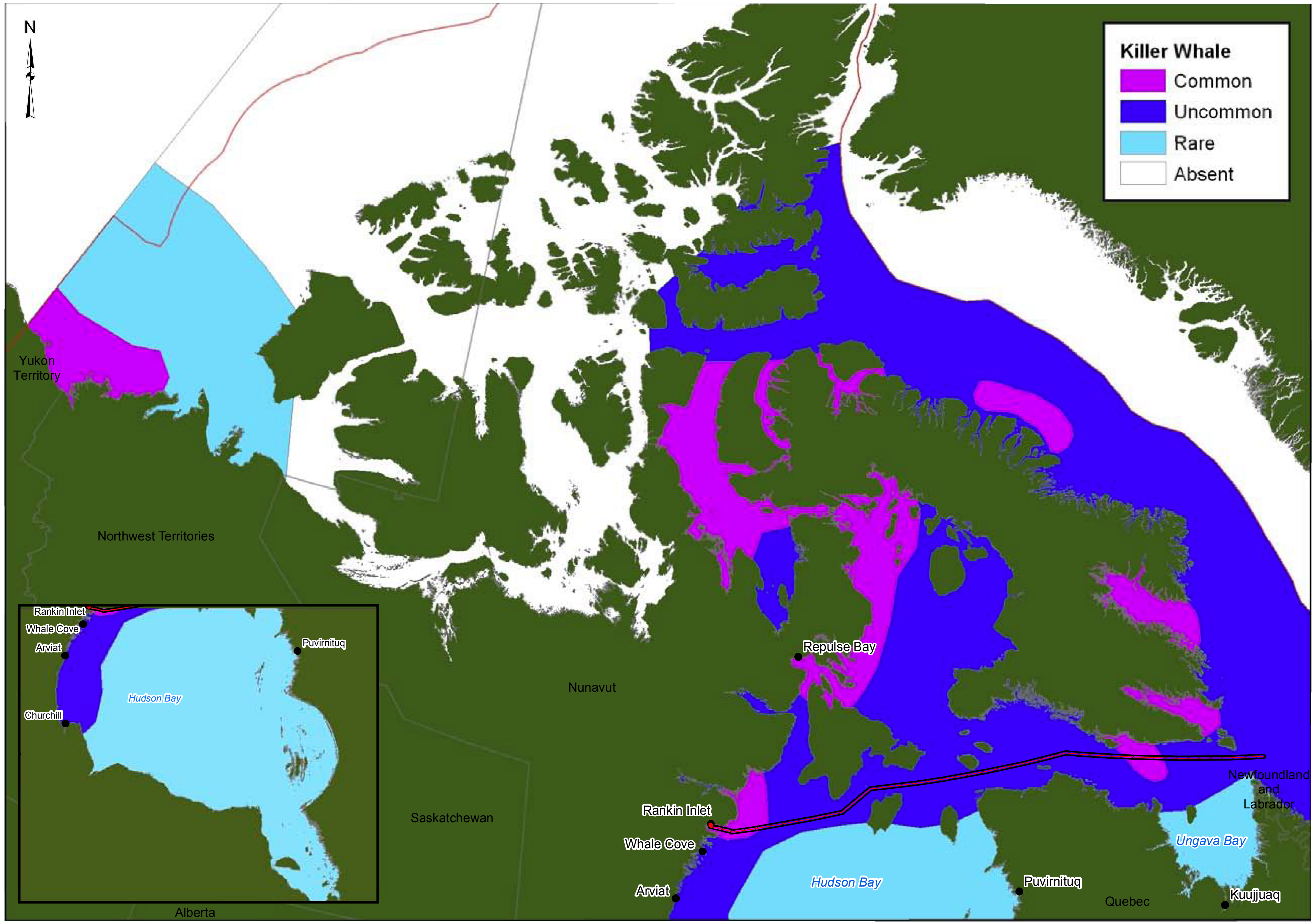
Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	24 Jul. 2012		
CHECK	PR	18 Jan. 2013	FIGURE B-19	
REVIEW	DW	18 Jan. 2013		

The population of EC-WG bowhead whales is currently estimated at 6,344 animals (95% CI 3119 to 12 906; COSEWIC 2009). EC-WG bowhead whales are currently designated as 'special concern' (COSEWIC 2009) and are being considered for listing under the federal SARA. EC-WG bowhead whales currently support a limited subsistence harvest by Inuit in Nunavut, which is co-managed by the Nunavut Wildlife Management Board (NWMB) and DFO. The population crosses international boundaries and in 2007, the International Whaling Commission granted Greenland a quota of two animals per year from this population pending annual review of the hunt sustainability.

Killer whale (Orcinus orca)

Killer whales are widely distributed throughout the Canadian Arctic, where they likely prey on a large variety of marine mammal species, including those harvested by coastal Inuit communities. They are known to migrate into Hudson Bay, Foxe Basin, and the central High Arctic each summer when open-water conditions allow (Dunbar and Moore 1980; Higdon 2007; COSEWIC 2008a), likely seeking out prey, such as seals (Leatherwood et al. 1976) and juvenile bowhead whales (Finley 2001). Declining summer sea ice may be allowing killer whales to expand their range in the Arctic, as they have been observed with increasing frequency in the Hudson Bay region (Higdon 2007). There is little available information on abundance or density of killer whales in Nunavut, and it is unknown if increases in sightings are representative of a growing population (Higdon 2007). The Inuit Traditional Ecological Knowledge of Killer Whales (Westdal 2009) summarised information on killer whales provided by workshop participants from Rankin Inlet, Arviat, Repulse Bay, Igloolik, and Hall Beach. Participants from Rankin Inlet indicated that killer whales have been around for a long time. In the past, there were not many killer whales seen near Rankin Inlet. About half the participants said that sightings have increased in recent years, and two participants mentioned that killer whales have been sighted by people in the community every summer since 2000 (Volume 9, Section 9.3.1.3.3.3). Figure B-20 provides an overview of killer whale distribution in the RSA based on historical sightings, current scientific knowledge (satellite telemetry studies and prey distribution), and IQ. Killer whales are not actively hunted by coastal Inuit communities in the Canadian Arctic.



LEGEND

LOCAL STUDY AREA (LSA)

MARINE REGIONAL STUDY AREA (MARINE RSA)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240
KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF KILLER WHALE (*Orcinus orca*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	24 Jul. 2012	**FIGURE B-20**	
CHECK	PR	18 Jan. 2013		
REVIEW	DW	18 Jan. 2013		

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Meliadine_Gold_Project\99_PROJECTS\1535029_WL_Tech_Sup\02_PRODUCTION\5000\MXD\Report\1535029_Figure_B-20_Distribution_of_Killer_Whales.mxd

Polar bear (Ursus maritimus)

Polar bears in the Canadian Arctic are segregated into 13 sub-populations, with those occurring in the RSA belonging to the Western Hudson Bay (WHB), Foxe Basin (FB), and Davis Strait (DS) sub-populations (Thieman et al. 2008). Delineation of the geographic separation of these three sub-populations is shown on Figure B-21. Polar bears generally occur at low densities throughout their range and are most abundant in shallow water areas near shore or where currents or upwellings increase biological productivity near ice edges associated with open water, polynyas, or lead systems (Schliebe et al. 2008). The productivity of polar bear habitat is closely linked to the physical attributes of sea ice and the density and distribution of ice-dependent seals, especially ringed and harp seals (COSEWIC 2008b; Peacock et al. 2013). From early winter until spring, polar bears are dispersed predominantly over sea-ice along the coast where they may range >200 km offshore. The annual ice melt generally forces polar bears in Hudson Bay and James Bay ashore from mid-July through late August, when they are at their maximum yearly weight from feeding on fat, newly-weaned seals. IQ on aspects of climate change from residents of Baker Lake and Arviat suggests that ice is melting earlier in recent years (as early as June) and may be forcing bears to retreat ashore sooner than in previous years (GN 2005). Polar bears tend to show long-term site fidelity with respect to preferred terrestrial summering grounds and spend several months of the open-water season in coastal areas, with some individuals also found inland (COSEWIC 2008b). During the summer, the WHB sub-population tends to congregate on coastal capes and headlands between Cape Churchill and Arviat (Figure B-22; Stapleton et al. 2014; Stirling et al. 1999). Arviat residents have reported that polar bears are becoming more common in areas in which they have not been observed previously, particularly during the summer months (GN 2005). The FB polar bear sub-population concentrates along the coastline during late summer and is observed in highest densities on Southampton Island, on several islands near Lyon Inlet, and on coastal islands throughout the Foxe Basin area (Figure B-23; Garshelis et al. 2012). In the Project area, the DS sub-population congregates along coastal areas of Frobisher Bay, on Akpatok Island, and along the northern tip of Ungava Bay (Labrador / Quebec border) at the entrance to Hudson Strait (Figure B-23; Peacock et al. 2013). During the open-water season, polar bears also have been observed offshore swimming in ice-free waters of Hudson Bay as reported during aerial surveys and other field investigations being conducted in the region (S. Atkinson 2013, pers. comm.). The majority of these sightings occurred less than 5 km from shore and in waters adjacent to larger islands (S. Atkinson 2013, pers. comm.; M. Dyck 2014, pers. comm.). No open-water surveys targeting polar bears have been conducted during the summer, and, therefore, no at-sea density estimates are available for this species during this period. However, the number of polar bears occurring offshore during the open-water summer season is thought to be minimal (S. Atkinson 2013, pers. comm; M. Dyck 2014, pers. comm.).

During fall, there is a gradual northward movement of the WHB subpopulation along the south coast of Hudson Bay, as bears gather to await the formation of new sea ice in November (Amstrup et al. 2007). Some polar bears tagged in the Churchill region moved northward along the Kivalliq Coast as far as Chesterfield Inlet (Stirling et al. 1999). Polar bears may overlap with the RSA and LSA in Melvin Bay during the winter time. During winter and spring, polar bears belonging to the Davis Strait sub-population use the sea ice along Davis Strait, Labrador Sea, and west to Ungava Bay and eastern Hudson Strait (Peacock et al. 2013). During winter, the FB sub-population generally is restricted within the mouth of Hudson Strait (COSEWIC 2008b). Figure B-23 provides an overview of polar bear distribution in the RSA based on historical sightings, current scientific knowledge, and IQ.

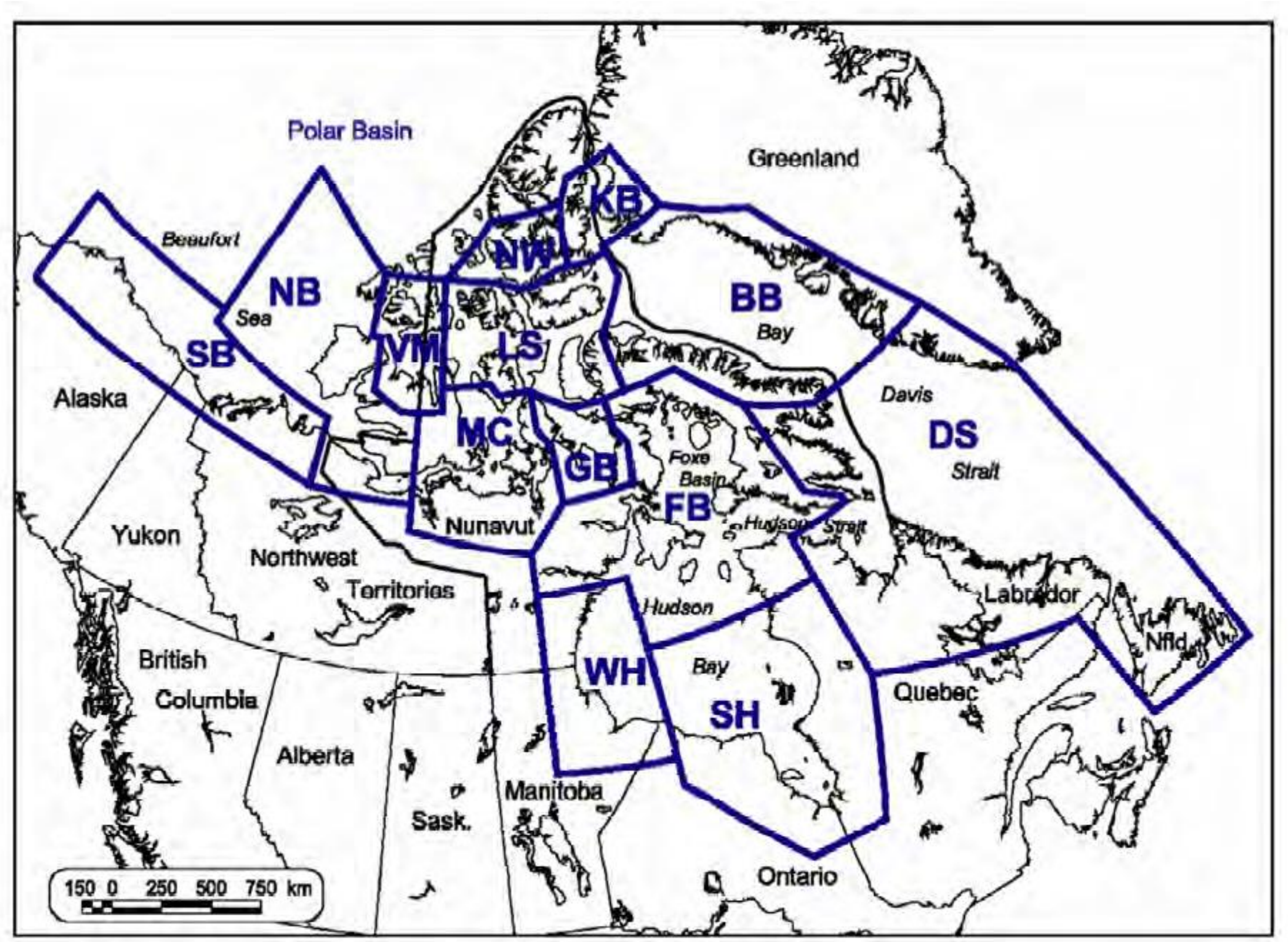


Figure B-21: Canadian Sub-populations of Polar Bears. Abbreviations of Delineated Sub-populations include Viscount Melville Sound (VM), Norwegian Bay (NW), Kane Basin (KB), Lancaster Sound (LS), Baffin Bay (BB), Davis Strait (DS) Southern Hudson Bay (SH), Western Hudson Bay (WH), Foxe Basin (FB), Gulf of Boothia (GB), M'Clintock Channel (MC), Southern Beaufort Sea (SB), and Northern Beaufort Sea (NB) (adapted from COSEWIC 2008b)

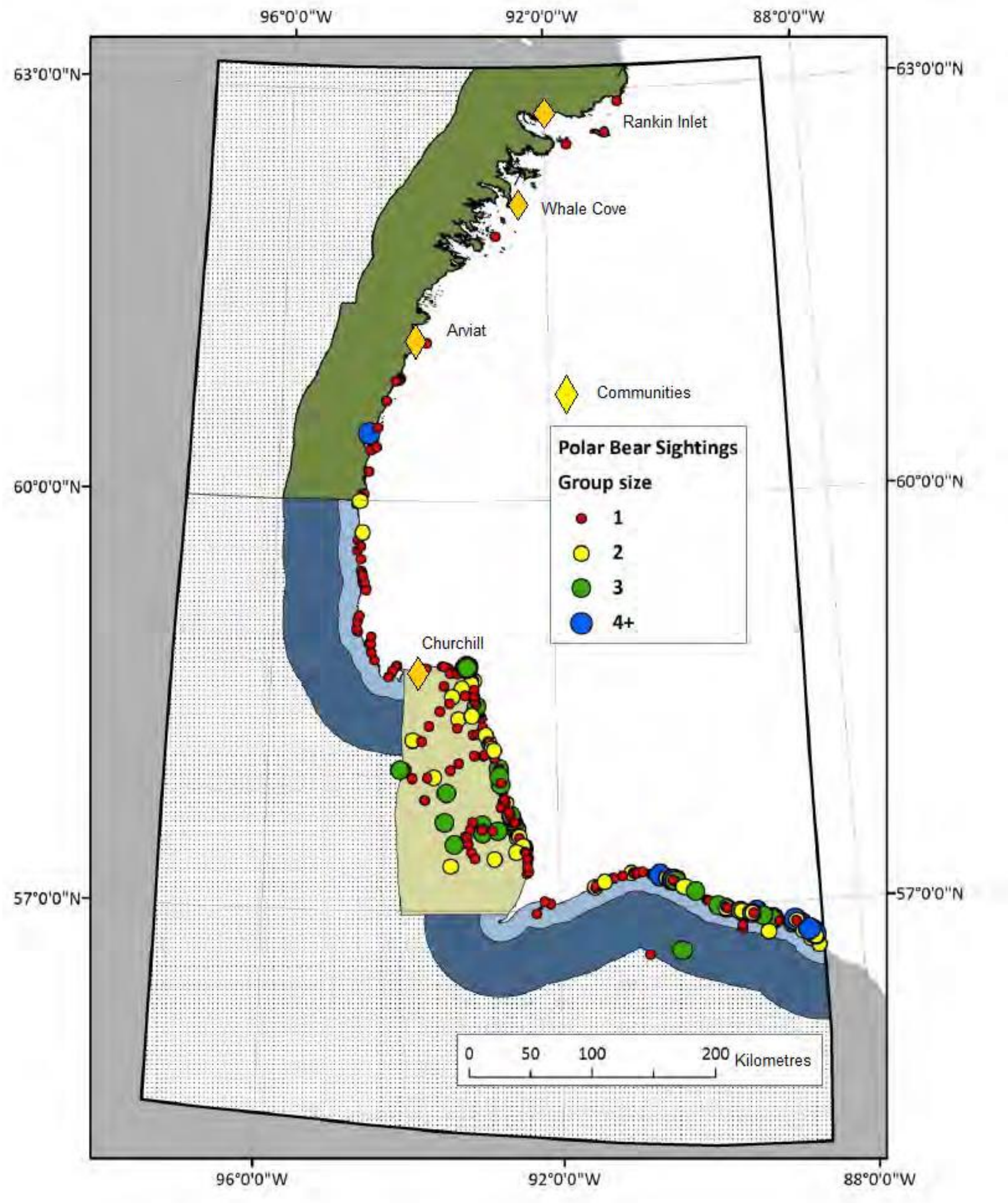
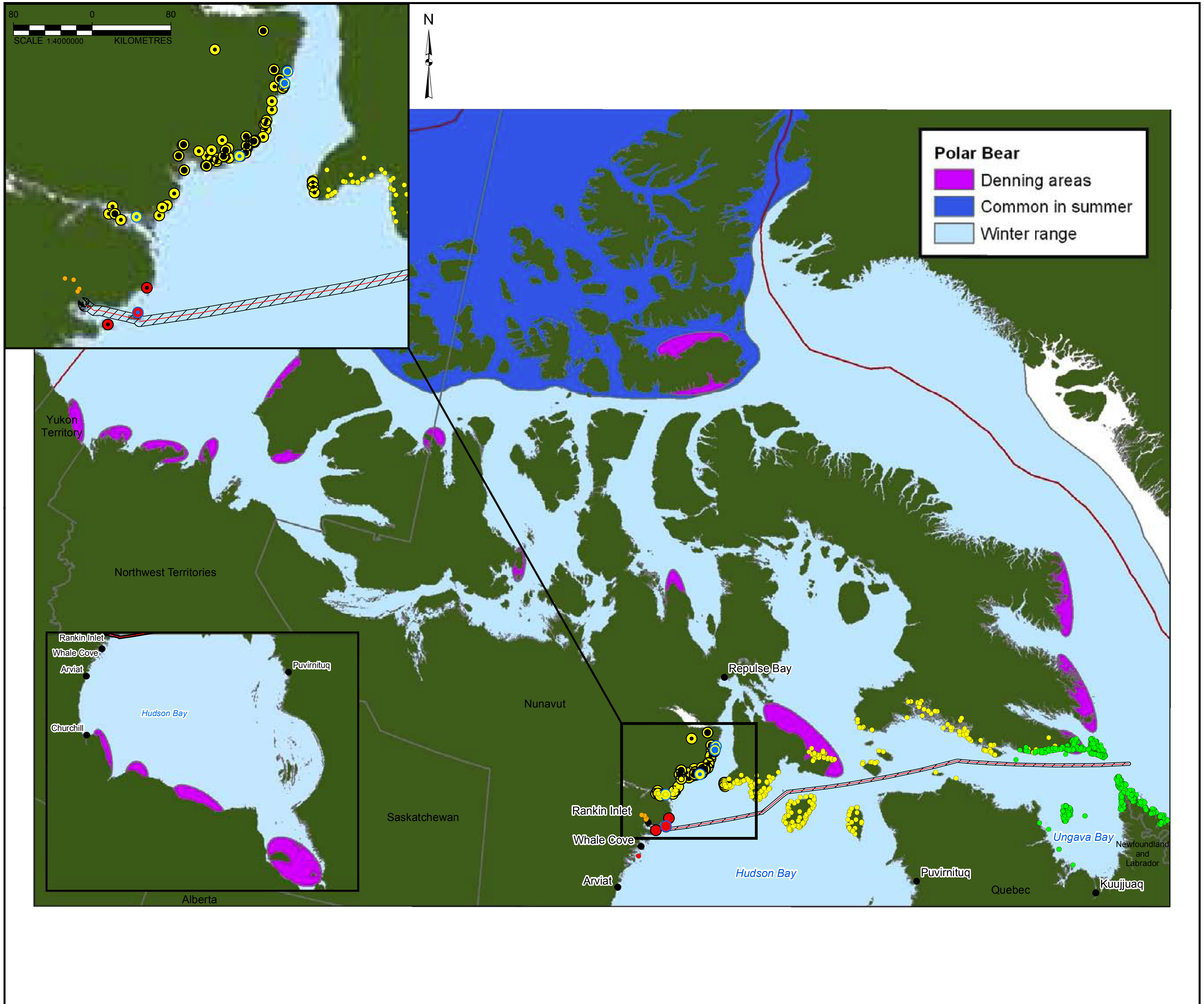


Figure B-22: Polar Bear of the Sightings Recorded During Aerial Surveys in the Western Hudson Bay in August of 2011 (extracted from Stapleton et al. 2014)



LEGEND

POLAR BEAR SIGHTINGS

- 2009/2010 AERIAL SURVEY SIGHTINGS DURING LATE SUMMER (GN UNPUBLISHED DATA)
- 2005-2007 MARK CAPTURE-RECAPTURE SURVEY (GN UNPUBLISHED DATA)
- WEST HUDSON BAY - AUGUST 2011 AERIAL SURVEY (GN UNPUBLISHED DATA)
- SUMMER POLAR BEAR SIGHTINGS COLLECTED DURING FIELD WORK
- 1 SPOTTING
- >1 SPOTTING
- SPOTTED IN WATER
- SHIPPING ROUTE (APPROXIMATE)

REFERENCE

PROVINCIAL DATA OBTAINED FROM E.S.R.I.
BASE IMAGE OBTAINED FROM STEPHENSON AND HARTWIG, 2010
GOVERNMENT OF NUNAVUT (GN) UNPUBLISHED DATA PROVIDED BY M.DYCK AND S.STAPLETON
DATUM: NAD 83 PROJECTION: CANADA ALBERS EQUAL AREA CONIC

240 0 240
KILOMETRES

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

DISTRIBUTION OF POLAR BEAR (*Ursus maritimus*) IN THE MARINE RSA AND ADJACENT ARCTIC WATERS (ADAPTED FROM STEPHENSON AND HARTWIG 2010, GN UNPUBLISHED DATA)

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	19 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	DSC	24 Jul. 2012		
CHECK	KZ	16 Feb. 2014		
REVIEW	DRW	16 Feb. 2014		

FIGURE B-23

When the majority of individuals move back onto the ice in November during freeze–up, pregnant females remain on land near the coast to dig maternity dens in deep snowdrifts and frozen ground. Breeding occurs in March to May, implantation is delayed until fall, and birth is generally thought to occur from late November to mid-January. Although some cubs are born in earth dens, most births occur in snow dens that may be occupied for 5 to 6 months during the maternal event (Schliebe et al. 2008). Only pregnant female polar bears den for this extended period of time, during which time they rely on fat stores for energy and sustenance. The average litter size is less than 2. Cubs are dependent upon mothers until after the start of their third year of life. Age of first reproduction is normally 5 to 6 years for females. These factors contribute to the low reproductive potential for the species (Schliebe et al. 2008).

The WHB subpopulation was shown to have declined by 22% between 1987 and 2004, from approximately 1294 indiviudals in 1,987 to 935 individuals in 2004 (Regehr et al. 2007). However, recent aerial surveys conducted during summer of 2011 estimate abundance of the WHB sub-population at just over 1000 animals (Stapleton et al. 2014). The highest concentrations of bears occurred along the coasts and surrounding islands, particularly in the area south of Arviat. This study is supported by IQ shared by Inuit Elders indicating that the number of polar bears and dens along the western coast of Hudson Bay are increasing (COSEWIC 2008b). Results from a compilation of interviews conducted with local Inuit by the Nunavut Tunngavik Incorporated (NTI) indicate that polar bear numbers in the Rankin Inlet region have been increasing since the 1980s (GN 2005).

The DS sub-population was recently estimated by Peacock et al. (2013) by compiling 35 years of mark-recapture studies. This sub-population was estimated to number 2,158 individuals (±180 SE) in 2007 - an increase from the last population assessment conducted in 1970. The population is thought to be influenced by low recruitment rates, average adult survival rates, high population density when compared to other sub-populations in the area, as well as high prey density but variable ice conditions. Peacock et al. (2013) suggest that the DS subpopulation appears to be stable and likely may be experiencing the effects of density dependence.

Mark-recapture surveys conducted from 1989 to 1994 estimated the FB sub-population at 2,197 individuals (+256 SE) (Taylor et al. 2006). In 2004, the estimated abundance of this sub-population had increased to 2,300 animals. Information from traditional knowledge studies suggested the population was increasing and the opinion of various scientists agreed that an increase may have occurred due to low historical harvests rates (COSEWIC 2008b). Recent aerial surveys conducted during the late summer of 2009 and 2010 generally agreed with these previous population assessments, and estimate polar bear abundance for the FB subpopulation at approximately 2580 individuals (95% CI about 2,100 to 3,200),; Garshelis et al. 2012). The FB sub-population, characterized by average litter sizes, robust annual growth rates, and good body conditions (Garshelis et al. 2012), appears to be near stable taking into account current harvest levels.

Polar bears are harvested by coastal Inuit communities in Nunavut throughout the year under a quota system. The polar bear quota increased from 8 to 21 bears from the 2010-2011 to the 2011-2012 annual quota for the Western Hudson Bay sub-population, which includes the area around the communities of Arviat, Baker Lake, Whale Cove, Rankin Inlet, and Chesterfield Inlet (GN 2011). The 2013-2014 recommended quota is 24 bears (GN 2013). The number of polar bears hunted in Rankin Inlet from 1996 to 2001 ranged from 1 to 13 bears (Priest and Usher 2004). The annual 2013-2014 hunting quota for the FB subpopulation is 106 bears and includes 7 communities in Nunavut and 4 in Quebec (GN 2013; COSEWIC 2008b). The annual quota for the DS subpopulation was 61 bear for 2012-2013; the recommended 2013-2014 quota is 48 bears (GN 2013). COSEWIC (2008b) currently recognizes polar bears in the Canadian Arctic as a species of "Special Concern".

Hearing Abilities of Marine Mammals

Marine mammals are acoustically diverse, with wide variations in ear anatomy, frequency range, and amplitude sensitivity (Ketten 1991). An animal's sensitivity to sound varies with frequency. Response to underwater sound likely depends strongly on the presence of and level of sounds in the frequency bands or range of frequencies to which the animal is most sensitive (Richardson et al. 1995a). The general trend is that larger species, such as bowhead whales, tend to have better hearing sensitivities at lower frequency ranges than smaller species, such as beluga whales and narwhal. Hearing abilities are generally only well understood in certain captive species where audiograms (plots of hearing threshold at different sound frequencies) have been developed based on behavioural response studies (reactions to sound) and electrophysiological experiments (measuring auditory evoked potentials) (Erbe 2002).

Toothed Whales (Beluga, Narwhal, Killer Whale)

The hearing abilities of beluga whales and narwhals at high frequencies are exceptionally well developed. This likely is related to their use of high frequency sounds for echolocation. Audible frequencies for toothed whales range from 80 Hz to 150 kHz, but they are most sensitive to sounds in the frequency range of 8 to 90 kHz (Richardson et al. 1995a).

Beluga whales are considered 'mid-frequency cetaceans' (Southall et al. 2007), meaning their most sensitive hearing range occurs in the mid-frequency range. Using sound for foraging, navigation, and social purposes, they are a highly vocal species with call types consisting of echolocation clicks, pulsed tones, whistles, and noisy vocals. Echolocation clicks are produced in the 40 to 60 kHz and 100 to 120 kHz range, with source levels reported at 206 to 225 dB re 1 µPa at 1 m (Au 1993). Non-echolocation calls (e.g., whistles) are centered on frequencies below 6 kHz, but may sometimes attain frequencies up to 14 kHz (Schevill and Lawrence 1949; Sjare and Smith 1986), with dominant frequencies ranging between 400 Hz and 8.3 kHz. Belugas can detect frequencies as low as 40 to 75 Hz; however, their sensitivity at this range is poor (Awbrey et al. 1988). Beluga whales have been documented to communicate with one another at distances of over 300 to 500 m (Bel'kovich and Shchekotov 1992).

No behavioural or electrophysiological audiograms are available for narwhals. Their vocalizations include echolocation clicks, pulsed tonal calls, and whistles. Narwhal echolocation sounds have been recorded at 40 kHz, with source levels reported at 218 dB re 1 µPa at 1 m (Mohl et al. 1990). Pulsed tones are produced in the 500 Hz to 5 kHz range, and whistles have been reported in the 300 Hz to18 kHz range, with dominant frequencies occurring at 300 Hz to10 kHz (Ford and Fisher 1978).

Baleen Whales (Bowhead Whales)

On a comparative basis, the baleen whale auditory system does not appear as specialized as that of toothed whales (Ketten 1997). Audiograms are not available for baleen whales due to the lack of these animals in captive settings, which is required (based on current technology) to conduct behavioural and electrophysiological hearing studies. Hearing thresholds and frequency sensitivities in baleen whales are thus inferred from anatomical ear structure, vocalizations, and behavioural studies in the wild (Richardson et al. 1995a). In general, most baleen whale species have been shown to react to frequencies below 1 kHz (Richardson et al. 1995a). They have an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007).

Hearing in bowhead whales can be inferred indirectly by the frequency at which they vocalize and the levels of sound at which behavioural reactions occur. Bowhead whales have been shown to react to sound with dominant frequencies between 50 and 500 Hz (Richardson et al. 1995a). Avoidance behaviour has been reported when bowhead whales were exposed to low broadband sounds of 90 dB re 1µPa (Richardson et al. 1995a). The majority of the sounds produced by bowhead whales are low frequency-modulated calls, with reported frequency ranges of approximately 25 to 900 Hz (Ljungblad et al.1982; Clark and Johnson 1984; Cummings and Holliday 1984). Bowhead vocalizations include pulsive and tonal sounds, the latter either descending, ascending, constant, or inflecting in frequency (Clark and Johnson 1984). The duration of bowhead vocalizations range from short 0.5 second signals to long and melodic 4 to 5 second tones (Clark and Johnson 1984). Most single-note tones carry little sound energy above 400 Hz (Wursig and Clark 1993). Source levels from tonal moans and pulsive sounds range from 128 to 185 dB re 1 µPa at 1 m, with some vocalizations recorded by hydrophones up to 20 km away from calling whales (Clark et al. 1986).

Singing behaviour is considered to be an advanced form of vocalization in baleen whales (Clark 1991). Songs are composed of units, phrases, and themes; units sung in a sequence form phrases, a repetition of a phrase is a theme, and several themes combined create a song that can last several minutes (Payne and McVay 1971). Songs have been documented to change within and between seasons (Clark and Johnson 1984; Würsig and Clark 1993; Tervo et al. 2007).

Pinnipeds (Seals and Walrus)

Underwater hearing sensitivity in seals and walrus falls in between that of baleen and toothed whales, with an estimated auditory bandwidth between 75 Hz and 75 kHz. Phocinid seals, such as the ringed seal and bearded seal, have underwater hearing thresholds between 60 and 85 dB re 1 µPa at 1 m, with flat audiograms between 1kHz and 30 to 50 kHz (Mohl 1968; Terhune and Ronald 1972, 1975; Terhune 1981). Some phocinids have been documented to be able to detect very high frequency sounds up to 180 kHz, although, their sensitivity to sounds above 60 kHz is poor and frequencies cannot be discriminated (Mohl 1968).

Ringed seal vocalizations include barks, clicks, and yelps, all of which occur in the 400 Hz to 16 kHz frequency range, with dominant frequencies concentrated above 5 kHz (Stirling 1973; Cummings et al. 1984). Source levels are between 95 and 130 dB re 1 µPa at 1 m, considerably lower in energy than other marine mammal vocalizations, and likely the reason why ringed seal vocalizations generally are detectable only within 1 km of the source (Cummings et al. 1984).

Bearded seals vocalize in the form of ‘songs’, which are presumed to be associated with territoriality and courtship (Ray et al. 1969; Budelsky 1993). Songs have been recorded at between 20 Hz and 6 kHz, with dominant frequencies occurring at 1 to 2 kHz, and source levels of 178 dB re 1µPa at 1 m (Ray et al 1969; Stirling et al 1983; Cummings et al. 1984). Unlike ringed seals, bearded seal vocalizations can be detected as far as 25 km from the source (Cleator et al. 1989).

Few studies have measured the audiogram of the walrus. In general, walrus have sensitive hearing to low frequency sounds (Kastelein et al. 2002). A study of an 18-year-old captive walrus reported an optimal hearing range between 1 kHz and 12 kHz, with maximum sensitivity (67 dB re 1 µPa at 1 m) occurring at 12 kHz

(Kastelein et al. 2002). Hearing sensitivity fell gradually below 1 kHz and dropped off sharply above 12 kHz (Kastelein et al. 2002). Walrus vocalizations include bell tones (male-specific), clicks, taps, knocks, rasps, and grunts. The dominant frequencies of most vocalizations occur between 400 and 1200 Hz (Ray and Watkins 1975). Clicks and taps are produced in the 100 Hz to 10 kHz range, with dominant frequencies concentrated below 2 kHz. Rasps are produced in the 200 to 600 Hz range, with dominant frequencies occurring between 400 and 600 Hz. The dominant frequencies of grunts occur below 1 kHz (Scheville et al. 1966; Ray and Watkins 1975; Stirling et al. 1983). Vocalizations in walrus are typically associated with herd organization and coordination behaviour (Richardson et al. 1995a).

Polar Bear

Little is known on underwater hearing abilities in polar bears. In-air hearing has been studied on captive subjects (using auditory evoked potentials to produce audiograms) demonstrating that polar bears can likely hear in-air at a slightly wider range of frequencies than humans (up to 25 kHz) and have absolute hearing thresholds below 27 to 30 dB re 20 µPa at 1 m (Nachtigall et al. 2007).

1.3.2.4 Species at Risk

COSEWIC and SARA-listed species potentially occurring within the RSA include 4 marine bird species and 6 marine mammal species, as outlined in Table B-5.

Table B-5: Species at Risk Potentially Occurring in the Shipping Corridor in Hudson Bay / Hudson Straight

Common Name	Species	SARA Status[(a)]	COSEWIC Status[(b)]
Marine Mammals			
Narwhal	*Monodon monoceros*	No status	SC
Beluga whale	*Delphinapterus leucas*	No status	EN – EHB stock SC – WHB stock
Bowhead whale	*Balaena mysticetus*	No status	SC
Polar bear	*Ursus maritimus*	SC – Schedule 1	SC
Walrus	*Odobenus rosmarus*	No status	SC
Killer Whale	*Orcinus orca*	No status	SC
Marine Birds			
Peregrine falcon	*Falco peregrinus tundrius*	SC-Schedule 1	SC
Ross's gull	*Rhodostethia rosea*	TH – Schedule 1	TH
Ivory gull	*Pagophila eburnea*	EN – Schedule 1	EN
Red knot	*Calidris canutus*	EN - *rufa ssp.* – Schedule 1 SC - *islandica ssp.* – Schedule 1	EN - *rufa ssp.* SC - *islandica ssp.*

(a) SARA (Species at Risk Act).The Act is a key federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery. It provides for the legal protection of wildlife species and the conservation of their biological diversity (extracted from SARA 2012).

(b) COSEWIC (Committee on the Status of Endangered Wildlife in Canada) is a committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada. It is up to Government to legally protect wildlife species designated by COSEWIC. The potential impacts of legal listing are for Government to analyse, and the Species at Risk Act (SARA) applies only to wildlife species on the SARA legal list (extracted from COSEWIC 2012).

EN=Endangered, SC=Special Concern, TH=Threatened

Mitigation measures will be implemented to avoid or minimize any adverse effects from the Project on species at risk (SAR) in the marine environment regardless of the 'significance' of effects determined as part of the assessment. If marine-based SAR are encountered during the Project, including evidence of a SAR (e.g., dens, nests or eggs of a SAR), the primary mitigation measure implemented will be avoidance. A monitoring program will be undertaken to confirm that mitigation measures are successful. The results of monitoring will be provided to the relevant agency with management responsibility for the applicable SAR involved. Mitigation and monitoring strategies will be consistent with applicable status reports, recovery strategies, action plans and management plans that may become available during the Project.

Detailed mitigation measures proposed for the Project effects are discussed in detail in the sections below. In some instances, mitigation measures for one species are also relevant for other species. Follow-up and monitoring is discussed for all species in Section 8.3.11 of the FEIS.

1.3.2.5 Sensitive/Protected Areas

Measures have been taken by federal, provincial, and territorial governments, non-governmental organizations, as well as international organizations to identify, evaluate and protect areas of biological importance in Nunavut's marine and coastal environment. This section provides an overview of these protected areas in Hudson Bay / Hudson Strait in relation to the proposed shipping corridor (RSA).

Marble Island

Marble Island, located approximately 45 km southeast (offshore) of Rankin Inlet (Figure B-24) in proximity to the existing shipping corridor, was identified during the traditional knowledge study as an important congregation area for whales, seals, and birds (FEIS Volume 9, Section 9.3). This area has a long history of diverse use by Inuit who first came to the island as seasonal hunters, taking advantage of its wide variety of wildlife (Davis 1996). Marble Island is formally listed on the Canadian Register of Historic Places (Parks Canada 2012). Stewart et al. (1991) recommended the Rankin Inlet–Marble Island marine area to Parks Canada for consideration as a national marine park to conserve and protect the following key ecological and cultural features of this area:

- a dense, breeding population of threatened peregrine falcons near Rankin Inlet;
- a large breeding colony of common eider on Marble Island;
- anadromous stocks of Arctic char, which are locally harvested by Inuit communities;
- unique oceanographic conditions influenced by the influx of Chesterfield Inlet waters;
- maritime historical sites at Marble Island from the Knight Expedition and the whaling period including 2 shipwrecks; and
- evidence of historical coastal Inuit cultures (Stewart and Lockhart 2005).

Both the exceptional peregrine population and the maritime historical sites at Marble Island are facing increasing human disturbance and would benefit from the protection afforded by National Parks designation as they are located near the growing community of Rankin Inlet and are a stop for tourists visiting by cruise ship. The area's rocky Canadian Shield shoreline provides a greater variety of marine habitats than the Churchill-Nelson area. Diana and Meliadine rivers provide small-scale estuarine habitats. This area would afford some protection to historical bowhead whale habitats, although more suitable bowhead whale habitat is present to the north in Roes Welcome Sound. All Project vessels along the shipping route will maintain a minimum distance of 2 km from Marble Island in order to avoid disrupting sensitive marine species located on or around the Island.

Ecologically and Biologically Significant Areas

DFO has identified a number of Arctic Ecologically and Biologically Significant Areas (EBSAs) in Hudson Bay and Hudson Strait using criteria from the Convention on Biological Diversity (Cobb 2011). These areas have been previously identified as important in ecosystem overviews, stock status reports, and traditional knowledge studies. Those EBSAs in the Hudson Bay Complex biogeographic region that overlap with the proposed shipping corridor are described below and illustrated in Figure B-24:

Southampton Island (including Coats Island) (EBSA 1.5)

- Largest island in Hudson Bay and situated near the confluence of Hudson Bay and Foxe Basin waters resulting in dynamic oceanographic mixing, and high marine productivity.
- Summer and winter use by the Northern Hudson Bay-Davis Strait population of Atlantic Walrus (Special Concern under COSEWIC).
- The waters surrounding Southampton Island are important spring and fall migration routes for beluga whales (Endangered under COSEWIC) and EC-WG bowhead whales (Special Concern under COSEWIC).
- Important nesting areas occur on Coats Island for seabirds (thick-billed murre, common eider, and black guillemot), which feed on aggregations of marine fish (e.g., capelin and Arctic cod) (Mallory and Fontaine 2004). The largest single colony of common eider in Nunavut occurs in East Bay.
- Southampton, Coats, and Mansel islands also are considered important denning and summer refuge habitat for the Foxe Basin polar bear population. Polar bears also frequent the land-fast ice adjacent to the islands in winter.
- Data confidence for this area is high due to intensive marine bird studies, tagging and survey data for marine mammals, and published IQ. The Southampton Island area scores high for several EBSA criteria.

Western Hudson Bay (Whale Cove to Arviat) (EBSA 1.6)

- Important area for beluga, killer whale, seabirds and Arctic char.
- Dense kelp beds occur along the coastline and provide important habitat for fish in the area.
- Area supports a wealth of LEK and TEK from the communities of Whale Cove, Rankin Inlet, and Arviat on the importance of marine mammals and fish (DFO 2011a).
- Important Arctic char stocks exist in this area and use the marine environment for feeding.

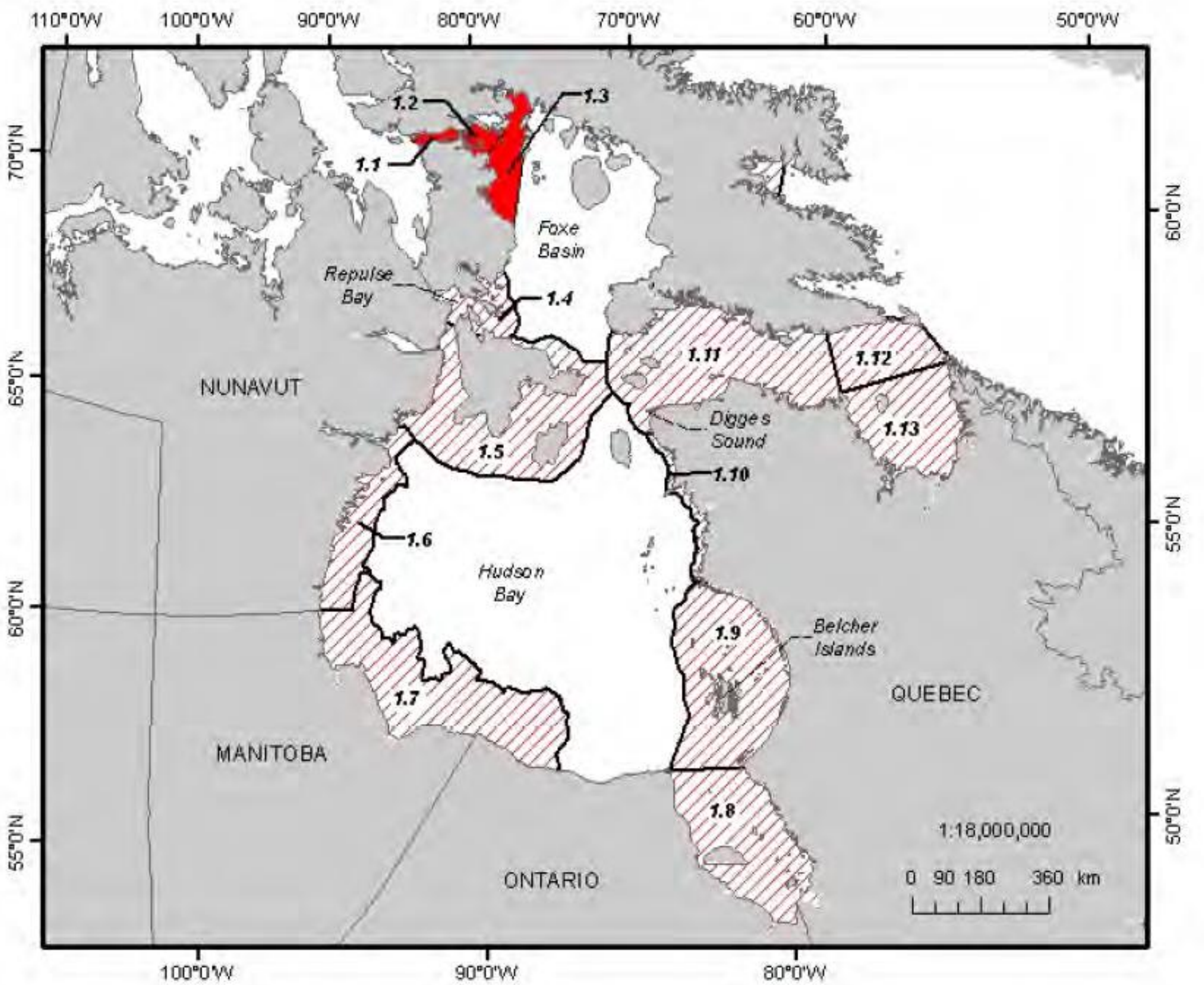


Figure B-24: Preliminary EBSA Identification Results for Foxe Basin (in solid red; 1.1 to 1.3) and for Hudson Bay / Hudson Strait (in red hatched lines; 1.4 to 1.12) as Determined Through a Series of Workshops Conducted in 2009 (DFO 2010b) (extracted from Cobb 2011)

Western Hudson Bay/Churchill/Nelson/Seal Estuaries (EBSA 1.7)

- The Nelson and Churchill estuaries provide an important habitat for a number of marine mammals and fish including the world's largest summer aggregation of beluga whales (Endangered under COSEWIC). Up to 3000 beluga whales congregate annually in the Nelson River estuary, with smaller numbers in the Churchill River estuary, to rear young and feed in these waters. Although the reason for these aggregations is not known, 2 commonly reported hypotheses are 1) thermal advantage from warm freshwater to initiate moulting; and 2) an evolutionary adaptation to take refuge from predation by killer whales in the shallow estuaries. Aggregations of approximately 70 000 beluga whales in this area are important for population fitness consequences.

- The Churchill region represents a key denning, feeding, and point of mobilization for Western Hudson Bay polar bear, which head north along the newly formed sea-ice to hunt ringed seal during fall/winter.
- A high degree of certainty exists for biophysical data available for this area due to Manitoba Hydro EIA Projects on the Nelson and Churchill rivers, as well as ongoing studies investigating the effects of climate change on marine mammals.
- The Seal River estuary was identified in 1999 as an Important Bird Area and is globally important for migrating black scoter.
- The Seal River is a Canadian Heritage River and remains a pristine, high-grade, remote wilderness river. It is the largest remaining undammed river in northern Manitoba. Harbour seals travel considerable distances up the Seal River estuary, representing an important adaptation to the freshwater environment by a marine mammal.
- The Province of Manitoba has designated a number of legally protected and managed lands, and identified Areas of Special Interest (candidate protected areas) along the Manitoba coastline for various ecological and biological reasons.
- Five internationally recognized Important Bird Areas have been identified along this part of Hudson Bay.
- Wapusk National Park and the provincially designated Churchill Wildlife Management Area, which extends to the Manitoba border and protects one of the world’s largest known polar bear maternity denning areas. This national park also protects important caribou habitat. Similarly, the Kaskatamagan Wildlife Management Area (provincial designation) was established to protect the fragile coastal and tundra ecosystems and to protect important habitat for a number of bird species. The Churchill Special Conservation Area, designated to conserve and protect the Ross’s gull, is also an integral part of the primary polar bear migration corridor in Manitoba.
- Hubbart Point, located north of the Seal River estuary, is an aggregation area for older male polar bears during the ice-free season. Beluga whales also congregate in waters off Hubbart Point, which is part of the North Hubbart Area of Special Interest.

West and Central Hudson Strait (EBSA 1.10):

- Serves as a key channel for Arctic waters via Foxe Basin, the outflow of Hudson Bay water, and also periodic intrusions of Atlantic water into northeastern Hudson Bay.
- Major seasonal migration route for all marine mammals that spend the summer in Hudson Bay and Foxe Basin and winter in either Hudson Strait or Davis Strait, including beluga whale, narwhal, and bowhead whale. The use of Hudson Strait by migrating marine mammals has been well documented through tagging studies and IQ.
- Walrus spend winters in west and central Hudson Strait on ice flows and on islands, such as Nottingham and Salisbury, where strong currents maintain open water. Walrus also overwinter on the northern shore of Hudson Strait near Kimmirut.
- Productivity is higher in West and Central Hudson Strait than Foxe Basin or Hudson Bay.

Support a number of important seabird nesting and feeding areas that occur on the northern and southern shores. Twenty percent of the North American population of thick-biller murres and a small colony of Atlantic Puffins are found near the Digges Sound and 10% of the Canadian population of common eiders breed and feed near Markham Bay (Mallory and Fontaine 2004).

- Physical oceanography in this EBSA has been well studied as part of long-term studies on Arctic flow-through.

Eastern Hudson Strait (EBSA 1.11):

- Heavily influenced by oceanographic conditions from Davis Strait resulting in high productivity.
- Important area for shrimp - Canadian Shrimp Fishing Area 3 occurs near Northern Ungava Bay eastward to Resolution Island.
- Supports western extent of Greenland halibut habitat.
- Provides significant overwintering refuge for Hudson Bay beluga whales and approximately 5000 to 8000 bowhead whales during winter.
- Support important occurrences of cold water corals in the deeper waters of the strait (Kenchington et al. 2011).

Ungava Bay (EBSA 1.12):

- Support Ungava Bay beluga whale stock, which has been reduced to as few as approximately 50 animals and may be extirpated (presently listed as Endangered under COSEWIC).
- Support important occurrences of corals in the deeper waters of the bay (Kenchington et al. 2011).
- Support 2 large colonies of thick-billed murre on Akpatok Island (Mallory and Fontaine 2004). Collectively, these colonies constitute the largest number of breeding thick-billed murre in Canada (>20% of the Canadian population). Black guillemots also nest along the Akpatok Island coast.
- A large portion of the breeding population of common eiders aggregate on the islands off the western shore of Ungava Bay. Key nesting sites occur at the Eider, Plover, Payne, and Gyrfalcon islands and the islands of northeastern Ungava Bay.
- Approximately 80 to 100 polar bear (~5% of the Davis Strait population) den and rear cubs along the southern shore of Akpatok Island during summer.

National Parks

To date, Parks Canada has established 2 National Parks in the Hudson Bay marine ecosystem: Wapusk and Ukkusiksalik (Stewart and Lockhart 2005). Wapusk National Park, established on 24 April 1996, is situated east of Churchill and protects an area of 11 475 km^2 that extends southward from Cape Churchill. Resources within the boundaries of the park are of national and international importance, including one of the world's largest known polar bear denning areas, and vital habitat for hundreds of thousands of waterfowl and shorebirds that nest along the coast of Hudson Bay or gather and feed there during the annual spring and fall migrations

(Stewart and Lockhart 2005). Park management is overseen by a board with representatives from the federal and provincial governments, the municipality of Churchill, and the First Nations of Fox Lake and York Factory. Ukkusiksalik National Park, established on 23 August 2003, extends westward from Roes Welcome Sound to include Wager Bay and the Brown and Piksimanik rivers, encompassing an area of 23 500 km^2 (Stewart and Lockhart 2005). Inuit residents from the Kivalliq communities, including Chesterfield Inlet, use this area for subsistence hunting and fishing.

Parks Canada also has identified several marine regions in arctic Canada within which it plans to recognize as Natural Areas of Canadian Significance. Two of the Natural Areas of Canadian Significance overlap with the proposed RSA, including Hudson Bay and Hudson Strait (Stewart and Lockhart 2005). The National Marine Parks Policy guides this process. Each area is intended to represent the natural, historical, and cultural diversity within a region. While National Marine Parks have yet to be established in northern Canada, Parks Canada has sought advice on which areas might make the best and most representative marine parks in the Hudson Bay and Hudson Strait marine regions. In Hudson Bay, Stewart et al. (1991) recommended 2 areas to Parks Canada for consideration as national marine parks – the Churchill-Nelson area and the Rankin Inlet-Marble Island area.

The Churchill-Nelson area was recommended for consideration as a National Marine Park prior to the establishment of Wapusk National Park, with the primary goal to protect the summer resident population of beluga whales in the Nelson, Churchill, and Seal rivers estuaries (known as the largest concentration of beluga whales in the world) (Stewart and Lockhart 2005). Other important physical, biological, and human use characteristics of this area include 1) extensive low-lying marshy coastal plains with wide tidal mud flats; 2) large estuarine habitats of the Churchill and Nelson rivers; 3) exceptional autumn concentrations of polar bears on the islands and headlands near Cape Churchill; 4) breeding shorebirds and waterfowl including the common eider; and 5) pre-historical coastal cultures, historical ports of entry instrumental in the exploration and development of central Canada, and the region's only deep water port for international shipping (Stewart and Lockhart 2005).

As noted earlier, the Rankin Inlet-Marble Island area was recommended as a National Marine Park to conserve and protect several key ecological and cultural features in this area (Stewart et al. 1991). The area of Hudson Strait immediately northeast of the Hudson Bay marine region was recommended as the most representative candidate for consideration as a future national marine park in the Hudson Strait marine region (DFO 2005b).

Migratory Bird Sanctuaries

Environment Canada’s Canadian Wildlife Service (EC-CWS) has established 11 migratory bird sanctuaries in Nunavut to control and manage areas of key importance for the protection of migratory bird species and their habitat (Stewart and Lockhart 2005). Three of these sanctuaries occur within, or in the vicinity of, the proposed RSA: the McConnell River Migratory Bird Sanctuary south of Arviat, and the Harry Gibbons and East Bay Migratory Bird Sanctuaries on the southeast coast of Southampton Island. Both areas include terrestrial, wetland, and marine habitats, with the latter typically consisting of nearshore foraging areas for migratory birds. The Migratory Birds Convention Act prohibits activities in Migratory Bird Sanctuaries. Canadian Wildlife Service manages the activities that can be carried out within these areas. Prohibitive measures are placed on what activities can occur in these areas, as outlined in the Bird Sanctuary Regulations. Although important fish habitat could be protected through migratory bird sanctuaries, it is not an effective measure unless there is valuable bird habitat associated with the area that coincides with important or critical fish habitat.

The McConnell River Migratory Bird Sanctuary, established in 1960 to protect a small colony of lesser snow geese, encompasses 32 800 hectares (ha) along the west coast of Hudson Bay south of Arviat. This sanctuary is owned by the Coastal Inuit of Nunavut and subject to co-management agreements under the Nunavut Land Claims Agreement (Stewart and Lockhart 2005). Subsistence hunting and fishing activities presently occur within the sanctuary, mostly by community members of Arviat. In 1982, under the terms of the Ramsar Convention, the sanctuary was designated as a “Wetland of International Importance especially as Waterfowl Habitat” (Ramsar Site 248) because it provided major nesting habitat for multiple migratory bird species including Canada geese, lesser snow geese, and Ross’s goose. Up to 200 000 birds colonize this sanctuary on an annual basis, with habitat degradation presently occurring due to a local increase in the snow goose population (Stewart and Lockhart 2005).

The Harry Gibbons Migratory Bird Sanctuary is located on Southampton Island in northern Hudson Bay, encompassing extensive tidal flat and wetland habitat areas along the Boas River delta and associated estuarine environment in the Bay of God’s Mercy. This area supports large nesting colonies of lesser snow goose (population >500 000 birds in 1997), Atlantic brant, Canada goose, and tundra swan (Stewart and Lockhart 2005). Smaller breeding colonies of migratory birds are located outside the sanctuary at Ell Bay and Bear Cove (Stewart and Lockhart 2005).

The East Bay Migratory Bird Sanctuary is located on Southampton Island near the community of Coral Harbour. Established in 1959, this area encompasses 113 800 ha including marine, intertidal, and subtidal components. Notable bird species include Arctic tern, Atlantic brant, lesser snow goose, Canada goose, common and king eider, black guillemot, jaeger, herring and Sabine’s gull, red knot, red phalarope, red-throated loon, ruddy turnstone, and several species of plover and sandpiper.

Important Bird Areas

Important Bird Areas (IBAs) are sites recognized as being globally important habitat for the conservation of bird populations, as designated by Bird Studies Canada, Nature Canada, and Birdlife International (Birdlife International 2012), an international bird protection organization. Collectively, these organizations support the international conservation of discrete sites that provide habitat for threatened birds, large groups of birds, and birds restricted by range or by habitat. Three Important Bird Areas occur within, or in the vicinity of the RSA; including Harry Gibbons and East Bay Migratory Bird Sanctuaries (sites #NU022 and #NU023 respectively) on Southampton Island, and McConnell River Migratory Bird Sanctuary south of Arviat.

International Biological Programme

In 1975, the International Biological Programme recognized a number of areas of biological, geological, and historical importance in northern Canada that were in urgent need of special protection (Nettleship and Smith 1975). Several of these areas, which have since been offered protection, and which occur within or in the vicinity of the RSA, include McConnell River (McConnell River Migratory Bird Sanctuary), and Boas River (Harry Gibbons Migratory Bird Sanctuary). Other areas near the RSA that have been identified as International Biological Programme sites but are not yet protected include Coats Island and Digges Islands. Coats Island is located northeast of Southampton Island. Digges Islands (West and East) are located in Digges Sound, at the northwest tip of the Ungava Peninsula in Western Hudson Strait. Both areas support key terrestrial habitats for migratory birds and seasonal habitats for several marine mammal species (Nettleship and Smith 1975).

Key Marine Habitat for Migratory Birds

EC-CWS has established 'key marine habitat' sites for migratory birds located near the proposed shipping route. Some of these sites overlap with existing protected/sensitive areas such as migratory bird sanctuaries designated by EC-CWS, IBAs, and/or International Biological Program sites. These areas were primarily established to protect terrestrial or coastal resources for marine birds. 'Key marine habitat' sites designated by EC-CWS aim specifically to identify important marine habitat areas for marine avifauna. Not all of these sites are protected under legislation; however, as local knowledge increases regarding habitat use and the overall importance of these sites to marine birds, legal protection status may follow. Generally, these areas are used by marine birds from late April through September. Additional details on the key marine habitat sites for migratory birds located near the proposed shipping route are summarized in Table B-6 and FigureB- 8 (adapted from Mallory and Fontaine 2004).

Table B-6: Environment Canada Key Marine Habitat Sites for Migratory Birds Located Near the Proposed Shipping Route

Site Name	Sensitivities	Biological Significance	Status	Size (km^2)		Distance from shipping lane (km)
				Marine	Land	
Coats Island near Cape Pembroke	Sensitive to disturbance of important nesting sites along coast, important foraging grounds and staging / breeding areas in the marine environment, and key migratory corridors. Concerns around increases in vessels in the area coming close to Coats and Walrus islands.	Important nesting areas occur on Coats Island for seabirds (thick-billed murre, common eider, and black guillemot), which feed on aggregations of marine fish (e.g., capelin and Arctic cod). Glaucous gull and peregrine falcon can be found along the cliffs at the colonies. Home to a large Iceland gull (*Larus glaucoides*) colony and the largest single colony of common eider in Nunavut occurs in East Bay.	International Biological Programme site (Region 9, Site No. 6-3) and an IBA (NU005).	1918	0	Overlaps
Digges Sound	Sensitive to disturbance of important nesting sites along coast, important foraging grounds and staging / breeding areas in the marine environment, and key migratory corridors. Concerns around increases in vessels in the area. Colonies are considered to be some of the most disturbed by human activities in the Canadian Arctic.	20% of North American population of thick-billed murre and a small colony of Atlantic puffin (*Fratercula arctica*) and razorbill (*Alca torda*) occur near Digges Sound. 10% of the Canadian population of common eider breed and feed near Markham Bay. Other species that also breed here are black guillemot, glaucous gull, Iceland gull, herring gull, and Arctic tern.	International Biological Programme site (Region 9, Site No. 6-7) and an IBA in Canada (NU001).	2207	102	~3

Table B-6: Environment Canada Key Marine Habitat Sites for Migratory Birds Located Near the Proposed Shipping Route

Site Name	Sensitivities	Biological Significance	Status	Size (km^2)		Distance from shipping lane (km)
				Marine	Land	
Frobisher Bay	Sensitive to disturbance of important nesting sites along coast, important foraging grounds and staging / breeding areas in the marine environment, and key migratory corridors. Concerns around increases in vessels in the area and potential hydrocarbon exploration. The complex nature of currents in the region suggests that a potential oil spill in southern Davis Strait could not reach this marine area.	Colony of 3% of Canadian thick-billed murre population. Glaucous gull, black-legged kittiwake, and possibly Northern fulmar breed here. Nearby Loks Land is thought to support Nunavut's largest known colony of razorbill (not been visited since 1953). Dovekies congregate off the Hall Peninsula in August. An important nesting, feeding, and migration stop-over for common eider, Iceland gull, ivory gull, and harlequin duck (*Histrionicus histrionicus*). Canada goods and long-tiled ducks may also be found here.	Hantzsch Island is an International Biological Programme site (Region 9, Site No. 7-10) and a Canadian IBA (NU025).	12442	1336	Overlaps
Button Islands	Sensitive to disturbance of important nesting sites along coast, important foraging grounds and staging / breeding areas in the marine environment, and key migratory corridors. Concerns around increases in vessels in the area and potential hydrocarbon exploration. The complex nature of currents in the region suggests that oil spills in southern Davis Strait could enter this marine area. Oil spills associated with shipping could endanger a large number of marine birds and pollute their feeding areas.	Black-legged kittiwake and northern fulmar forage near the Button Islands. Ivory gulls and common eider have been observed. Thick-billed murre breed here.	International Biological Programme site (Region 9, Site No. 6-8).	3909	81	Overlaps

Table B-6: Environment Canada Key Marine Habitat Sites for Migratory Birds Located Near the Proposed Shipping Route

Site Name	Sensitivities	Biological Significance	Status	Size (km^2)		Distance from shipping lane (km)
				Marine	Land	
Akpatok Island	Sensitive to disturbance of important nesting sites along coast, important foraging grounds and staging / breeding areas in the marine environment, and key migratory corridors - particularly for murres. Shoreline around Akpatok Island is considered to be "high hazardous risk of oil spills". Concerns around increases in vessels in the area and potential hydrocarbon exploration. The complex nature of currents in the region suggests that oil spills in southern Davis Strait could reach this marine area. Oil spills associated with shipping could endanger a large number of marine birds and pollute their feeding areas.	Large breeding colony of thick-billed murre. Black guillemots also nest along the Akpatok Island coast. Black guillemot nest along the island's coast. Peregrine falcon and glaucous gull also breed here.	Biological Programme site (Region 9, Site No. 6-6) and an IBA in Canada (NU007).	4943	859	82
Ungava Bay Archipelagoes	Sensitive to disturbance of important nesting sites along coast, important foraging grounds and staging / breeding areas in the marine environment, and key migratory corridors.	Support a large portion of breeding common eider. Eider occur in this area from April through October	The Plover and Payne, Gyrfalcon, and north eastern Ungava Bay islands are Canadian IBA (NU027, NU028, NU029).	5624	5	93
Sleeper Islands	Degradation of staging and foraging areas, particularly for eiders. Potential hydrocarbon exploration. Prevailing west and north west winds render the east coast of the Bay most susceptible to oil damage.	Common eiders nest here in the summer months. Over 30 species of birds have been observed in the Sleeper Islands.	IBA site (NU033).	1880	90	536

Table B-6: Environment Canada Key Marine Habitat Sites for Migratory Birds Located Near the Proposed Shipping Route

Site Name	Sensitivities	Biological Significance	Status	Size (km^2)		Distance from shipping lane (km)
				Marine	Land	
Belcher Islands	Degradation of staging and foraging areas, particularly for eiders. Excessive harvest of down from breeding colonies. Potential hydrocarbon exploration. Prevailing west and north west winds render the east coast of the Bay most susceptible to oil damage.	Common eider nest here in the summer. In the winter, polynyas and the floe edge support substantial numbers of common eider and long-tailed duck.	The North Belcher and South Flaherty islands are Canadian IBA (NU031, NU100).	5 to 15 recurrent, small polynyas		680
Northern Ontario Coastline	Degradation of staging and foraging areas, particularly for ducks. Potential hydrocarbon exploration.	Black scoter moult along this marine area feeding on blue mussels and other molluscs. Common eiders are year-round residents. Canada geese and lesser snow geese make use of coastal areas.	Waters in James Bay are part of the James Bay Preserve.	7860	41	607
Markham Bay	Disturbance and sensitivity to potential pollution of foraging, staging and migrating areas.	Support a large portion of breeding common eider. Support substantial numbers of Kumlien's gull (*Larus glaucoides kumlieni*) colonies and black guillemot. Eiders occur in this area from April through October.	No special designation.	4015	423	58
East Bay	Disturbance and sensitivity to potential pollution of foraging, staging and migrating areas.	Supports Arctic Canada's largest single colony of common eider. Supports colony of black guillemot and a large population of lesser snow goose. Substantial numbers of Atlantic brant and Sabine's gull also breed here. Supports some of the highest known breeding densities of shorebirds in the eastern Arctic. Red phalarope are the most common shorebirds.	Migratory Bird Sanctuary and a Canadian IBA (NU023).	274	1	84

Areas of High Biological Importance

Fisheries and Oceans Canada sponsored an Arctic Marine Workshop to bring together expert knowledge on marine fauna and habitat use in the Canadian Arctic (Stephenson and Hartwig 2010). The objective of the workshop was to identify overlapping areas of habitat use by different Arctic species, and, therefore, areas of High Biological Importance (HBI) to wildlife. In total, 19 HBI were identified; 3 of these occur within, or in the vicinity of, the proposed RSA including Southampton Island, Chesterfield Inlet, and Hudson Strait. The Southampton Island HBI extends from Cape Bylot to Ell Bay and includes the north and west coasts of Coats Island. This area provides important habitat for several species of seal, walrus (including an overwintering area), and numerous marine bird species. It also provides key denning habitat for polar bears and important foraging grounds for bowhead whales. The Chesterfield Inlet HBI consists of the Hudson Bay coast from Whale Cove to Arviat. This area provides key habitat for beluga whales, killer whales, several species of seal, Arctic char, and several seabird species along the coast. The Hudson Strait HBI, which includes Akpatok, Salisbury, and Nottingham Islands, has been identified as being amongst the most productive areas in the Arctic (Stephenson and Hartwig 2010), supporting several large seabird colonies along the coast, key shrimp habitat, and important overwintering areas for several marine mammals including narwhal, beluga whale, and walrus. This area is known to be more productive than Hudson Bay due to an increased level of surface mixing and a large tidal exchange. The ice edge, which extends the length of the Strait during winter, is also considered dynamic habitat for numerous Arctic marine species.

Bowhead Whale Critical Habitat Areas

Wheeler et al. (2012) investigated critical summer and fall habitat for bowhead whales in the eastern Canadian Arctic by performing a monthly ecological niche factor analysis for 3 bowhead whale spatial datasets in contrast to concurrent eco-geographical variable datasets (including sea surface temperature, chlorophyll, ice cover, water depth, slope, and distance to shore) to determine overall bowhead whale habitat suitability in this region. The study produced 11 habitat suitability models, and resulted in the development of a composite map of predicted high suitability habitat for the months of June to October. In total, 21 discrete areas were identified (with low confidence) within the Eastern Canadian Arctic as ‘critical habitat’ during the open-water season (Figure B-25). Of these, 9 (Areas 13, 14, 15, 16, 17, 18, 19, 20, and 21) were located within, or in the vicinity of, the proposed RSA or shipping corridor between Rankin Inlet and eastern Hudson Strait. Coastal Inuit knowledge (referred to as Inuit Qaujimajatuqangit or IQ – see Figure B-26) supported the identification of critical habitat in northwest Ungava Bay (Big Island; Area 15). Aerial surveys (Cosens and Innes 2000) and telemetry studies (Dueck et al. 2006) supported the identification of critical habitat near Southampton and Coats islands (Area 20). There was no corroborating IQ or scientific evidence to support other identified critical habitat in northern Hudson Bay, Hudson Strait, and Labrador (Areas 13 to 15, 18, and 19). This may be due to bowhead whales no longer frequenting these areas, or population surveys and IQ studies were not conducted in these areas.

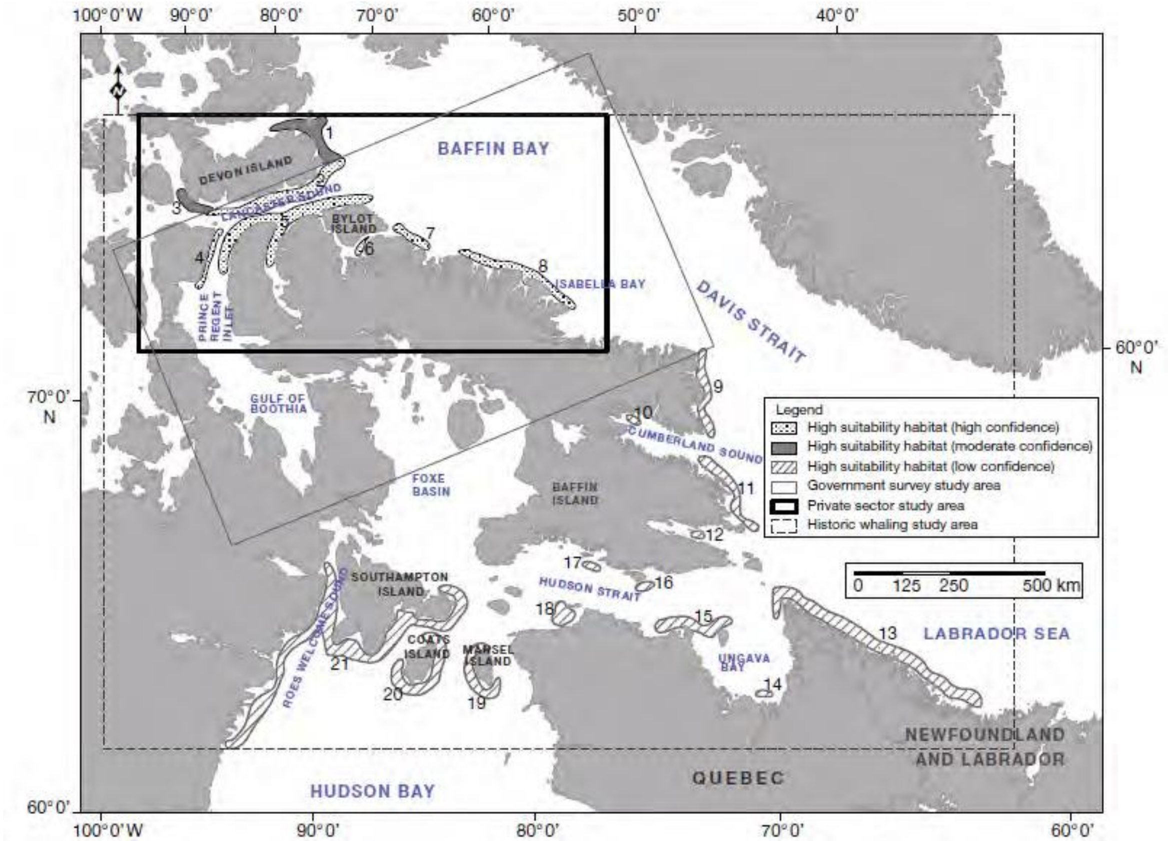


Figure B-25: Discrete Areas of Highly Suitable Bowhead Whale Habitat Identified for 3 or More Months from June to October in the Eastern Canadian Arctic (by analytical confidence) Produced by Ecological Niche Factor of 3 Bowhead Location Datasets and Associated Eco-Geographical Variables (extracted from Wheeler et al. 2012)

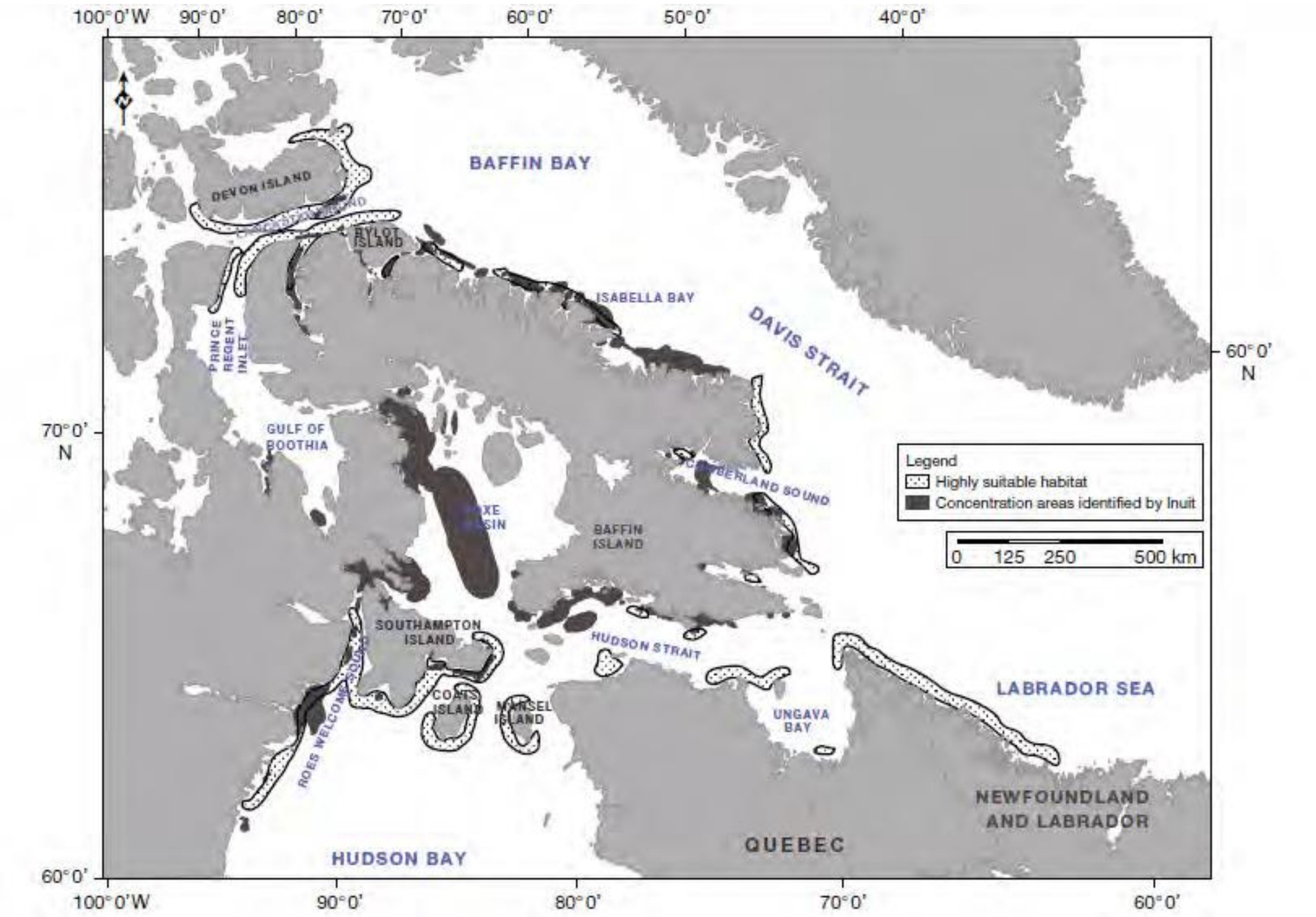


Figure B-26: Comparison of Highly Suitable Bowhead Whale Habitat Predicted by Ecological Niche Factor Analyses with Bowhead Concentration Areas Identified by Inuit in Nunavut, Canada, in Late Spring, Summer, and Early Fall (adapted from NWMB 2000 and Wheeler et al. 20

1.4 Traditional Knowledge

Sources of IQ for marine wildlife included the following:

- IQ studies conducted by Nanuk Enterprises in 1997 and 1998 in Rankin Inlet and Chesterfield Inlet. The results of these studies are summarized in FEIS Volume 9, Section 9.3;
- IQ studies conducted by Nanuk Enterprises in 2010-2011 in Rankin Inlet, Chesterfield Inlet, and Whale Cove. The full report is included as FEIS Volume 9, Appendix 9.3-A and summarized in FEIS Volume 9, Section 9.3;
- Interview conducted on 15 July 2011 by Nunami Stantec in Rankin Inlet with representatives from the Kangiqliniq Hunters and Trappers Organization. The full report is included as Appendix 8.2-A of the FEIS;
- IQ studies conducted by Nanuk Enterprises / Outcrop Ltd. during 2012, consisting of interviews with local hunters, fishers, tour operators, and experienced seamen representing the communities of Rankin Inlet,

Chesterfield Inlet, and Whale Cove. The 2012 interviews focused on marine resources along the proposed shipping route through Hudson Bay and the marine approaches to Rankin Inlet. The full report is included as FEIS Volume 9, Appendix 9.3-C and summarized in FEIS Volume 9, Section 9.3; and

- A literature review of the Nunavut Atlas (Canadian Circumpolar Institute 1992) and the Inuit Land and Occupancy Project (Freeman and Murty 1976) conducted by Golder in 2012 summarizing historical Traditional Resource Use (TRU) in the Rankin Inlet region and surrounding communities as described in FEIS Volume 9, Section 9.3.

Collectively, these studies identify the following main points of interest with respect to traditional resource use and traditional knowledge in the Project area:

- Itivia is commonly used by local community members for small boat operations including boat mooring and launching. The location of the proposed landing barge corresponds with the only navigable area at Itivia during a low tide;
- Arctic char represent an important food species for the local community and are mainly harvested during August in the Rankin Inlet region. Some residents also participate in the commercial Arctic char fishery, which occurs approximately 40 to 50 km (25 to 30 miles) outside Rankin Inlet, although it occurred closer historically. Other fish species locally harvested in the Project area (in marine waters) include sculpin, cod, capelin, whitefish, and trout;
- Hunting and fishing in Melvin Bay is thought to be less productive today than in the past (1960s and 1970s), a factor potentially linked to recent increases in local vessel traffic in the bay;
- Marine mammal species harvested in the Rankin Inlet region include the following:
- Beluga whales - hunted during the open-water season (primarily in August and September) – mainly near Marble Island. Most individuals summer near Churchill and migrate north along the west coast of Hudson Bay beginning in late August. Some individuals overwinter in polynya areas (when ice conditions allow) in northwestern Hudson Bay, Roes Welcome Sound, and Hudson Strait;
- Walruses – uncommon in Rankin Inlet in recent years, this species is hunted year-round in areas north of Marble Island. During summer and winter, large numbers of walruses haul-out on Bencus, Coats, Walrus, and Southampton islands;
- Polar bears – hunted primarily during winter on the sea-ice. Hunting is based on a quota system, which was lowered for the WHB sub-population during the 2010-2011 harvest to 8 individuals due to concerns for the population size, and then raised to 21 individuals for the 2011-2012 quota following increased reports by community members of problem bears near the communities (GN 2011). Some individuals have been observed on Marble Island and swimming offshore during the summer months between the surrounding islands. There is some concern by community members that increased shipping in the area may result in adverse impacts on polar bears, including behavioural disturbance (active avoidance or displacement effects) and/or physical injury / mortality from potential ship strikes;

- Four species of seal (ringed, bearded, harp, and harbour) – hunted throughout the year (on sea-ice and in open-water), with ringed seals being the most commonly hunted species. Recent increases in the number of harp seals near Rankin Inlet may represent influx of animals from adjacent Chesterfield Inlet that have been displaced by increased shipping / icebreaking activities in this area;
- Hunters have expressed concern over the proximity of the shipping route to Marble Island and potential effects of shipping on marine mammal distribution / migration, and hunting activities in this area. However, the implementation of a 2 km buffer (exclusion zone) around Marble Island for all Project vessels is deemed sufficient to mitigate these concerns;
- Narwhals and bowhead whales are not an important subsistence species for the Rankin Inlet community and are uncommon in the Rankin Inlet area. Narwhals summer north of Rankin Inlet in Daly Bay, Roes Welcome Sound, and Foxe Basin and winter in pack-ice regions of eastern Hudson Strait and Davis Strait. Bowhead whales are occasionally observed near Repulse Bay, Frozen Strait, Southampton Island, and Chesterfield Inlet;
- Hudson Strait is considered an important migratory corridor for marine mammals (beluga whales, narwhals, bowhead whales, and harp seals) transiting between Davis Strait / Labrador Sea and Hudson Bay / Foxe Basin. The critical migratory periods are early summer (June) and fall (late August to October). Proposed shipping activities for the Project coincide with the fall migratory period;
- Killer whales appear to be increasing locally in number particularly near Marble Island, although this species is not traditionally harvested. Concerns have been raised regarding the potential effects of the increasing killer whale population on other marine mammals due to predation, particularly with respect to bowhead whales;
- Several marine bird species are known to forage and/or nest in the Project area, including eider ducks (common eiders), black guillemots, Arctic terns, and several species of gull. Most nesting periods fall outside the shipping season (open-water). Egg harvesting occurs in spring for goose, eider duck, tern, guillemot, and gull. Shorebirds and raptors are not harvested by Inuit. The number of marine birds in Melvin Bay in recent years is thought to have decreased;
- Locally harvested shellfish species include blue mussels and clams. Historically, shellfish harvesting occurred along the north shore of Melvin Bay. Today, the harvest mainly occurs outside the harbour due to related health advisories from the Department of Health and Social Services. Scallops collected from the stomachs of hunted walruses are highly regarded by elders;
- Seaweeds (marine vegetation) are not locally harvested in the Project area in Melvin Bay;
- With respect to climate change, several major changes have been observed over the past 20 years in Rankin Inlet and include later freeze-ups, shorter sea-ice periods, decreases in land-fast ice, greater uncertainty in weather conditions, higher frequency of severe storm events, decreases in marine mammals observed in July, and changes in the timing of moulting of ringed seals (occurring as early as April); and
- Rankin Inlet community members recognize 2 shipping routes for access to Rankin Inlet (see Maps 1 and 2 in FEIS Volume 9, Appendix 9.3-C). In the deep-water sections of the shipping corridor, the exact shipping routes are not marked and likely vary by several kilometres. Recent increases in local shipping activity have been linked to several large Projects in the region including Meliadine, Meadowbank, Kiggavik, Baffinland, and Roche Bay.

2.0 CLOSURE

We trust that this report meets your immediate requirements. If you have any questions regarding the content of this report, please do not hesitate to contact this office.

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https://capws.golder.com/sites/p1656645managementplanupdate/p3500shippingmanagement/updated smp/doc 552-1535029-r-reva-sd8-1-app b_mm baseline 5aug16.docx

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3.1 Personal Communication

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APPENDIX C • RISK ANALYSIS OF MARINE TRANSPORTATION ROUTES

The approach used for the risk assessment draws on that of Areva for the Kiggavik Project[21].

A hazard is a condition with the potential to cause personal injury or death, property damage, environmental harm, or loss of service. Hazard severity along shipping and tug-barge routes can range from catastrophic resulting in fatalities and/or loss of the ship to minor where the incident does not significantly reduce ship safety and where mitigation measures are well within the crew's capabilities. A complete range of hazard severity is presented below in Table C-1.

Table C-1 Hazard Severity for Ship and Tug with Barge Routes

Hazard Severity and Rating Value	Definition
Catastrophic (Value 4)	Results in multiple fatalities and/or loss of the ship, tug or barge.
Hazardous (Value 3)	Reduces the capability of the ship or its operator's ability to cope with adverse conditions to the extent that there would be: • Large reduction in safety margin or functional capability; • Crew physical distress/excessive workload such that operators cannot be relied upon to perform required tasks accurately or completely; • Serious injuries to a small number of the crew; and • Possible fatality of one or more of the crew.
Major (Value 2)	Reduces the capability of the ship or its operators to cope with adverse operating conditions to the extent that there would be: • Significant reduction in safety margin or functional capability; • Significant increase in operator workload; • Conditions impairing operator efficiency or creating significant discomfort; • Physical distress to crew, including injuries; and • Major environmental damage, and/or major property damage.
Minor (Value 1)	Does not significantly reduce ship safety. Actions required by operators are well within their capabilities. Include: • Slight reduction in safety margin or functional capabilities; • Slight increase in workload such as routine ship navigation plan changes; • Some physical discomfort to the crew; and • Minor occupational illness and/or minor environmental damage, and/or minor property damage.

Likelihood ranges from probable where the incident is anticipated to occur one or more times in shipping and barge movements over the life of the Project, to extremely improbable where it is not anticipated to occur during the entire life-of-mine for the Project to any of the ships, tugs and barges contracted to AEM. Table C-2 provides a complete range of likelihoods.

[21] Areva. 2011. Kiggavik Project, Environmental Impact Statement, Marine Transportation, Tier 3 Technical Appendix 2J.

Table C-2 Likelihood of Mishap along Ship and Tug-Barge Routes

Likelihood and Rating Value	Definition
Probable (Value 4)	Qualitative: Anticipated to occur one or more times in ship or tug-barge operations over the life of the Project. Quantitative: Probability of occurrence per operational hour is greater than $1x10^{-5}$.
Remote (Value 3)	Qualitative: Unlikely to occur to each ship or tug-barge during its contract with the mine. May occur several times in the life of all ships and tankers for the life of the Project. Quantitative: Probability of occurrence per operational hour is less than $1x10^{-5}$ but greater than $1x10^{-7}$.
Extremely Remote (Value 2)	Qualitative: Not anticipated to occur to each ship or tug-barge while it is contracted by AEM during the life of the Project. May occur a few times in the life-of-mine to the ships and tankers contracted to AEM. Quantitative: Probability of occurrence per operational hour is less than $1x10^{-7}$ but greater than $1x10^{-9}$.
Extremely Improbable (Value 1)	Qualitative: So unlikely that it is not anticipated to occur during the entire life-of-mine for the Project to any of the ships and tankers contracted to AEM. Quantitative: Probability of occurrence per operational hour is less than $1x10^{-9}$.

The hazard severity value is multiplied by the likelihood value to determine the risk level. Table C-3 outlines the risk levels outcomes, which range from negligible to catastrophic.

Table C-3 Risk Levels

Severity and Value		Likelihood			
		Extremely Improbable	Extremely Remote	Remote	Probable
		1	2	3	4
Minor	1	1	2	3	4
Major	2	2	4	6	8
Hazardous	3	3	6	9	12
Catastrophic	4	4	8	12	16

Risk Levels 1-2 represent a negligible to low level of hazard to shipping. It does not significantly reduce the safety of the ship or tug-barge. Actions required by the ship's or tug's crew are well within their capabilities to avoid harm to the vessel, the crew and the environment.

Risk Levels 3-4 represent low to major risk. There is a significant reduction in the safety margin or functional capability of the ship or tug-barge. A great effort on the part of the crew will be required to avoid damage to the ship, major environmental effects and/or injuries to the crew.

Risk Levels 6-9 represent major to hazardous risk. The ship's or tug-barge's crew will have difficulty in coping with the adverse conditions to the extent the ship or tug barge will have a large reduction in its safety margin or functional capability, which could lead to serious injury to the crew and possible environmental harm.

Risk Levels 12-16 represent hazardous to catastrophic risk and is to be avoided. There could be fatalities, loss of the vessel, and/or major environmental harm.

Table C-4 Preliminary Risk Analysis of Tug-Barge and Ship Marine Routes

Preliminary Risk Analysis of Tug-Barge and Ship Marine Routes							
	Before Controls				After Mitigation		
Hazard	Severity	Likelihood	Risk Level	Mitigation Measures	Severity	Likelihood	Residual Risk
Tug-barge or ship runs aground	3	3	9	• Use electronic navigation aids; • Remain in shipping lanes; • Buoys within the near-shore islands; • Monitor adherence to standard operating procedures; and • One way traffic only in the access passage to Melvin Bay and Itivia harbour.	3	2	6
Loss of or damage to sea cans in heavy seas	2	3	6	• Lock sea cans to the deck; • Use appropriate stacking height for voyage; and • Slow tug tow speed in heavy seas.	2	2	4
Tug-barge or ship has mechanical failure	2	3	6	• Regular preventative maintenance schedule; • Maintain an inventory of critical parts on board; and • Have redundant critical systems.	2	2	4
Barge tow line breaks	2	3	6	• Have redundant tow line for safety purposes; and • Slow tow speed in heavy seas.	2	2	4
Collision or grounding of tugs between mooring location of large ships and Itivia harbour	3	4	12	• One way traffic only in the access passage to Melvin Bay and Itivia harbour; • Install Automatic Identification System on all tugs; and • Tugs proceed at a slower speed during low visibility periods.	3	2	6
Tug-barge or ship collides with a small boat from Rankin Inlet	2	3	9	• Education of public on use of shipping lanes; • Make public aware of incoming ships and tug-barge traffic in Melvin Bay; • Tugs-barge and ships proceed at a slow speed in periods of low visibility; and • Tug-barge and ships use horn in periods of heavy fog.	2	2	4
Tug-barge or ship sinks upon hitting ice	4	3	12	• Shipping is scheduled for open water; • Sail around ice; and • Slow vessel speed to avoid damage.	3	2	6

APPENDIX D • MARINE ENVIRONMENTAL MANAGEMENT PLAN (MEMP)

March 29, 2017

MARINE ENVIRONMENTAL MANAGEMENT PLAN (MEMP)

Appendix D

Submitted to:
Agnico Eagle Mines Limited
10200, Route de Preissac
Rouyn-Noranda QC
Stephane Robert, Manager Regulatory Affairs

REPORT

Report Number: Doc 613-1671431
Distribution:

1 copy - Agnico Eagle Mines Limited
2 copies - Golder Associates Ltd.

Golder Associates

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Acronyms

Agnico Eagle	Agnico Eagle Mines Limited
BTEX/VPH	benzene, toluene, ethylbenzene, o-xylene, m-xylene, p-xylene/Volatile Petroleum Hydrocarbons
CCG	Canadian Coast Guard
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
ECSAS	Eastern Canada Seabirds at Sea
ECCC	Environment and Climate Change Canada
ERT	Emergency Response Team
EPH	Extractable Petroleum Hydrocarbon
IQ	Inuit Qaujimajatuqangit
JNCC	Joint Nature Conservation Committee
MEMP	Marine Environmental Management Plan
MMSO	Marine Mammal and Seabird Observer
PAHs (parent)	Polyaromatic Hydrocarbons
QEP	Qualified Environmental Professional
RSA	Regional Study Area
SOPEP	Shipboard Oil Pollution Emergency Plan
TOC	Total Organic Carbon
TK	Traditional Knowledge
UTM	Universal Transverse Mercator
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

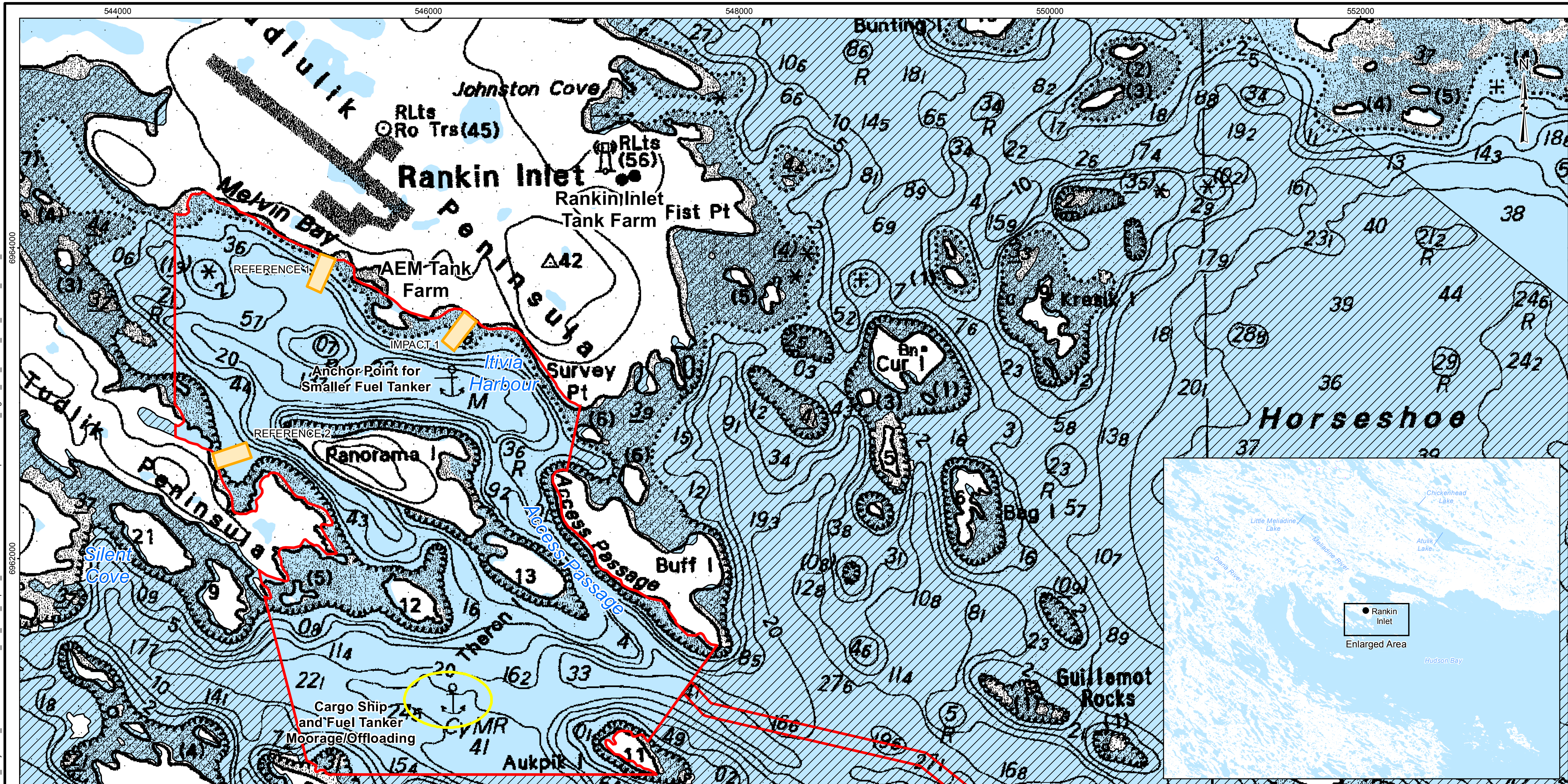
Agnico Eagle Mines Limited (Agnico Eagle) plans to ship approximately 40,000 tonnes of dry cargo (equipment and supplies) and 122 million litres of diesel fuel annually for the operations of the Meliadine Gold Mine in Rankin Inlet, Nunavut (the Mine). To meet these needs, approximately 8 ships per year will be needed to deliver dry cargo and up to 4 additional ships per year to deliver fuel. All shipping will be carried out during the open water season (typically from early July to late October) and will follow recommended shipping routes that are presently in use for the annual sea lift to Rankin Inlet and other communities (Figure D-1 and Figure D-2). The Mine will not involve any ice breaking to extend the shipping season. This Marine Environmental Management Plan (MEMP) has been developed for the Mine to meet the Terms and Conditions of the Project Certificate related to shipping activities and potential marine spills. It should be considered a living document that can be updated throughout the Mine lifecycle in order to implement adaptive management techniques. Updates shall be made in consultation with the relevant regulatory agencies (e.g., DFO, CWS, and the Government of Nunavut) as appropriate.

The MEMP has been designed to provide protocols for conducting a vessel-based Marine Mammal and Seabird Observer (MMSO) program during all routine shipping activities in the Local and Regional Study Area (LSA and RSA) and for conducting monitoring of marine wildlife and their habitats (wildlife defined as mammals, fish, and birds - including upland birds, migratory birds, waterbirds, raptors, and seabirds) in the event of any Mine-related fuel spill in the RSA.

During routine shipping operations, Mine-specific mitigation measures designed to minimize Mine impacts on marine mammals and seabirds will be initiated by vessel-based MMSOs and implemented by the ship's crew. In the event of a spill, the shipping contractor will be responsible for retaining a qualified environmental professional (QEP)[1] to implement the wildlife monitoring framework described below. The MMSO will work with the QEP to provide on-site information as required.

Data collected by the MMSOs will provide information to the Government of Nunavut and other applicable regulators (e.g., Canadian Wildlife Service) regarding the location, behaviour, abundance, and species observed as well as any interactions with Mine vessels during shipping activities in the RSA.

[1] An applied scientist or technologist who is registered and in good standing with an appropriate professional organization constituted under an Act. The QEP must be acting under that association's code of ethics, and subject to the organization's disciplinary action. The QEP should have experience in the area of interested. In this case the area of interest includes marine spill response monitoring for marine mammals, birds fish and their habitats.



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METRES

LEGEND

- BASELINE SAMPLING AREA
- MOORAGE AND OFFLOADING
- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- BATHYMETRIC DEPTH CONTOUR
- WATERBODY

REFERENCE

BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED (AEM). BASELINE SAMPLING OBTAINED FROM NUNAMI STANTEC ON BEHALF OF AGNICO EAGLE MINES LIMITED (AEM). ATLAS OF CANADA DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. COUNTRY BACKGROUND DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: UTM ZONE 15

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

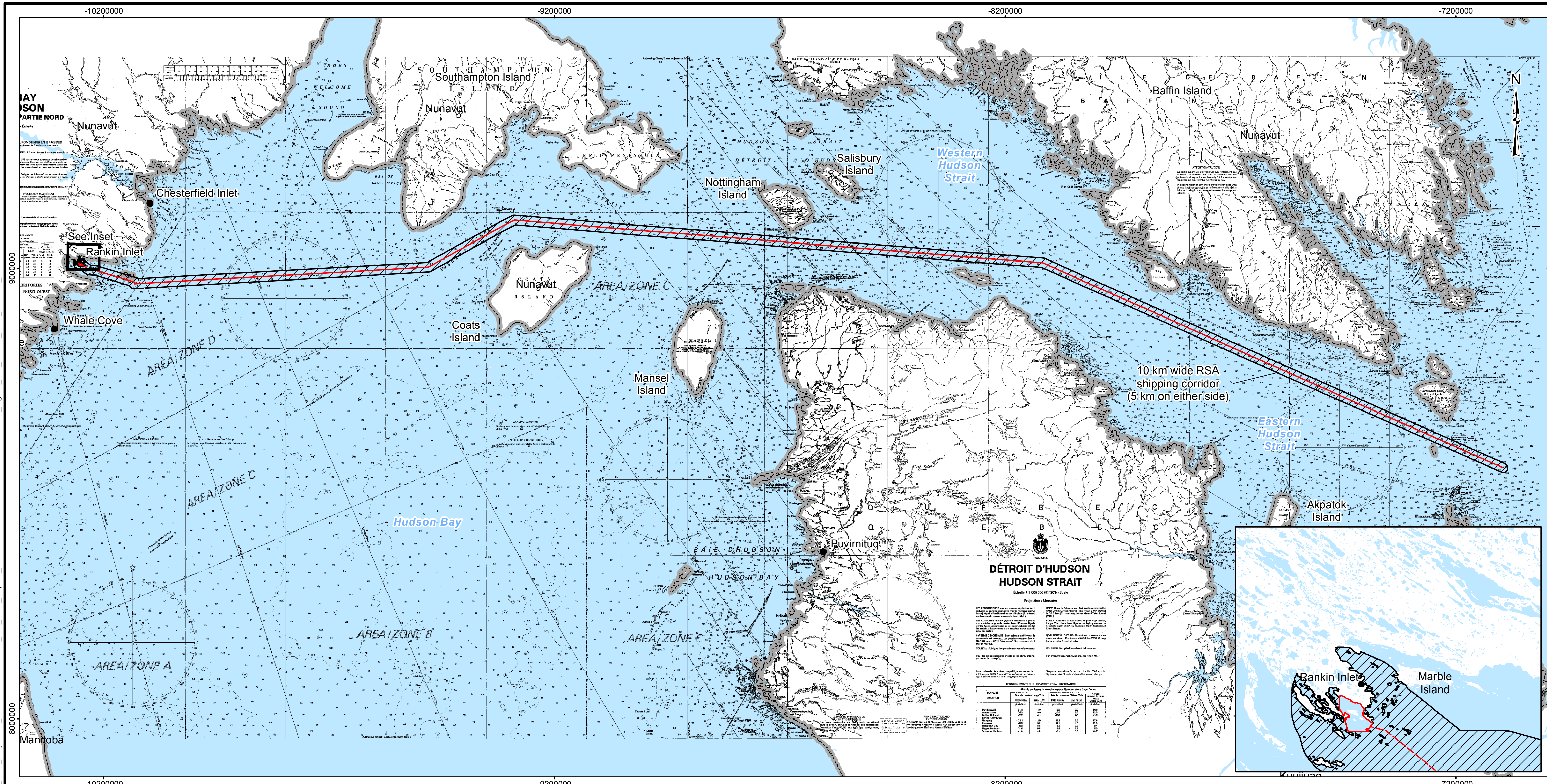
TITLE

MARINE LOCAL STUDY AREA

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	AK	25 Jul. 2012	SCALE AS SHOWN	REV. 0
GIS	MH	15 Mar. 2018		
CHECK	PR	18 Jan. 2013	FIGURE D-1	
REVIEW	DW	18 Jan. 2013		

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Meliadine_Gold_Project\99_PROJECTS\1535029_WL_Tech_Sup\02_PRODUCTION\5000\MXD\Report\1535029_Figure_B-1_Marine_LSA_Nautical_Charts_rev1.mxd



200 0 200

KILOMETRES

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA) (SEE INSET)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- COMMUNITY
- WATERBODY

REFERENCE

BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED (AEM).
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NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: WGS 84 PROJECTION: WORLD MERCATOR

PROJECT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE

MARINE REGIONAL STUDY AREA

Golder Associates

PROJECT NO.		1535029	FILE No.
DESIGN	AK	16 Jul. 2012	SCALE AS SHOWN REV. 0
GIS	DSC	18 Jul. 2012	
CHECK	PR	18 Jan. 2013	FIGURE D-2
REVIEW	DW	18 Jan. 2013	

Y:\burnaby\CAD-GIS\Client\Agnico_Eagle_Mines_Ltd\Meliadine_Gold_Project\99_PROJECTS\1535029_WL_Tech_Sup\02_PRODUCTION\5000\MXD\Report\1535029_Figure_D-2_Marine_RSA_Nautical_Charts.mxd

2.0 MARINE MAMMAL AND SEABIRD OBSERVER PROGRAM

2.1 Routine Shipping Operations

This section outlines the protocol for undertaking a vessel-based Marine Mammal and Seabird Observer (MMSO) program involving full-time marine wildlife monitoring during all routine shipping activities in the LSA and RSA (Figure D-1 and Figure D-2) in accordance with Project Certificate Condition 82, which states the following:

"The Proponent shall require all contracted shipping companies to provide full-time marine wildlife monitoring using trained observers and established data collection and recording protocols. Monitoring plans should include provisions for all Species at Risk Act (SARA) and for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed species (birds and mammals)."

The seabird survey protocols were revised in February 2017 to include specific survey protocols for seabirds as laid out in Section 4.0 of the Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms.

A review of relevant marine mammal survey protocols was also undertaken and the marine mammal survey protocols were revised based on the following guidance documents:

- Guidelines for Minimising the Risk of Disturbance and Injury to Marine Mammals from Seismic Surveys (JNCC 2010).
- Recommended seabird and marine mammal observational protocols for Atlantic Canada (Moulton and Mactavish 2004)

The MMSOs will record marine mammal and seabird observations based on the protocols presented below through the LSA and RSA (Figure D-1 and Figure D-2). Datasheets outlined in Attachment A and Attachment B and daily reports outlined in Attachment C will be completed throughout the transit, copied for backup purposes and provided to Agnico Eagle upon arrival in Rankin Inlet or, when transiting from Rankin Inlet, will be provided as online communications allows, once the vessel has exited the RSA. Additional reporting requirements in the event of a spill are outlined in Section 2.2.1.5.

2.1.1 Observer Qualifications and Training

Appropriately qualified MMSOs should be selected based on their knowledge and experience with the MMSOs protocols laid out below. Previous wildlife observation field experience will be considered an asset during the MMSO selection process. Depending on the level of experience of the selected MMSO, a MMSO training session(s) will be considered and will be completed by qualified/certified marine wildlife observers with previous arctic wildlife monitoring experience. The training, if required, will review the monitoring protocols outlined below and provide instruction on how to spot and identify marine mammal and seabird species.

Primary objectives of the training will could include the following, dependent on the expertise of the MMSOs:

- Role and responsibilities of MMSOs;
- Review of the MEMP including mitigation measures;
- Health, Safety, and Environment;

- Review of marine mammal and seabird species identification (including upland birds (including migratory birds), waterbirds, raptors, as well as seabirds) observation, identification, and distance estimation methods;
- Review of operation of MMSO equipment (reticle binoculars, GPS system);
- Distances estimation techniques for various scenarios (reticle binoculars, no horizon);
- Review of, and classroom practice with, data recording and data entry; and
- Reporting templates and requirements.

2.1.2 Program Protocol

Mitigation measures outlined in Section 4.2 of the Shipping Management Plan will be implemented during all Mine shipping activities by the shipping contractor(s). MMSOs will not be directly responsible for implementing mitigation measures. The role of the MMSO is to record and report on marine mammals and seabird sightings during shipping activities, and to advise the contractor (i.e., captain and ship crew) on the location of observed marine mammals and if any action is recommended based on mitigation measures outlined in the Shipping Management Plan.

The following protocol will be implemented during the MMSO program:

- A minimum of one trained MMSO will be present on-board the Mine shipping vessels during all transits within the RSA;
- The MMSO will conduct marine mammal and seabirds observations in the RSA from the bridge during daylight hours as described in Section 2.1;
- The MMSO will observe and record sightings of marine mammals and birds during vessel movements in the RSA (including upland birds, migratory birds, waterbirds, raptors, and seabirds) as well as environmental conditions as described in Section 2.1;
- A communication plan will be established between the MMSO(s) and the ship's crew in order to provide information regarding marine mammal and seabird sightings;
- The shipping contractor will initiate mitigation measures designed to minimize Mine impacts on marine mammals and seabirds, as identified in the Shipping Management Plan; and
- MMSOs will assist in observing for marine mammals and seabirds in the event of a spill (see Section 2.2).

The MMSO program will allow for the opportunity of adaptive management techniques to be implemented if monitoring identifies potential for adverse effects on marine wildlife along the shipping route. This may include modification of mitigation measures in response to new information arising from the monitoring carried out by the MMSO and vessel crew. Adaptive management will be conducted in consultation with the Kivalliq Inuit Association, the Hunters and Trappers Organizations of the Kivalliq communities, and the relevant regulators.

2.1.3 Marine Mammal Observing Protocols

Dedicated marine mammal observations will be conducted in the RSA. The protocol outlined in this section are best conducted along a transect line, therefore, it is best to start a marine mammal observation period when the vessel is and will be moving in a straight line for an extended period of time. Note the time and location (GPS) of the start and end of each observation period as well as the vessel speed (in knots). If vessel speed or direction changes significantly during the observation period, record the time and location and the change.

Observer Position

Observations will be done from a high location on the vessel and ideally outdoors if possible and will be conducted at the same location each time. For marine mammal observations with a single observer, the MMSO will position themselves in the middle of the ship at the front (bow) to observe marine mammal on both the starboard and the port side (Figure D-3).

Observation Period

MMSO observation periods (marine mammal and seabird observations) should not last longer than 2 hours to mitigate observer fatigue and eye strain, and a MMSO observation day should not exceed 12 hours. Based on these requirements, dedicated marine mammal observations will be conducted over a 1.5 hours period following a seabird survey (approximately 30 minutes). A suggested MMSO schedule for moving and stationary ships is provided below in Table D-1 and Table D-2.

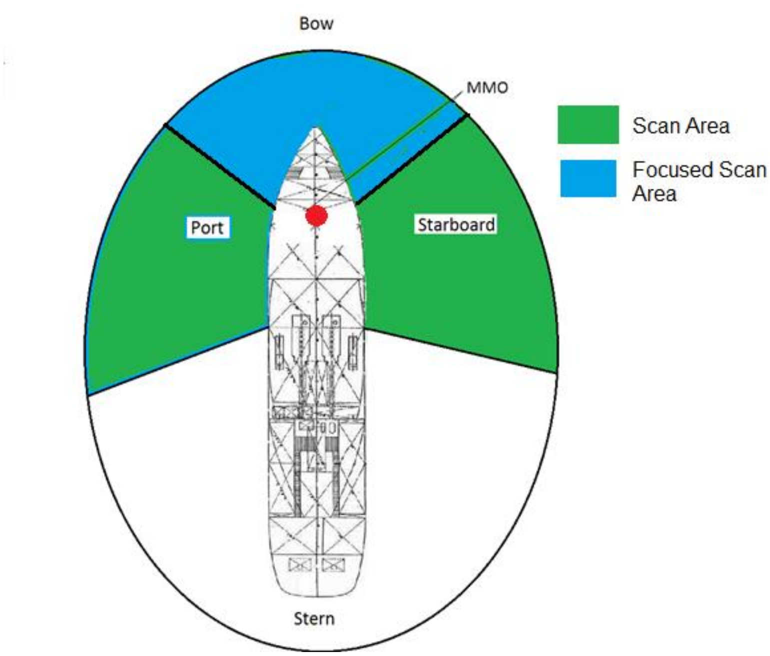

Figure D-3: MMSO position and respective observation field on a hypothetical ship

2.1.3.1 Scan Routine

The following scan routine should be conducted throughout the marine mammal observation period. Scan the water with the naked eye and use binoculars only to focus on possible sightings. Perform S and U scans of the observation field about every 20 seconds (Figure D-4). The most important aspect of marine mammal observing is to constantly scanning the observation field to capture animals that could be located in the peripheral view for brief moments (e.g., surfacing). Scans should be made from the middle of the vessel (for one MMSO) and cover the scan area shown in Figure D-3 with a focus on the water ahead and to the side to the moving vessel (e.g., focused scan area in Figure D-3). If the vessel is stationary (e.g., anchored) scans should be conducted over the entire scan area (e.g., blue and green in Figure D-3) in a uniform fashion. When the vessel is stationary, less priority can be attributed to marine mammal observations and the MMSO can switch to an observation schedule similar to that shown in Table D-2.

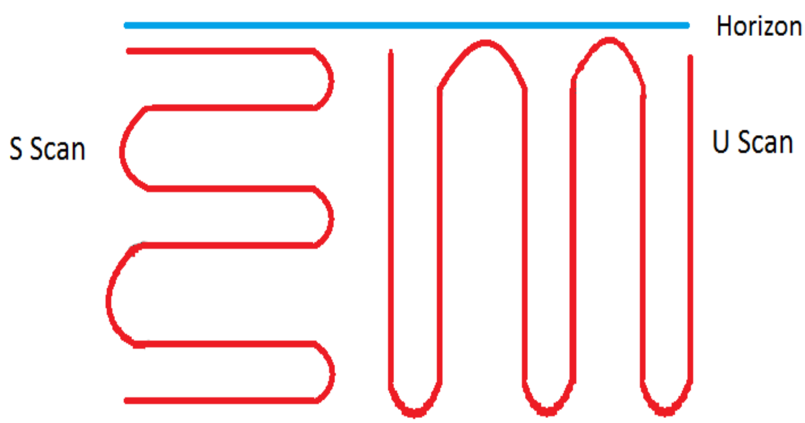

Figure D-4: S and U scanning techniques

All marine mammals observed during the dedicated marine mammal observational periods as well as incidental sightings will be recorded including GPS location, distance to animal, angle to animal, number of individuals, species, behaviour etc. (see Section 2.1.5.2 below). If a species is unknown or if a blow is the only detection of the animal observed, then mark the sighting as unknown. Marine mammals in large groups that are close together should be marked as a single sighting. When possible, photographs of marine mammal sightings will be taken and recorded alongside sightings records.

Angle to a marine mammal or group of marine mammal can be calculated using a Pelorus or by estimating the angle with an angle board. Figure D-5 shows how an angle to a marine mammal from the vessel should be estimated.

On-effort sightings should be recorded by the MMSO only, with no assistance permitted by other crew members. If additional sightings are made by other crew members or if sightings are made outside the designated marine mammal observation period (see Table D-1) then these sighting should be marked as incidental sightings on the marine mammal sighting record (Attachment A). Sightings of pinnipeds hauled-out on land will be recorded as off-effort sightings. Bow-riding dolphins or porpoises are also not recorded as on-effort sightings unless they are observed prior to their initial approach to the vessel (as it was assumed that the sighting of a bow-riding cetacean was not random but rather influenced by the presence of the vessel). Bow-riding dolphins or porpoises are recorded as incidental (off-effort) sightings.

All efforts will be made to avoid double counting individuals or groups of individuals. If a marine mammal is counted twice in the sightings record, then a note of a re-sighting should be marked. Additional information to be collected for marine mammals is outlined in Section 2.1.5.2 below.

Table D-1: Example of Daily MMSO Schedule – Moving Ship

Time of Day (24 hour Clock, UTM)	Shift Type
7:00	Seabird
7:30	Marine Mammal
8:00	Marine Mammal
8:30	Marine Mammal
9:00	Break
9:30	Break
10:00	Seabird
10:30	Marine Mammal
11:00	Marine Mammal
11:30	Marine Mammal
12:00	Break
12:30	Break
13:00	Seabird
13:30	Marine Mammal
14:00	Marine Mammal
14:30	Marine Mammal
15:00	Break
15:30	Seabird
16:00	Marine Mammal
16:30	Marine Mammal
17:00	Marine Mammal
17:30	Break
18:00	Daily Reporting
18:30	Daily Reporting

Table D-2: Example of Daily MMSO Schedule – Stationary Ship

Time of Day (24 hour Clock, UTM)	Shift Type
7:00	Seabird
7:30	Marine Mammal
8:00	Seabird
8:30	Marine Mammal
9:00	Break
9:30	Break
10:00	Seabird
10:30	Marine Mammal
11:00	Seabird
11:30	Marine Mammal
12:00	Break
12:30	Break
13:00	Seabird
13:30	Marine Mammal
14:00	Seabird
14:30	Marine Mammal
15:00	Break
15:30	Seabird
16:00	Marine Mammal
16:30	Seabird
17:00	Marine Mammal
17:30	Break
18:00	Daily Reporting
18:30	Daily Reporting

Notes: The full 30 minutes may or may not be used for seabird surveys depending on the survey method implemented. Further details are described in Section 2.1.4 below.

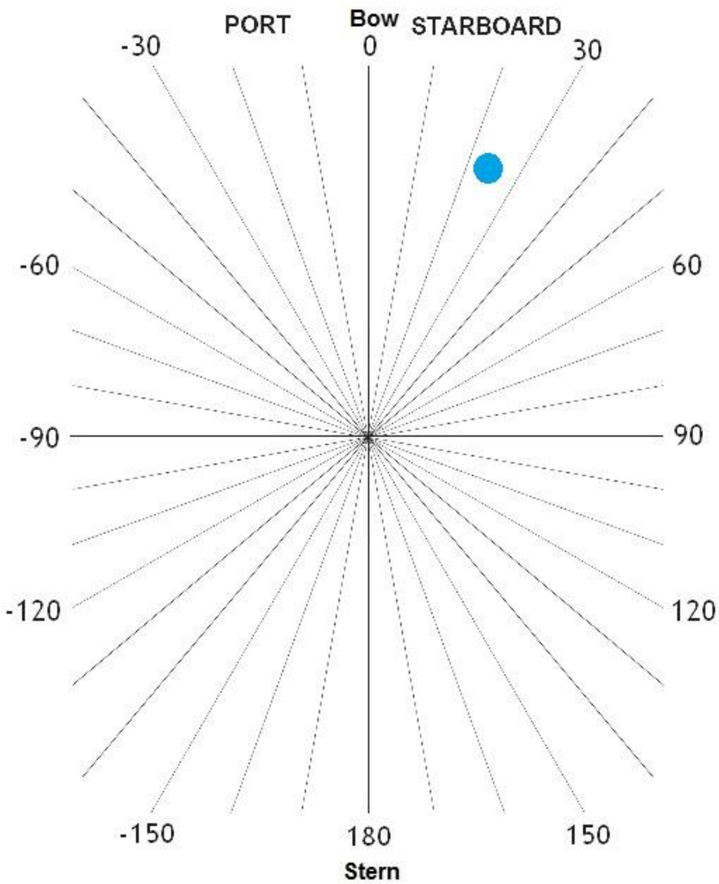

Figure D-5: Angle to Marine Mammal (blue dot) is approximately 22^{o}

2.1.3.2 Estimating Distance

Observers should practice estimating the distance bands prior to beginning surveys. This can be accomplished by using reticle binoculars as described below or with a distance gauge made from a transparent plastic ruler (see Attachment B).

Record the distance to each marine mammal or group of marine mammal (to the centre of the group). For all marine mammals, estimate the angular distance between the marine mammal(s) and the observer.

Using Reticle binoculars

Reticle binoculars have a built in scale called a reticle (Attachment B). Estimating distances to marine mammals using reticles is based upon the distance to the horizon which is dependent on:

- the height of the observer eye above sea level in meters; and
- radians per reticle mark for the type of binoculars.

The height of the eye includes the height of the platform above the surface of the water. The number of radians (usually milliradians[2]) will depend on the type of reticles binoculars that are used. The number of radians per reticle mark can be used to produce a distance table based on an equation provided by the binocular manufacture. An example of an equation provided by Fujinon 2006 is:

Distance = (eye height + height above sea level in meters) x 1000 / # of milliradians

Reticle binoculars cannot be used to estimate distance if the horizon is obscured (by fog or land), or if they are used from a different height above sea level. Their use becomes minimal in nearshore waters.

2.1.4 Seabird Survey Protocols

Seabird survey will be conducted in the RSA. The protocols laid out bellow were extracted and adapted from the Canadian Wildlife Service (CWS) standardized protocol for pelagic seabird surveys from moving and stationary platforms (Gjerdrum et al. 2012).

Observer Position

Observations should be done from a high location on the vessel, when possible, at a location as close to the edge of the platform as possible to increase the detection of seabirds, especially for individuals that use the waters at the base of the vessel. All surveys should be conducted at the same location each time.

2.1.4.1 Survey Protocol – Moving Vessel

Transect Methods

Moving vessel seabird surveys should be conducted along a transect line when the vessel is and will be moving along a straight line for an extended period of time. Note the time and location (GPS) of the start and end of each survey period (described below) as well as the vessel speed (in knots) as laid out in the seabird survey sighting form (Attachment B).

During transect surveys, the observer is to look forward from the vessel, scanning at a 90° angle from either the port (left) or starboard (right) side depending where he or she is located. The transect width within seabirds are recorded is 300 m from the side of the vessel (see Figure D-6). Scan ahead regularly (e.g., every minute) to spot birds that may dive as the vessel approaches.

All birds observed within this 300 m transect, whether flying or on the water, are recorded and are considered in-transect sightings. The methods for recording birds on the water verses birds in flight are outlined below. All five minute surveys should begin with a snapshot survey to capture flying birds. The perpendicular distance from the line to the seabirds detected on the water or in flight is estimated for each sighting. Birds observed outside the 300 m transect are also recorded if this does not affect observations within the 300 m transect. Distance categories "E" and "T" in Figure D-6 are both considered not in transect. Binoculars and spotting scopes can be used to confirm species identification and other details as necessary. Information that will be collected during each sighting is outlined in Section 2.1.5.4.

[2] unit of angular measurement

Moving platform transect survey are best conducted when travelling at a minimum of 4 knots (7.4 km/h) and a maximum of 19 knots (35.2 km/h). These surveys can be done when the ship is travelling less than 4 knots, but birds are often attracted to slow moving or stationary ship. If birds are clearly gathering around the ship and settling on the water when the ship is moving at decreased speeds cease the surveys until the ship resumes a higher speed. If the ship is no longer moving (e.g., anchored or on standby) switch to the stationary platform survey methods described below.

Observation Period

Each seabird survey period will be conducted during six consecutive five-minute periods which is repeated three times a day to capture morning, afternoon and evening periods (see Table D-1). These five minute surveys should be dedicated to surveying for seabirds only. These surveys should be completed regardless if birds are present or not. If the vessel is not moving (stationary), use the method for stationary vessel described in Section 2.1.4.2 below.

Short breaks should be taken at the end of each five minute period to record the vessel's position and any conditions that may have changed since the last five minute survey period. If ship speed or direction changes significantly the survey period, record the time and location (GPS), cease the current survey and begin a new five minute survey period.

The frequency of the seabird surveys outlined in Table D-1 has been selected to provide time for the MMSO to:

- have dedicated seabird and marine mammal observation periods (as described above);
- take necessary breaks to avoid observer fatigue; and
- conduct daily reporting.

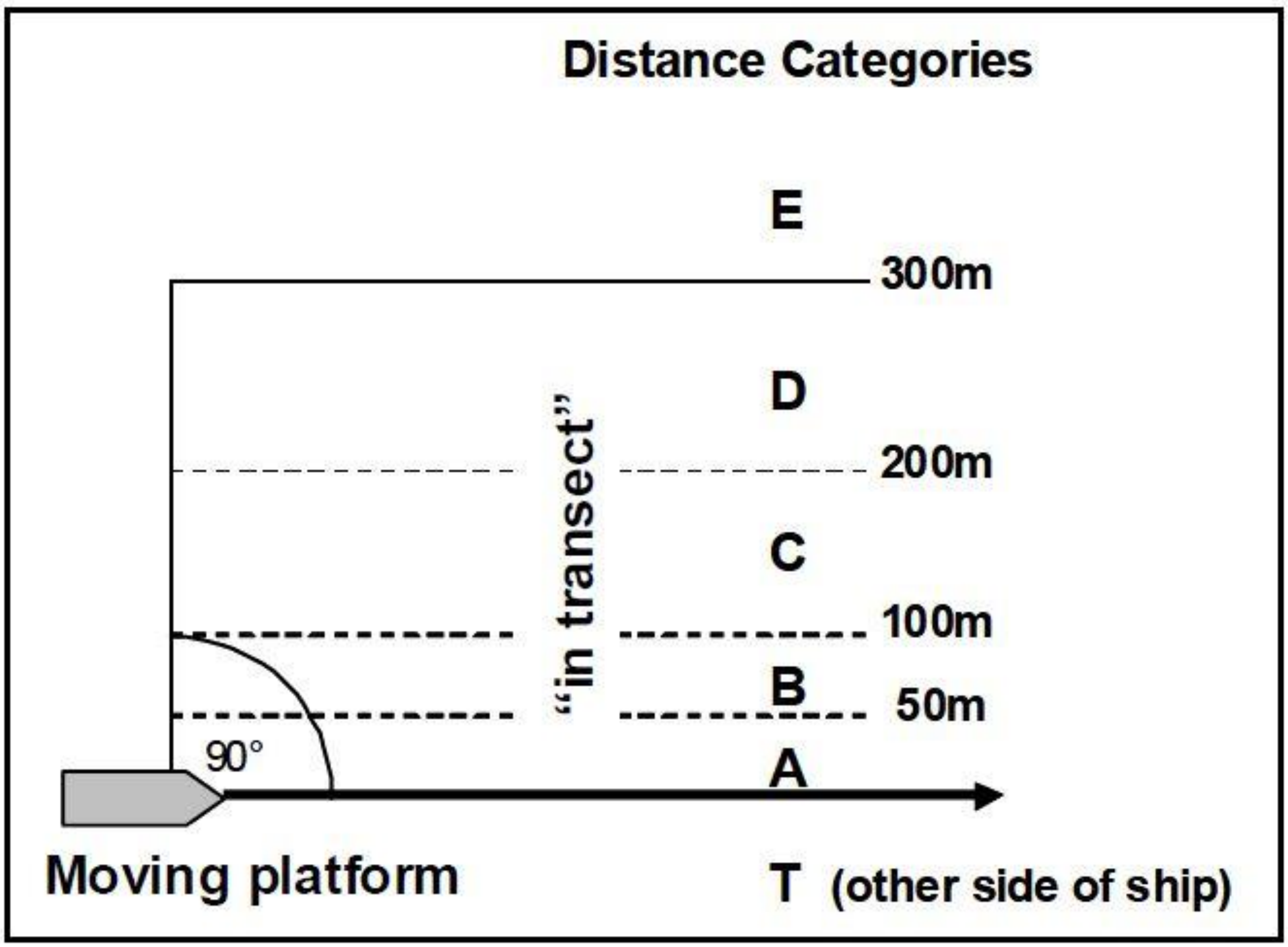

Figure D-6: Illustration of a survey using a 90° scan, covering a 300 m transect from a moving platform (extracted from Gjerdrum et al. 2012)

Birds on the Water

All birds observed on the water are continuously recorded throughout the five minute survey period. If birds in the transect fly off the surface of the water as the vessel approaches, use binoculars to help count them, and record these birds as being on the water as outlined in the seabird survey sighting form (Attachment B). These birds are not subsequently counted as a flying bird during a snapshot survey (described below for flying bird).

Birds on the water may be observed up ahead of the platform, perhaps as far as 400 m or 500 m, but still within the 300 m transect (Figure D-6). Because these individuals may dive or fly away as a result of the approaching ship, they should be counted as in transect and their perpendicular distance recorded when they are first observed. If the five minute survey will end before the ship reaches them they should be recorded in the next five minute survey period.

Birds in Flight – Snapshot method

All five min surveys should begin with a snapshot of flying birds. Flying birds are not recorded continuously throughout the five minute survey period as with birds on the water, as this would overestimate bird density. Create a routine of snapshot counts to record flying birds during the survey period. Only use the snapshot method when there are many birds observed flying in the area. The number of snapshots done will depend on the speed of the vessel (Table D-3).

During each snapshot, record flying birds as in transect if they are flying above the 300 m transect. Record all other flying birds that are seen outside of the 300 m transect or between snapshot intervals as not in transect.

Some species may fly in long lines across the 300 m survey transect. At the time of the snapshot, the number of birds in the flock is recorded and the distance class is assigned according to the location of the centre of the flock. All the birds in the flock are recorded as in transect if the centre is within the 300 m transect. If the centre of the flock is outside the 300 m transect, all birds are recorded as not in transect.

Large Groups of Birds

When very large numbers of birds are encountered that overwhelm the observer's ability to count the number of birds and measure the distance to flocks the snapshot method can be used to count all birds in flight and on the water. If this protocol is used, note the change in protocol on the seabird survey sighting form (Attachment B). If it is not practical to estimate distance to each bird or flock of birds, the observer should at least indicate whether the birds were observed in or out of transect. If it is not practical to note which birds are on the water and which are in flight use the following guidelines:

- If the majority of the birds are in the air, they can be recorded as flying.
- If birds appear first on the water and then fly away as the vessel approached, or they continuously move between the water and air, recorded them being as on the water.

Birds that follow the Vessel

To avoid double counting birds, once a bird is recorded in-flight it is not subsequently recorded again if it follows the ship and it is not recorded on subsequent snapshots. If many birds are following the vessel and it becomes difficult to determine which individuals have already been recorded, the number of birds following the ship can be estimated and recorded at regular intervals (i.e., in between each five minute survey or as possible).

Table D-3: Intervals at Which Instantaneous or "Snapshot" Counts of Flying Birds Should be conducted during a Moving Vessel Survey

Platform Speed (knots)	Interval Between Counts (minutes)
<4.5	2.5
4.5 – 5.5	2.0
5.5 – 8.5	1.5
8.5 – 12.5	1.0
12.5 - 19	0.5

Poor Visibility

When a survey period cannot be done because of poor visibility (i.e., when the entire width of the 300 m transect is not visible), the extent of visibility should be noted on the seabird survey information form.

Observation Periods with no birds

If no birds are observed during a five minute survey period, “no seabirds observed” must be noted on the seabird survey information form.

2.1.4.2 Survey Protocol – Stationary Vessel

Scan Method

Surveys while the vessel is stationary (e.g., on standby or anchored) are done using instantaneous counts, or “snapshots” of birds within a 300 m “semi-circle” area from the vessel. These surveys are conducted by scanning through a 180° arc, limiting observations to a semi-circle around the observer (Figure D- 7)

The area should be scanned from one side to the other, and all seabirds on water and in flight that are observed within 300 m are systematically recorded. Birds visible beyond 300 m are also, if possible. The distance to seabirds (inside and outside the 300 m area) from the observer is estimated and recorded for all birds. Birds observed outside the 300 m semi-circle are recorded as not in semi-circle on the seabird survey information form. Binoculars and spotting scopes can be used to confirm species identification and other details as necessary.

Observation Period

When the vessel is stationary, less priority can be attributed to marine mammal observations. Therefore, scans should be completed once every hour when the vessel is stationary (Table D-2). The length of each scan will depend on the number of birds present at the time of the scan (e.g., it may only last a few seconds if there are no birds present).

Poor Visibility

When an observation period cannot be done because of poor visibility (i.e., when the entire width of the 300 m transect is not visible), the extent of visibility should be noted on the seabird survey information form.

Observation Periods with no birds

If no birds are observed during a five minute survey period, “no seabirds observed” must be noted on the seabird survey information form.

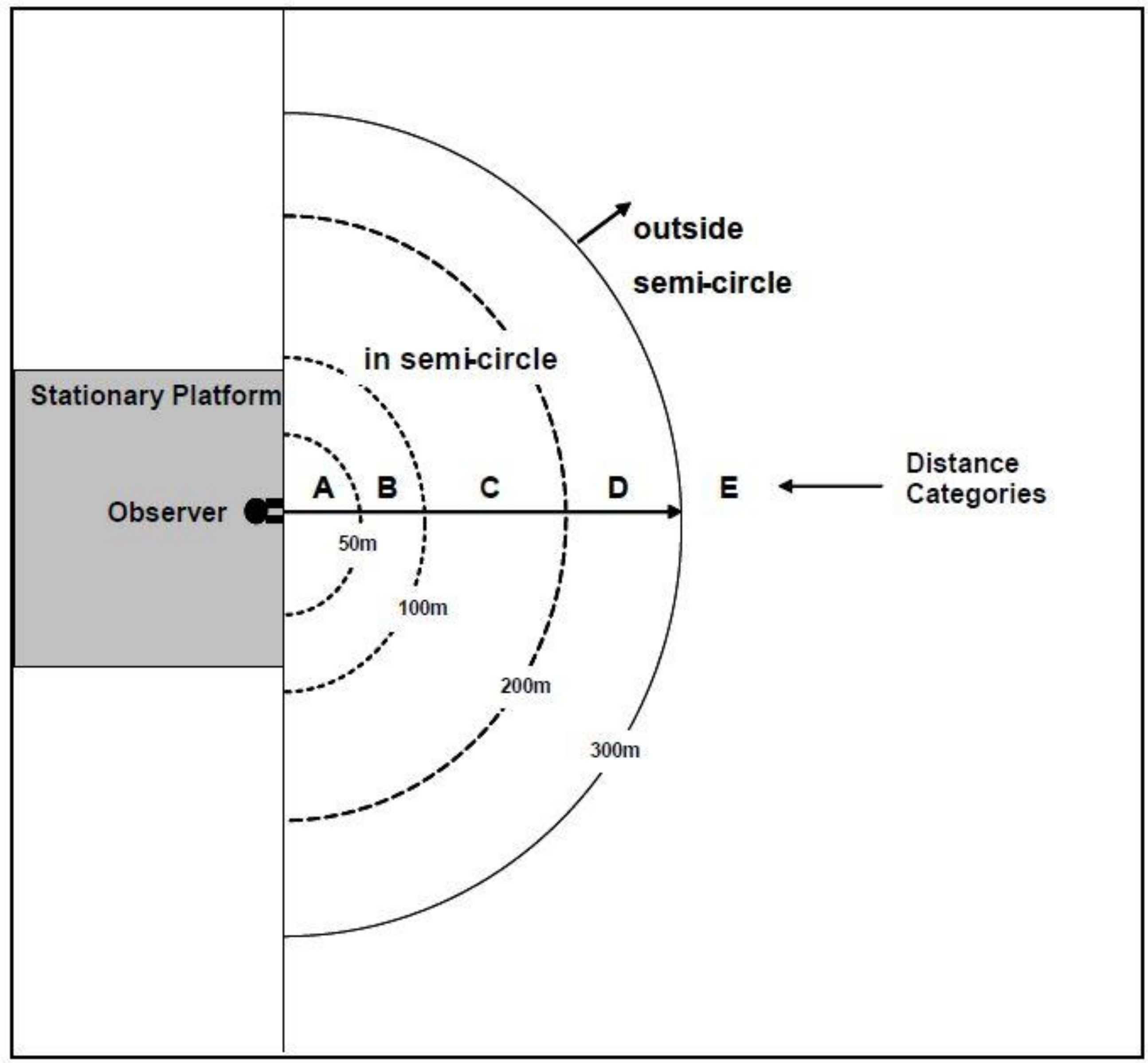

Figure D- 7: Survey using an 180º scan, surveying an area 300 m from a stationary observer (Extracted from Gjerdrum et al. 2012)

2.1.4.3 Estimating Distance

Observers should practice estimating the various distance bands prior to beginning surveys. This can be accomplished by using reticle binoculars as described above in Section 2.1.3.2 or with a distance gauge made from a transparent plastic ruler (see Attachment B).

Record the distance to each bird or flock of birds (to the centre of the flock). For all birds, estimate the perpendicular distance between the bird(s) and the observer (Figure D-6). If a group of birds is straddling the 300 m boundary with the flock centre located in D (some individuals inside and some individuals outside the transect) record the entire flock as being in D. If the flock centre is outside the transect, record the entire flock as distance class E. It is very important to record distance to birds within the 300 m strip, but if this is not possible (i.e., too busy), you may use the code 3 = within 300 m but no distance recorded. Distance T is used to indicate that the bird or flock was observed on the opposite side of the vessel.

2.1.5 Recording Observations

2.1.5.1 General Environmental Information

This information should be collected for both marine mammal and seabird observations as shown on the marine mammal and seabird sightings forms in Attachment A and Attachment B.

Ship name, agency and type: Agency is the company that has requested the survey (e.g., Agnico Eagle Mines Limited, Meliadine Division). Type may include container vessel, barge, tug, or fuel supply vessel.

Observer(s): Indicate the first and last name of the observer. Also record the name of any additional observers assisting with the survey.

Date: Date that the observation period occurred. Use format DD-MMM-YYYY (e.g. 12-Apr-2008)

Time start/Time end: Time (using 24-hour notation) at the start and end of each seabird survey or marine mammal observation. Use Universal Time (UTC) to standardize across regions.

Coordinates at start and end of observation period of track of observation period: GPS coordinates of the vessel.

Platform activity: Platform activity may influence observations and should therefore be noted. Activities could include traveling, off-loading, anchored etc.

Visibility: Estimate visibility in km from 0.3 (which is 300 m) to 20 km; estimates should also be made on foggy days.

Sea state code: Select Sea state code according to codes in Appendix II.

Swell height: Estimate the height of the swell.

Weather conditions: Record the general weather conditions at the time of the survey according to codes in Appendix II. Record the most prominent conditions within the survey area. For example, if there are distant fog patches that do not directly affect the survey conditions, the weather code will be 0 or 1. Alternatively, if there is <50% cloud cover but you are travelling through fog patches, the weather code will be 2.

Glare conditions: Light reflecting off the surface of the water can often influence detection. Record the glare conditions at the time of the survey according to codes in Appendix II.

Wind speed or force: Enter the speed of the wind in knots if instrument to measure wind is available on the bridge or use Beaufort code from Appendix III. When taking measurements from a moving platform, be sure to record the TRUE wind speed/direction.

Wind direction: Enter compass direction (**N, NE, E, SE, S, SW, W, or NW**) of the wind. See note above regarding true wind speed/direct.

Ice Type and Concentration: If ice is present during the survey, indicate the type and concentration using codes from Appendix IV. Indicate in the notes if the ice is present only beyond the transect limits.

Platform speed (knots): If speed changes during observation period, enter new speed and time that the change happened.

Platform direction: Enter compass direction (**N, NE, E, SE, S, SW, W, or NW**); if direction changes during the observation period enter new direction and time at which change happened.

Observation side: Starboard (right) or Port (left).

Height (metres): Enter height of observers' eye above water from observation point in metres.

Outdoors or Indoors: Circle **Out** when doing observations from a position outdoors and **In** for indoor observations. Remember survey should be conducted from the same location on the vessel each time.

Other Notes: Make note of disturbances or relevant activities in the area, especially if there are large vessels or fishing activities nearby, or if your vessel is sounding the fog horn.

2.1.5.2 Marine Mammal Sightings Record

Species: choose the species observed. Record all unknowns, even if they are identified only as "baleen whale" or "toothed whale".

Number of individuals: Record the number of marine mammals in each sighting. Record groups as one sighting (e.g., one line item), if they behave as a group and have the same morphological and behavioural characteristics (e.g., all adults of the same species). Record other individuals from the group that have different characteristics (e.g., different species or juveniles of the same species) in the next line but link all the sighting together to indicate they were a single sighting.

Distance: Record the distance to the marine mammal when first observed

Angle: Sighting angle to the marine mammal can be calculated using a Pelorus or an angle board

Behaviour: Chose a behaviour based on the list below

- ***Surfacing***: Marine mammals will surface in order to breathe, often exposing their backs.
- ***Breaching***: full or partial jump out of the water
- ***Fluking***: Some whales bring their tail flukes high up into the air on a deeper dive.
- ***Flipper-slapping***: Marine mammals may use their flippers to slap the surface of the water.
- ***Lob-tailing***: Whales raise their fluke high into the air in order to slap the surface of the water.
- ***Spyhopping***: Head of the marine mammal will surface out of the water as a means to get an in-air look.

- ***Porpoising***: high speed swimming is more efficiently accomplished if an animal jumps out of the water, usually observed in dolphins, porpoises, and pinnipeds.
- ***Bow- or Wake-riding***: Some species of dolphins and porpoises are attracted to ride the bow or the wake of a passing vessel.
- ***Logging***: Marine mammals resting at the surface.
- ***Feeding***: Marine mammals observed feeding on fish, krill or other marine mammals
- ***Hauled*-out**: For pinnipeds only. When they haul themselves onto land. Remember these individuals should be recorded as off-effort sightings.

Age: If possible, select whether the marine mammal is a:

- **Adult**
- **Juvenile**
- **Immature**

Sex: If possible, Male or Female

Direction of travel (N, NE, E, SE, S, SW, W, or NW): which direction the marine mammals are traveling. Not if they change the direction of travel in response to the vessel.

Note: Space is provided to record other important information, such as the presence of fishing vessels in the survey area, if the marine mammal suddenly changes behaviour etc.

2.1.5.3 Seabird Sightings Record

Observation period information: Fill in all the fields within the seabird survey form at the beginning of every five minute transect survey period (moving survey) or every scan (stationary survey).

Scan type (for stationary platforms only): Conduct a 180° scan for all stationary surveys. If part of the survey area is obstructed, indicate the scan angle used.

Scan direction (for stationary platforms only): Indicate the true (not magnetic) bearing when looking straight ahead, at centre of semi-circle.

With snapshot? Enter whether the snapshot method for birds in flight is being used by checking **Y or N.**

Species: choose the species observed. Record all unknowns, even if they are identified only as “gull” or “bird”.

Number of individuals: Record the number of birds in each sighting in the count field. Record groups of birds as one sighting, if they behave as a group and have the same morphological and behavioural characteristics (e.g., all adults of the same species in breeding plumage flying in the same direction). Record other individuals from the group that have different characteristics (e.g., different species or juveniles of the same species) in the next row but link all the sighting together to indicate they were a single sighting.

In transect or semi-circle? Y or N: Enter whether a bird observed is in (Y) or out (N) of the transect. Give priority to birds that are in transect; record birds seen outside of the observation area if this does not affect “in-transect” observations.

Behaviour (flying, on sea, and/or feeding): Record which activity a bird or group of birds is doing by selecting the activity from the drop-down menu.

Associated with platform? Y or N: Enter whether birds are following/associated with the moving platform with either a **Y** (Yes) or **N** (No).

Distance: Record the distance to each bird or flock of birds (to the centre of the flock). For all birds, estimate the perpendicular distance between the bird(s) and the observer (Figure D-6). Distance categories are as follows: A = 0 to 50 m, B = 51 to100 m, C = 101 to 200 m, D = 201 to 300 m, and E = >300 m.

Age: If possible, select whether the bird is a:

- **A** (adult plumage)
- **J** (juvenile, first coat of true feathers acquired before leaving nest)
- **I** (immature, first fall or winter plumage that replaces juvenile plumage and may continue in a series that includes first-spring plumage, but is not the complete adult plumage).

Plumage of adults: If possible, choose whether the bird has:

- **B** (breeding plumage usually in spring and summer – will apply to most birds seen during the survey)
- **NB** (non-breeding plumage, fall and winter plumage)
- **M** (moult, transitional phase between these two plumages, often with some flight feathers missing; generally not flying when molting)

Sex: (Male or Female)

Flight direction (N, NE, E, SE, S, SW, W, or NW): which direction birds in flight are heading, if not associated with platform (this info can be obtained from instruments on the bridge). If birds are flying erratically such that no one direction is appropriate, record them as ND (no direction).

Note: Space is provided to record other important information, such as the presence of fishing vessels in the survey area, if a particular bird was carrying fish, etc.

2.1.5.4 Additional Information

MMSOs will record any responsive actions undertaken by the vessel crew in response to sightings (e.g., reducing vessel speeds). This will be recorded on a daily basis as outlined in the MMSO daily reporting template provided in Attachment C and will include:

- Description of any vessel mitigation implemented (e.g., reduction in speeds, evasive maneuvers etc.); and
- Record of any vessel-animal collision (marine mammal or seabird) including the following information:
  - date, time, spatial coordinates;

- wind speed and direction, visibility, precipitation, sea state;
- number of animals found dead or injured on the deck (seabirds) and on the water (seabirds or marine mammals); and
- if search lights or vessel lighting sources were active at the time of collision.

This information will be summarized in a daily report by the MMSO. All records of vessel strikes on marine mammals and bird collisions will be provided to Fisheries and Oceans Canada (DFO) and the Canadian Wildlife Service (CWS) on a weekly basis, as vessel communications allow (i.e., as internet connections allow). Immediate reporting will be required in the event that a ship strike occurs on a marine mammal, or multiple bird collisions occur (involving more than five individuals) and the incidents appear related (i.e., similar time period, location, and weather conditions). In this instance, the regional Environment Canada (EC) Wildlife Enforcement Officer (contact information provided below) will be contacted to provide advice on the implementation of adaptive management techniques (see Merkel and Johansen 2011) to attempt to reduce the likelihood of collisions occurring in the future.

2.2 Spill Scenario

This section outlines the protocol for undertaking wildlife monitoring in the event of a major fuel spill in the LSA and RSA in accordance with Project Certificate Condition 64, which states the following:

"*The Proponent shall develop a framework for monitoring of marine bird species and their habitat in the event of a major marine fuel spill. Specific details regarding the scope of follow-up monitoring may be further refined if and when such an event were to occur."*

There are three potential scenarios during Mine shipping operations when a fuel spill could occur:

1) During shipping activities;
2) During ship-to-ship fuel transfer; or
3) During ship-to-shore transfer of fuel.

A spill risk assessment (SD8-1: Appendix E) was conducted at 14 sites along the shipping route to better understand how a potential fuel spill would behave over time within the RSA.

In the event of a fuel spill, the following wildlife monitoring framework will be implemented. It will be the responsibility of the shipping contractor(s) to employ a qualified environmental professional (QEP) to implement this framework in the event of an incident and will be a requirement of the shipping contract. It is recommended that a QEP be retained under contract on a stand-by basis during the shipping season to be able to respond to a spill in a timely fashion.

Not all spill scenarios will require the implementation of all aspects of this framework (i.e., a small spill contained close to the vessel will not require the same level of monitoring as a larger spill). It is the responsibility of the QEP, in consultation with the relevant regulators, to determine what aspects of the framework should be implemented.

The monitoring framework outlined below is intended to be a 'living document' which provides an opportunity for adaptive management techniques to be implemented throughout an event. The objective of the framework is to provide a strategy for the coordination of marine wildlife monitoring in order to minimize potential effects as a result of an incident. The framework should be amended as new information becomes available (e.g., changes to the extent of a spill) and should ultimately address both potential acute effects to wildlife and their habitats as well as potential long term chronic effects.

There is an opportunity to involve local communities and hunters, other organizations, institutions, government departments and/or individual researchers during the initial response phase and the follow-up phase during an incident. These opportunities include, but are not limited to:

- Providing information regarding sensitive resources in the area;
- Assisting in collecting baseline sediment and water quality samples;
- Assisting with wildlife surveys;
- Collecting wildlife who have come into contact with the spill;
- Providing information regarding the extent and direction of a spill; and
- Assisting with on-going wildlife monitoring.

The involvement of these organizations in the wildlife monitoring framework should be coordinated by the QEP as well as the vessel response team (to be identified in Shipboard Oil Pollution Emergency Plan (SOPEP) or Agnico Eagle's Emergency Response Team (ERT) depending on who is taking on coordination of the clean-up efforts (See section 2.0 of the Shipping Management Plan).

Monitoring during a spill event is divided into two phases, an 'Initial Response Phase' and a 'Follow-up Phase'.

2.2.1 Initial Response Phase

The initial response phase addresses the management of anticipated acute effects of the spill on marine wildlife and their habitats. The framework for the initial response phase should be managed and updated to incorporate new information as it becomes available.

Within 24 hours of an incident, the following marine wildlife monitoring objectives should be achieved:

- Identify a QEP to coordinate the wildlife monitoring framework; and
- Set-up of a 24 hour communication line and provide contact information to the community where local community members and other interested parties can call-in to report fouled or at-risk wildlife sightings.

2.2.1.1 Surveys and Sampling

2.2.1.1.1 Marine Wildlife

During the initial phases of a spill, all wildlife observed in direct contact with the fuel spill or present in the vicinity of the spill will be recorded in a wildlife sightings record (see example in Table D-4). Encounters may be called in by local community members, other vessels, MMSO(s) onboard Mine vessel(s), or by the spill response teams themselves. If possible, the QEP or suitable designate will conduct an initial survey of the affected area to record all species occurrences as soon as possible following a spill. This may be via ground, small support vessel or by aircraft and if possible, should be continued on a daily basis until the spill is contained. Aerial surveys can assist the focus of ground surveys, depending on the extent of a spill. The purpose of these surveys is to identify wildlife resources at risk within the vicinity of the spill and develop appropriate management strategies for minimizing risk and/or impacts to these resources. Resources to be identified during the surveys include presence of pelagic birds, waterfowl, marine mammals, and sensitive fish and wildlife habitat.

In the event that a spill reaches landfall, an intertidal community structure survey should be completed in affected areas and at suitable reference locations in the region. The intertidal surveys should involve intertidal quadrat-based transect sampling and should be conducted in accordance with DFOs marine habitat assessment guidelines as outlined in Attachment E.

Table D-4: Example of a Wildlife Sightings Record in the Event of a Spill

Common Name	Number of Individuals	Date/Time	Location (GPS location if possible in UTM)	Behaviour	Condition of Animal*	Photos**
MAMMALS						
BIRDS						
FISH						

Notes: * - note if the animal has been in contact will the spill or not, if individuals have been observed moving towards the spill, or if the animal is dead.

** Photos should be attached when possible

2.2.1.1.2 Marine Habitats and Benthic Communities

Marine water, surficial sediment, and benthic invertebrate tissue samples should be collected in the affected area(s) as soon as practical to establish baseline and initial spill conditions for water, sediment and tissue quality at the time of the spill. Samples should be collected from a near field to far field direction and should start as close to the spill as possible. The sampling plan should be evaluated on an on-going basis during the initial response phase to determine if the sampling intensity is appropriate relative to the nature of the spill (e.g., additional sampling sites may be required if the trajectory of the fuel spill changes).

Standard sample collection and environmental effects monitoring methods and analytical requirements implemented during fuel spills are provided in Table D-5. Ultimately, monitoring requirements will be at the discretion of the applicable regulators (e.g., EC-CWS and DFO).

Table D-5: Example of Sampling Methods and Analytical Requirements

Parameter	Location	Collection Methods	Laboratory Analyses
Water	Sites should be distributed from a near field to far field direction. Locations as close as possible to the perimeter of the spill should be collected first.	*In situ* measurement of pH, conductivity, salinity, temperature and turbidity throughout the water column. One sample should be collected at each site with a grab sampler (e.g., a Niskin bottle or Kemmerer). *In situ* and water samples should be collected at the surface, mid-water and deep water.	• BTEX/VPH • EPH • VOCs • PAHs (parent) • Total and Dissolved Metals (including mercury) • TOC • Major ions • General parameters
Sediment	Sites should be distributed from a near field to far field direction. Locations as close as possible to the perimeter of the spill should be collected first.	Five replicates collected at each shore site where sediments are sand-sized (e.g., less than approximately 2.0 mm) or finer. For shoreline areas, samples collected with a grab sampler (e.g., Ponar) at high tide, or a stainless steel spoon and bowl at low tide, with replicates randomly distributed within the sample area. For each station, samples should be collected at high and mid to low intertidal zone. For deepwater stations, one surface sediment sample should be collected.	• BTEX/VPH • EPH • VOCs • PAHs (parent) • Metals (including mercury) • TOC • Grain size distribution
Tissue – Requires a DFO scientific fish collection permit	Sites should be distributed from a near field to far field direction. Locations as close as possible to the perimeter of the spill should be collected first.	Five replicates consisting of a composite of 20 individual bivalves collected randomly at each station where bivalves are present. Bivalves should be shucked and the soft tissues rinsed in with deionized water to remove shell pieces and other debris. Tissue samples will be handled with clean stainless steel instruments (i.e., scalpels), weighed and divided between two certified-clean, laboratory-supplied glass containers with Teflon®-lined lids, which will be then stored in a freezer. The samples will be transported on ice (frozen) to an accredited lab for analysis of parent and alkylated PAHs (following silica-gel cleanup to remove natural polar organic compounds that can cause false positives), metals, lipids and moisture content.	• PAH (parent) after silica-gel clean-up. • Metals • Moisture • Lipids

2.2.1.2 Species and Habitats of Immediate Risk

Marine species and habitats of immediate risk from the spill should be identified in order of priority (see Table D-6). This will depend on a variety of factors including the location of the spill, timing, and prevalent weather conditions. Examples of sensitive habitats of potential immediate risk include fish bearing streams, narwhal congregation areas, walrus haul-outs, coastal nesting bird sites etc. Specific locations of habitats are important to note. A revised marine baseline report (SD8-1: Appendix B of the Shipping Management Plan) provides the most current information on known sensitive marine resources in the RSA. Figure B-3 of SD8-1: Appendix B – Revised Baseline – Marine Environment outlines the various coastal habitat types in Melvin Bay in the event of a spill within the limits of the harbour.

The above information should be provided by the QEP to the spill response team and others involved in the spill clean-up (e.g., the Canadian Coast Guard) along with recommendations on what environmental resources are of greatest concern to protect. The QEP should also be involved in discussions relating to the implement of mitigation measures to avoid impacts to sensitive resources. Recommendations regarding mitigation from the QEP should be made in consultation with the relevant regulatory agencies (DFO for marine mammals and fish, CWS for marine birds and the Government of Nunavut for polar bears). The CWS provides spill response guidance on what techniques are available to be used during a spill in relation to marine birds (provided in Attachment D), this includes:

- Hazing;
- Dispersing Oil;
- Bird Collection;
- Wildlife Monitoring (as covered by this framework);
- Beached Bird Surveys (as covered by Section 3.2.1.1);
- Drift Blocks; and
- Live Oiled Bird Response (CWS 2012).

Several of these techniques require specific training and permit authorization before implementation. Therefore, prior to initiation of any of these techniques, the CWS should be contacted for input and guidance.

No similar guidance is provided by DFO for dealing with marine mammals in the event of a spill. DFOs Marine Mammal Response Program is responsible for tracking and responding to contaminated animals (DFO 2015). In the event of a major fuel spill in the RSA, DFO should be contacted immediately by the QEP to determine appropriate mitigation techniques to be utilized to limit potential adverse impacts on marine mammals.

Table D-6: Species and Habitats of Immediate Management Concern

Species and/or Habitat	Location*	Comments

Notes: * A general description of the location of the species (e.g., haul-out areas, congregating areas, fish bearing streams etc.) or specific GPS locations (in UTM) if available

2.2.1.3 Fish and Marine Wildlife Permitting

Table D-7 provides an overview of permitting requirements that may be required to implement the wildlife monitoring framework in the event of a major fuel spill. The CWS and DFO should be contacted to determine the course of action in relation to the collection of live or dead wildlife during the initial response phase.

Table D-7: Potential Permitting Requirements

Agency	Permit	Required for
CWS	Variance Order to the Migratory Bird Regulations	Required for collection, transportation, holding, treating and hazing of migratory birds (live and dead).
DFO	Fish Collection Permit	Required for the collection of marine species (live or dead).
Government of Nunavut	Scientific Research Permit	May be required for the collection of wildlife in Nunavut (live or dead).

2.2.1.4 Daily Assessment Objectives in Order of Priority

Daily assessment objectives should be reviewed each morning and updated as necessary by the QEP. An example of daily assessment objective list is provided below. These objectives will change over the course of an event as the spill is contained and cleaned up.

1) Determine maximum extent of spill area to define hazard zones to marine wildlife and their habitats. The extent of the spill will be in-flux, therefore, seek an update each morning from the spill response team.

2) From the spill origin, travel by boat along the shoreline to search for wildlife or evidence of wildlife.

3) Survey pelagic areas for birds and marine mammals.

4) Document species observations and important habitat areas that may potentially be at risk from spilled product. Bird species observations should detail species, number, behaviour, condition (oiled, not oiled), and location (UTMs). Visual and auditory indications should be used.

5) Conduct marine mammal monitoring; use binoculars to scan for the presence of marine mammals within spill area from on-shore vantage points located at a high location that have good vantage areas. The MMSO(s) can assist with this duty.

6) Update the spill response team and relevant regulators (CWS and DFO) regarding the observations of wildlife.

7) Maintain and monitor the 24 hour wildlife hotline and respond to information gathered.

8) Document impacts to wildlife and habitat, severity of impact, and potential biological implications on a daily and cumulative basis.

9) Implement and maintain wildlife deterrence strategies from oil impacted areas in consultation with the relevant regulatory agency.

2.2.1.5 Reporting

Updates to CWS and DFO regarding observations of wildlife should be a daily objective during a major fuel spill event. In addition, all wildlife sightings records (Table D-4) should be provided on a weekly basis to DFO and the CWS by the QEP.

2.2.2 Follow-up Phase

During the initial phase, all resources should be focused on limiting the effects of the spill. The follow-up phase consists of follow-up monitoring that should be executed through a long-term monitoring framework. The objective of this framework is to assess impacts to wildlife resources and their habitats as a result of the spill and any cleanup measures implemented (e.g., dispersants), as well as to measure the success of applied mitigation techniques.

The follow-up monitoring framework should be developed after the completion of the initial phase monitoring. This allows the follow-up monitoring to focus on species and habitats that have been most impacted by the spill. The framework may contain, but will not be limited to:

- Marine bird surveys;
- Coastal nest surveys;
- Marine mammal surveys;
- Fish surveys;
- Sediment quality monitoring; and
- Water quality monitoring.

The follow-up phase framework should be completed in consultation with the relevant regulatory agencies. It should also provide a mechanism to allow for local community members to be involved in monitoring, remediation and reporting efforts.

3.0 SUMMARY

This MEMP outlines the protocol for monitoring of marine mammals and seabirds during routine shipping operations of the Meliadine Gold Mine. Mine-specific mitigation measures designed to minimize Mine impacts on marine mammals and seabirds will be initiated by vessel-based MMSOs and implemented by the ship’s crew. The MEMP also provides a framework to monitor for marine wildlife and their habitats in the event of a Mine-related spill. An opportunity for inclusion of local community members exists and should be considered an asset when implementing this plan. Communication and consultation with relevant regulatory agencies is essential when attempting to implement adaptive management strategies during routine operations as well as during a spill event.

This plan should be considered a living document that can be updated throughout the Mine in order to implement adaptive management techniques.

Report Signature Page

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https://golderassociates.sharepoint.com/sites/10440g/shared documents/3000 on-call regulatory support/shipping management plan/shipping management plan/appendixd_memp/app d_memp 28macrh17.docx

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ATTACHMENT A

Marine Mammal Sightings Record

Observation Period Information:				
Company/agency			Sea state code	
Platform name and type			Wave height (m)	
Observer (s)			True wind speed (knots) **OR** Beaufort code	
Date (DD/MMM/YYYY)			True wind direction	
Time at start (UTC)			Ice type code	
Time at end (UTC)			Ice concentration code	
Latitude at start / end			True platform speed (knots)	
Longitude at start / end			True platform direction	
Visibility (km)			Observation side	Starboard Port Middle
Weather code			Height of eye (m)	
Glare conditions code			Outdoors or Indoors	Out or In
Platform Activity			Notes	

Date and Time of Sighting	Vessel Travel Direction and Speed	Weather / Sea State	Re-Sighting? (Y or N)	Sighting Waypoint or Lat/Long(Garmin GPS)	Species, Number of Individuals	Distance to Animal (m or km)	Angle to Sighting	Behaviour/Travel Direction	Age/Sex	Mitigation Required?	Photo Number (if any)
Notes:											

Species	How Animal Was Spotted	Certainty of ID	Animal Activity
Narwhal Whale	By Eye	Definite	Slow Swimming
Beluga Whale	Reticle Binoculars	Probable	Medium Swimming
Bowhead Whale	Big-eye Binoculars	Possible	Fast Swimming
Atlantic Walrus			Looking – Seals
Bearded Seal			Feeding
Ringed Seal			Flipper Slapping
Harbour Seal			Surfacing
Hooded Seal			Resting
Harp Seal			Diving
Polar Bear			Diving (Fluke Visible)
Killer Whale			Splashing
			Surfacing
			Fluking
			Lobtailing
			Bow Riding
			Wake Riding
			Porpoising
			Spyhopping
			Breaching
			Acrobatic
			Startle Response
			Milling
			Unknown

ATTACHMENT B

Record Sheet for a Moving Platform Survey[3]

Record Sheet for a Stationary Platform Survey[3]

Appendix I - Estimating Distance Categories Using Ruler Gauge[3]

Appendix II Through VI - Codes for General Weather Conditions and Glare, Sea State and Beaufort Wind Force, Ice Conditions, Species Codes for Eastern Seabirds, and Codes for [3]Associations and Behaviours[3]

[3] Eastern Canada Seabirds at Sea (ECSAS) Seabird Sightings Records and Background Material (Extracted from Gjerdrum et al. 2012)

Record sheet for a moving platform survey

Observation Period Information:

Company/agency			Sea state code	
Platform name and type			Wave height (m)	
Observer (s)			True wind speed (knots) **OR** Beaufort code	
Date (DD/MMM/YYYY)			True wind direction (deg)	
Time at start (UTC)			Ice type code	
Time at end (UTC)			Ice concentration code	
Latitude at start / end			True platform speed (knots)	
Longitude at start / end			True platform direction (deg)	
Platform activity			Observation side	Starboard Port
Visibility (km)			Height of eye (m)	
Weather code			Outdoors or Indoors	Out or In
Glare conditions code			Snapshot used?	Yes or No

Notes:

Bird Information: *this field <u>must</u> be completed for each record

* Species	* Count	* Fly or Water?	* In transect?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.
[2]Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction
[3]***J***(uvenile), ***I***(mmature), or ***A***(dult); [4]***B***(reeding), ***NB***(non-breeding), ***M***(oult)

Record sheet for a stationary platform survey

Scan Information:

Company/agency		Weather code	
Platform name and type		Glare conditions code	
Observer (s)		Sea state code	
Date (DD/MMM/YYYY)		Wave height (m)	
Time at start (UTC)		True wind speed (knots) **OR** Beaufort code	
Latitude		True wind direction (deg)	
Longitude		Ice type code	
Platform activity		Ice concentration code	
Scan type	180º or other (specify:)	Height of eye (m)	
Scan direction		Outdoors or Indoors	Out or In
Visibility (km)			

Notes:

Bird Information: *this field <u>must</u> be completed for each record

* Species	* Count	* Fly or Water?	* In semi-circle?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.
[2]Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction
[3]***J***(uvenile), ***I***(mmature), or ***A***(dult); [4]***B***(reeding), ***NB***(non-breeding), ***M***(oult)

APPENDIX I. Estimating distance categories

The various distance categories can be estimated using the following equation[1]:

$$d_h = 1000\frac{(ah3838\sqrt{h}) - ahd}{h^2 + 3838d\sqrt{h}}$$

e.g. if a = 0.730 m, h = 12.5 m, and d = 300 m

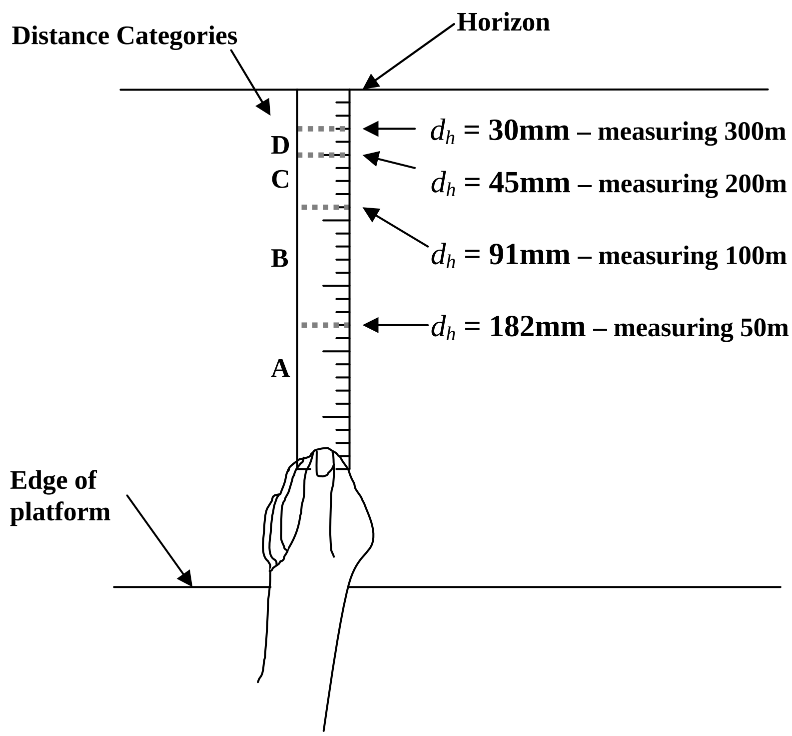
then d_h = 30.0 mm

where:

d_h = distance below horizon (mm)
a = distance between the observer's eye and the ruler when observer's arm is fully out-stretched (m)
h = height of the observer's eye above the water at the observation point (m)
d = distance to be estimated (m; a separate calculation is required for each of 50, 100, 200, 300)

Distances are easily estimated using a gauge made from a transparent plastic ruler. A different ruler will be required for each combination of observer arm length (a) and platform height (h). Calculate d_h for the boundary of each distance class (A, B, C, D) and mark them on the ruler (dashed lines in figure). To use the gauge, extend the arm fully and keep the top end of the ruler aligned with the horizon. The dashed lines now demark the distance class boundaries on the ocean surface. Keep the gauge nearby during surveys to quickly verify bird distances.

Measurements for an observer with a = 73 cm and h = 12.5 m:



[1] Formula derived by J. Chardine, based on Heinemann 1981. A spreadsheet is available from the corresponding author to perform this calculation.

APPENDIX II. Codes for general weather conditions and glare

Code	Description	Explanation
Weather conditions		
0		< 50% cloud cover (with no fog, rain, or snow)
1		> 50% cloud cover (with no fog, rain, or snow)
2		patchy fog
3		solid fog
4		mist/light rain
5		medium to heavy rain
6		fog and rain
7		snow
Glare conditions		
0		none
1		slight/grey
2		bright on the observer's side of vessel
3		bright and forward of vessel

APPENDIX III. Codes for sea state and Beaufort wind force

Wind Speed (knots)	Sea state code and description	Beaufort wind force and description
0	**0** Calm, mirror-like	**0** calm
01 – 03	**0** Ripples with appearance of scales but crests do not foam	**1** light air
04 – 06	**1** Small wavelets, short but pronounced; crests do not break	**2** light breeze
07 – 10	**2** Large wavelets, crests begin to break; foam of glassy appearance; perhaps scattered white caps	**3** gentle breeze
11 – 16	**3** Small waves, becoming longer; fairly frequent white caps	**4** moderate breeze
17 – 21	**4** Moderate waves with more pronounced form; many white caps; chance of some spray	**5** fresh breeze
22 – 27	**5** Large waves formed; white foam crests more extensive; probably some spray	**6** strong breeze
28 – 33	**6** Sea heaps up; white foam from breaking waves blows in streaks in direction of wind	**7** near gale
34 – 40	**6** Moderately high long waves; edge crests break into spindrift; foam blown in well-marked streaks in direction of wind	**8** gale
41 – 47	**6** High waves; dense streaks of foam in direction of wind; crests of waves topple and roll over; spray may affect visibility	**9** strong gale
48 – 55	**7** Very high waves with long overhanging crests; dense foam streaks blown in direction of wind; surface of sea has a white appearance; tumbling of sea is heavy; visibility affected	**10** storm
56 - 63	**8** Exceptionally high waves; sea is completely covered with white patches of foam blown in direction of wind; edges blown into froth; visibility affected	**11** violent storm
64 +	**9** Air filled with foam and spray; sea completely white with driving spray; visibility seriously affected	**12** hurricane

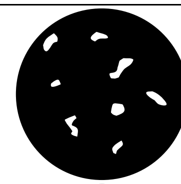
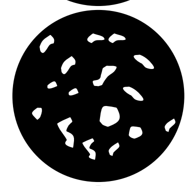
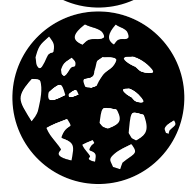
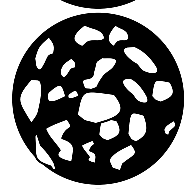
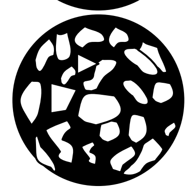
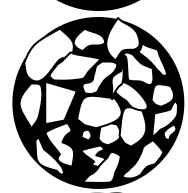
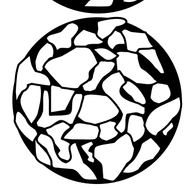
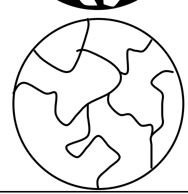
APPENDIX IV. Codes for ice conditions

Adapted from NOAA: Observers Guide to Sea Ice

Sea Ice Forms

Code	Name	Description
0	New	small, thin, newly formed, dinner plate-sized pieces
1	Pancake	rounded floes 30 cm - 3 m across with ridged rims
2	Brash	broken pieces < 2 m across
3	Ice Cake	level piece 2 - 20 m across
4	Small Floe	level piece 20 - 100 m across
5	Medium Floe	level piece 100 -500 m across
6	Big Floe	level, continuous piece 500 m - 2 km across
7	Vast Floe	level, continuous piece 2 - 10 km across
8	Giant Floe	level, continuous piece > 10 km across
9	Strip	a linear accumulation of sea ice < 1 km wide
10	Belt	a linear accumulation of sea ice from 1 km to over 100 km wide
11	Beach Ice or Stamakhas	irregular, sediment-laden blocks that are grounded on tidelands, repeatedly submerged, and floated free by spring tides
12	Fast Ice	ice formed and remaining attached to shore

Sea Ice Concentration

Code	Concentration	Description	
0	< one tenth	"open water"	
1	two-three tenths	"very open drift"	
2	four tenths	"open drift"	
3	five tenths	"open drift"	
4	six tenths	"open drift"	
5	seven to eight tenths	"close pack"	
6	nine tenths	"very close pack"	
7	ten tenths	"compact"	

APPENDIX V. Species codes for birds seen in Eastern Canada

Common name	Species code	Latin name
COMMON, REGULAR OR FREQUENTLY SEEN SPECIES		
Northern Fulmar	NOFU	*Fulmarus glacialis*
Great Shearwater	GRSH	*Puffinus gravis*
Manx Shearwater	MASH	*Puffinus puffinus*
Sooty Shearwater	SOSH	*Puffinus griseus*
Wilson's Storm-Petrel	WISP	*Oceanites oceanicus*
Leach's Storm-Petrel	LESP	*Oceanodroma leucorhoa*
Northern Gannet	NOGA	*Morus bassanus*
Red Phalarope	REPH	*Phalaropus fulicaria*
Red-necked Phalarope	RNPH	*Phalaropus lobatus*
Long-tailed Jaeger	LTJA	*Stercorarius longicaudus*
Parasitic Jaeger	PAJA	*Stercorarius parasiticus*
Pomarine Jaeger	POJA	*Stercorarius pomarinus*
Great Skua	GRSK	*Stercorarius skua*
Herring Gull	HERG	*Larus argentatus*
Iceland Gull	ICGU	*Larus glaucoides*
Glaucous Gull	GLGU	*Larus hyperboreus*
Great Black-backed Gull	GBBG	*Larus marinus*
Black-legged Kittiwake	BLKI	*Rissa tridactyla*
Common Murre	COMU	*Uria aalge*
Thick-billed Murre	TBMU	*Uria lomvia*
Razorbill	RAZO	*Alca torda*
Dovekie	DOVE	*Alle alle*
Atlantic Puffin	ATPU	*Fratercula arctica*
SPECIES MORE COMMONLY SEEN INSHORE		
Common Loon	COLO	*Gavia immer*
Red-throated Loon	RTLO	*Gavia stellata*
Red-necked Grebe	RNGR	*Podiceps grisegena*
Horned Grebe	HOGR	*Podiceps auritus*
Great Cormorant	GRCO	*Phalacrocorax carbo*
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*
Greater Scaup	GRSC	*Aytha marila*
Common Eider	COEI	*Somateria mollissima*
Harlequin Duck	HARD	*Histrionicus histrionicus*
Long-tailed Duck	LTDU	*Clangula hyemalis*
Surf Scoter	SUSC	*Melanitta perspicillata*
Black Scoter	BLSC	*Melanitta nigra*
White-winged Scoter	WWSC	*Melanitta fusca*
Red-breasted Merganser	RBME	*Mergus serrator*
Black Guillemot	BLGU	*Cepphus grylle*

Common name	Species code	Latin name
INFREQUENTLY OR RARELY SEEN SPECIES		
Cory’s Shearwater	COSH	*Calonectris diomedea*
Audubon’s Shearwater	AUSH	*Puffinus lherminieri*
Lesser Scaup	LESC	*Aythya affinis*
King Eider	KIEI	*Somateria spectabilis*
South Polar Skua	SPSK	*Stercorarius maccormicki*
Bonaparte's Gull	BOGU	*Larus philadelphia*
Ivory Gull	IVGU	*Pagophila eburnea*
Black-headed Gull	BHGU	*Larus ridibundus*
Laughing Gull	LAGU	*Larus articilla*
Ring-billed Gull	RBGU	*Larus delawarensis*
Lesser Black-backed Gull	LBBG	*Larus fuscus*
Sabine’s Gull	SAGU	*Xema sabini*
Common Tern	COTE	*Sterna hirundo*
Arctic Tern	ARTE	*Sterna paradisaea*
Roseate Tern	ROTE	*Sterna dougallii*
CODES FOR BIRDS IDENTIFIED TO FAMILY OR GENUS		
Unknown Bird	UNKN	
Unknown Shearwater	UNSH	*Puffinus* or *Calonectris*
Unknown Storm-Petrel	UNSP	Hydrobatidae
Unknown Duck	UNDU	Anatidae
Unknown Eider	UNEI	*Somateria*
Unknown Phalarope	UNPH	*Phalaropus*
Unknown Jaeger	UNJA	*Stercorarius*
Unknown Skua	UNSK	*Stercorarius*
Unknown Gull	UNGU	Laridae
Unknown Tern	UNTE	*Sternidae*
Unknown Alcid	ALCI	Alcidae
Unknown Murre or Razorbill	MURA	*Uria* or *Alca*
Unknown Murre	UNMU	*Uria*

APPENDIX VI. Codes for associations and behaviours

From Camphuysen and Garthe (2004). Choose one or more as applicable.

Code	Description
Association	
10	Associated with fish shoal
11	Associated with cetaceans
13	Associated with front (often indicated by distinct lines separating two water masses or concentrations of flotsam)
14	Sitting on or near floating wood
15	Associated with floating litter (includes plastic bags, balloons, or any garbage from human source)
16	Associated with oil slick
17	Associated with sea weed
18	Associated with observation platform
19	Sitting on observation platform
20	Approaching observation platform
21	Associated with other vessel (excluding fishing vessel; see code 26)
22	Associated with or on a buoy
23	Associated with offshore platform
24	Sitting on offshore platform
26	Associated with fishing vessel
27	Associated with or on sea ice
28	Associated with land (e.g., colony)
50	Associated with other species feeding in same location

Code	Description	Explanation
Foraging behaviour		
30	Holding or carrying fish	carrying fish towards colony
32	Feeding young at sea	adult presenting prey to attended chicks (e.g., auks) or juveniles (e.g., terns)
33	Feeding	method unspecified (see behaviour codes 39,40,41,45)
36	Aerial pursuit	kleptoparisitizing in the air
39	Pattering	low flight over the water, tapping the surface with feet while still airborne (e.g., storm-petrels)
40	Scavenging	swimming at the surface, handling carrion
41	Scavenging at fishing vessel	foraging at fishing vessel, deploying any method to obtain discarded fish and offal; storm-petrels in the wake of trawlers picking up small morsels should be excluded
44	Surface pecking	swimming birds pecking at small prey (e.g., fulmar, phalaropes, skuas, gulls)
45	Deep plunging	aerial seabirds diving under water (e.g., gannets, terns, shearwaters)
49	Actively searching	persistently circling aerial seairds (usually peering down), or swimming birds frequently peering (and undisturbed by observation platform) underwater for prey
General behaviour		
60	Resting or apparently sleeping	reserved for sleeping seabirds at sea
64	Carrying nest material	flying with seaweed or other material; not to be confused with entangled birds
65	Guarding chick	reserved for auks attending recently fledged chicks at sea
66	Preening or bathing	birds actively preening feathers or bathing
Distress or mortality		
71	Escape from ship (by flying)	escaping from approaching observation platform
90	Under attack by kleptoparasite	bird under attack by kleptoparasite in an aerial pursuit, or when handling prey at the surface
93	Escape from ship (by diving)	escaping from approaching observation platform
95	Injured	birds with clear injuries such as broken wings or bleeding wounds
96	Entangled in fishing gear or rope	birds entangled with rope, line, netting or other material (even if still able to fly or swim)
97	Oiled	birds contaminated with oil
98	Sick/unwell	weakened individuals not behaving as normal, healthy birds, but without obvious injuries
99	Dead	bird is dead

ATTACHMENT C

MMSO Daily Reporting Template

1.0 MARINE MAMMALS AND SEABIRD OBSERVING (MMSO) DAILY REPORT

Project Information

Client:	**Date:**
Project Name:	**Location:**

Ship Contractor Information

Ship Contractor Name:	**Site Supervisor or Captain:**
Ship Name/Type:	

MMSO name:	
General weather conditions (throughout the day)	**Cloud cover:** **Precipitation:** **Wind (knots):** **Sea state:** **Swell height:** **Air temperature:** **Ice presence:** **Notes:**
Time start/Time end MMSO duties (UTC):	

2.0 MITIGATION LOG

Mitigation Implemented	Time (UTC)	GPS Location	Rational for Implementation

Under Activity note the following: Description of any vessel mitigation implemented (e.g., reduction in speeds, evasive maneuvers etc.)

3.0 RECORD OF VESSEL-ANIMAL COLLISIONS/INTERACTIONS

Species	Number of Individuals	Time (UTC)	GPS Coordinates	Visibility/Sea State	Comments

In the comments note the following: Animals observed on the deck (seabirds) or in the water (seabirds or marine mammals), if search lights or vessel lighting sources were active at the time of collision, and any other relevant notes.

4.0 MMSO CHECKLIST

Item or Location to Check	Yes	No	Comments - Discussed (D) with relevant Ship personnel - Observed (O) - Not Applicable (NA) - Action required (as/if applicable)
General			
Copy of SMP and appendices posted on-site			
Orientation to mitigation measures outlined in Section 4.2 of the SMP			
Overview of MMSO duties and protocols (e.g., ship crews should be made aware that the MMSO is the only individual that can mark sightings during the dedicated surveys/observation periods)			
Add additional items as necessary and depending on the role of the MMSO			

General Notes:

5.0 SUMMARY OF ISSUES AND RECOMMENDATIONS / ACTIONS

Date Noted	Issue	Recommendation/Action	Completed (Date Resolved)	Comments

ATTACHMENT D

Birds and Oil - CWS Response Plan Guidance

Birds and Oil - CWS Response Plan Guidance

In all circumstances where a polluter is identified the burden of cleanup and response lies with the polluter. However, responsibility for government overview of a response to an oil spill depends on the source of the spill. The identified **lead agency** has responsibility to monitor an oil spill response and to take control if an appropriate response is not undertaken by a polluter or their agent.

Lead agency responsibilities lie with:

- **Environment Canada**
  - For spills and incidents on federal lands and from federal vessels
  - Potentially for land-based incidents in waters frequented by fish
  - May take lead if environment is not being protected by other leads, Cabinet Directive 1973
- **Canadian Coast Guard**
  - For spills from ships
  - All spills of unknown sources in marine environment
- **Provincial Department of Environment**
  - For spills from land-based sources
- **Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and Canada-Nova Scotia Offshore Petroleum Board (C-NSOPB)**
  - For spills related to offshore oil and gas exploration and production
- **Transport Canada**
  - To investigate ship source and mystery spills in the marine environment

The Canadian Wildlife Service has the responsibility for licensing activities which involve the handling or disturbance of birds, and of providing advice and often direction to other agencies, responders and the polluter during oil spill incidents.

1. Hazing[1]

Purpose: Prevent birds from coming in contact with oil

Options:

- Hazing by helicopter
- Hazing by FRC or other watercraft
- Release of scare devices (e.g. Breco Buoys, Phoenix Wailer)
- Use of hazing sound makers: propane cannons, whizzers, bangers, pyrotechnic devices etc.

Scare devices have a limited range of influence and likely are not a viable option with a large slick. Use of Breco Buoys and Phoenix Wailers can be used but we consider them to be largely ineffective in the situation of a large slick. Logistically, helicopter hazing would be difficult unless it was possible for a helicopter to remain on a platform offshore overnight. Hazing by FRC or other vessels would be ideal.

[1] There are several scare techniques which may be effective and do not require a permit, however a permit under the Migratory Bird Regulations **is required** for the use of aircraft or firearms (defined as capable of emitting at projectile at more than 495 feet per second). Propane cannons, blank pistols or pyrotechnical pistols firing crackers shells with **less than 495fps are legal without a permit**. Most scare tactics are relatively short lived in terms of effectiveness as birds acclimatize to the disturbance so scare techniques should be alternated to be effective.

Short-term focused hazing by the most expedient means should be attempted to move the birds away from the slick, if logistical conditions permit. Vessels at the site should have the ability to use sound makers (propane canons, pyrotechnic devices) to disperse birds in local areas. Such equipment should be deployed immediately to these ships with trained personnel to operate them. The vessels on site should be tasked to actively search and monitor for congregations of birds which could be vulnerable to oiling. If such groups are found then attempts should be made to disperse the birds away from the oil.

2. Disperse oil

Purpose: Prevent birds from contacting oil by getting oil off the surface of the water as soon as possible.

Options:

- Dispersants
- Mechanical dispersal with FRCs or other vessels
- Natural dispersal by environmental conditions

For small spills, mechanical dispersal would be the preferred method.

3. Bird Collection[2]

Purpose: Implement a humane response to oiled birds as required by Environment Canada's National Policy on Oiled Birds and Oiled Species At Risk (http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=A4DD63E4-1)

Options:

- The only option would be a ship-based effort to detect and collect dead and live oiled birds, both within the slick and adjacent to it.

All vessels in or near the slick should understand the need to collect birds. All vessels should have dip-nets, large plastic collecting bags to hold dead birds, and cloth bags or cardboard boxes in which to hold live oiled birds. Efforts should be made to retrieve live oiled birds to ensure they are dealt with humanely.

4. Wildlife monitoring

Purpose: Determine potential impact of spill

Options:

- Ship-based surveys for oiled and unoiled wildlife
- Aerial surveys for oiled and unoiled wildlife. Will require structured surveys (e.g. strip or transect surveys of spill area)
- Placement of CWS staff on vessels and aircraft

[2] Only those individuals authorized to do so (nominee on an existing federal salvage permit) can be involved with the collection of migratory birds.

Dedicated ship-based bird surveys should be initiated immediately. Ideally arrangements should be made to have a CWS observer on vessels or flights. In addition trained seabird observers need to be placed on all vessels monitoring a slick. This should continue until the slick is dispersed.

5. Beached Bird Surveys

Purpose: Determine impact of spill on wildlife and retrieve any live oiled wildlife on beaches.

Options:

- Conduct daily beached bird surveys during the incident and until one week after slick has been removed or dissipated.

CWS or other government officials (CCG, Enforcement Officers) will oversee the collection of dead and live oiled birds[3] as instructed in CWS' protocol for collecting birds during an oil spill response. This would only be required in circumstances where a large number of birds are potentially oiled or if the spill occurs in a sensitive area.

6. Drift Blocks

Purpose: Drift blocks may be deployed in slick to provide an estimate of bird mortality.

Options:

- Release from vessel
- Release from aircraft

The deployment of drift blocks would only be expected if there was a large spill and blocks should be released as soon as possible after a spill (CWS should be consulted to determine protocol for drift block deployment and tracking). The polluter or their agent would be expected to ensure drift blocks are tracked and collected as appropriate.

7. Live oiled bird response

Purpose: Implement a humane response to oiled birds as required by Environment Canada's National Policy On Oiled Birds And Oiled Species At Risk

Options:

- Rehabilitation
- Euthanization

CWS will be consulted to determine the appropriate response and treatment strategies which may include cleaning and rehabilitation or euthanization. CWS policy specifically requires that species at risk or other species of concern be rehabilitated.

[3] Only those individuals authorized to do so (nominee on an existing federal salvage permit) can be involved with the collection of migratory birds.

ATTACHMENT E

DFO's Marine Foreshore Environmental Assessment Procedure

MARINE FORESHORE ENVIRONMENTAL ASSESSMENT PROCEDURE

Marine development projects have the potential to effect fish[1] and fish habitat[2]. Fisheries and Oceans Canada (DFO) is responsible for the protection and management of fish habitats under the authority of the *Fisheries Act* and may request plans, specifications and environmental assessments specific to marine projects where more detailed information is required. Assessments may be necessary for all types of projects, including, but not limited to aquaculture, log handling, industrial port development, marinas, private moorage facilities, marine repair facilities, pipeline or outfall installations, vessel launches or barge ramps, dredging projects and shoreline protection projects (breakwaters and seawalls). Presented below are standardized, transect-based assessment procedures intended to provide DFO with the basic information required to determine the potential effects of a development project on fish habitat.

Assessment Area

For comparative purposes, the assessment area should include both the foreshore site proposed for development as well as the adjacent foreshore. This will provide a context for the project and may provide data about cumulative effects if similar developments already occur on-site. A large scale site plan, preferably an enlargement of the hydrographic chart, with a small scale insert of the general geographic location will serve as a base map of the study area.

Tidal Height and Water Depth Measurements

The lowest normal tide (0.0 m), or chart datum, will be used as the reference point for the measurement of tidal height and water depth. Tidal height is recorded as positive relative to chart datum, while water depth below chart datum will be recorded as a negative value. For example, if the assessment is made when the tide is at 2 m, and observations are taken at a water depth of 6 m, then the depth will be recorded as -4 m. Tidal height will be corrected using the closest secondary port to the reference port found in the Canadian Tide and Current Tables, with further correction made for daylight savings time as required.

Transect Layout

Transects should be established perpendicular to the shoreline at regular intervals both within and adjacent to the proposed or active development area so as to sample representative fish habitat conditions. A preliminary low water reconnaissance or dive survey may be advisable to establish

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[1] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

[2] shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals;

appropriate boundaries for the assessment. Transects should begin at the highest high water mark (HHWM: distance referenced as Station 0.0 m) and, at a minimum, extend to a depth of -20 m (–30 m if the development has the potential to effect deeper benthic habitats). Though small-scale intertidal projects may only require intertidal transects, care must be taken to ensure that a representative sample is collected across the proposed development area. Procedural manuals are available from DFO if sampling of intertidal clam or benthic invertebrates is required. To ensure complete assessment of marine plants and animals in the photic zone, deeper transects may be necessary, especially to determine the effects of sunken debris or woodwaste accumulations resulting from existing developments. Transects should be spaced approximately 25 m apart, although this interval may vary depending on the width of the site. The number of transects required will depend on the nature of the foreshore development proposed, anticipated effects of the development, and local site conditions (tides and currents, geography, fetch, geology, etc.). Transects should be individually numbered and indicated on the site plan, and their commencement point referenced to benchmarks, where possible.

Recording Observations

Habitat inventories should be conducted during the more productive spring and summer months. At that time, algae and saltmarsh species are more readily identifiable, enabling a better assessment of the productive capacity of the site.

Observations should be recorded every 5 m along the transect or at significant changes in habitat type. Observations should include substrate type and composition, presence and relative abundance of marine animals and plants, and any other notable features (e.g., debris accumulations) using the following format:

Substrate

Substrate types are to be subdivided into the following size class categories:

- Bedrock
- Boulder (>256 mm diameter)
- Cobble (64-256 mm diameter)
- Gravel (2-64 mm diameter)
- Sand (0.0625-2 mm diameter)
- Silt/Mud/Clay (<0.0625 mm diameter)

Substrate types are recorded cumulatively as percentages out of a total of 100% (e.g., Boulder 5%; Cobble 15%; Gravel 60%, Sand 20%)

Marine Plants

Marine plants include rooted vascular vegetation (e.g., eelgrass, saltmarsh vegetation, etc.) and marine algae (e.g., rockweed, kelp, etc.). Marine plant observations are recorded as percent areal coverage estimated per 5 m × 1 m transect segment. Observations can be recorded as percentages (5%, 10%, 15%, etc.) or by utilizing the following areal coverage classes:

+	<5%
1	5-25%
2	>25-50%
3	>50-75%
4	>75-100%

Sessile Animals

Many marine animals permanently attached to substrates function as important fish habitat (e.g., barnacles, bay mussels, etc.). Sessile animals are recorded as percent areal coverage along the transect line using either estimated percentages or by areal coverage classes, as presented above.

Motile Animals

Motile animals include fish and marine invertebrates such as crabs and snails. These can be individually counted along the transect or, where too numerous, their estimated numbers can be recorded. Population estimates will most likely be applied to species such as herring or mysid shrimp that naturally occur in large numbers.

Other Features

Accumulations of wood bark and debris, sunken logs or other waste materials arising from onsite or nearby development activities should also be recorded. For wood bark and related small size debris, observations are recorded as percent areal coverage estimates per 5 m × 1 m transect segment and estimated deposition depth (e.g., 15% / 10 cm). For larger materials (sunken logs, wood chunks, etc.), observations can be recorded by individual piece count or by estimate of percent areal coverage.

Observations should be correlated to the transect distance from the HHWM and (corrected) tidal height or water depth (e.g., Sta. 0+80 m / +4.5 m), with information compiled in tabular form, by transect. Common names of observed animals and plants are acceptable for the data table; a species list with scientific names should, however, be appended to the report.

General marine plant categories (e.g., rockweed, eelgrass, bull kelp, saltmarsh, etc.) and any other notable features should be sketched to scale directly on a copy of the site plan, drawings or photographs of the site. A site profile should be prepared for each transect showing the slope of the foreshore and the location of indicator marine plants or invertebrates. A sketch of the proposed marine development should be superimposed over the site plan so that any potential effect of the project on fish habitat is clear. Compensatory habitat proposed for offsetting altered habitat should also be sketched on site maps and profiles to enable review of the positioning of replacement habitat relative to the project.

Photographic Documentation

It is essential to produce a photographic record along the intertidal and subtidal transects. A videographic record of subtidal transects is also recommended. Photos and videos provide a real-time record of characteristic fish habitat at the proposed site and can be invaluable to future post-development site monitoring. Photographic records also facilitate comparison of the productivity of natural habitats with any compensatory habitat constructed to offset habitat losses. As visibility may be a problem, careful attention should be given to appropriate tidal levels, and midday lighting conditions are recommended. Aerial photos, taken at low tide, are often useful to put the site into context with the surrounding area and to verify information provided from other sources.

Assessment reports should include photographs of representative fish habitat types. Depending upon the scope of the proposed foreshore development, an unedited, labelled copy of the assessment video may also be required for the report submission. The video footage should be referenced with pertinent information (e.g., time, date, depth, heading, etc.), and a written or recorded interpretation should accompany the video.

Summary of information to be submitted

1. Basemap showing tenure area boundaries, surrounding area, transect locations and sampling stations
2. Shoreline video/photographs of intertidal zone
3. Underwater video/photographs of transects
4. Tabular data for each transect describing substrate type and composition, marine plants, sessile and motile marine animals, and other notable features
5. Habitat map showing location of different substrate types, plants, animals and operational infrastructure
6. Profile diagrams of each transect showing slope, sediment types and the major marine plants or animals observed
7. Photographs of site and aerial photographs if available.

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APPENDIX E • SPILL RISK ASSESSMENT

REPORT

March 10, 2016

SPILL RISK ASSESSMENT

Appendix E

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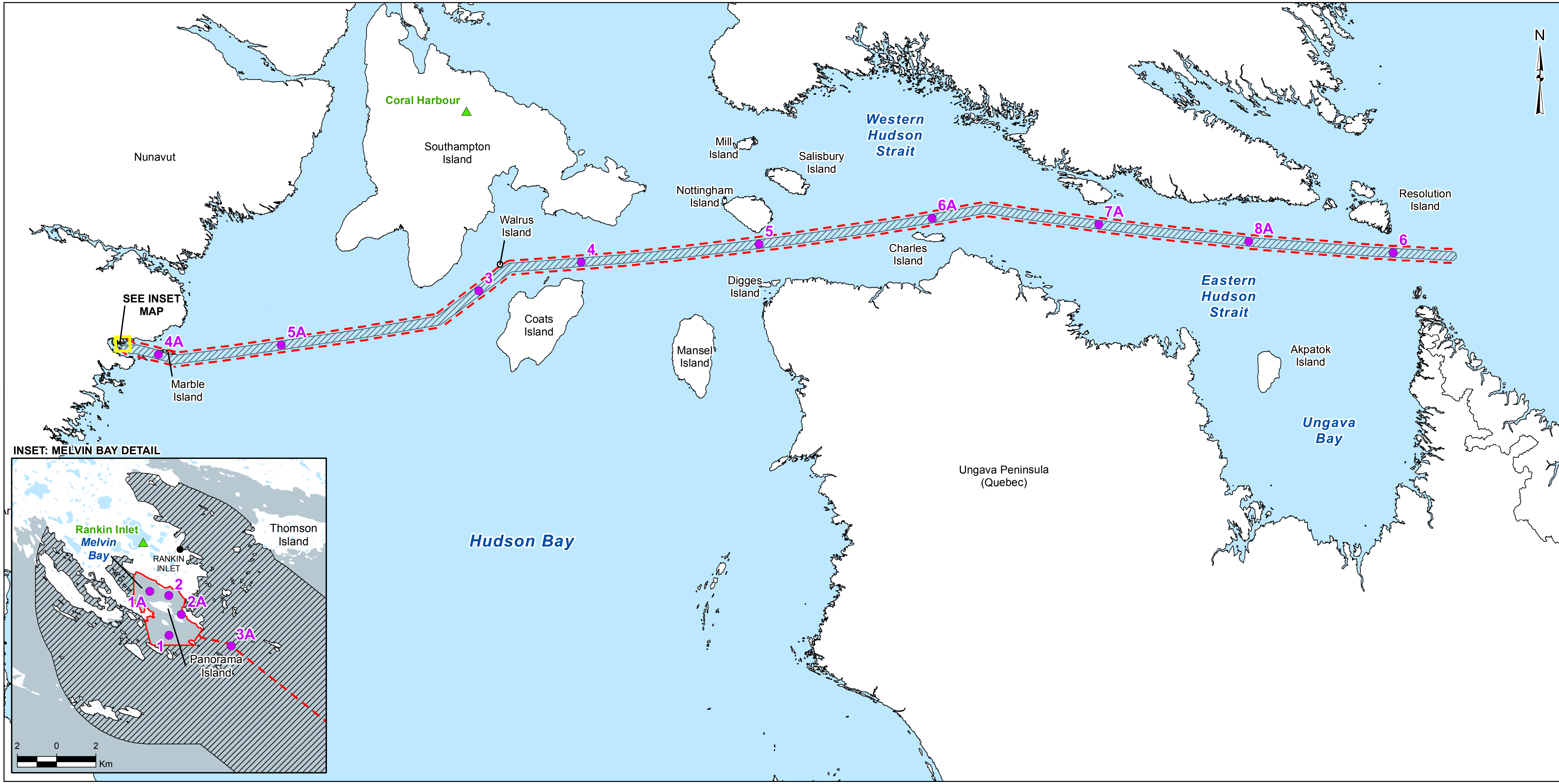
1.0 INTRODUCTION

This report presents a desktop level assessment of potential diesel fuel spill risk in the marine environment related to the Meliadine Gold Project (Project). The effects of fuel spills on sensitive biological receptors such as marine mammals and marine birds are discussed in Section 8.3.6.5 of the Final Environmental Impact Statement (FEIS) for the Meliadine Project. Golder Associates Inc. (Golder) has applied a modified version of the risk assessment strategy presented in ITOPF-TIP16 Contingency Planning for Marine Oil Spills (ITOPF 2011) based on existing Project information and available biophysical data in the Project area. This report includes an overview of oil spills in Canadian waters and potential open-water P50 diesel spills near Melvin Bay (ship-to-shore and ship-to-ship fuel transfer areas near Rankin Inlet) and along the primary deep-draught shipping route used by Project vessels during Project construction and operations phases (Figure E-1). The behavior of a diesel fuel spill in the marine environment was assessed at 14 different hypothetical spill locations in the Project area, considering aspects of evaporation, dispersion, spreading and potential distance traveled from the spill location. Five locations near Melvin Bay were considered in the assessment as these corresponded with ship-to-shore and ship-to-ship fuel transfer areas where a higher potential for fuel spills would occur (Figure E-1). Nine locations along the shipping route were also considered in the assessment as these corresponded with navigation zones in close proximity to islands or known sensitive/important coastal areas for marine mammals and/or marine birds; including Walrus Island, Coats Island, Ungava Peninsula, and Eastern Hudson Strait (Figure E-1). This assessment considered a low-probability, large spill scenario of 2 Million Litres (ML) (2,000 cubic metres [m^3]) of P50 diesel and a worst case spill scenario of 20 ML (20,000 m^3) of P50 diesel released at sites in Melvin Bay and along the shipping route. An additional spill scenario of a 100,000 litres (L) (100 metres m^3) spill was also considered at the ship-to-ship and ship-to-shore fuel transfer sites near Melvin Bay, representing smaller spills that could occur during fuel transfer activities.

The Project is primarily land-based with operations in the marine environment limited to six fuel tanker transits to Rankin Inlet from eastern North America during the open-water season (approximately August to October), and subsequent transfer of this fuel to shore using established fuel transfer locations near Melvin Bay. There were no Project-specific meteorological or oceanographic data collected as part of the baseline assessment for the Project; therefore, this assessment is based solely on information from existing literature and available third party data. Because of the limited marine operations planned for the Project, resulting in an overall low probability of a spill, this analysis was conducted with a simple fuel weathering model that does not include detailed hydrodynamic modelling.



LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- HYPOTHETICAL FUEL SPILL RELEASE LOCATION

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

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KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
SPILL RISK ASSESSMENT FOR FOURTEEN LOCATIONS

PROJECT NO.	1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN / REV. A
GIS	CDB	06 Jan. 2016	
CHECK			FIGURE E-1
REVIEW			

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2.0 OIL SPILLS IN CANADIAN WATERS

No information is available in the public domain/published literature related to existing fuel spill rates (e.g., frequency of spills) in the Hudson Bay region, although broader-scale information is available. The Arctic Monitoring and Assessment Programme (AMAP 2010) conducted an assessment of the effects of oil and gas activities in the Canadian Arctic to quantify the potential impacts from oil spills to the Arctic ecosystem and human health. Spills in the Arctic are considered rare and are typically associated with tanker traffic, with the most common location of spills occurring near ports (ITOPF 2011). From 1972 to 2003, a total of 1,226 oil spills were reported in the Canadian Arctic region; equivalent to a total volume of 3.3 ML (3,300 m^3) and a spill frequency of 2.5 spills per year. Of this total, 75 spills consisted of diesel fuel, equivalent to 334,000 L (334 m^3) and a frequency of one spill every 0.4 years (AMAP 2010).

Transport Canada commissioned WSP (formerly GENIVAR) to prepare a risk assessment for marine ship-based spills in Canadian waters north of the 60° North parallel (WSP 2014a). The study found the probability of oil spills in the Canadian Arctic is significantly lower than in the rest of Canada primarily due to the lower vessel traffic and volumes of oil transported. For the years 2002 to 2011, the volume of refined cargo products transported in the Arctic represented 0.18% of total volumes in Canada. The risk assessment found there to be a very low risk across the Canadian Arctic for a ship-source oil spill, however, the risk is slightly higher for the Hudson Strait and the coast of Labrador, mostly due to higher volumes of oil transported and traffic in these areas. Estimates of fuel spill frequency rates in the Arctic ranged from a return period of 285 years (i.e., one spill approximately every 285 years) for small spills (10 to 99.9 m^3) to 920 years for medium spills (100 to 999.9 m^3) and 92,000 years for large spills (1,000 to 9999.9 m^3) (WSP 2014a). According to the study, the frequency estimate for spills larger than 10,000 m^3 (10 ML) is zero for fuel oil and refined cargo products due to the lack of historical spills in this size range.

The trends of spill frequency have decreased over time due to improved technology, navigation, construction of vessels, and more stringent regulations (AMAP 2010; Anderson et al. 2012; WSP 2014b). Marine transportation in the Arctic is limited due to seasonal presence of ice. The lower frequency of ship transits in the Arctic region will downward bias spill rates calculated from Arctic data when compared to global statistics of spill frequency. However, as climate change causes a decrease in ice cover and the potential for transportation and other industrial activities in the Arctic increases, potential for spills may increase as well.

A study titled “Probability of Oil Spills from Tankers in Canadian Waters” by SL Ross Environmental Research Ltd. (SL Ross) predicts the frequency of oil spills from tankers in various areas of Canada (SL Ross 1999). The expected spill rate per year is calculated by multiplying the tonnage of oil loaded and unloaded at Canadian ports by spill frequencies derived from historical statistics. The expected spill rates for large (> 159,000 L) medium (8,000 to 159,000 L), and small (< 8,000 L) spills of product oil is 2.5, 12.3, and 36 spills per 10^8 ML loaded or unloaded per year, respectively.

3.0 MARINE TRANSPORT OF DIESEL FUEL FOR THE MELIADINE PROJECT

The FEIS for the Meliadine Project states that approximately 122 ML (122,000 m^3) of P50 diesel fuel will be delivered annually during operations. P50 is an Arctic diesel fuel with a lower temperature pour point than other diesel fuels. Based on the total volume of diesel fuel that will be transported throughout the life of the Project and spill rates reported by SL Ross (1999), the overall likelihood of a fuel spill for the Project is once every 36 years for small spills and once every 526 years for large spills. The approximate Project life that includes construction, operations, and closure is 18 years.

During construction and operations, approximately six large tankers will arrive to deliver P50 diesel fuel throughout the open-water shipping season. Each vessel trip will deliver approximately 20 ML (20,000 m^3) of P50 diesel fuel. The large tankers will anchor in deeper waters outside of Melvin Bay upon arrival in Rankin Inlet (Figure E-1). Large tanker to small tanker transfer of diesel fuel will occur at the large freighter anchor location. The carrying capacity of the small tanker will be either 7,300 m^3 or 10,500 m^3, depending on which vessel is used. Therefore, each of the six large tanker deliveries will take two to three trips to offload all of the fuel. The small tankers will anchor opposite Itivia and a floating pipeline of some 300 to 500 metres (m) will connect to a shore-based pipeline for transfer of fuel to the Project tank farm located near Itivia in Rankin Inlet. Fuel will be transferred through the pipeline at approximately 400 cubic metres per hour (m^3/h) for about 18 to 26 hours (h), depending on the carrying capacity of the small tanker. Agnico Eagle Mines Limited (AEM) has prepared an Oil Pollution Emergency Plan (SD 8-2) that details necessary actions to be implemented to reduce or minimize the loss of diesel fuel. Communication between the small tanker and the shore will be maintained throughout the transfer to safeguard the transfer of the diesel and to avoid overfilling of the tanks.

4.0 WEATHERING PROCESSES OF OIL SPILLS

The fate, toxic effect and weathering of an oil spill depends on the specific gravity, pour point, viscosity, chemical composition of refined and non-refined components, volume released, area of spreading, and the environmental conditions involved (ITOPF 2002). Environmental conditions include wind speed and direction, water depth, wave energy, solar radiation, current speed and direction, water temperature and distance to land. The weathering processes include dispersion, evaporation, spreading, adsorption to sediments, biodegradation, dissolution, emulsification, and photo oxidation (Figure E-2). Dispersion, evaporation, and spreading are the primary processes for determining fate and transport of diesel fuel, which is the primary fuel type being used for the Project. Oil dispersion is largely dependent upon the type of oil and the sea state, dispersing most rapidly with low viscosity oils, in the presence of breaking waves (ITOPF 2002). The rate of evaporation depends on ambient temperatures, wind speeds, and type of fuel. Spreading of the slick depends to a great extent on the viscosity of oil, the volume and the wind stress on the slick and surface water (Lehr et al 2002).

Diesel fuel has a low viscosity and will weather rapidly when spilled into the marine environment (NOAA 2006). With a lower density than water, diesel fuel will tend to stay on the water surface and be readily dispersed by wave action. Over 90% of a small spill of diesel in the marine environment is either evaporated or naturally dispersed over a time scale of several hours to days (NOAA 2006).

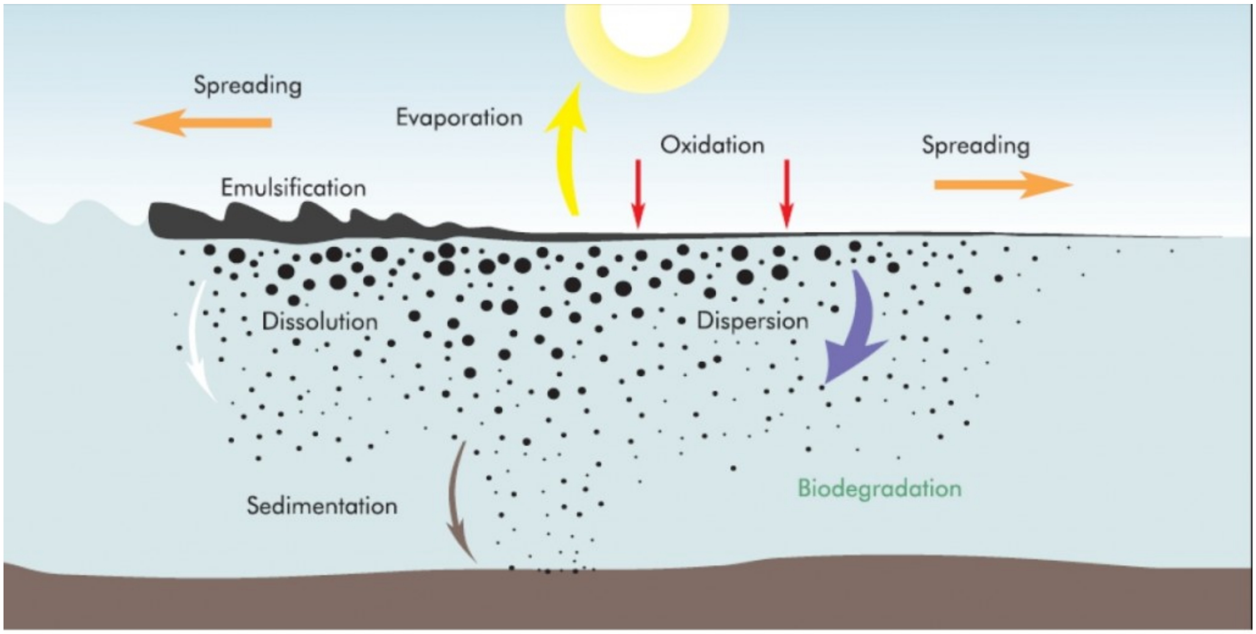


Figure E-2: Weathering Processes Action on Spilled Oil. Source: ITOPF 2002

5.0 OIL SPILL INTERACTION WITH SEA ICE

This section provides a summary of the potential ice conditions along the transportation route during the months of August to October and addresses potential effects of oil and fuel interactions and dispersion on ice covered waters in the event of a spill. The ADIOS model does not incorporate oil-ice interaction in its algorithms. Other models like the Oil Weathering Model (OWM) and Sea Ice-Ocean-Oilspill Modelling System (SIOMS) do, but they are still under development. The limited marine operation for the Project and the lack of data along the route limits the necessity and applicability of ice process-based models to this Project.

5.1 Sea Ice along the Transit Corridor

Hudson Bay is usually completely covered by ice by December or January and typically free of ice from August to October (Gagnon and Gough 2005). Sea ice in southwestern Hudson Bay typically does not breakup until well into the summer because winds and ocean currents tend to push large accumulations of ice into this region (Etkin 1991). The presence of sea ice into summer keeps waters of Hudson Bay at lower temperatures in comparison with other regions situated at similar latitudes. Hudson Bay is an enclosed bay sheltered by land with limited narrow access channels to larger ocean basins. Therefore, Hudson Bay water temperature, sea ice flows, and circulation are not strongly influenced by ice flows from other ocean basins. Instead, Hudson Bay dynamics are primarily controlled by local meteorological and micro-climate influences such as local wind and air temperature variations (Saucier and Dionne 1998; Gagnon and Gough 2005).

Ice melt starts in May and June, as an open water area develops along the northwestern shore, and a narrow coastal lead (i.e., space between ice floes, refer to Figure E-6) develops around the rest of the Bay. Open water starts to appear and expand around the shorelines in June and July. By the end of July, large patches of ice are limited to only the southern reaches of the Bay (CIS 2011). Figure E-3 shows that along the transportation route, the average ice break-up dates occur on July 2 for most of the route and on June 18 on the west side of Hudson Bay near Rankin Inlet.

Normal clearing of the pack ice progresses southward from the Chesterfield Inlet - Southampton Island area and westward from Eastern Hudson Bay. The melting of sea ice is a slow process which accelerates in July as air and water temperatures begin to warm with increased summer solar radiation. The ice pack in Hudson Bay typically breaks up into several large patches of ice prior to finally clearing in August (CIS 2011).

Sea ice typically begins to form along the northwestern shores of Hudson Bay in late October. Ice flows from Foxe Basin may also start to move into northeastern Hudson Bay in late fall. In November, the sea ice begins to accumulate and thicken as prevailing winds push it east and southeast toward the margins of the Bay. Finally, by December, Hudson Bay becomes covered with first-year ice, which continues to thicken into the winter months (CIS 2011).

In Hudson Strait, freeze-up starts as early as mid-October and as late as the first week of December as shown in Figure E-4, while complete clearing has occurred as early as late as July and as early as September. Sea ice in Hudson Strait and Ungava Bay is mostly formed locally but winds and currents can carry floes from Foxe Basin or Davis Strait into these areas. Freeze-up typically starts in western Hudson Strait and ice formation progresses eastward over the late fall months and cover the entire Hudson Strait by December (CIS 2011).

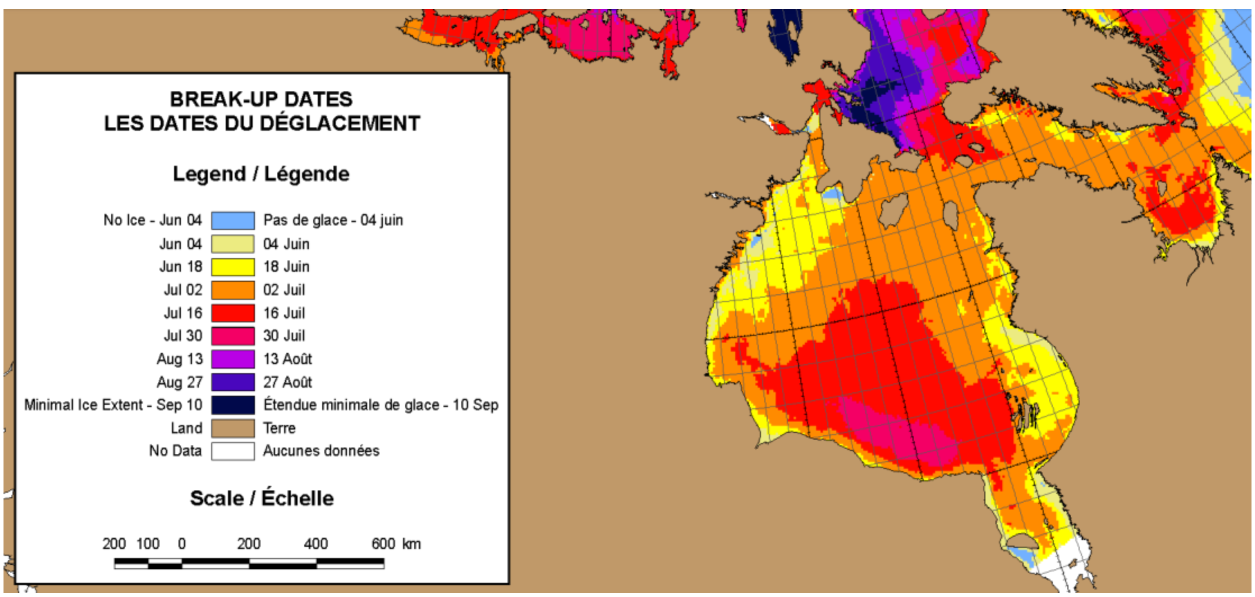


Figure E-3: Ice break-up and dates at Hudson Bay and Hudson Strait, source: CIS (2011)

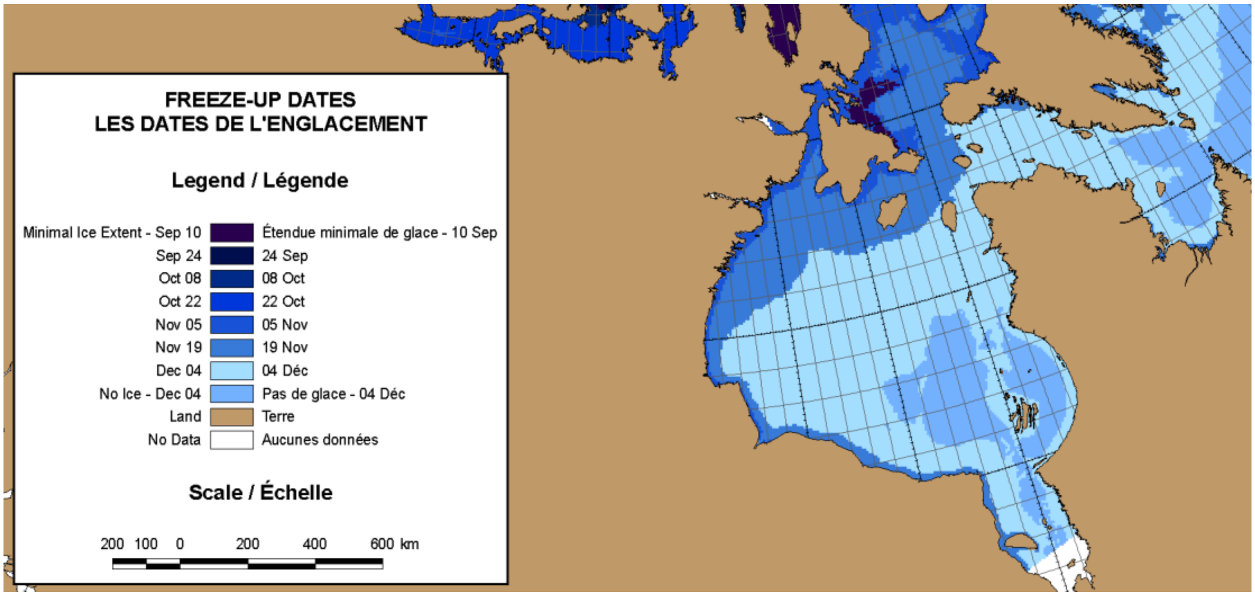


Figure E-4: Ice freeze-up dates at Hudson Bay and Hudson Strait, source: CIS (2011)

Ice-break up along the transportation route break-up occurs on June 18 in northwestern Hudson Bay in northeastern Hudson Bay as shown in Figure E-3. Therefore, early June and July are the months of greatest relevance in terms of potential oil spill interaction with sea ice.

The dates of ice freeze-up and break-up are derived from sea ice concentration data, which refers to the proportional surface area, covered by ice and is categorized over a range presented as fractional tenths (0 to 10/10). The ice break-up date represents the earliest day of the year when ice concentration reaches 5/10 or less. The ice freeze-up date represents the earliest day of the year when ice concentration reaches 5/10 or more (Gagnon and Gough 2005).

Figure E-5 presents ice concentration maps of Hudson Bay from July to November taken from the Sea Ice Climatic Atlas prepared by CIS (2011). The following observations are made from Figure E-5:

- In July (Figure E-5a), the median concentration of ice along the eastern portion of the transportation route is around 3-4/10 (open drift ice) and close pack fast ice (8-9/10) is expected on the northwest shoreline;
- The area within the route is considered ice-free for the months of August (Figure 8.2-B-4a), September (Figure E-5b) and October (Figure E-5c); and
- During November, freeze-up is expected on the northwest shoreline (4-9/10) and south shoreline of Southampton Island.

According to Dickins (2011), 1-5/10 drift ice conditions represent the greatest challenge in terms of spill containment and recovery. For ice concentrations of 6/10 and greater, spilled oil will tend to move at similar drift rates as sea ice. The intrusion of drift ice from Foxe Basin could interfere with Project vessels along the navigation route during the open water season from August to October.

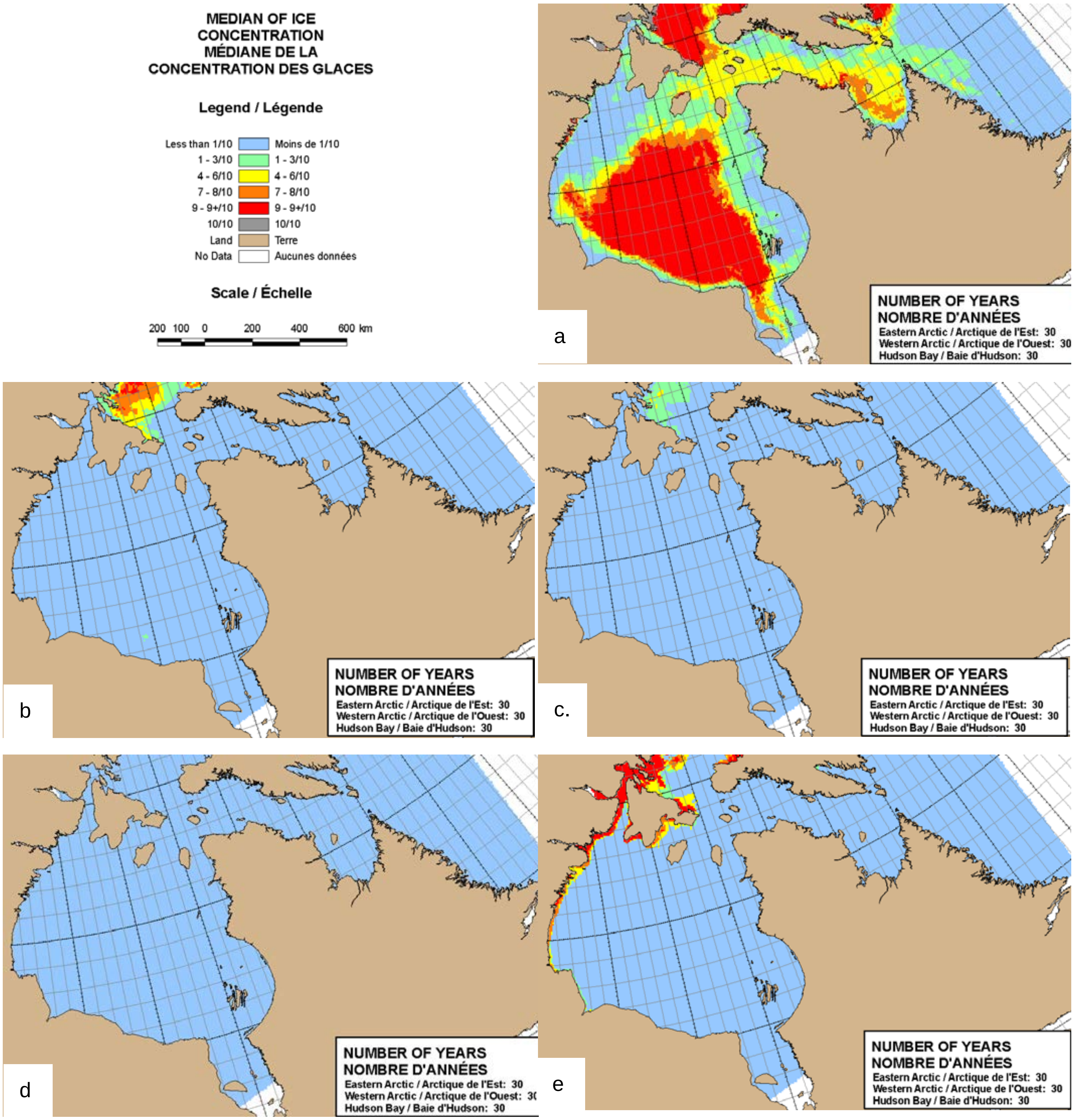


Figure E-5: Median of ice concentration in Hudson Bay and Hudson Strait during a) July, b) August, c) September, d) October and e) November, source: CIS (2011)

5.2 Ice Dispersion of a Potential Oil Spill

The behaviour of a spill in ice-covered waters is determined by the sea ice conditions at the time of the spill. Sea ice can be present in the seawater in multiple forms. A thorough understanding of the ice condition, ice coverage, energy conditions and the type of the spill and oil properties may help inform the study to determine the potential spill behaviour and fate and, consequently, improve the effectiveness for human response strategies to different spill events.

Several experiments described in Dickins (2011) have been designed to evaluate the response of the spill in different ice conditions: on and under drift and closed pack and fast ice, on surface melt pools, on snow and ice, in slush between floes, and under ice floes. Figure E-6 presents a schematic showing a range of ice and oil interactions resulting from oil spills in ice-covered waters.

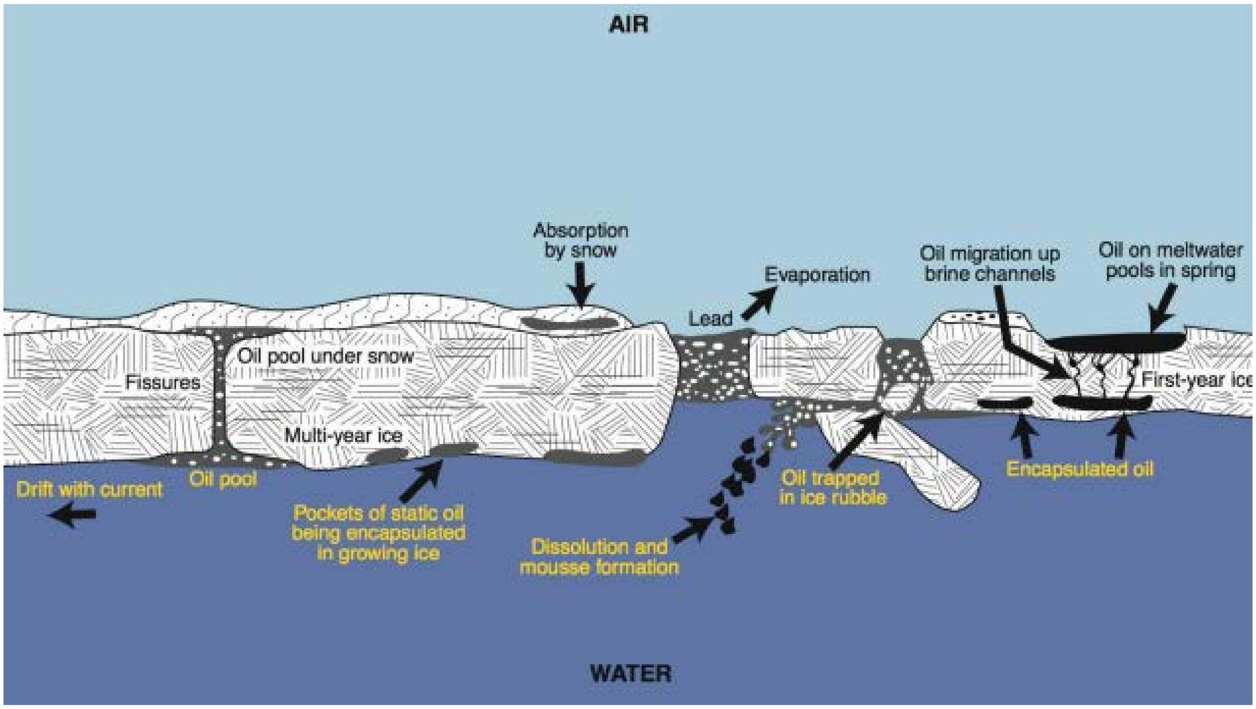


Figure E-6: Schematic showing ice and oil interactions (source: Dickins, 2011; derived from original sketch by A. Allen)

For the purposes of this study, the oil type P50 diesel fuel is examined. Some characteristics of P50 diesel are listed below:

- Most crude oils and light products such as diesel and gasoline experience significant evaporation (Potter et al. 2012);
- Small diesel spills usually evaporate and disperse naturally within a day for spills of 500 to 5,000 gallons, even in cold water (NOAA 2016);
- Diesel oil spreads very quickly to a thin film of rainbow and silver sheens (NOAA 2016);

- Diesel has a very low viscosity and is readily dispersed into the water column when winds reach 5-7 knots or with breaking waves (NOAA 2016);
- Since diesel is much lighter than seawater it is not possible to sink and accumulated on the seafloor (NOAA 2016);
- Wave action can disperse diesel to form droplets that are small enough to be kept in suspension and moved by the currents (NOAA 2016);
- Moderately volatile; will leave residue (up to one-third of spill amount) after few days (OSHA 2013);
- Moderate concentrations of toxic (soluble) compounds (OSHA 2013);
- Will “oil” intertidal resources resulting in potential for long-term contamination (OSHA 2013); and
- Cleanup can be very effective (OSHA 2013).

Table E-1 outlines different oil spill response methods for oil releases in cold and icy conditions, including a description of advantages and disadvantages for each method, as described by Lampala (2011).

Table E-1: Response Methods Used on Oil Spill Events

Method	Description
Mechanical recovery	From the environmental point of view, the mechanical recovery is usually considered as the most favorable oil spill combating method. Several skimmer types and techniques exist, but, because of variations in circumstances and climate conditions, ice coverage varies case-specifically and conditions may change even during response to a single incident, necessitating a toolbox of several response tools.
In-situ burning	*In situ* burning is particularly suitable for use in icy conditions, sometimes offering the best option for removal of surface oil. *In situ* burning of thick, fresh oil slicks can often be initiated very quickly through ignition of the oil with simple devices such as an oil-soaked sorbent pad. Oil from the water's surface can be removed efficiently and well via *in situ* burning: It is reported that the removal efficiency for thick slicks can exceed 90%. Oil removal rates of 2,000 m^3/hr can be achieved with a fire area of about 10,000 m^2.
Chemical Recovery	Dispersant chemicals work by enhancing the natural dispersion of the oil into the water column. A dispersant consists of a mixture of surfactants (surface-active agents) in a solvent. When applied to an oil slick, the surfactants will be positioned at the oil–water interface and contribute to formation of small oil droplets that will readily be mixed into the water column and be rapidly diluted and later biodegraded.
Bioremediation	Bioremediation is natural biodegrading of spilled oil, which to a certain extent can be accelerated through the addition of nutrients, oil-degrading bacteria, or both. Nutrient and bacteria addition has been tested, and some positive effects have been observed. It had been assumed that biodegrading does not occur in cold and icy conditions or is at least very slow; however, lab and field tests have shown that a low water temperature and even the presence of ice do not hamper the biodegrading of oil as much as expected. Nonetheless, it should be noted that bioremediation is a slow process that very seldom, if ever, can be considered as the primary countermeasure. The most beneficial use of bioremediation is as a secondary combating method that completes the recovery result after application of some other cleanup method.
Others	■ Use of vacuum pumps to suck oil between and under ice blocks. ■ Use of air bubbles to separate the oil and ice, with an air-induced current directing the oil into free water between ice blocks. ■ Use of propeller flow to direct oil under ice in the desired direction. ■ Creation of an ice boom to prevent drifting of oil in an undesired direction. ■ Use of specialized saw to cut slots in ice where oil can be removed.

Note:
The information in this table was derived from Lampala (2011).

In general, interactions between Project vessels and sea ice along the navigation route are predicted to be rare during the open- water season. However, changes in climate and larger scale weather patterns can result in variation to the typical break-up and/or freeze-up dates. Also, occasional incursions of drift ice from Foxe Basin and Davis Strait can be expected along the navigation route, particularly in Hudson Strait and Ungava Bay.

6.0 DIESEL FUEL SPILL SCENARIOS

For this analysis, we considered a worst case spill scenario of 20 ML (20,000 m^3) assuming all (100%) of the P50 diesel fuel carried on the ship was spilled. A second spill scenario was considered for 2 ML (2,000 m^3) based on the conservative assumption of 10% of the total P50 diesel fuel (20 ML) being carried on a single ship for the Project. Previous research indicates that spill volumes are best expressed as being equivalent to 5% to 10% of the total fuel being transported (McKenna and McClintock 2005; Coastal Ocean Resources 2013).Therefore, the 100% diesel spill assumed in the worst case scenario is extremely conservative and unlikely.

The Automated Data Inquiry for Oil Spills (ADIOS2), an oil weathering model (NOAA 2014), was used to provide estimates of the expected characteristics and behavior of fuel spilled in the marine environment. We analyzed a 20 ML and a 2 ML fuel spill at four locations in Melvin Bay and ten locations along the shipping route (Table E-2). Additional scenarios of 100,000 L (100 m^3) spills were analyzed at the four fuel transfer locations in Melvin Bay – as these represent smaller-scale spills that could occur during transfer of fuel from ship-to-ship or ship-to-shore. One of the main causes of fuel spills is related to navigational error where a tanker deviates from its planned track along the shipping route. The modelled scenarios assumed that the fuel spill would occur near the center of the main shipping lane and that ships would not deviate from this route (Figure E-1).

Table E-2: Hypothetical Fuel Spill Locations

Location Number	Location Name	UTM Zone	Easting (metres)	Northing (metres)
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546,173	6,961,117
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546,143	6,963,142
3	Shipping route south of Walrus Island	16	641,869	6,988,220
4	Shipping route north of Coats Island	17	456,430	7,000,031
5	Shipping route north of Ungava Peninsula	18	351,235	6,986,598
6	Shipping route in Eastern Hudson Strait	20	399,876	6,775,840
1A	West Melvin Bay	15	545,185	6,963,365
2A	East Melvin Bay	15	546,798	6,962,172
3A	Entrance to Melvin Bay	15	549,334	6,960,588
4A	West Hudson Bay	15	585,757	6,949,020
5A	Hudson Bay crossing	16	416,455	6,950,265
6A	Western Hudson Strait	18	546,017	6,967,899
7A	Mid-Hudson Strait	19	415,679	6,911,718
8A	Eastern Hudson Strait	19	570,404	6,842,009

6.1 Model Parameters

6.1.1 Extremal Analysis for Rankin Inlet and Coral Harbour Winds

Historical hourly wind records were obtained for Rankin Inlet (station ID: 71083) and Coral Harbour (station ID: 71915). The Rankin Inlet station is located at 62.82° N, 92.12° W at an elevation of 32.3 metres (m) above mean sea level (msl) and the Coral Harbour station is located at 64.78° N, 83.92° W at an elevation of 62.2 m above msl. Figure E-7 shows wind roses for the hourly record at Rankin Inlet from 1981 through 2012 for all wind measurements over the duration of the record (Figure E-7a) and for a filtered subset of only wind measurements made during the open water seasons (August to October) over the duration of the record (Figure E-7b). Figure E-8 shows wind roses for the hourly record at Coral Harbour for the same time period for all wind measurements over the duration of the record (Figure E-8a) and for a filtered subset of only wind measurements made during the open water seasons (August to October) over the duration of the record (Figure E-8b). In general, the prevailing wind direction at both sites is from the north-northwest (prevailing winds from 343° at both stations). The wind distribution observed between the full record and the record limited to open water seasons only are nearly identical at both stations. This indicates that there is no seasonal bias during the open water season that is not observed during the full annual distribution. Wind speed statistics were calculated for both stations and the results are shown in Table E-3 and Table E-4. Data were filtered for “0” values.

Wind speeds recorded at Rankin Inlet and Coral Harbour between 1981 and 2012 were used to determine probability distributions of wind speeds and their associated return periods. A peaks-over-threshold (POT) analysis was used to calculate the peak wind speeds of the largest storms during the 31-year record at each site. Extreme wind speeds were determined by filtering the record for peak wind speeds during storms with speeds greater than the 95 percentile value (Table E-3) sustained for at least 4 hours.

An extremal analysis following Leenknecht et al. (1992) was applied to the station record of extremes in order to determine the 5, 10, 25, 50 and 100-year wind speeds at the site. A time series of 77 maximum wind speeds measured during discrete storms between 1981 and 2012 were input to the extremal analysis. The analysis included the application of Fisher Tippett Type 1 (FT-1) and Weibull distributions to the peak water level time series. Results of the analysis for Rankin Inlet are summarized in Table E-5 and a plot of the Weibull distribution with shape parameter (k) = 1.15 is shown in Figure E-9. Results of the analysis for Coral Harbour are summarized in Table E-6 and a plot of the Weibull distribution with k = 2.00 shown in Figure E-10. The wind analysis indicates that the prevailing winds are from the north-northwest (343°) at both Rankin Inlet and Coral Harbour, while the extreme storm winds are from the north-northwest (343°) at Rankin Inlet and from the northeast (40°) at Coral Harbour. Therefore, wind direction for the 50-year storm should be applied as 343° for oil spill model points near Melvin Bay (represented by Rankin Inlet winds) and as 40° for oil spill model points along Hudson Strait (represented by Coral Harbour winds).

Table E-3: Wind Statistics for Rankin Inlet and Coral Harbour (1981-2012) in Metres/Second

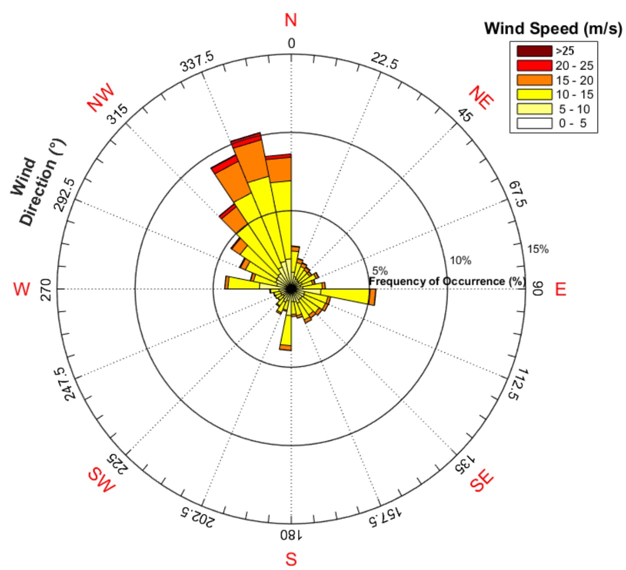
	Min	1%	5%	25%	Median	Mean	75%	95%	99%	Max	Std
Rankin Inlet	0.6	1.1	1.9	4.2	6.1	6.6	8.3	12.8	15.8	28.3	3.3
Coral Harbour	0.6	1.1	1.7	3.1	5.3	5.4	7.2	11.4	15.0	28.3	3.1

Minimum (Min), Maximum (Max), Standard Deviation (Std)

Table E-4: Wind Statistics for Rankin Inlet and Coral Harbour (1981-2012)

	Record Length	Missing	Number Invalid	% Invalid
Rankin Inlet	281,088	0	8,474	3%
Coral Harbour	280,608	480	23,285	8%

Invalid = “0” value



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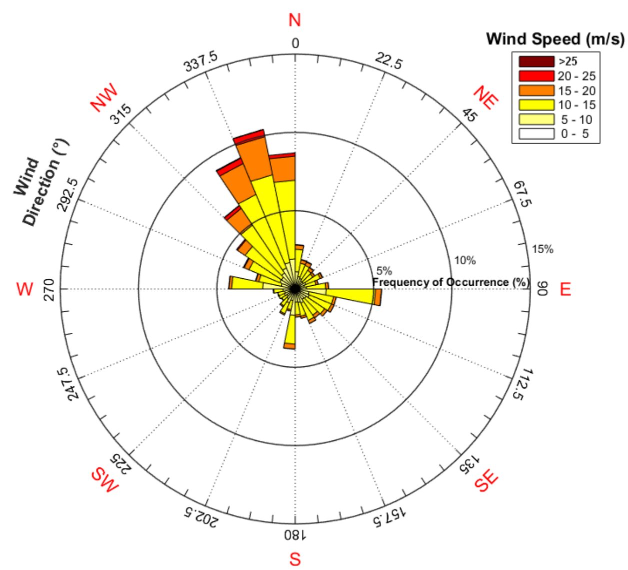


b.

Figure E-7: Wind Roses for Rankin Inlet from 01 October 1981 to 01 October 2012 for (a) all wind measurements and (b) wind measurements during the open water seasons only

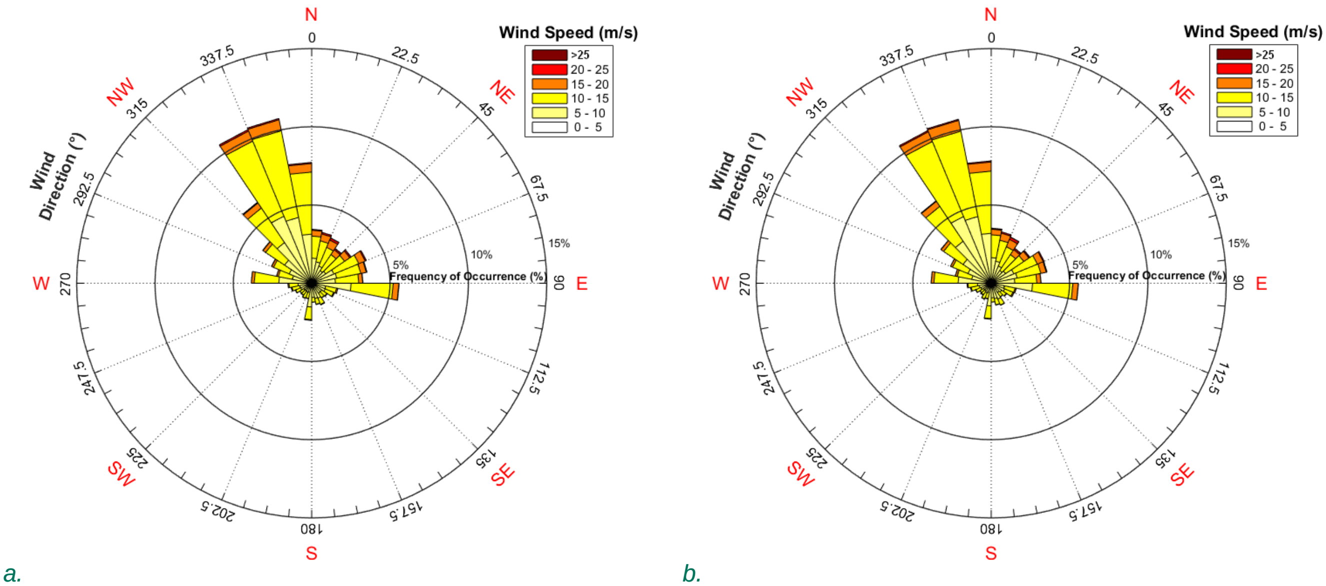


Figure E-8: Wind Roses for Coral Harbour from 01 October 1981 to 01 October 2012 for (a) all wind measurements and (b) wind measurements during the open water seasons only

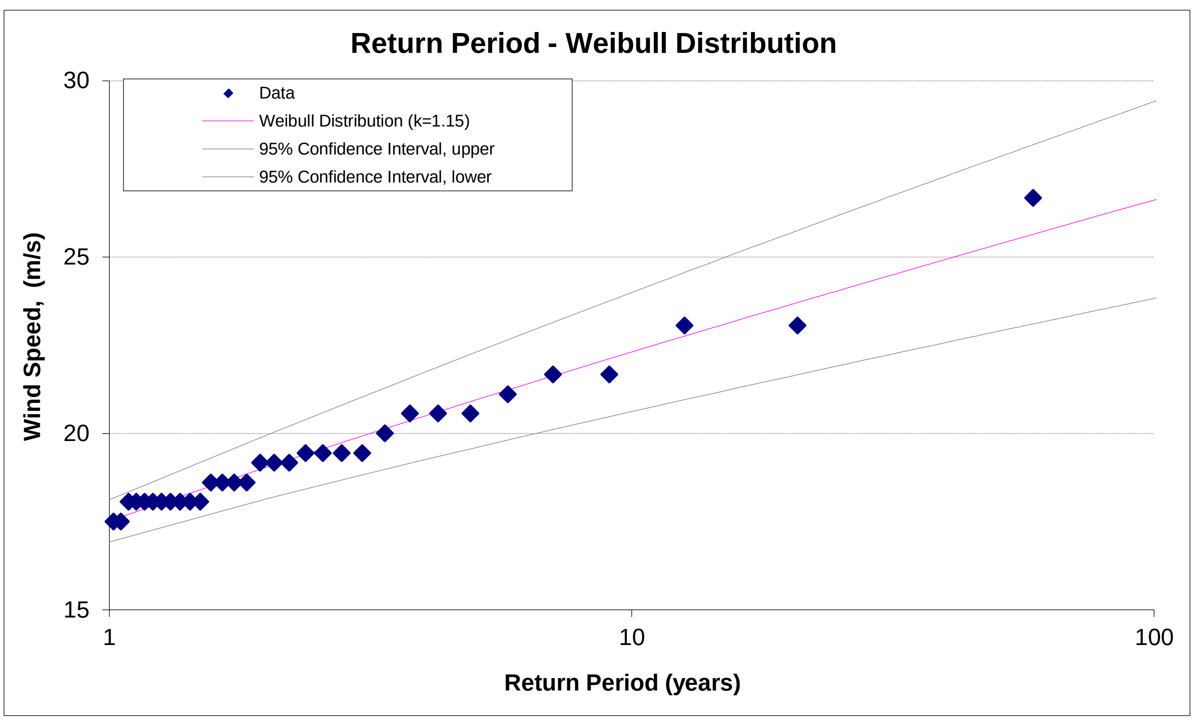


Figure E-9: Wind speed as a function of return period for a Weibull (k=1.15) distribution for Rankin Inlet wind record

Table E-5: Extreme Wind Speeds (m/s) and Associated Return Periods for Rankin Inlet

N= 77	Nu= 1.00					
NT= 77	K= 32	FT-I	Weibull	Weibull	Weibull	Weibull
Lambda=2.41			k= 0.75	k= 1.15	k= 1.49	k= 2.00
Correlation Coefficient		0.9880	0.9711	0.9918	0.9860	0.9708
Sum Square of Residuals		8.23	19.72	5.65	9.64	19.89
Return Period (yr)		m/s	m/s	m/s	m/s	m/s
	2	19.2	18.52	19.05	19.23	19.33
	5	20.8	20.59	20.94	20.92	20.80
	10	22.0	22.34	22.31	22.07	21.73
	25	23.6	24.85	24.06	23.46	22.82
	50	24.7	26.88	25.35	24.44	23.56
	100	25.9	28.20	26.62	25.03	24.00
Confidence Interval	Return Period (yr)	m/s	m/s	m/s	m/s	m/s
95 % C.I.	5	19.7 - 21.9	18.4 - 22.7	19.6 - 22.3	19.8 - 22.0	19.9 - 21.7
95 % C.I.	10	20.7 - 23.3	19.4 - 25.3	20.6 - 24.0	20.7 - 23.4	20.7 - 22.8
95 % C.I.	25	21.9 - 25.2	20.7 - 29.0	21.9 - 26.2	21.9 - 25.0	21.6 - 24.0
95 % C.I.	50	22.8 - 26.6	21.8 - 31.9	22.9 - 27.8	22.7 - 26.2	22.2 - 24.9
95 % C.I.	100	23.7 - 28.1	22.5 - 33.9	23.8 - 29.4	23.1 - 26.9	22.6 - 25.4

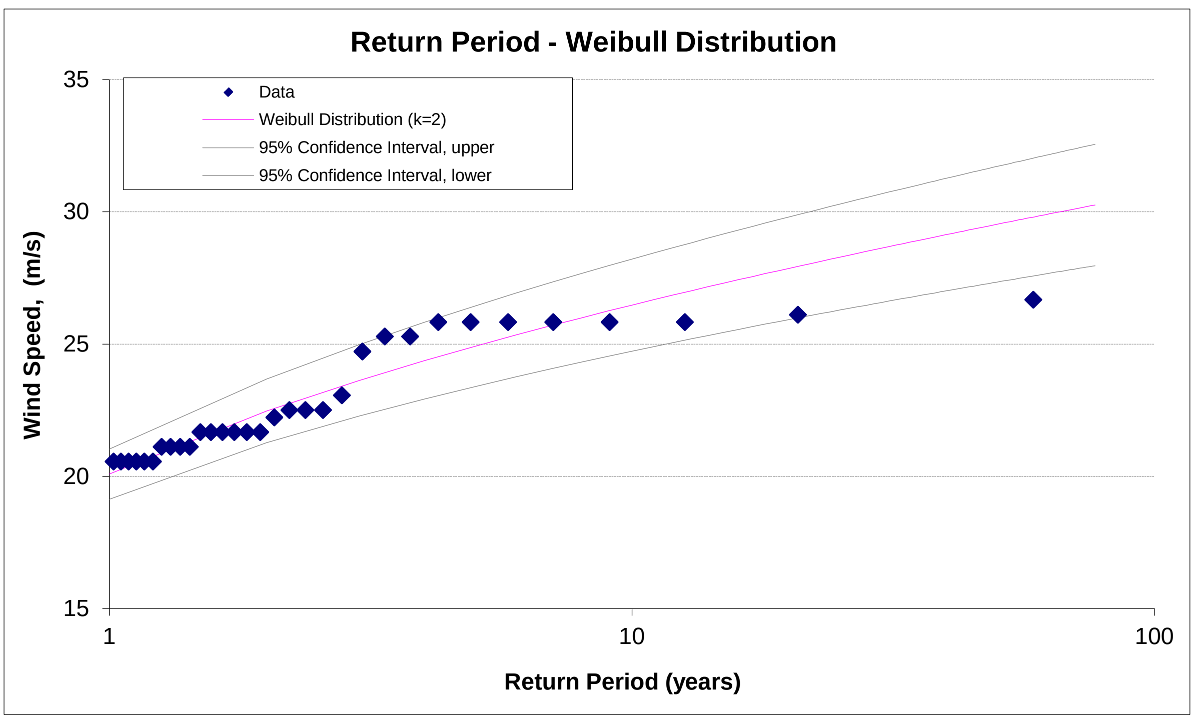


Figure E-10: Wind speed as a function of return period for a Weibull (k=2.00) distribution for Coral Harbour wind record

Table E-6: Extreme Wind Speeds (m/s) and Associated Return Periods for Coral Harbour

N= 77	Nu= 1.00					
NT= 77	K= 32	FT-I	Weibull	Weibull	Weibull	Weibull
Lambda=2.41			k= 0.75	k= 1.15	k= 1.49	k= 2.00
Correlation Coefficient		0.9580	0.8222	0.9195	0.9535	0.9757
Sum Square of Residuals		78.25	308.39	147.11	86.46	45.71
Return Period (yr)		m/s	m/s	m/s	m/s	m/s
	2	22.1	20.90	21.83	22.21	22.48
	5	24.8	23.80	24.74	24.92	24.92
	10	26.7	26.26	26.84	26.76	26.48
	25	29.2	29.79	29.54	28.99	28.29
	50	31.1	32.64	31.52	30.57	29.53
	100	32.9	34.49	33.47	31.52	30.26
Confidence Interval	Return Period (yr)	m/s	m/s	m/s	m/s	m/s
95 % C.I.	5	23.0 - 26.5	20.2 - 27.4	22.5 - 27.0	23.1 - 26.8	23.4 - 26.4
95 % C.I.	10	24.5 - 28.9	21.3 - 31.2	24.0 - 29.6	24.6 - 29.0	24.7 - 28.2
95 % C.I.	25	26.4 - 31.9	23.0 - 36.6	26.0 - 33.1	26.4 - 31.6	26.3 - 30.3
95 % C.I.	50	27.9 - 34.2	24.2 - 41.0	27.4 - 35.6	27.6 - 33.5	27.3 - 31.7
95 % C.I.	100	29.3 - 36.5	25.1 - 43.9	28.8 - 38.1	28.4 - 34.7	28.0 - 32.6

6.1.2 Spill Scenarios and Input Parameters

ADIOS2 predicts changes over time in the density, viscosity, and water content of diesel fuel, including evaporation and dispersion rates. The following assumptions were made for model set-up:

- ADIOS 2 diesel fuel oil (Canada), equivalent to P50;
- Spill of 100,000 L (100 m^3) and 2 ML (2,000 m^3) for near-shore spills;
- Spill of 2 ML (2,000 m^3) for shipping route spills;
- Spill of 20 ML (20,000 m^3) for shipping route spills;
- Sea salinity of 32 parts per thousand (ppt);
- Surface water and diesel fuel temperature of 5° Celsius (C);
- Sediment load of 5 milligrams per litre (mg/L);
- Spill occurs near the center of the proposed shipping lane; and
- Spill scenarios assume no mitigation.

Winds and waves are generally the driving physical forces used to determine the oil drift slick speed and distance travelled (DNV 2011). Golder analyzed winds from Rankin Inlet and Coral Harbour and performed an extremal analysis for 31-years of hourly data (Section 6.1.1). For modeling simulations, Golder used mean, 2-year, and 50-year wind conditions. For the 31-year record, the majority of the winds from both stations originated from 343° (North-Northwest). The extreme winds at Rankin Inlet also originate from North-Northwest (typically 343°), but the extreme winds at Coral Harbour originate from the northeast (typically 40°). For all scenarios except the 50-year extreme wind scenario, the fetch was measured along the axis of prevailing wind direction from 343° to 163°. The 50-year extreme wind scenario was measured along the axis of the dominant wind direction. In Rankin Inlet, extreme winds typically blow from 343° to 163° and this wind alignment would be applicable for points in Melvin Bay and Hudson Bay (points 1, 1A, 2, 2A, 3A, 4A, and 5A). At Coral Harbour, extreme winds blow from 40° to 220° and this wind alignment would be applicable for points along Hudson Strait (points 3, 4, 5, 6A, 7A, 8A and 6). Wind-related model parameters (i.e., fetch, distance to shore, and wind speeds) for the hypothetical fuel spill locations are provided in Table E-7. Summary tables and figures from the ADIOS2 model simulations inputs and outputs are provided in Attachment A.

Table E-7: Wind Related Model Parameters for Spill Scenarios along Shipping Route

Location (Number)	Fetch (km)			Distance to Shore (km)			Wind Speed (m/s)		
	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Ship-to-ship fuel transfer (1)	0.5	Mean[1]	Mean[1]	0.9	Mean[1]	Mean[1]	6.6	19.0	25.4
Ship-to-shore fuel transfer (2)	0.4	Mean[1]	Mean[1]	0.4	Mean[1]	Mean[1]	6.6	19.0	25.4
West Melvin Bay (1A)	0.9	Mean[1]	Mean[1]	0.6	Mean[1]	Mean[1]	6.6	19.0	25.4
East Melvin Bay (2A)	1.3	Mean[1]	Mean[1]	0.3	Mean[1]	Mean[1]	6.6	19.0	25.4
Walrus Island (3)	43	Mean[1]	134	55	Mean[1]	760	5.4	22.5	29.5
Coats Island (4)	58	Mean[1]	50	23	Mean[1]	22	5.4	22.5	29.5
Ungava Peninsula (5)	16	Mean[1]	24	46	Mean[1]	106	5.4	22.5	29.5
Eastern Hudson Strait (6)	26	Mean[1]	775	46	Mean[1]	325	5.4	22.5	29.5

Location (Number)	Fetch (km)			Distance to Shore (km)			Wind Speed (m/s)		
	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Entrance to Melvin Bay (3A)	2	Mean[1]	Mean[1]	12	Mean[1]	Mean[1]	6.6	19	25.4
West Hudson Bay (4A)	14	Mean[1]	Mean[1]	700	Mean[1]	Mean[1]	6.6	19	25.4
Hudson Bay crossing (5A)	148	Mean[1]	Mean[1]	857	Mean[1]	Mean[1]	6.6	19	25.4
Western Hudson Strait, Charles Island (6A)	183	Mean[1]	115	20	Mean[1]	21	5.4	22.5	29.5
Mid-Hudson Strait (7A)	45	Mean[1]	29	160	Mean[1]	93	5.4	22.5	29.5
Eastern Hudson Strait, north Ungava Bay (8A)	47	Mean[1]	48	305	Mean[1]	164	5.4	22.5	29.5

Notes:
1. Cells listed as "Mean" indicates that cell values are equivalent to the mean wind case values.

The 2 ML and 20 ML spill scenarios were each modelled with and without the influence of currents on the slick trajectory. A summary of the predominant current velocities at each location is presented in the results table in Section 6.3, Table E-9 through Table E-11. A background literature review was conducted to provide the oceanographic conditions along the shipping route with particular attention to the surface currents along the route. Current velocity along the western portion of the shipping route (Rankin Inlet to Coats Island) is predominantly forced by tides running along the axis of the route, but the eastern portion of the route through Hudson Strait east of Coats Island is dominated by the cyclonic circulation forcing a current to the east-southeast (Drinkwater 1986; Drinkwater 1988; Saucier et al 2004). South of the proposed shipping route in Hudson Bay, currents have been modelled to predict the seasonal cycle of water masses and sea ice by Saucier et al. (2004) and Wang et al. (1994). Currents from the Arctic Ocean flow around both sides of Southampton Island from the north (Ingraham and Prisenburg 1998). Coastal currents flow counter-clockwise along the southwestern portion of Hudson Bay towards James Bay, north along the eastern coast of Hudson Bay and through the southern Hudson Strait into the Labrador Sea. The surface eddy current is strongest during ice-free periods and reaches 15 to 20 centimetres per second (cm/s) (Saucier et al. 2004) in northeastern Hudson Bay. Current enters into Hudson Strait from the Atlantic along the southern shore of Baffin Island and exits along the northern shore of Quebec (Drinkwater 1986; Drinkwater 1988; Ingraham and Prisenburg 1998; Straneo and Saucier 2008). In the center of Hudson Strait there is a cyclonic pattern which brings the current across the channel from the north to south. Figure E-11 provides an overview of circulation patterns for the region, adapted from Straneo and Saucier (2008) and Drinkwater (1986).

Current data are available at several mooring locations in Hudson Strait and west of Southampton Island from the MERICA (*etudes des MERs Interieures du Canada*) 2003 to 2007 oceanographic data collection program (DFO 2015). Surface current data from representative sites were used to supplement or verify the literature review.

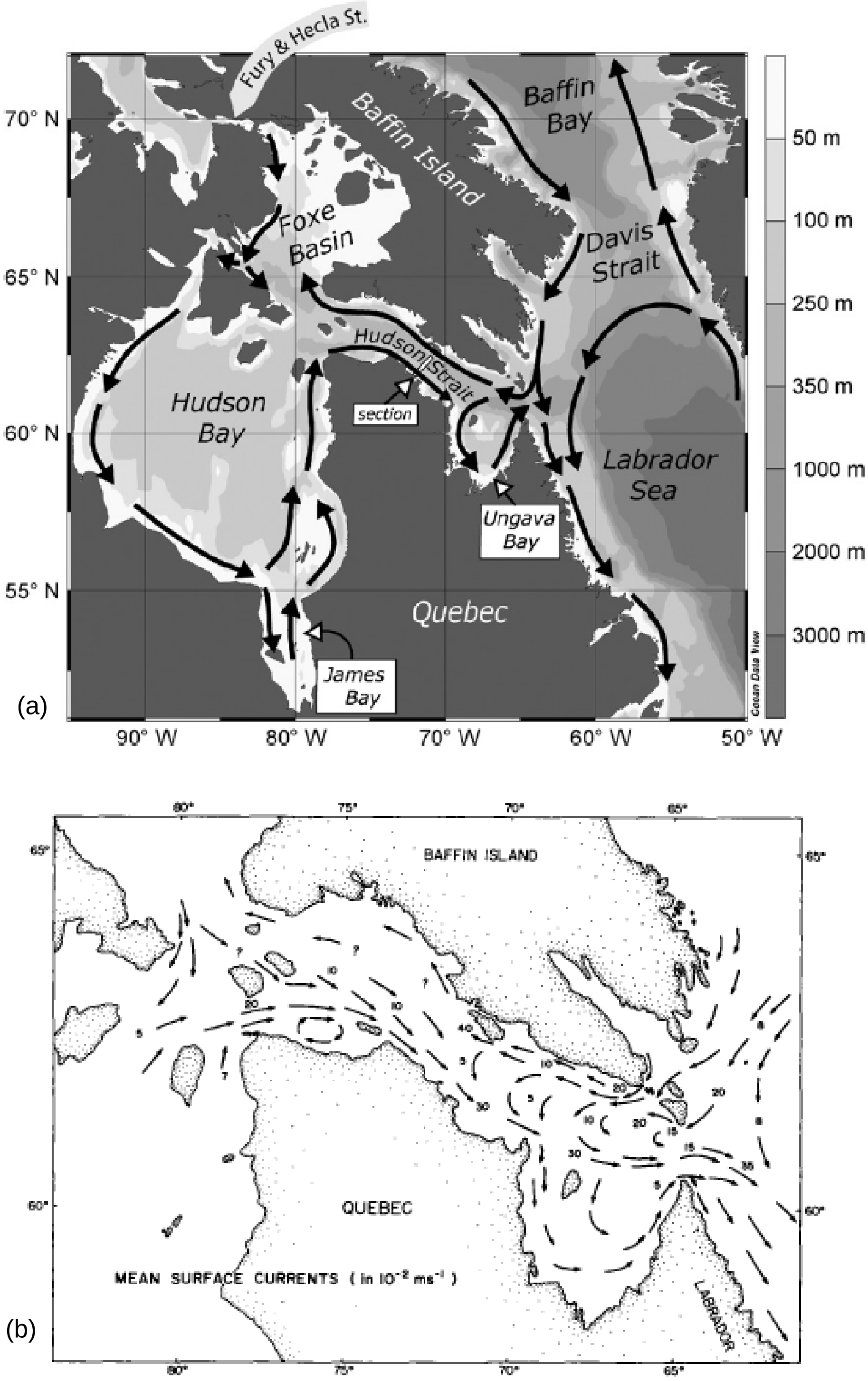


Figure E-11: (a) Hudson Bay system bathymetry and schematic circulation. Source: Straneo and Saucier 2008 and (b) Surface circulation in Hudson Strait and Ungava Bay. Source: Drinkwater 1986

Mean surface currents were considered at the locations along the shipping route when available. No information on currents in Melvin Bay near Rankin Inlet were available, therefore, no currents were applied to locations 1, 2, 1A, 2A, or 3A in the calculations. For the purpose of this analysis, predominant current direction and velocity at each location were used based on the availability of data, influence of currents on dispersion, and periodicity of the tides. Peak tidal currents were not considered because the tides are semi-diurnal and would switch direction multiple times during the course of a potential oil spill which could continue weathering for 12 hours or longer.

Currents were not input into the ADIOS2 model because these scenarios were considered instantaneous releases of fuel and each part of the slick would therefore experience the same net displacement (Lehr et al. 2002). The input of currents into the ADIOS2 model is generally used for modeling a spill from a fixed point such as an offshore platform. Mean surface currents were used for calculation of the slick velocity as a vector sum in combination with drift resulting from wind velocity.

6.1.3 Modelling Methodology

The ADIOS2 model output provided weathering half-life, and equations presented by the Australian Maritime Safety Authority were used to calculate the time for a spill to reach shore and the quantity of fuel from a spill that would be deposited on shore (DNV 2011). The quantity and proportion of fuel deposited on shore was determined after calculating the quantity of fuel remaining in the slick at the shore. The time between the occurrence of the spill and the slick initially reaching the shore (T_{shore}) depends primarily on the distance to shore (D_{zone}), wind velocity in the direction of the shore (V_{wind}), and the slick's velocity represented as a fraction (3%) of the wind velocity (RV_{drift}) (DNV 2011):

$$T_{shore} = \frac{D_{zone}}{V_{wind} RV_{drift}}$$

The quantity remaining in the slick (Q_s) relates to the original spill quantity (Q), weathering half-life to the quantity of fuel remaining (H), and time to shore (T_{shore}) (DNV 2011).

$$Q_s = Q * 2^{-T_{shore}/H}$$

For the scenarios where the mean surface current was considered, the slick velocity was calculated as a vector combination of the wind velocity and the current velocity:

$$V_{slick} = V_{wind} RV_{drift} + V_{current} RV_{drift}$$

Studies have found that slick transport due to surface currents is typically 60% (RV_{drift}) of the ambient current speed (Blaikley et al 1977): A new distance to shore was calculated based on the trajectory of the slick (V_{slick}) and used to determine the quantity deposited on shore.

6.2 Spills near Melvin Bay

The spill scenarios in Melvin Bay were completed for three different spill volumes: 100,000 L, 2 ML, and 20 ML, representing an average spill scenario, a large but low-probability spill scenario (10% spilled from a large tanker), and a worst case spill scenario (100% spilled from a large tanker), respectively. The weathering half-life (time required for removal of 50% of the diesel fuel from the sea surface) was determined using the ADIOS2 model. The amount of time it would take for a fuel spill to reach the shoreline given anticipated wind effects was then determined (originating from approximately 343º from the spill location) (Table E-8) along with the proportion of fuel estimated to be deposited on shore under the different spill scenarios.

Weathering characteristics for a 2 ML fuel spill are shown in Figure E-12. This figure illustrates the amount of fuel that would evaporate and disperse over time following the initial spill. For all spill scenarios considered at the fuel transfer locations near Melvin Bay, the weathering half-life was determined to be < 35 h. The time required for the spill to reach shore varied from approximately 6 minutes (min) (0.1 h) to 1 h 20 min. For all sites in Melvin Bay, it was determined that between 89% and 100% of the total volume of spilled diesel fuel would reach shore assuming no responsive mitigation occurred.

Table E-8: Distance to Shore, Weathering Half-Life, Time to Shore, and Estimated Percent of Spill Deposited on Shore for 100,000 L, 2 ML, and 20 ML Diesel Fuel Spill Scenarios in Melvin Bay

Location	Spill Amount (L)	Distance to Shore (km)	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Ship-to-ship fuel transfer (1)	100,000	0.9	7.8	3.4	2.7	1.3	0.4	0.3	89%	91%	92%
Ship-to-ship fuel transfer (1)	2,000,000	0.9	18.5	9.2	6.9	1.3	0.4	0.3	95%	97%	97%
Ship-to-ship fuel transfer (1)	20,000,000	0.9	34.8	16.1	14.8	1.3	0.4	0.3	98%	98%	98%
Ship-to-shore fuel transfer (2)	100,000	0.4	7.8	3.4	2.7	0.6	0.2	0.1	95%	96%	96%
Ship-to-shore fuel transfer (2)	2,000,000	0.4	18.5	9.2	6.9	0.6	0.2	0.1	98%	99%	99%
Ship-to-shore fuel transfer (2)	20,000,000	0.4	34.8	16.1	14.8	0.6	0.2	0.1	99%	99%	99%
West Melvin Bay (1A)	100,000	0.6	8	3.5	2.7	0.8	0.3	0.2	93%	94%	95%
West Melvin Bay (1A)	2,000,000	0.6	18.5	8.7	6.9	0.8	0.3	0.2	97%	98%	98%
West Melvin Bay (1A)	20,000,000	0.6	33.7	16.5	17.4	0.8	0.3	0.2	98%	99%	99%
East Melvin Bay (2A)	100,000	0.3	8	3.5	2.7	0.4	0.1	0.1	97%	97%	97%

Location	Spill Amount (L)	Distance to Shore (km)	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
East Melvin Bay (2A)	2,000,000	0.3	18.5	8.7	6.9	0.4	0.1	0.1	99%	99%	99%
East Melvin Bay (2A)	20,000,000	0.3	33.7	16.5	17.4	0.4	0.1	0.1	99%	99%	100%

km (kilometre); yr (year); h(hour); L (liter)

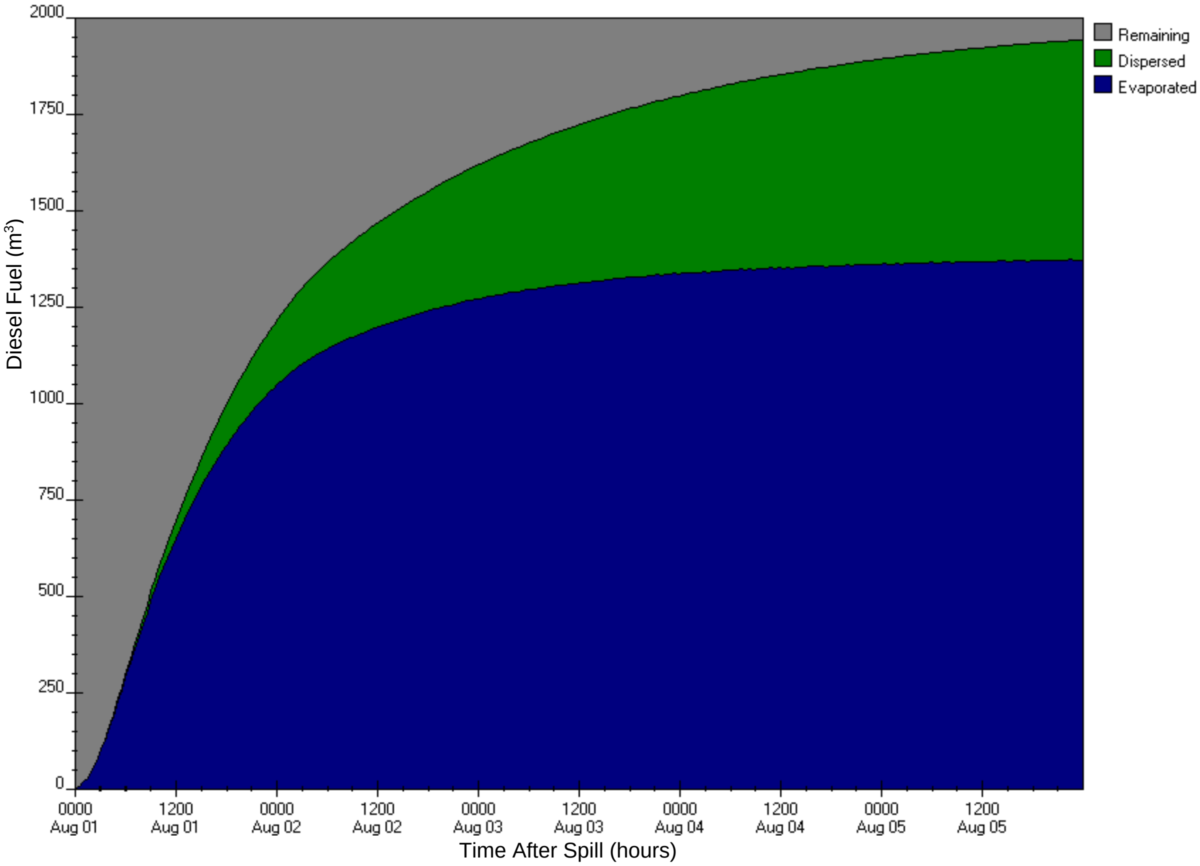
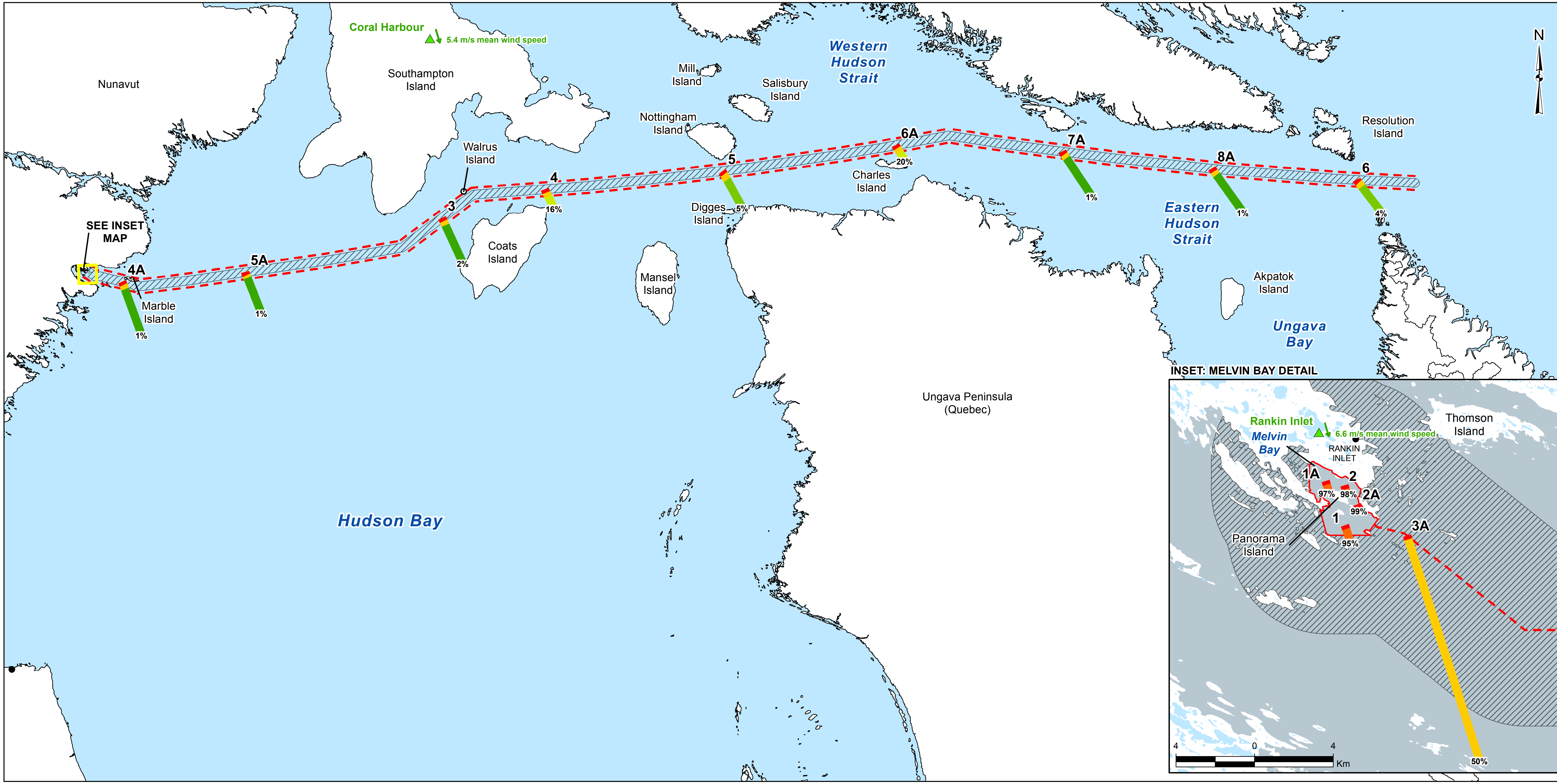


Figure E-12: Weathering Characteristics of a 2 ML Diesel Fuel Spill in Melvin Bay under Mean Wind and Wave Conditions



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KILOMETRES

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

• LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
• WIDTH OF LINE IS NOT TO SCALE
• ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

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DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, MEAN WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016	FIGURE E-13	
CHECK	JC	06 Jan. 2016		
REVIEW	LY	06 Jan. 2016		

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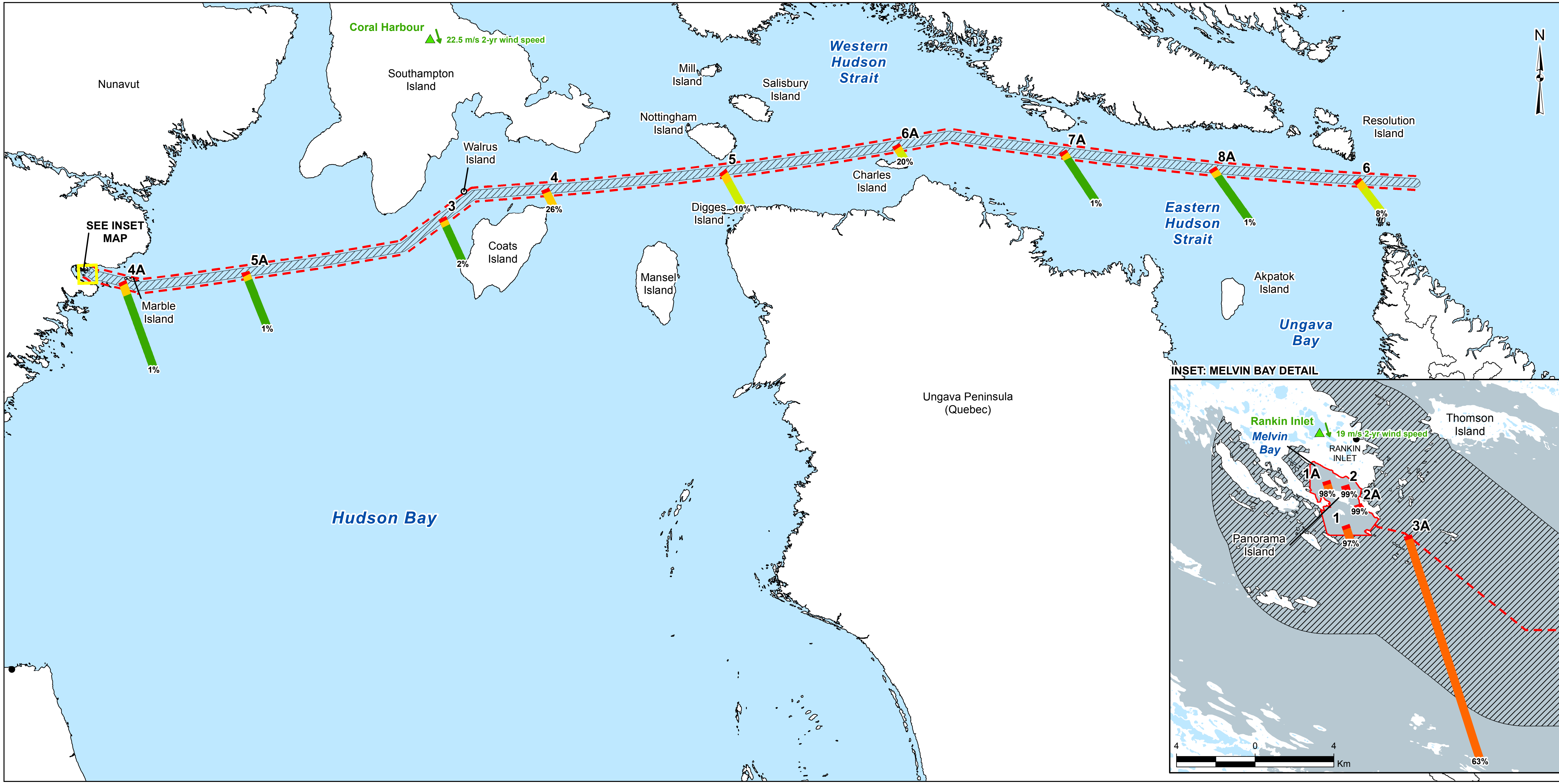

LEGEND

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- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
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5A	Hudson Bay crossing	16	416455	6950265
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7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 2-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.	1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN / REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-14
REVIEW	LY	06 Jan. 2016	

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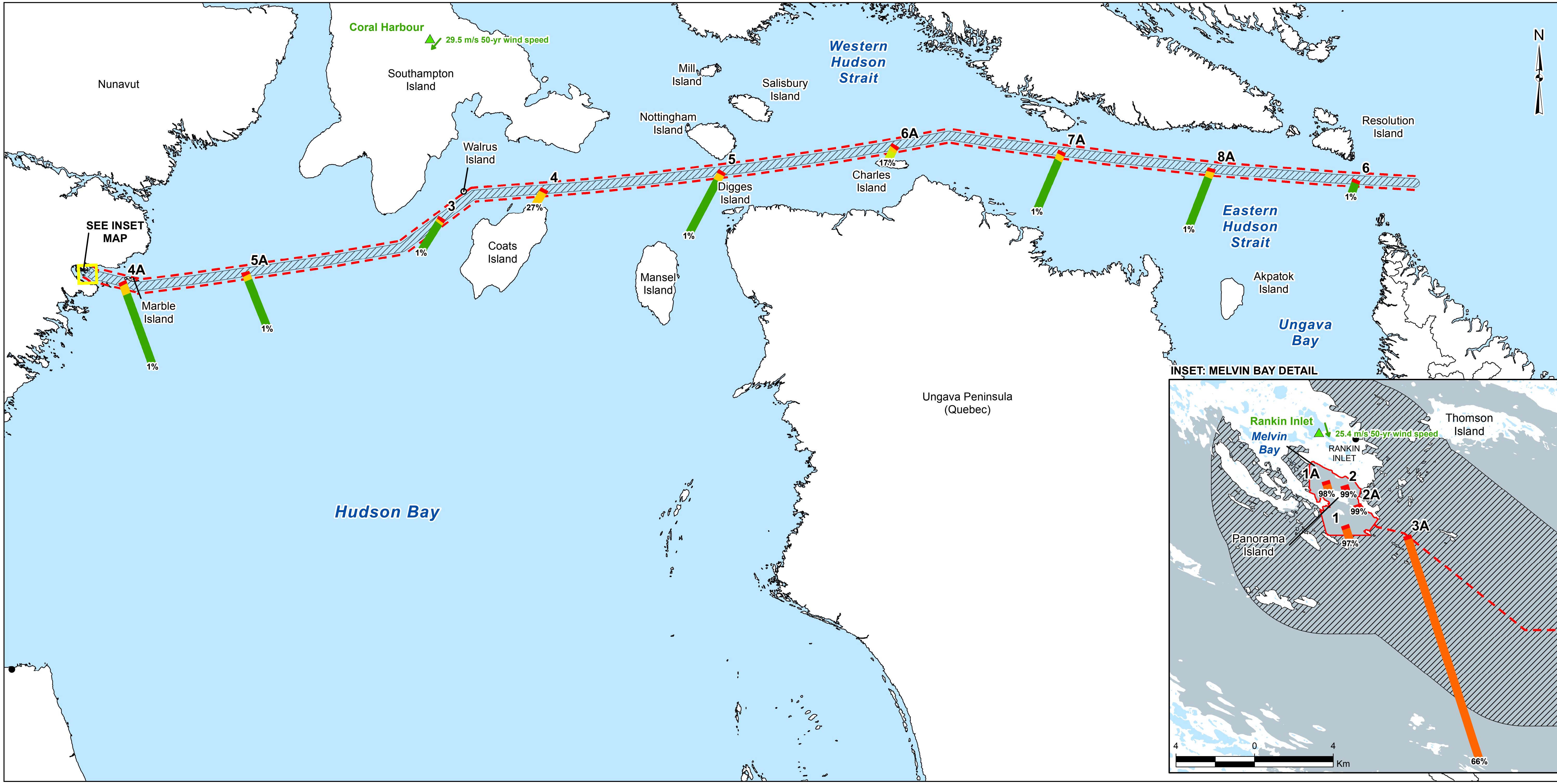

LEGEND

MARINE REGIONAL STUDY AREA (MARINE RSA)
MARINE LOCAL STUDY AREA (MARINE LSA)
WATERBODY
SHIPPING ROUTE (APPROXIMATE)
WIND STATION
WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

• LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
• WIDTH OF LINE IS NOT TO SCALE
• ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 50-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.	1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN / REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-15
REVIEW	LY	06 Jan. 2016	

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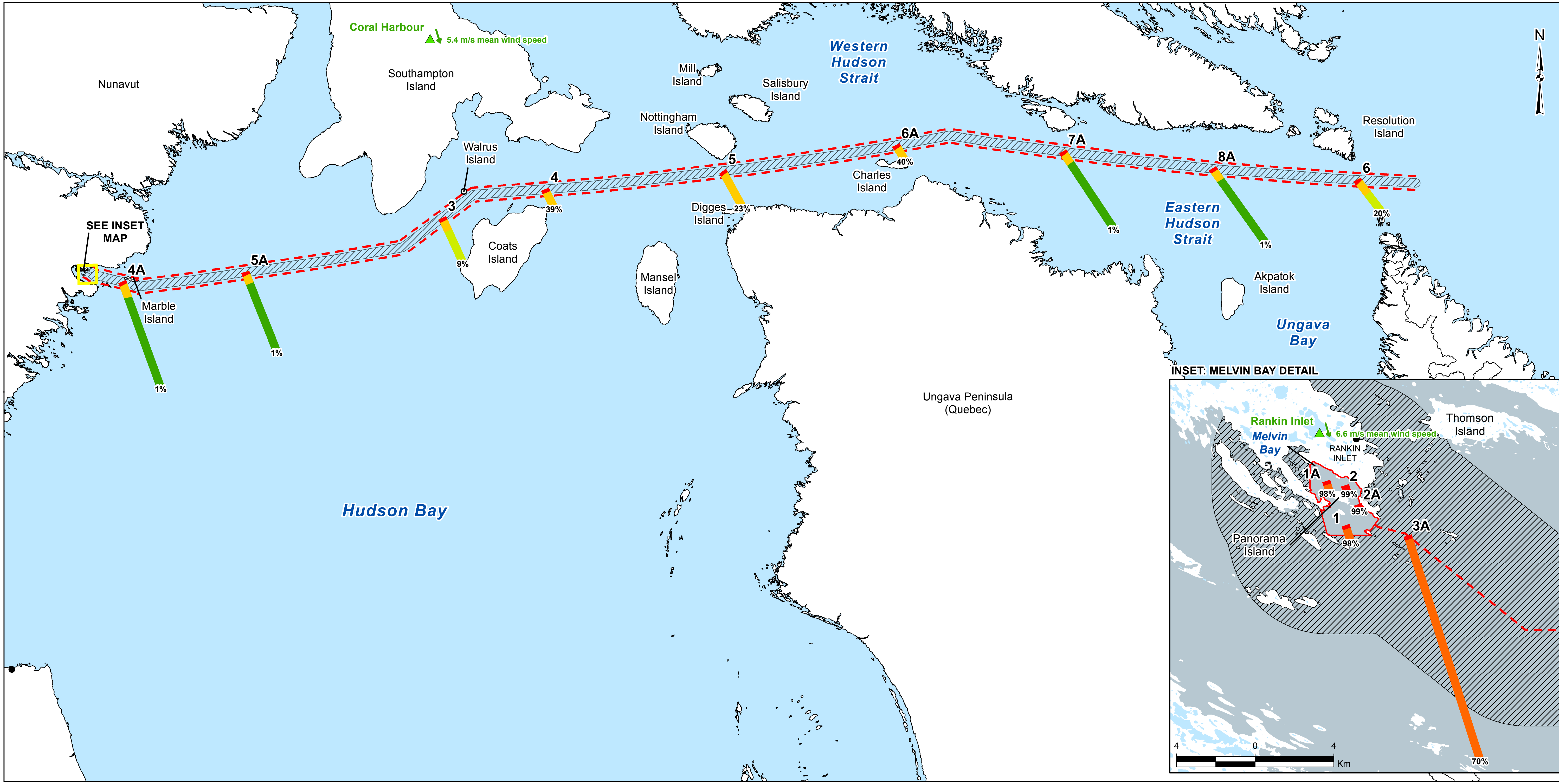

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, MEAN WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-16	
REVIEW	LY	06 Jan. 2016		

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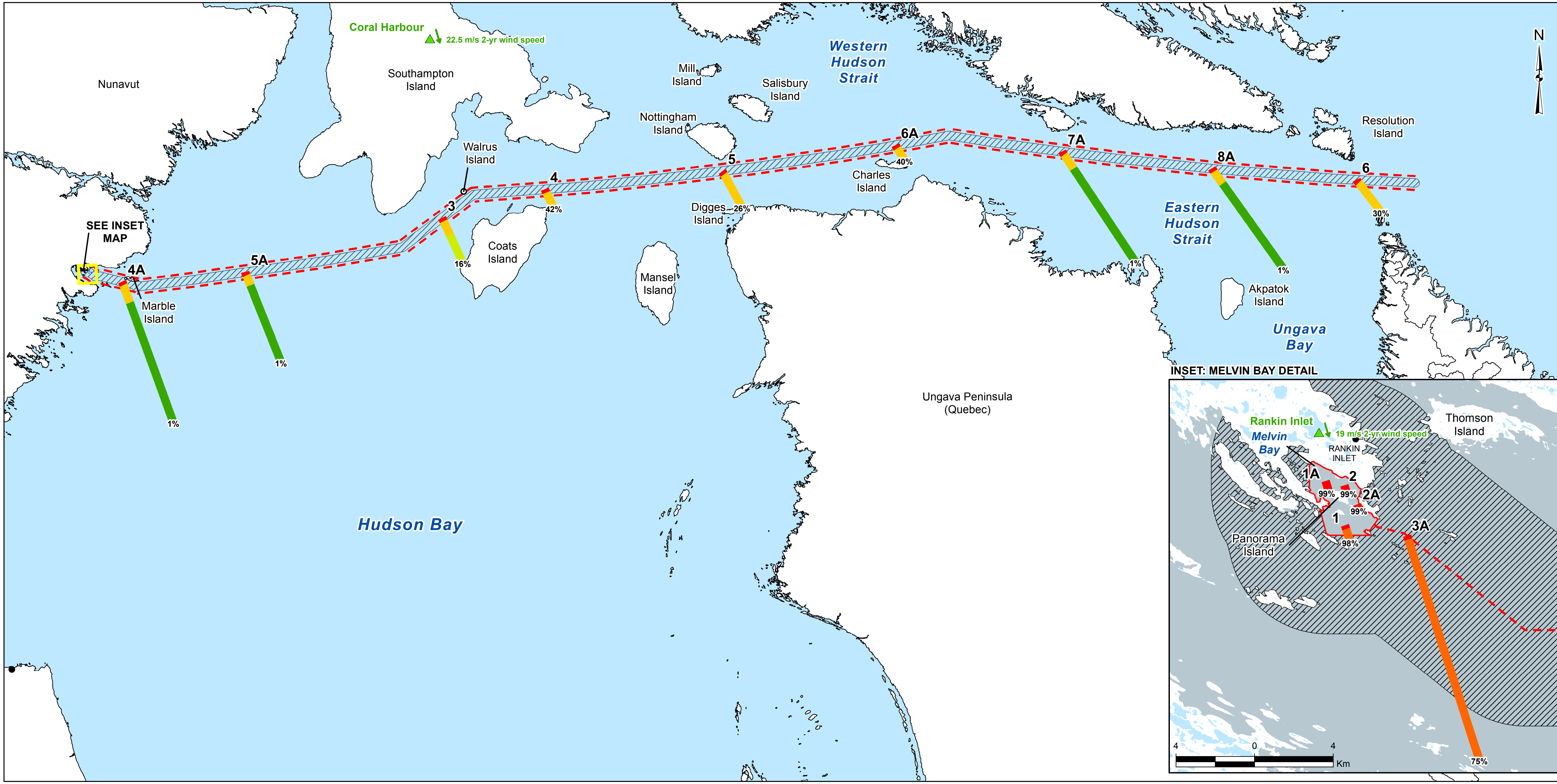

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 2-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.	1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN / REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-17
REVIEW	LY	06 Jan. 2016	

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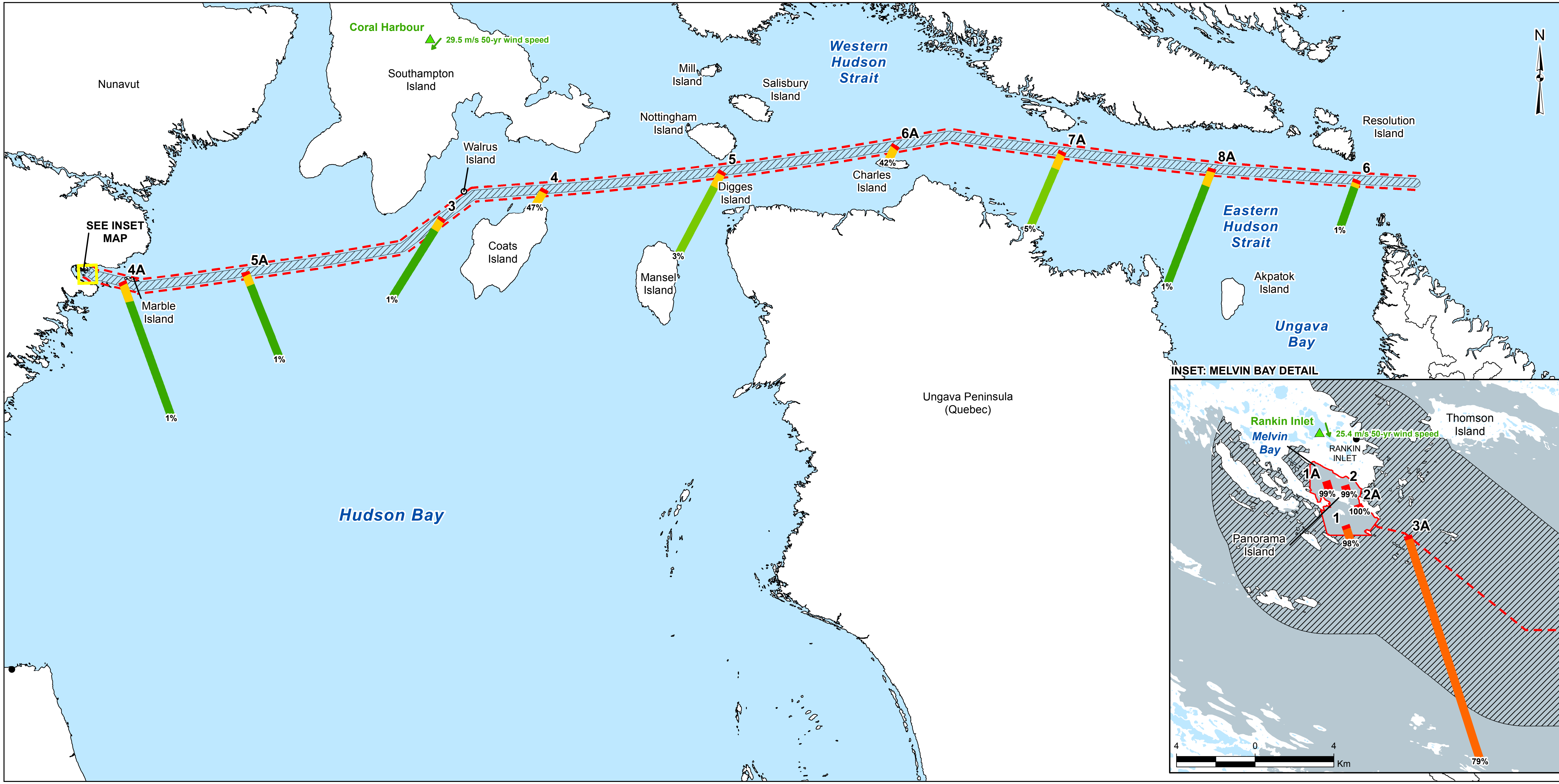

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 50-YR WIND, NO SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-18	
REVIEW	LY	06 Jan. 2016		

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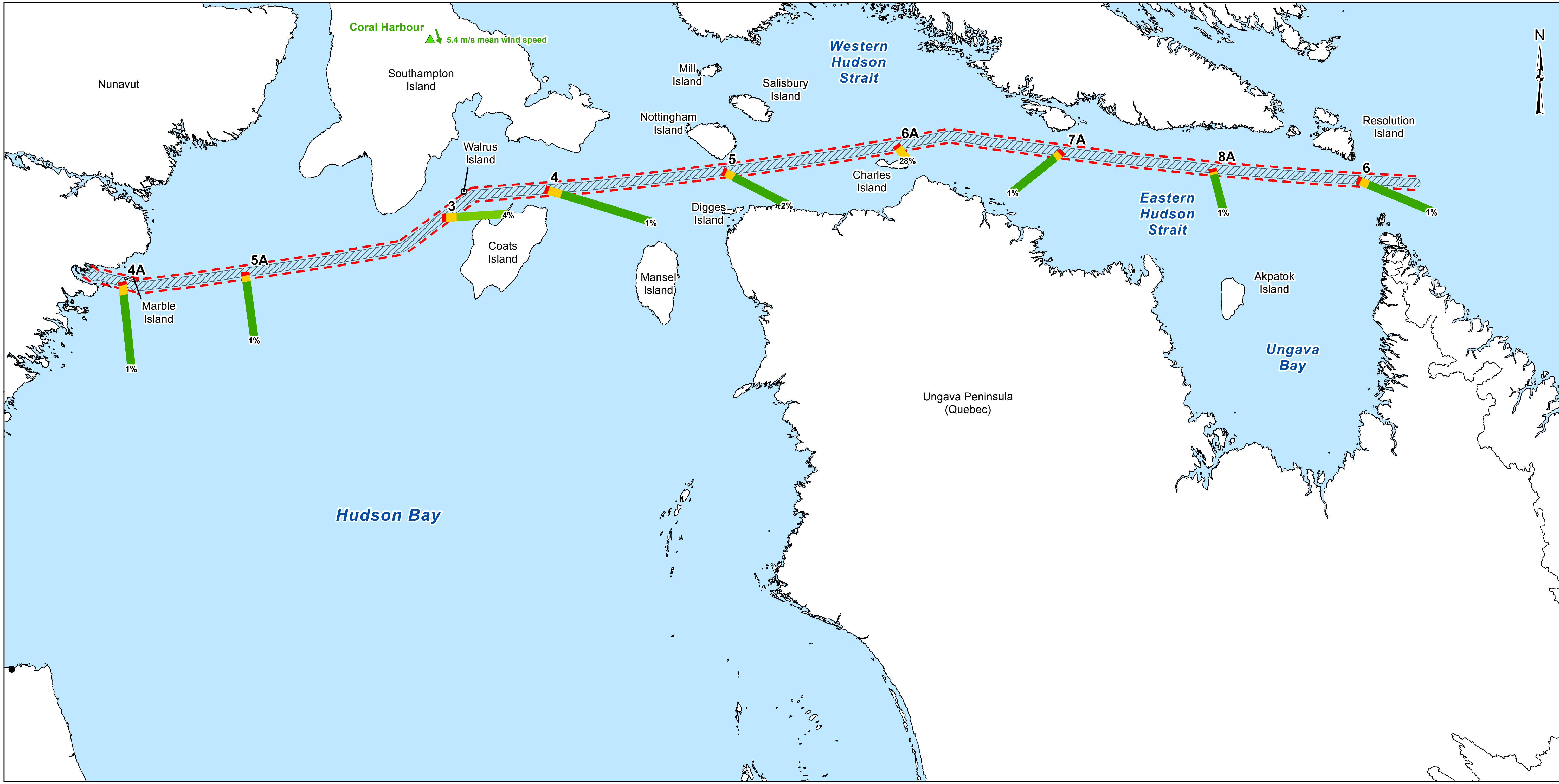

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

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NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, MEAN WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.	1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-19
REVIEW	LY	06 Jan. 2016	

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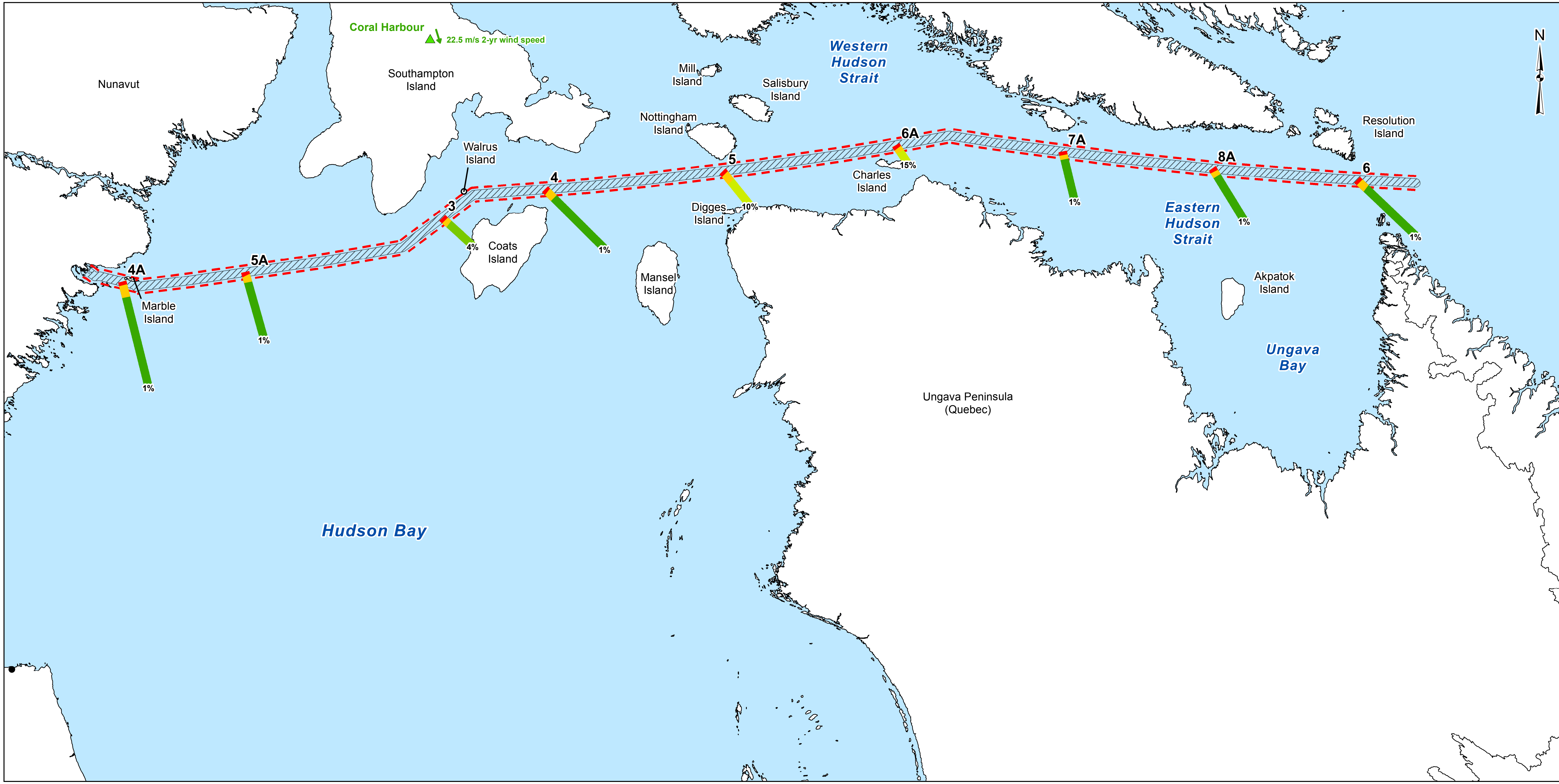

LEGEND

MARINE REGIONAL STUDY AREA (MARINE RSA)
MARINE LOCAL STUDY AREA (MARINE LSA)
WATERBODY
SHIPPING ROUTE (APPROXIMATE)
WIND STATION
WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING
- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

CANVEC DATA OBTAINED FROM © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 2-YR WIND, SURFACE CURRENT

PROJECT NO.	1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN / REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-20
REVIEW	LY	06 Jan. 2016	

Golder Associates

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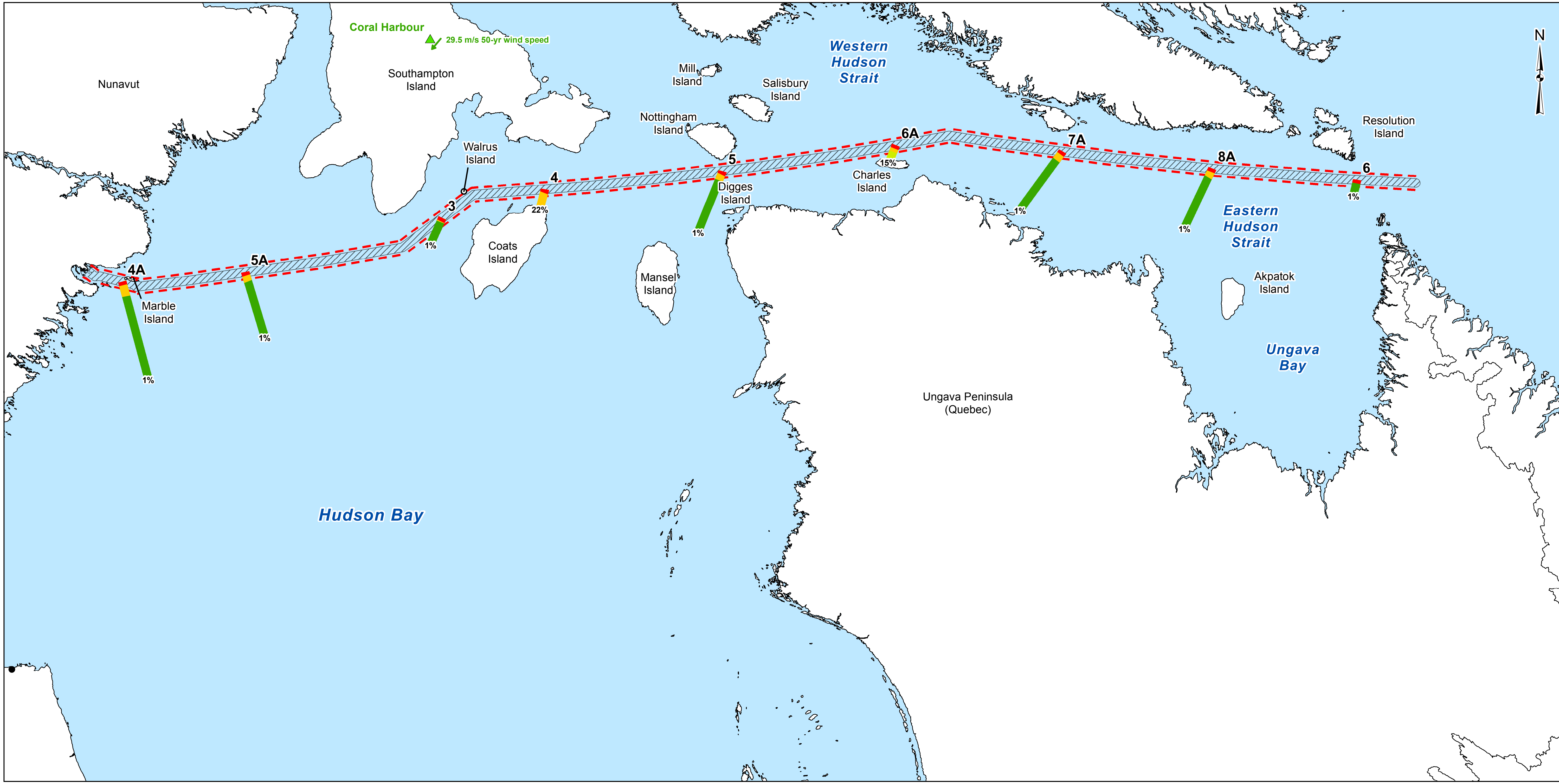

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 2,000,000 L SPILL, 50-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-21	
REVIEW	LY	06 Jan. 2016		

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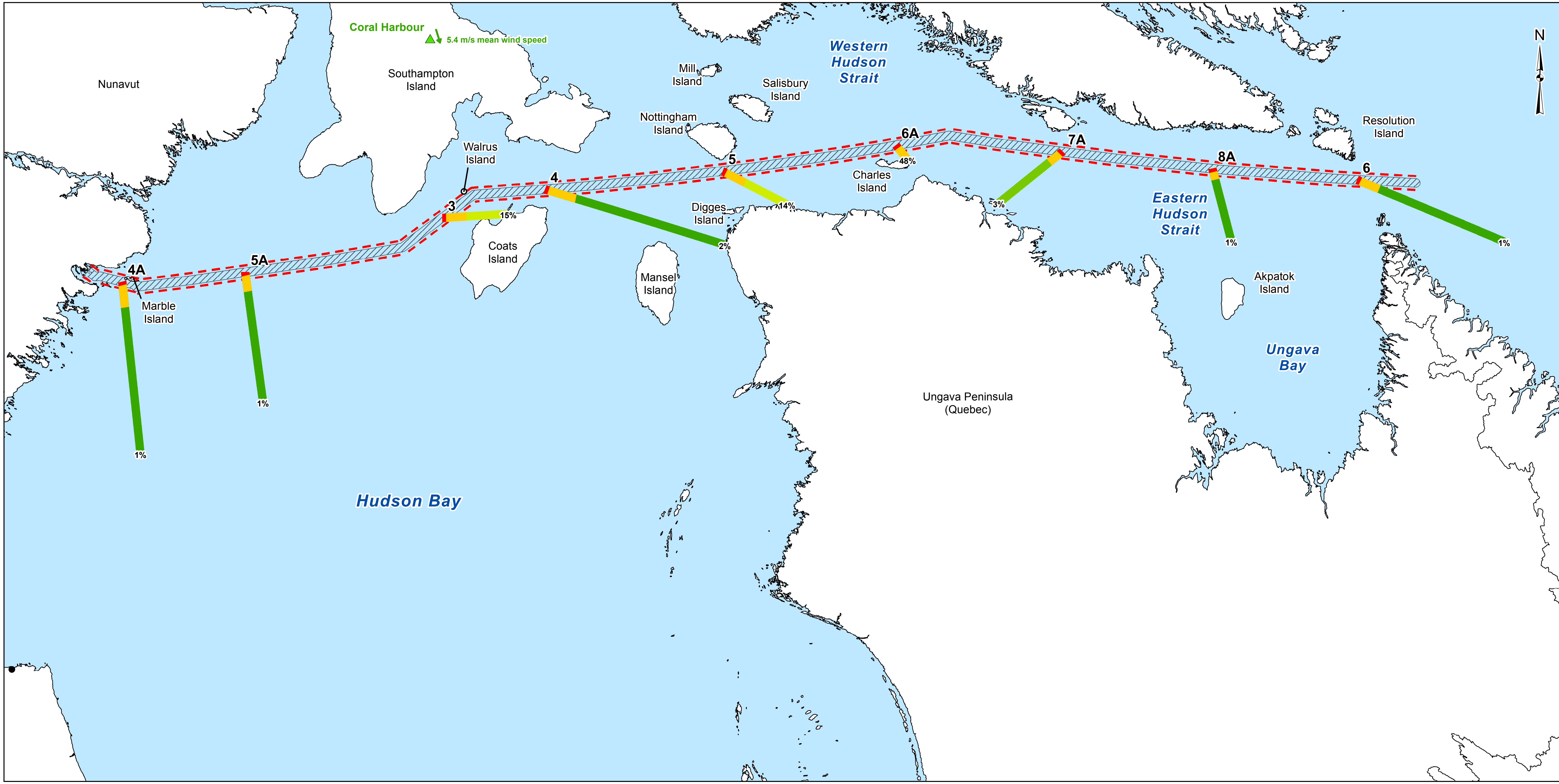

LEGEND

MARINE REGIONAL STUDY AREA (MARINE RSA)
MARINE LOCAL STUDY AREA (MARINE LSA)
WATERBODY
SHIPPING ROUTE (APPROXIMATE)
WIND STATION
WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING
- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

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NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, MEAN WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN — REV. A
GIS	CDB	06 Jan. 2016	
CHECK	JC	06 Jan. 2016	FIGURE E-22
REVIEW	LY	06 Jan. 2016	

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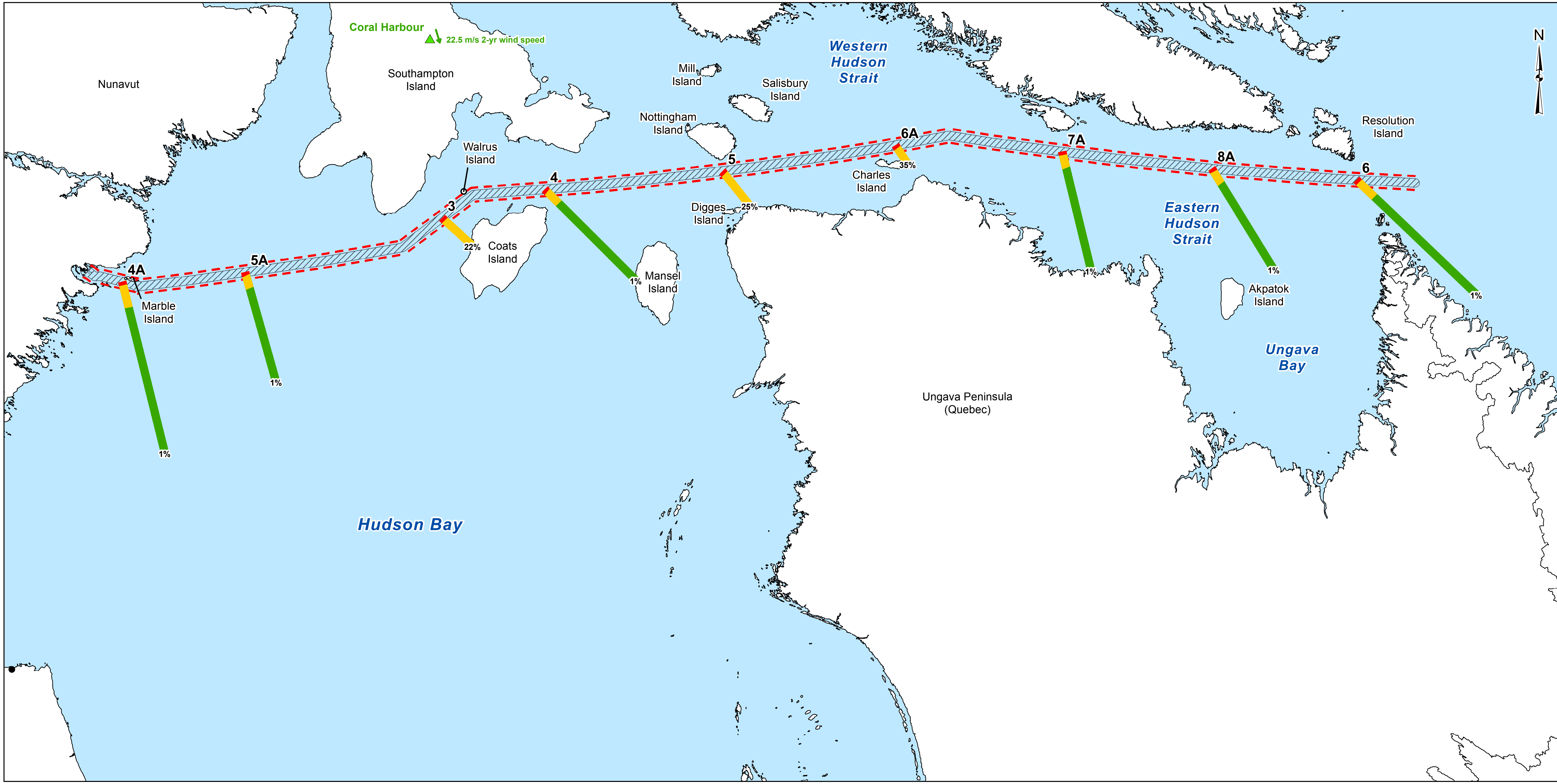

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
1	Ship-to-ship fuel transfer site outside Melvin Bay	15	546173	6961117
1A	West Melvin Bay	15	545185	6963365
2	Ship-to-shore fuel transfer site in Melvin Bay	15	546143	6963142
2A	East Melvin Bay	15	546798	6962172
3	Shipping route south of Walrus Island	16	641869	6988220
3A	Entrance to Melvin Bay	15	549334	6960588
4	Shipping route north of Coats Island	17	456430	7000031
4A	West Hudson Bay	15	585757	6949020
5	Shipping route north of Ungava Peninsula	18	351235	6986598
5A	Hudson Bay crossing	16	416455	6950265
6	Shipping route in Eastern Hudson Strait	20	399876	6775840
6A	Western Hudson Strait, Charles Island	18	546017	6967899
7A	Mid Hudson Strait	19	415679	6911718
8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 2-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-23	
REVIEW	LY	06 Jan. 2016		

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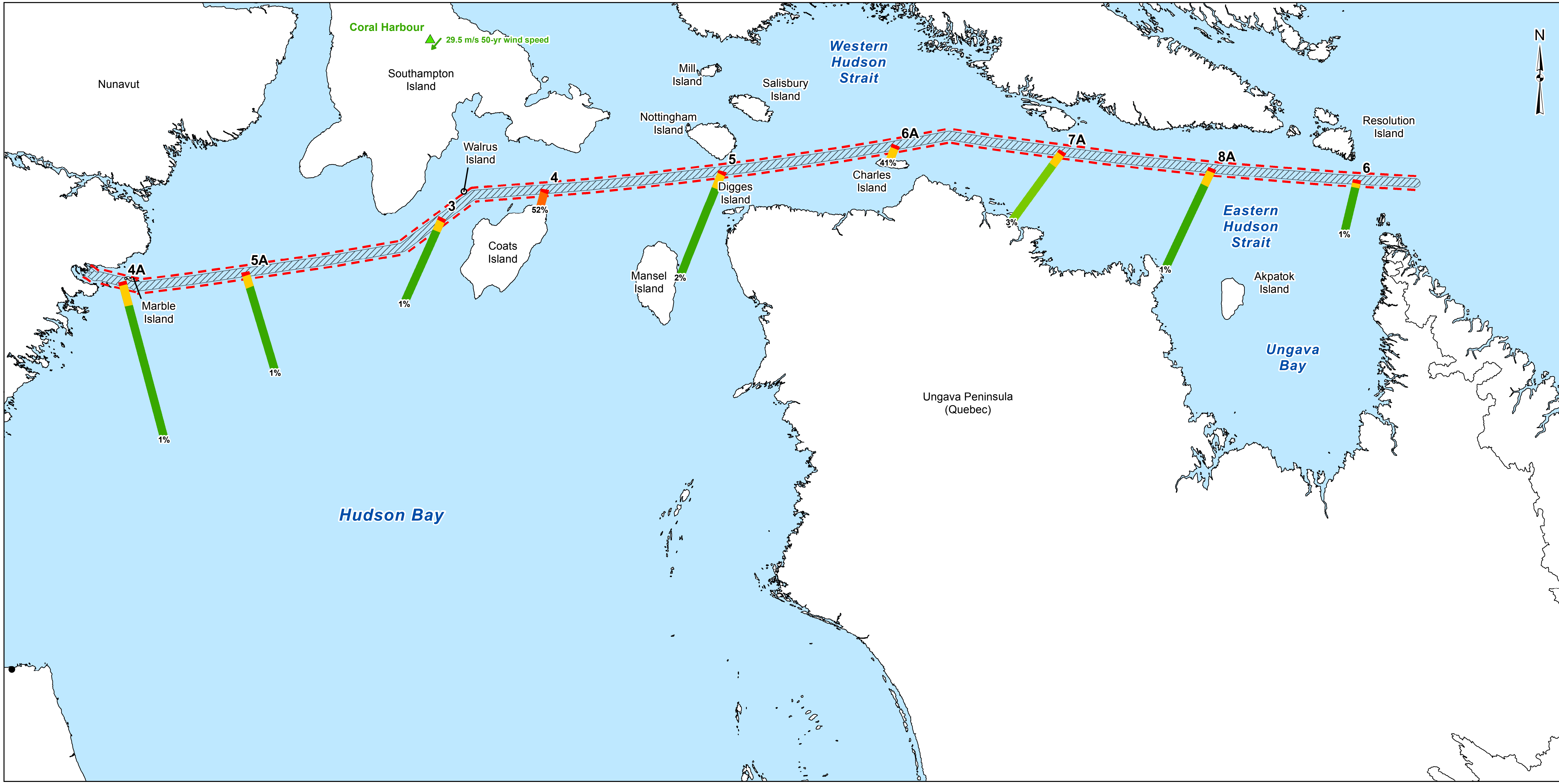

LEGEND

- MARINE REGIONAL STUDY AREA (MARINE RSA)
- MARINE LOCAL STUDY AREA (MARINE LSA)
- WATERBODY
- SHIPPING ROUTE (APPROXIMATE)
- WIND STATION
- WIND VECTOR (DIRECTION BLOWING TOWARDS)

% SPILL VOLUME REMAINING

- 98.1 - 100.0
- 50.1 - 98.0
- 20.1 - 50.0
- 5.1 - 20.0
- 2.1 - 5.0
- 1.0 - 2.0

NOTES

- LENGTH OF LINE REPRESENTS THE ESTIMATED TRAVEL DISTANCE FOR A GIVEN SPILL VOLUME
- WIDTH OF LINE IS NOT TO SCALE
- ANGLE OF LINE REPRESENTS THE CALCULATED SPILL TRAJECTORY

REFERENCE

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NAUTICAL CHART DATA OBTAINED FROM THE CANADIAN HYDROGRAPHIC SERVICE. PROVINCIAL DATA OBTAINED FROM ESRI.
DATUM: NAD 83 PROJECTION: LAMBERT CONFORMAL CONIC

HYPOTHETICAL FUEL SPILL RELEASE LOCATION	LOCATION NAME	UTM ZONE	EASTING	NORTHING
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8A	Eastern Hudson Strait, north Ungava Bay	19	570404	6842009

90 0 90
KILOMETRES

PROJECT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
OIL SPILL SCENARIO: 20,000,000 L SPILL, 50-YR WIND, SURFACE CURRENT

Golder Associates

PROJECT NO.		1535029	FILE No.	
DESIGN	GC	06 Jan. 2016	SCALE AS SHOWN	REV. A
GIS	CDB	06 Jan. 2016		
CHECK	JC	06 Jan. 2016	FIGURE E-24	
REVIEW	LY	06 Jan. 2016		

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6.3 Spills along Shipping Route

Diesel fuel spills have the potential to occur anywhere along the shipping route. For the purpose of the ADIOS2 analysis, ten (10) sites were chosen along the shipping route that correspond with either areas of the route that are in close proximity to land (e.g., pinch points) or established sensitive habitat areas for marine mammals and/or marine birds. These sites include Walrus Island, Coats Island, Ungava Peninsula and Eastern Hudson Strait (sites numbered 3 to 6); and entrance to Melvin Bay, western Hudson Bay, Hudson Bay crossing, western Hudson Strait near Charles Island, mid-point Hudson Strait, and eastern Hudson Strait north of Ungava Bay (sites numbered 3A to 8A). Tables E-4 and E-5 include the weathering half-life, time to shore, and proportion of spill deposited on shore for the 2 ML and 20 ML spill scenarios, respectively, (for mean, 2-yr, and 50-yr wind speeds). The weathering half-life was predicted to be less than 19 h for all the 2 ML scenarios and less than 34 h for all the 20 ML scenarios. Depending on the distance to shore and wind scenario, the time to shore would vary from about 4 h to 50 days for the 2 ML scenario and the amount of fuel predicted to be deposited on shore would vary from 0% to 66%. For the 20 ML scenario, the amount of fuel predicted to be deposited on shore would vary from 0% to 79%. The trajectory of the slick drift is a primary factor in the amount, if any, of fuel deposited on shore. For example, at site 3 (Walrus Island), 16% of the spill is deposited on shore for the 20 ML, 2-yr wind spill scenario because the direction of the slick drift is 163°, directly towards Coats Island. For the 50-yr wind scenario, the direction of the slick drift is 220°, towards the open water of Hudson Bay.

The influence of currents on the trajectory of the slick drift was considered using the mean currents at each site when data was available. Table E-9 provides the mean current velocity at each site, resultant wind and current vector speed and direction, distance to shore in the direction of the resultant vector, time to shore, and proportion of spill deposited on shore for the different 2 ML and 20 ML spill scenarios.

The predominant current patterns enhance the rate at which the fuel would spread across the water surface, particularly along narrower portions of the route where current speeds can be enhanced and slicks spread in the direction of the current. This typically results in the slick trajectory being altered to more parallel to the shipping route and in most cases less fuel deposited on the shore. However, in some cases, the change in trajectory results in a shorter distance to shore and a higher proportion of fuel deposited onshore.

Table E-9: Distance to Shore, Weathering Half-Life, Time to Shore, and Estimated Percent of Spill Deposited on Shore for 2 ML Diesel Fuel Spill Scenarios along Shipping Route

Location (Number)	Distance to Shore (km)	Distance to Shore (km); 50-yr wind	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Walrus Island (3)	55	760	15.6	4.1	2.1	94.3	22.6	239	2%	2%	0%
Coats Island (4)	23	22	14.7	4.9	3.7	39.4	9.5	6.9	16%	26%	27%
Ungava Peninsula (5)	46	106	18.5	5.8	3.8	78.9	18.9	33.3	5%	10%	0%
Eastern Hudson Strait (6)	46	325	17.0	5.3	0.9	78.9	18.9	102	4%	8%	0%
Entrance to Melvin Bay (3A)	12	N/A	17.5	8.7	7.4	16.8	5.8	4.4	51%	63%	66%
West Hudson Bay (4A)	700	N/A	13.3	7.6	5.5	982	341	255	0%	0%	0%
Hudson Bay crossing (5A)	857	N/A	10.4	4.9	3.7	1202	417	312	0%	0%	0%
Western Hudson Strait, Charles Island (6A)	20	21	14.8	3.5	2.6	34.3	8.2	6.6	20%	20%	17%
Mid-Hudson Strait (7A)	160	93	15.6	4.2	3.4	274	65.8	29.2	0%	0%	0%
Eastern Hudson Strait, north Ungava Bay (8A)	305	164	15.6	4.5	3.4	523	126	51.5	0%	0%	0%

Notes:
km (kilometre); yr (year); h(hour); L (liter)

Table E-10: Distance to Shore, Weathering Half-Life, Time to Shore, and Estimated Percent of Spill Deposited on Shore for 20 ML Diesel Fuel Spill Scenarios along Shipping Route

Location (Number)	Distance to Shore (km)	Distance to Shore (km); 50-yr wind	Weathering Half-Life (h)			Time to Shore (h)			% Deposited on Shore		
			Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Walrus Island (3)	55	760	26.8	8.7	5	94.3	22.6	239	9%	16%	0%
Coats Island (4)	23	22	28.7	7.6	6.4	39.4	9.5	6.9	39%	42%	47%
Ungava Peninsula (5)	46	106	37	9.7	6.4	78.9	18.9	33.3	23%	26%	3%
Eastern Hudson Strait (6)	46	325	33.7	10.9	2.8	78.9	18.9	102	20%	30%	0%
Entrance to Melvin Bay (3A)	12	N/A	32.8	14.4	12.7	16.8	5.8	4.4	70%	75%	79%
West Hudson Bay (4A)	700	N/A	26.8	12.4	8.9	982	341	255	0%	0%	0%
Hudson Bay crossing (5A)	857	N/A	20.3	8	5.7	1202	417	312	0%	0%	0%
Western Hudson Strait, Charles Island (6A)	20	21	26	6.2	5.3	34.3	8.2	6.6	40%	40%	42%
Mid-Hudson Strait (7A)	160	93	26.8	9.3	6.7	274	65.8	29.2	0%	1%	5%
Eastern Hudson Strait, north Ungava Bay (8A)	305	164	26.8	8.7	6.7	523	126	51.5	0%	0%	0%

Notes:
km (kilometre); yr (year); h(hour); L (liter)

Table E-11: Weathering Half Life and Time to Shore for 2 ML and 20 ML Diesel Fuel Spill Scenarios along Shipping Route with Currents

Location (Number)	Mean Current		Vector Sum Speed (Direction), m/s and deg			Distance to Shore (km)			Time to Shore (h)			% Deposited on Shore 2 ML			% Deposited on Shore 20 ML		
	Speed (m/s)	Dir (deg)	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr	Mean	2-yr	50-yr
Walrus Island (3)	0.45[(a)]	60	0.3(94)	0.7 (140)	0.6 (212)	74	46	732	73.1	19.0	316	4%	4%	0%	15%	22%	0%
Coats Island (4)	0.45[(a)]	90	0.4 (116)	0.8(144)	0.7 (204)	211	144	22	167	49.9	8.2	0%	0%	22%	2%	1%	52%
Ungava Peninsula (5)	0.2[(b)]	80	0.2 (129)	0.7 (153)	0.8 (214)	81	49	127	106	19.3	44.0	2%	10%	0%	14%	25%	2%
Eastern Hudson Strait (6)	0.2[(b)]	90	0.2 (133)	0.7 (154)	0.8 (214)	1000	354	33	1227	136	113	0%	0%	0%	0%	0%	0%
West Hudson Bay (4A)	0.2[(c)]	200	0.3 (177)	0.7 (169)	0.9 (168)	600	650	652	547	270	210	0%	0%	0%	0%	0%	0%
Hudson Bay crossing (5A)	0.2[(c)]	200	0.3 (177)	0.7 (169)	0.9 (168)	684	784	789	623	325	255	0%	0%	0%	0%	0%	0%
Western Hudson Strait, Charles Island (6A)	0.2[(b)]	135	0.2 (155)	0.7 (161)	0.9 (216)	21	25	23	27.2	9.5	6.8	28%	15%	15%	48%	35%	41%
Mid-Hudson Strait (7A)	0.4[(b)]	290	0.2 (248)	0.6 (183)	1.0 (233)	92	138	97	133	67.4	27.0	0%	0%	0%	3%	1%	3%
Eastern Hudson Strait, north Ungava Bay (8A)	0.1[(b)]	290	0.1 (184)	0.6 (167)	0.9 (224)	134	319	125	280	137	38.1	0%	0%	0%	0%	0%	1%

Notes:
km (kilometre); yr (year); dir (direction); ML(million litres); m/s (metres per second); N/A (not available)
[a] DFO (2015); mooring H9
[b] Drinkwater (1986)
[c] DFO (2015); mooring H7

6.4 Discussion of Mapped Results

Maps representing the results of the hypothetical spill scenarios are presented in Figure E-13 through Figure E-24. The maps are provided for the 2 ML and 20 ML spill scenarios, three (mean, 2-yr, and 50-yr) wind scenarios, and with and without currents. Each map shows the estimated trajectory of the spill at the fourteen locations based on the wind and current for the given scenario and the spill volume remaining (percentage) at a given distance based on the weathering results from the ADIOS2 model. The percentage of the spill volume remaining is shown by the color ramp gradation from red (more remaining) to green (less remaining). The extent of the slick drift is shown at the start of the spill (100% volume), at one half-life (50% spill volume remaining), and when the slick reaches shore or is weathered to 1% of the spill volume remaining (whichever occurs first). If the slick is estimated to reach shore, the percentage of the spill volume remaining is labeled at this location. In some cases, particularly in Melvin Bay, the spill reaches shore quickly and only two colored lines are shown on the map. Wind vectors are also provided for each scenario to illustrate the wind direction and speed used for a given map scenario.

There is a slight apparent difference in spill trajectory angles between the westernmost points when compared to the easternmost points despite scenarios that use the same wind direction. This slight apparent difference in spill trajectory angles is a function of the map projection extending over a large area and over multiple UTM zones and is therefore a projection distortion rather than a measureable difference in trajectory.

It is important to consider these maps as a depiction of the potential fuel spill trajectory and percent remaining at a coarse scale under a very specific set of climate conditions. As noted on the maps, the length of the fuel spill path represents the estimated travel distance and the angle represents the calculated spill trajectory given the specific wind, current, and spill volume conditions bracketed by each spill scenario. The actual distance travelled and the angle of the spill trajectory will be highly dependent on the site-specific ambient conditions and the nature and location of the spill at the time of a potential spill. In general, the width of a fuel spill at land fall and the length of shoreline that could potentially be affected by a given fuel spill is difficult to estimate due to the high degree of uncertainty related to the spreading of a slick (DNV 2011).

A summary of the mapped scenarios follows:

- The dominant slick drift trajectory for the modelled scenarios is towards the south-southeast (163°) for all scenarios without currents except for the 50-yr wind scenario at sites east of site 5A, where it is towards the southwest (220°). The south-southeast trajectory results in a slick trajectory headed towards open water at sites 4A, 5A, 7A, and 8A. At sites in Melvin Bay (1, 2, 1A, and 2A) the fuel slick reach shore within a few hours. Trajectory at these sites is less important as they are almost entirely bounded by land, resulting in a majority of the spill reaching land in any direction. At sites 3A, 3, 4, 5, 6A, and 6, the slick is estimated to reach shore with 50% or less of the spill volume remaining.
- The 50-yr wind scenario at sites 3 and sites further east results in a slick trajectory to the southwest (220°). Under this scenario a slick at site 3 would head towards open water and sites 5 and 6 would have a longer distance to travel to shore than for the other wind scenarios. Differences in the direction to shore for slicks originating at sites 4, 6A, 7A, and 8A are minimal between wind scenarios.
- The percentage of the fuel deposited on shore increases for the 20 ML spill scenario versus the 2 ML spill scenario because of the increase in the weathering half-life.

- The addition of mean currents in the modelling typically results in altering the slick trajectory to a more parallel orientation to the shipping route and in most cases less fuel deposited on the shore. However in some cases the trajectory results in a shorter distance to shore and more fuel deposited on the shore. For example, at site 6 the trajectory of the spill drift is altered when an eastward current is considered such that the slick heads towards open water rather than south-southeast towards land in close proximity. Conversely, for site 3, 9% of a 20 ML spill volume is estimated to reach shore for the mean wind and no surface current scenario, but due to the orientation of the shipping route with respect to Coats Island, 15% of the spill volume is estimated to reach shore when the surface current is considered. Similarly, site 6A increases from 20% to 28%, and site 7A increases from 1% to 3% with the addition of the current forcing.

7.0 CONCLUSIONS

Although diesel spills have a low likelihood of occurrence, it is important to understand where the spill will travel and the best way to mitigate impacts. Based on the total amount of diesel fuel transported and predicted spill rates reported by SL Ross (1999), the overall likelihood of a fuel spill ranges from a return period of 285 years (i.e., one spill approximately every 285 years) for small spills (10 to 99.9 m^3) to 920 years for medium spills (100 to 999.9 m^3) and 92,000 years for large spills (1,000 to 9999.9 m^3) (WSP 2014a). If a spill was to occur near Melvin Bay, it is predicted that for all spills, a majority of the fuel would reach the nearby shoreline within several hours without mitigation efforts. If a spill was to occur along the shipping route, the amount of weathered fuel, the trajectory of the slick, and amount deposited on shore varies by site and wind and current scenario. The different spill scenarios are provided in summary tables in Sections 6.2 and 6.3 and presented in oil spill projection maps in Appendix C. Proximity of land in the direction of the slick drift is a primary consideration for the potential for fuel to be deposited on shore. The inclusion of mean currents in the modelling typically results in reorienting the slick trajectory along an alignment that is more parallel to the shipping route and in most cases this results in less fuel deposited on the shore, with the exception of sites 3, 6A, and 7 where there is an increase in percentage (of about 2% to 8%) of remaining fuel that reaches the shore.

An important consideration when interpreting the hypothetical fuel spill scenarios is the relative response times. Without mitigation, a spill in Melvin Bay is estimated to reach shore relatively quickly and with a higher proportion of the spill reaching shore before being naturally dispersed, however, there is potential for a more rapid spill response in this area. Open water spills along the shipping route are predicted to be less severe in most cases, but the potential response time is slower due to the distance offshore. As part of the Oil Pollution Emergency Plan (SD 8-2), AEM has committed to pre-emptive and responsive mitigation actions to reduce or minimize the loss of diesel fuel during ship-to-ship and ship-to-shore transfers near Melvin Bay.

This analysis has been conducted to assess the potential for impacts associated with a diesel fuel spill in the marine environment. The ADIOS2 model was used with the input of local wind speed to approximate wave conditions and then predict the weathering half-life of the fuel. This is a one-dimensional analysis and does not account for other site-specific effects such as modifications to the wave height, period and direction due to local bathymetry. Therefore it is an approximation of the travel time and percent diesel fuel remaining to be used for planning and decision making purposes.

8.0 CLOSURE

We trust that this report meets your immediate requirements. If you have any questions regarding the content of this report, please do not hesitate to contact this office.

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https://capws.golder.com/sites/capws2/1114280011meliadine/type a water license/5_post-submission/project certificate conditions/shipping management plan/appendix e - spill risk assessment/552-1535029-r-reva-sd8-1-appespill risk assmt.docx

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ATTACHMENT A

ADIOS2 Hypothetical Spill Modelling Inputs and Outputs

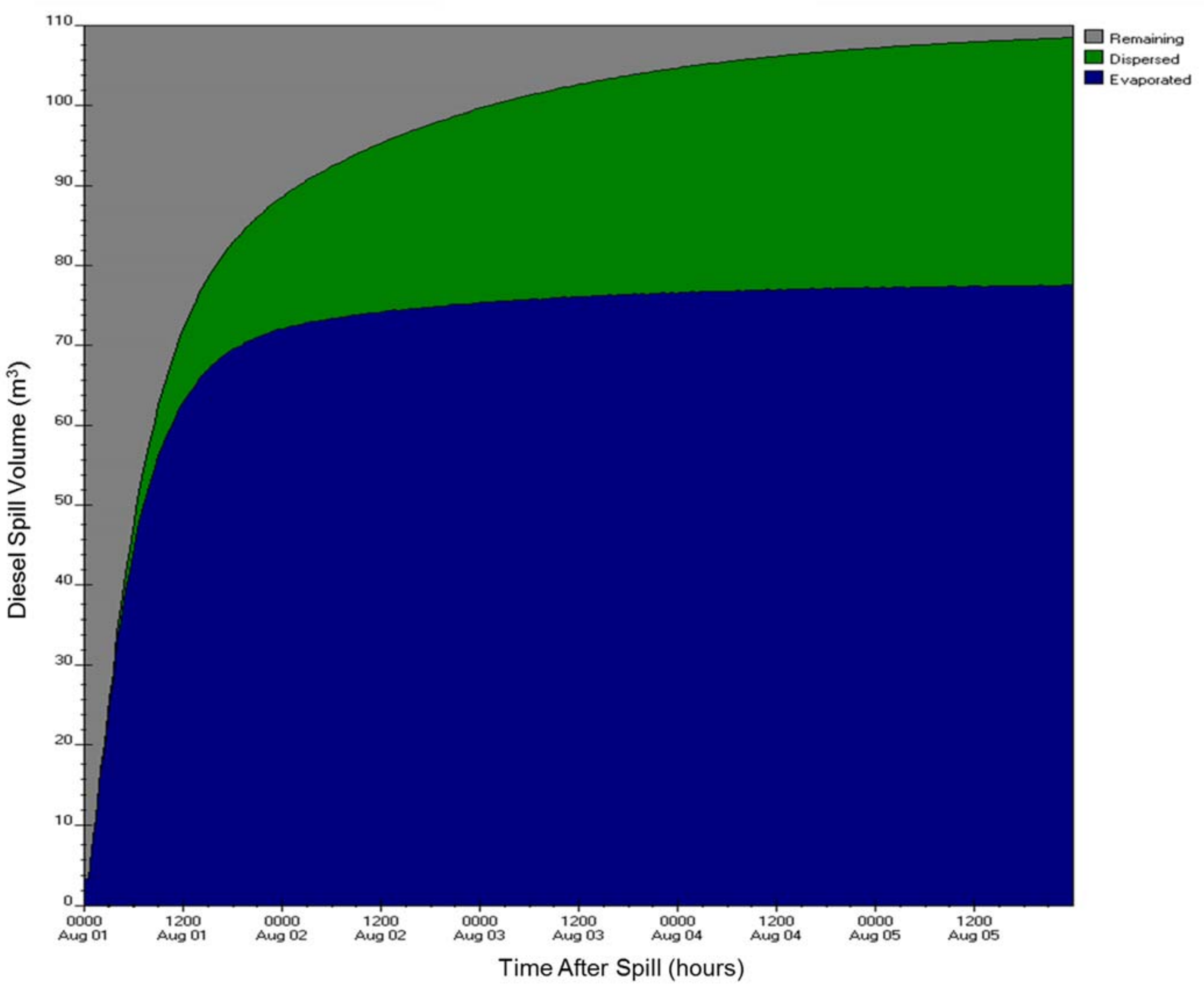

Figure E-A1: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 100 m^3, mean wind speed scenario

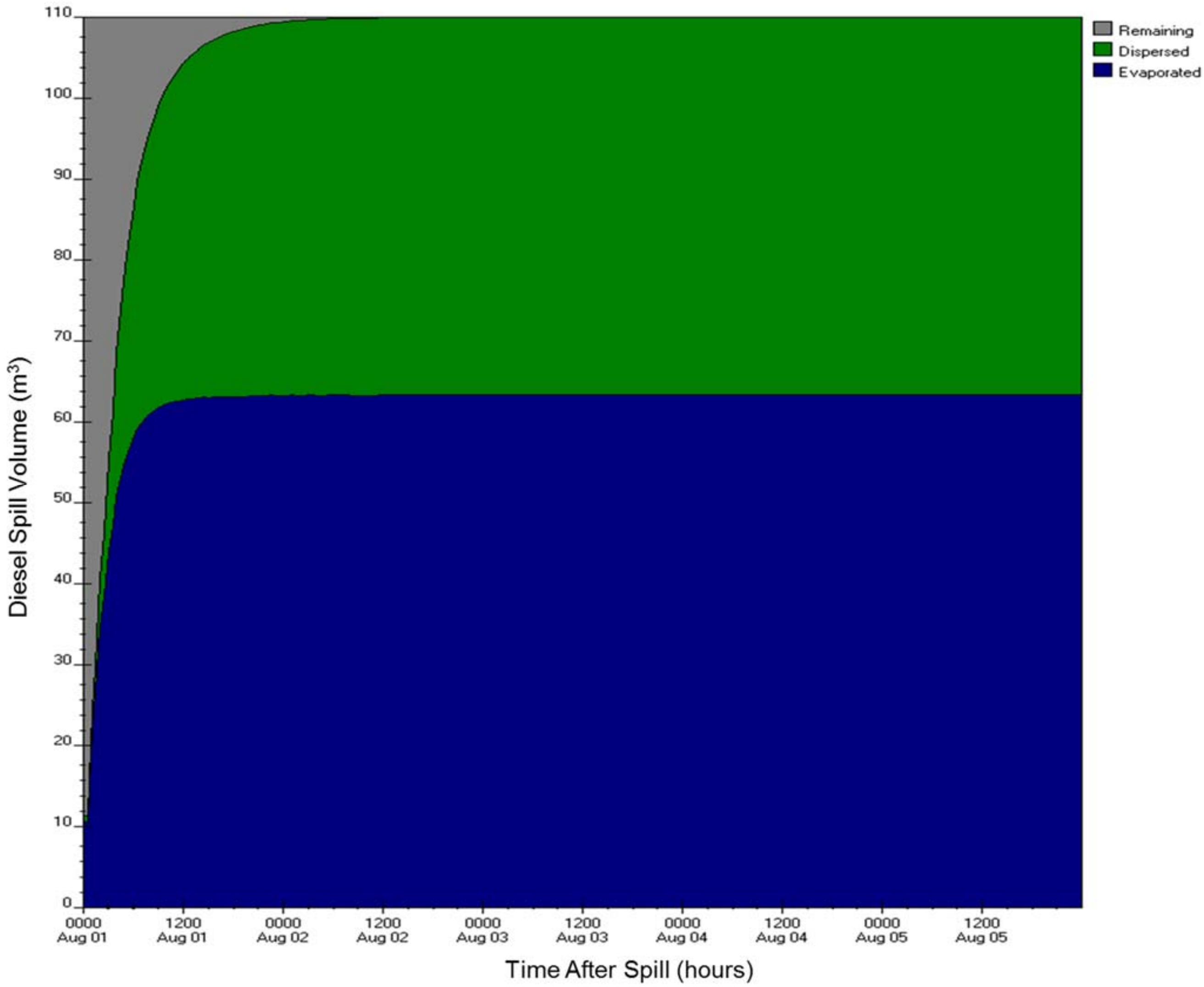

Figure E-A2: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 100 m^3, 2-yr wind speed scenario

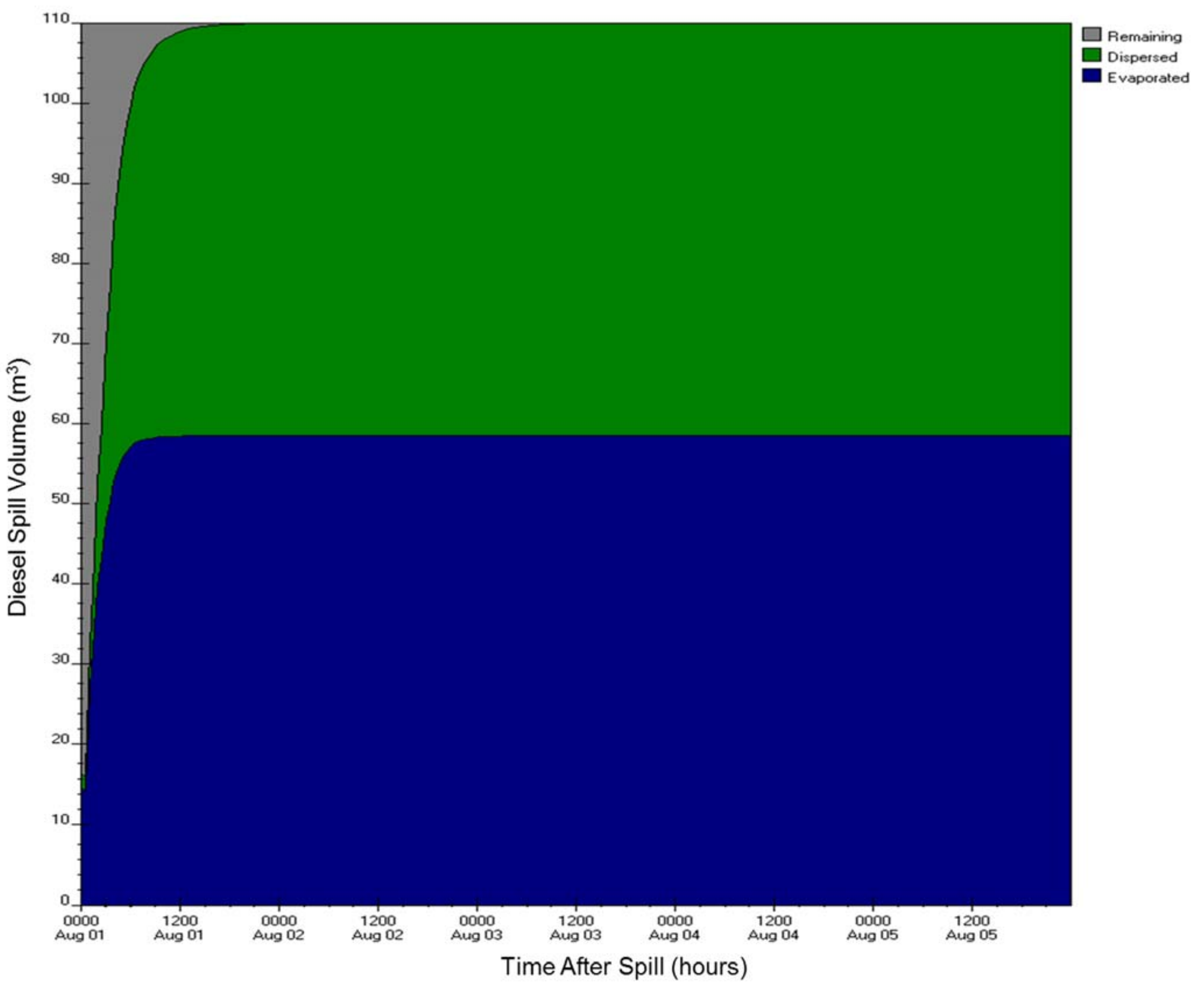

Figure E-A3: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 100 m^3, 50-yr wind speed scenario

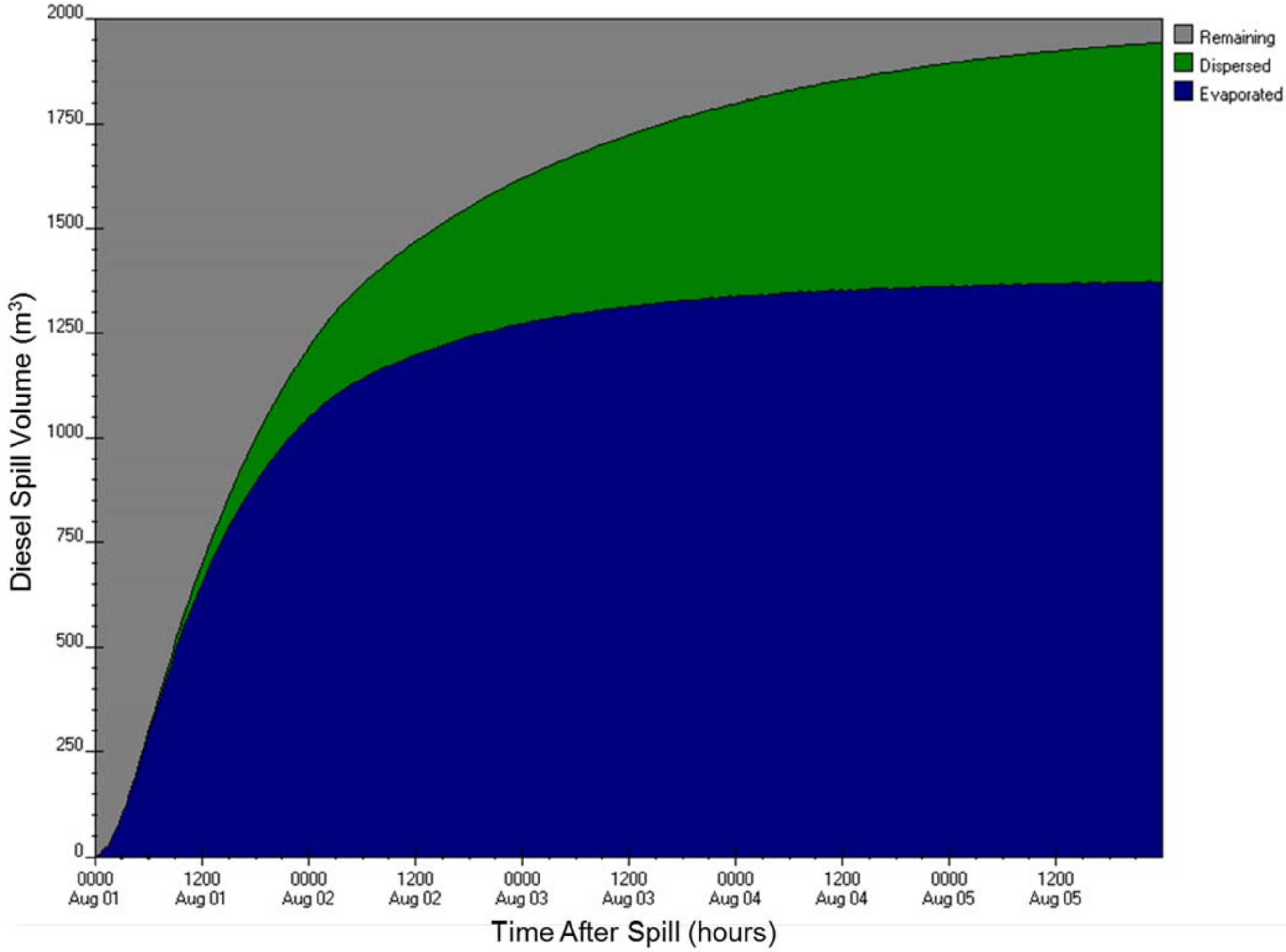

Figure E-A4: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 2,000 m³ spill, mean wind speed scenario

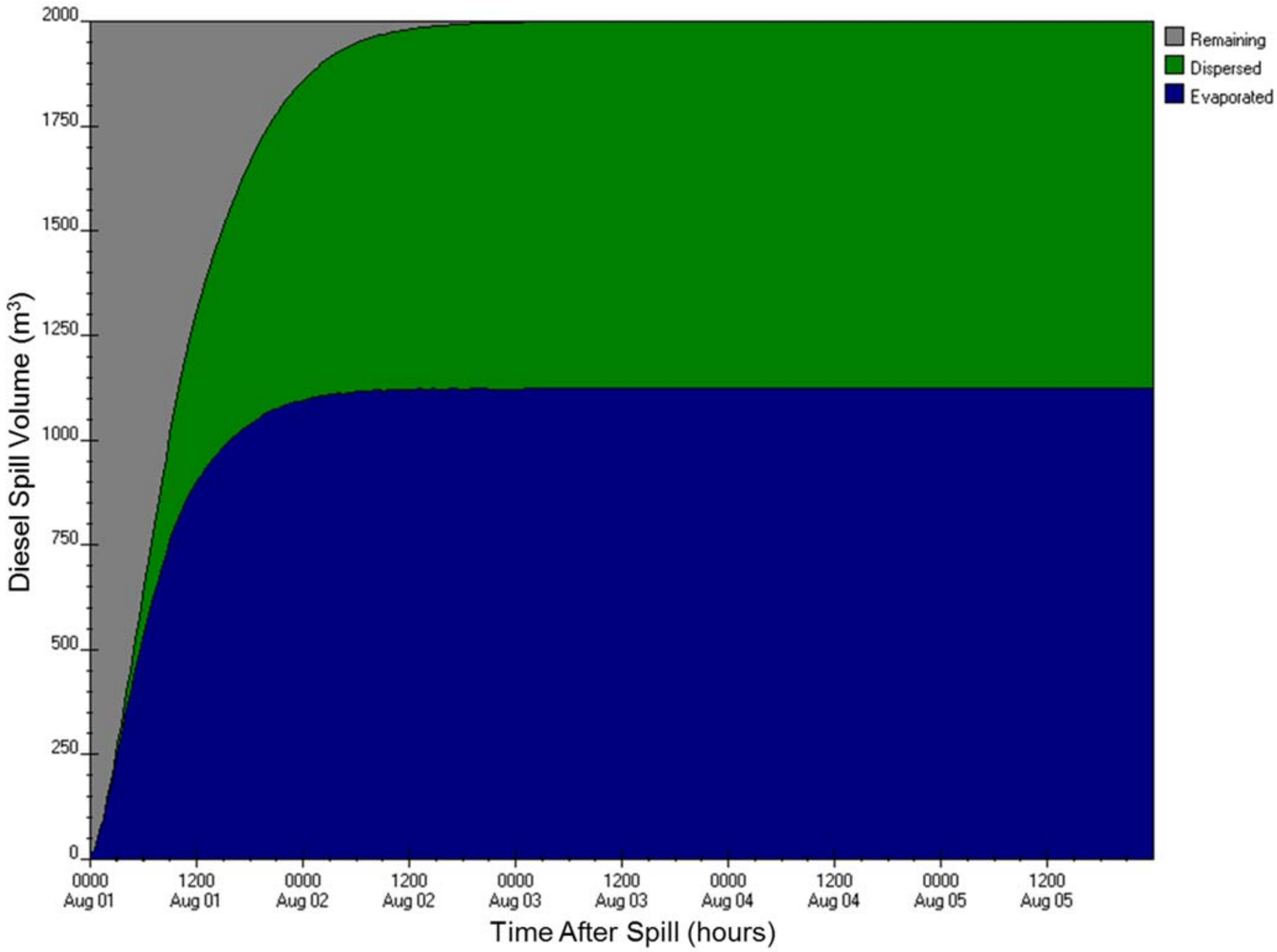

Figure E-A5: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 2,000 m³, 2-yr wind speed scenario

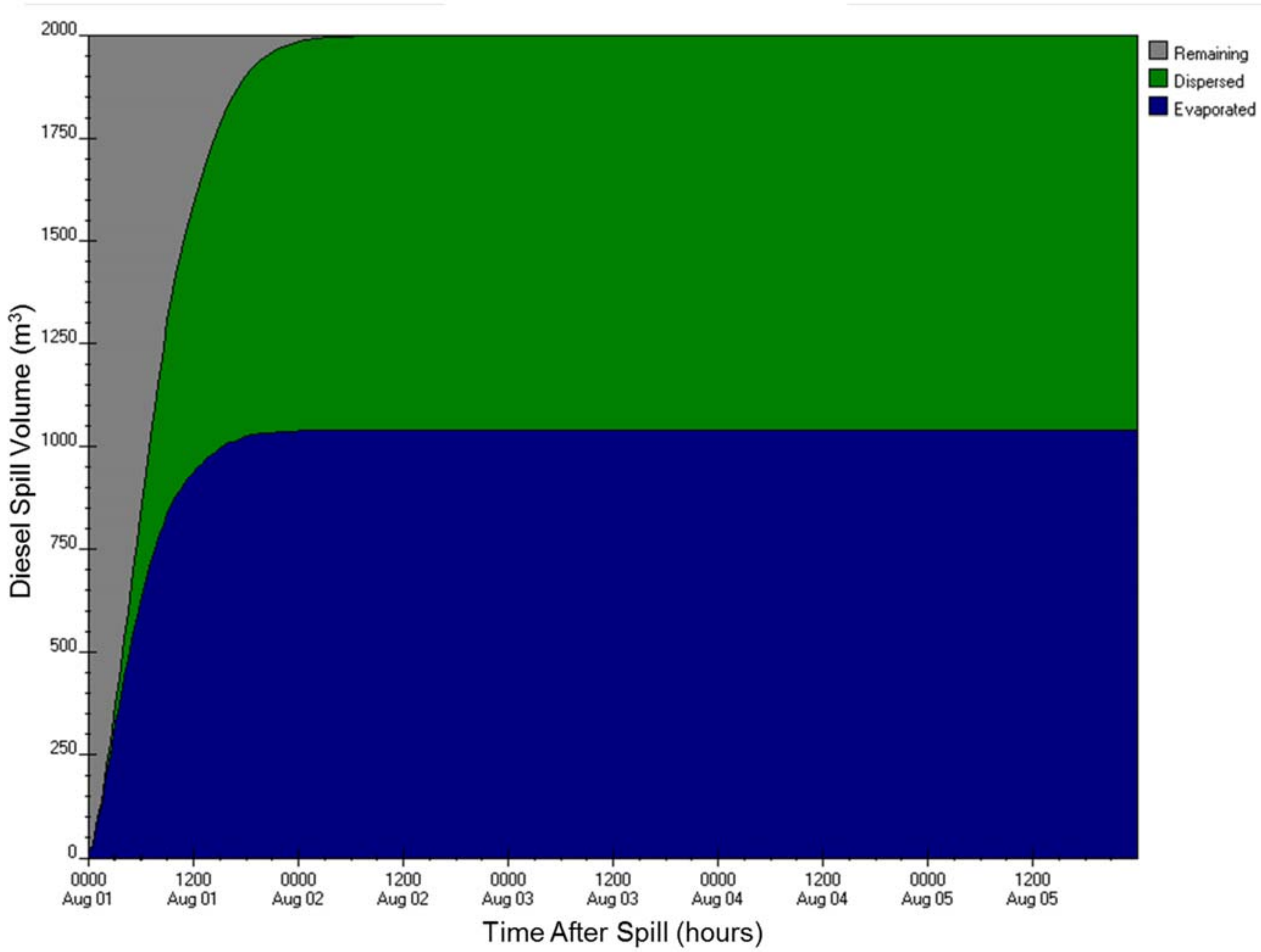

Figure E-A6: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 2,000 m^3, 50-yr wind speed scenario

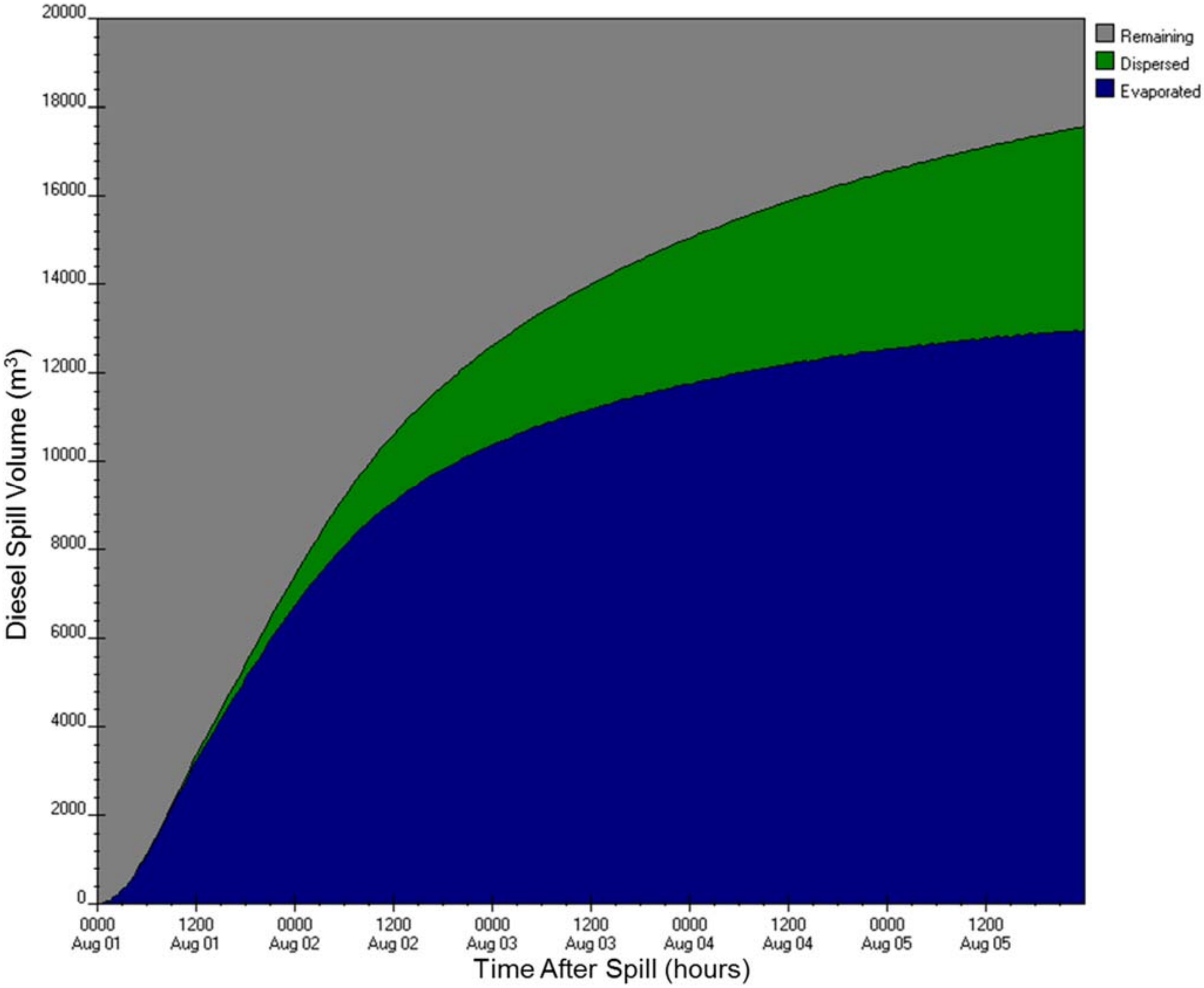

Figure E-A7: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 20,000 m^3 spill, mean wind speed scenario

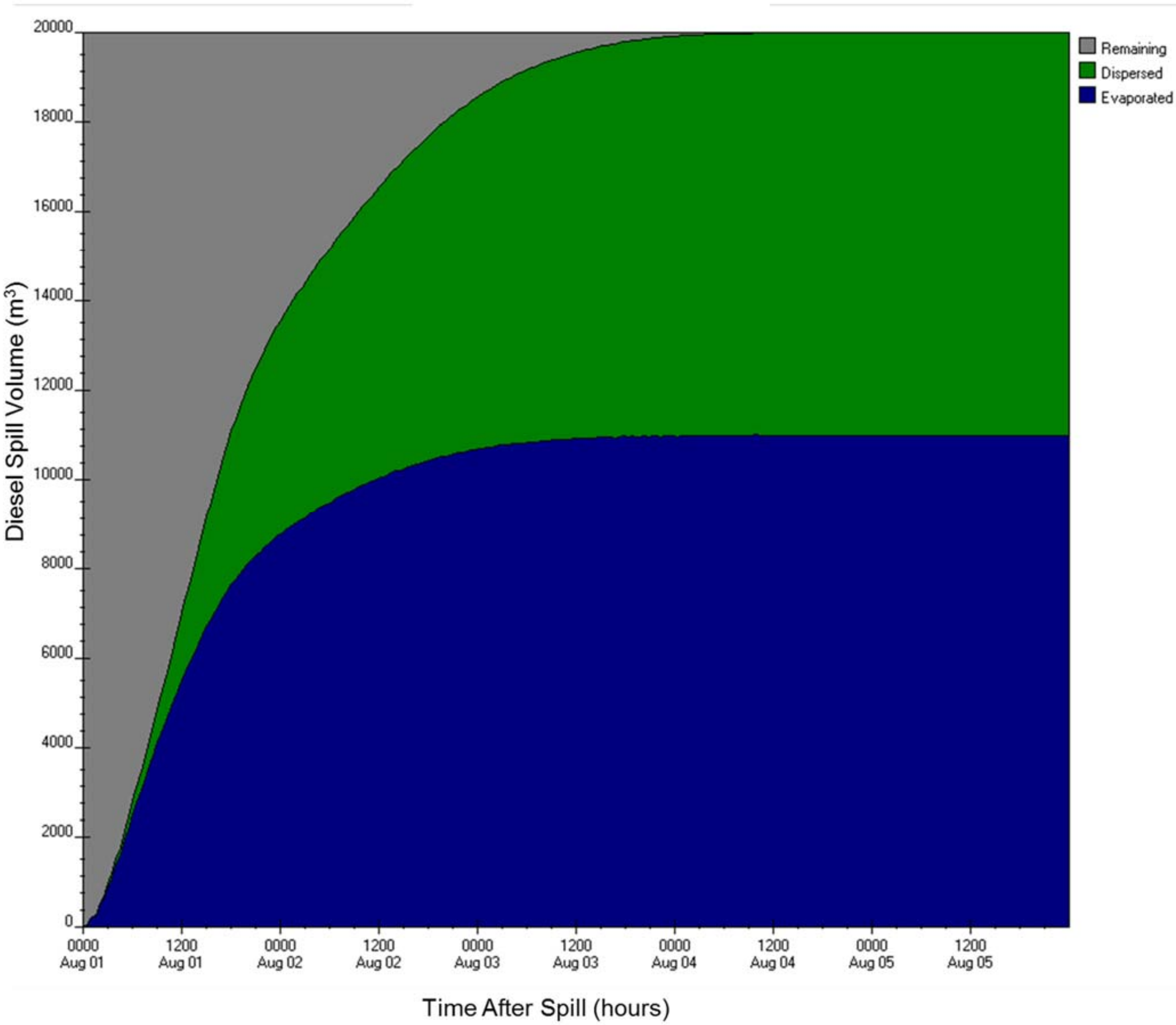

Figure E-A8: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 20,000 m³, 2-yr wind speed scenario

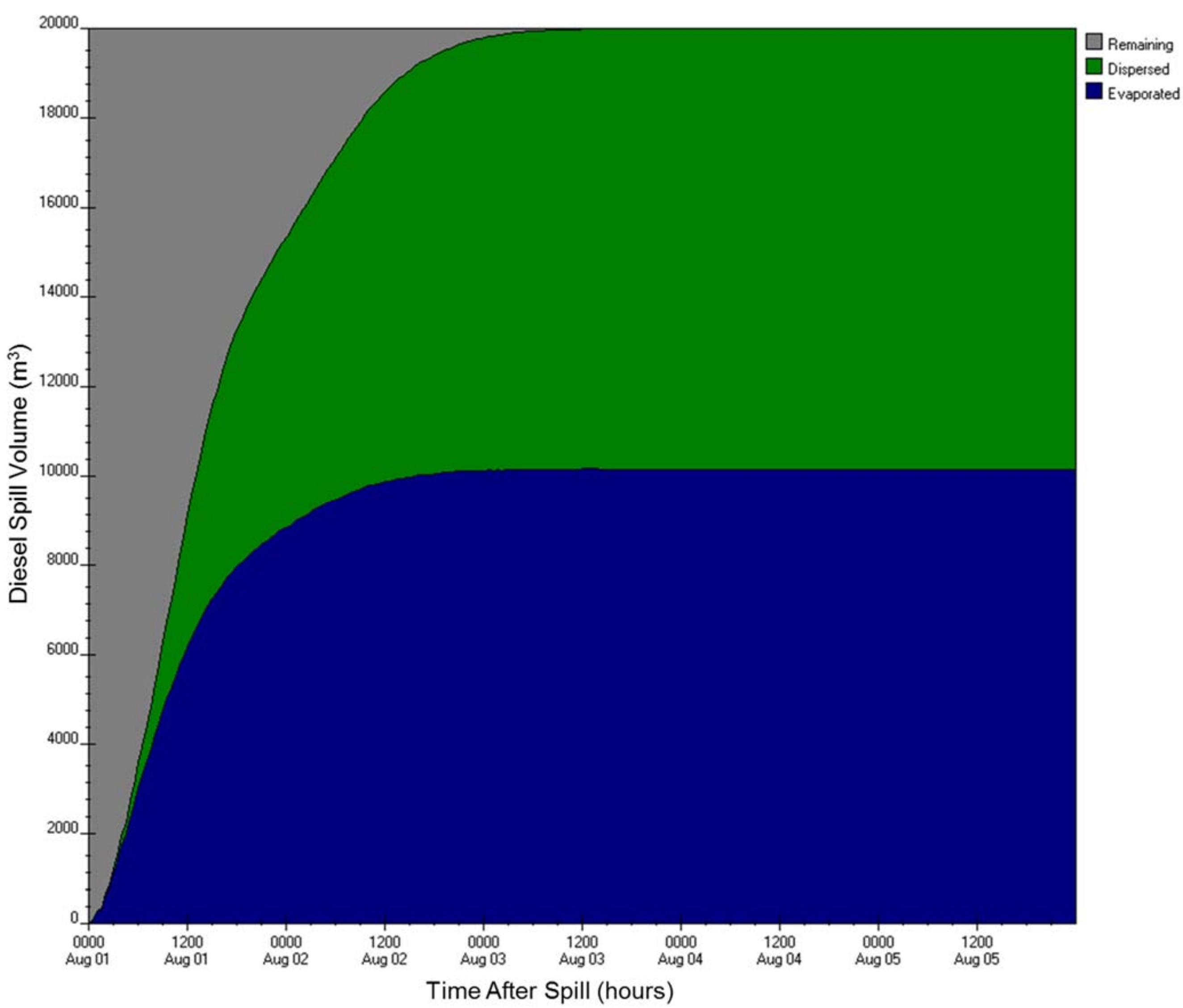

Figure E-A9: ADIOS2 diesel fuel budget output for two fuel transfer stations (1 and 2) near Melvin Bay for 20,000 m^3, 50-yr wind speed scenario

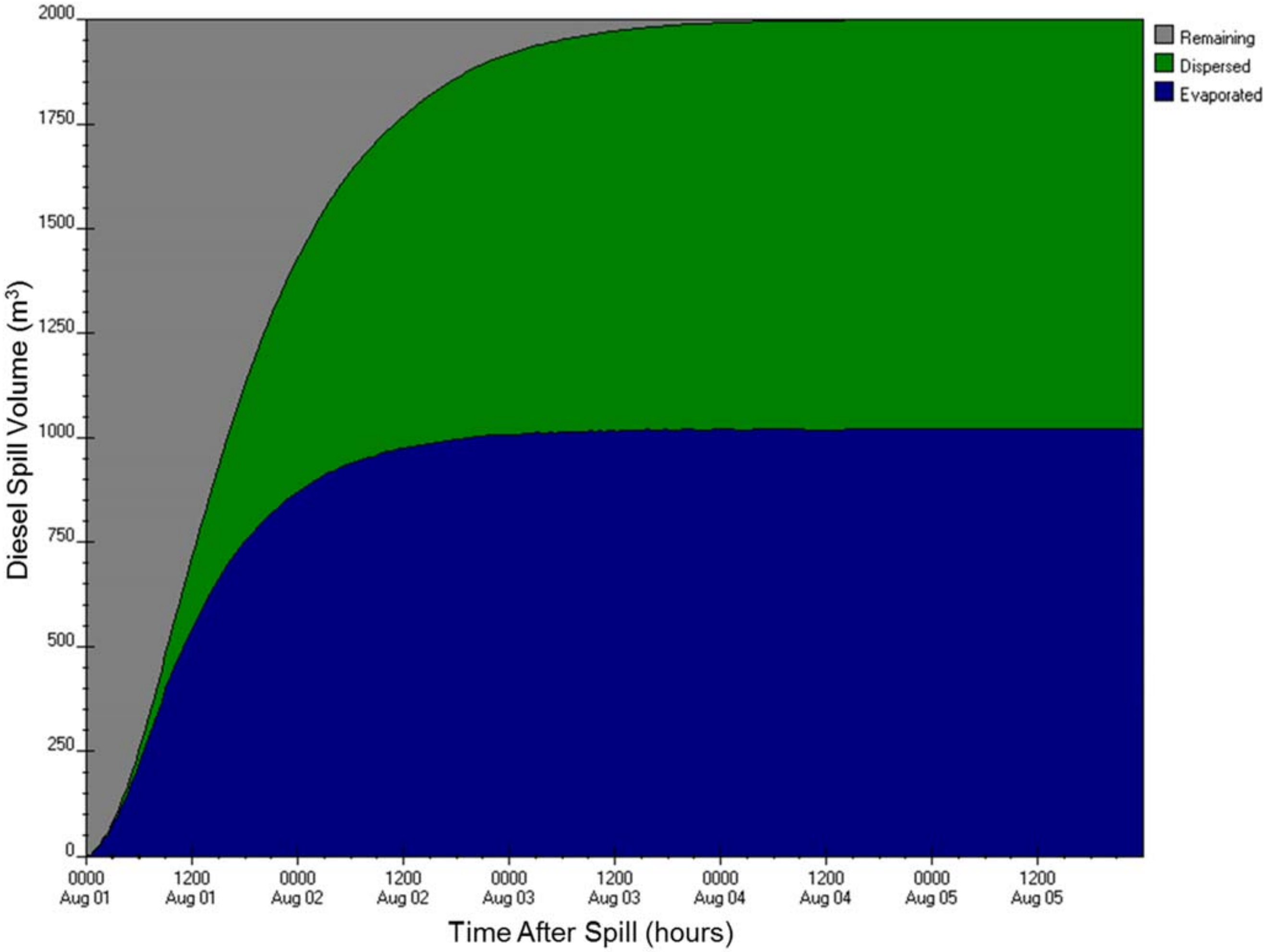

Figure 8E-A10: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 2,000 m^3, mean wind speed scenario

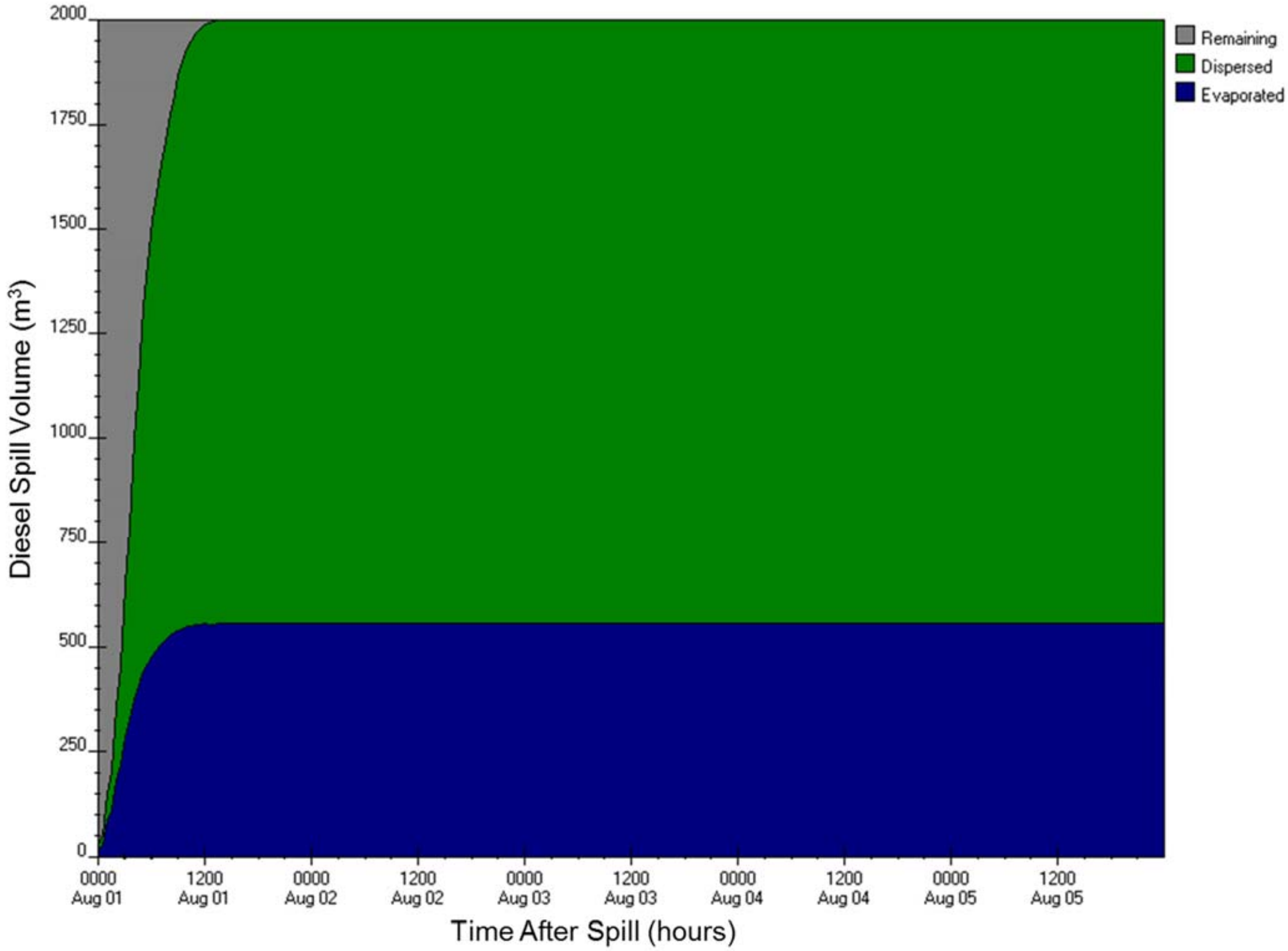

Figure E-A11: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 2,000 m^3, 2-yr wind speed scenario

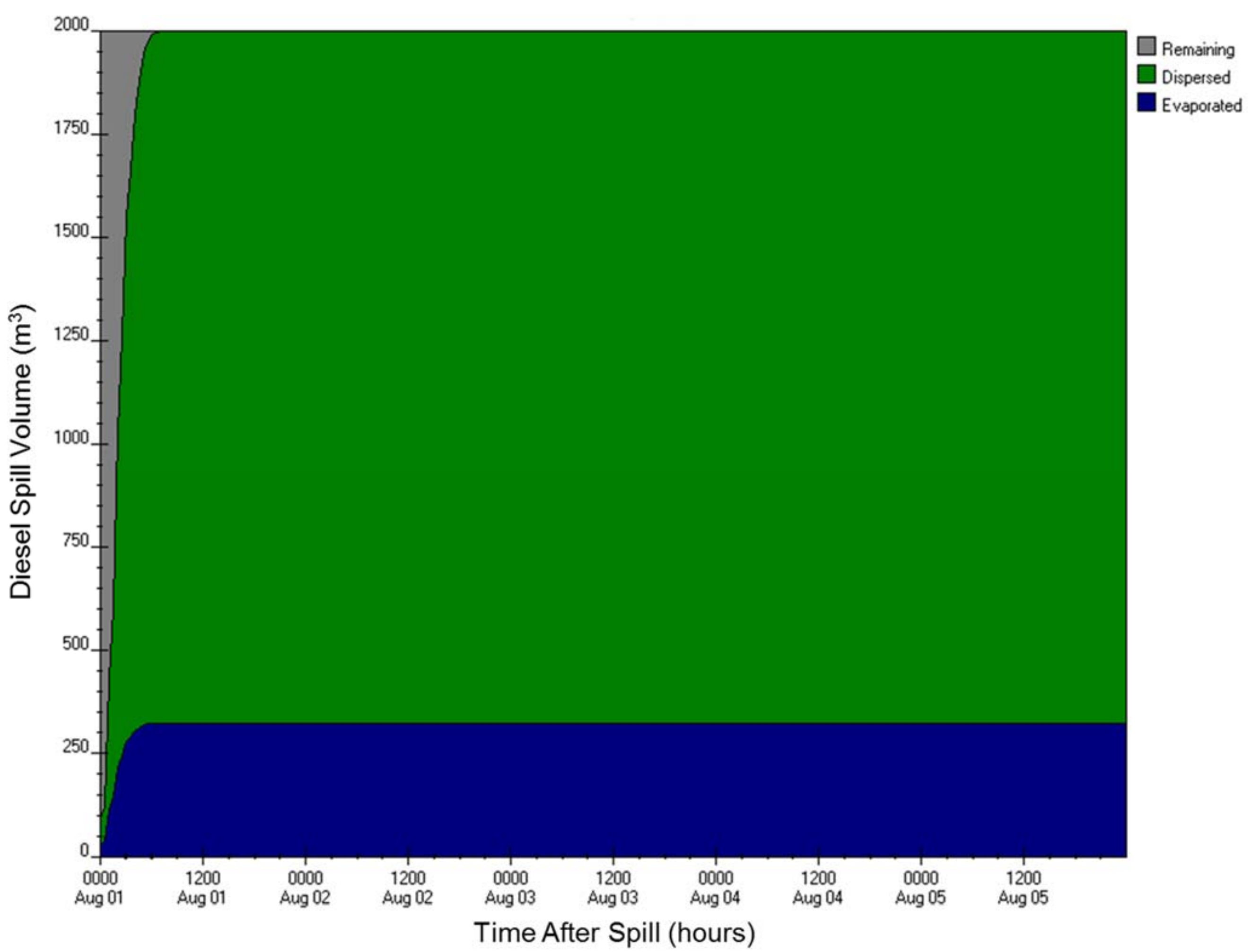

Figure E-A12: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 2,000 m^3, 50-yr wind speed scenario

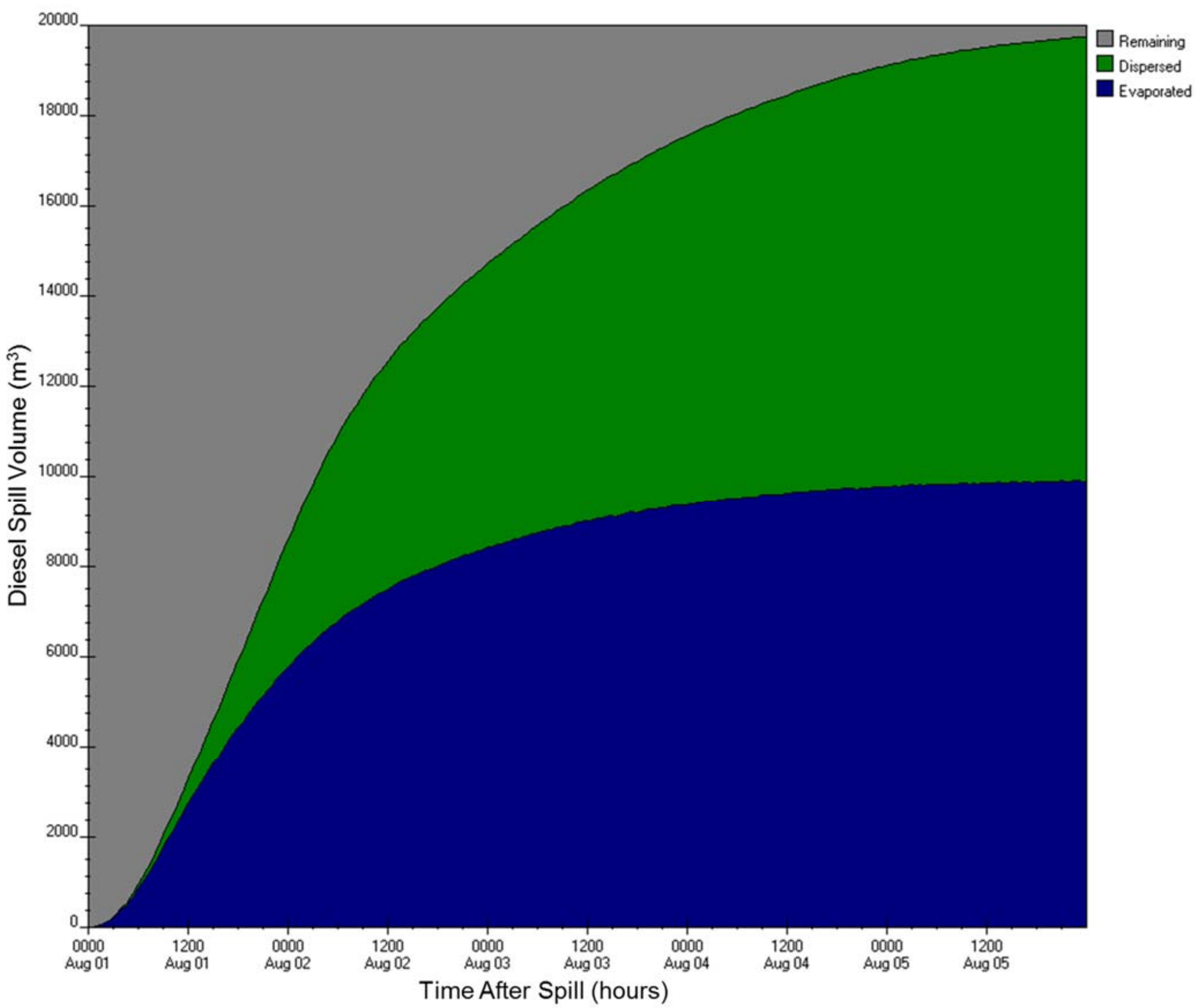

Figure E-A13: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 20,000 m^3, mean wind speed scenario

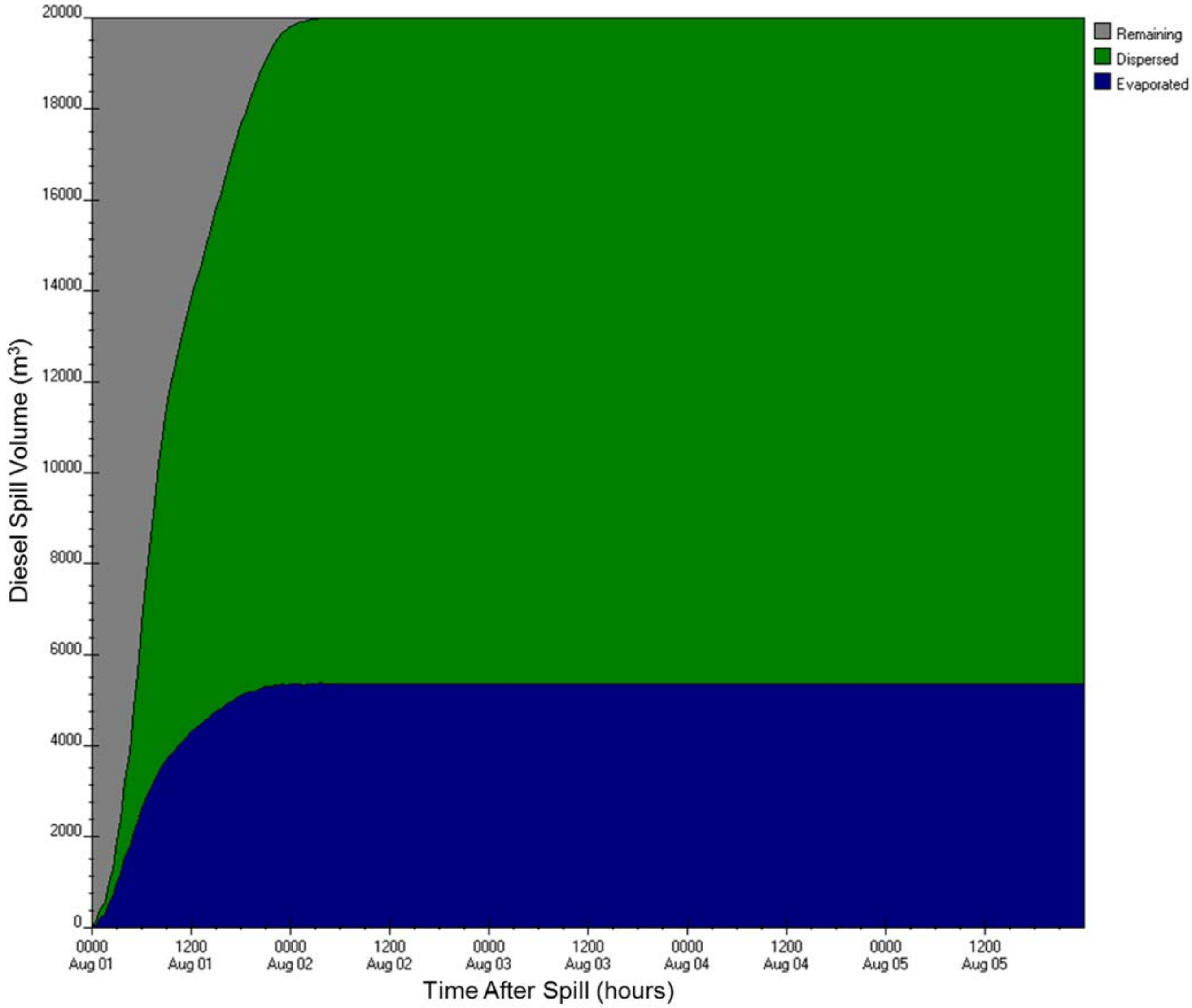

Figure E-A14: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 20,000 m^3, 2-yr wind speed scenario

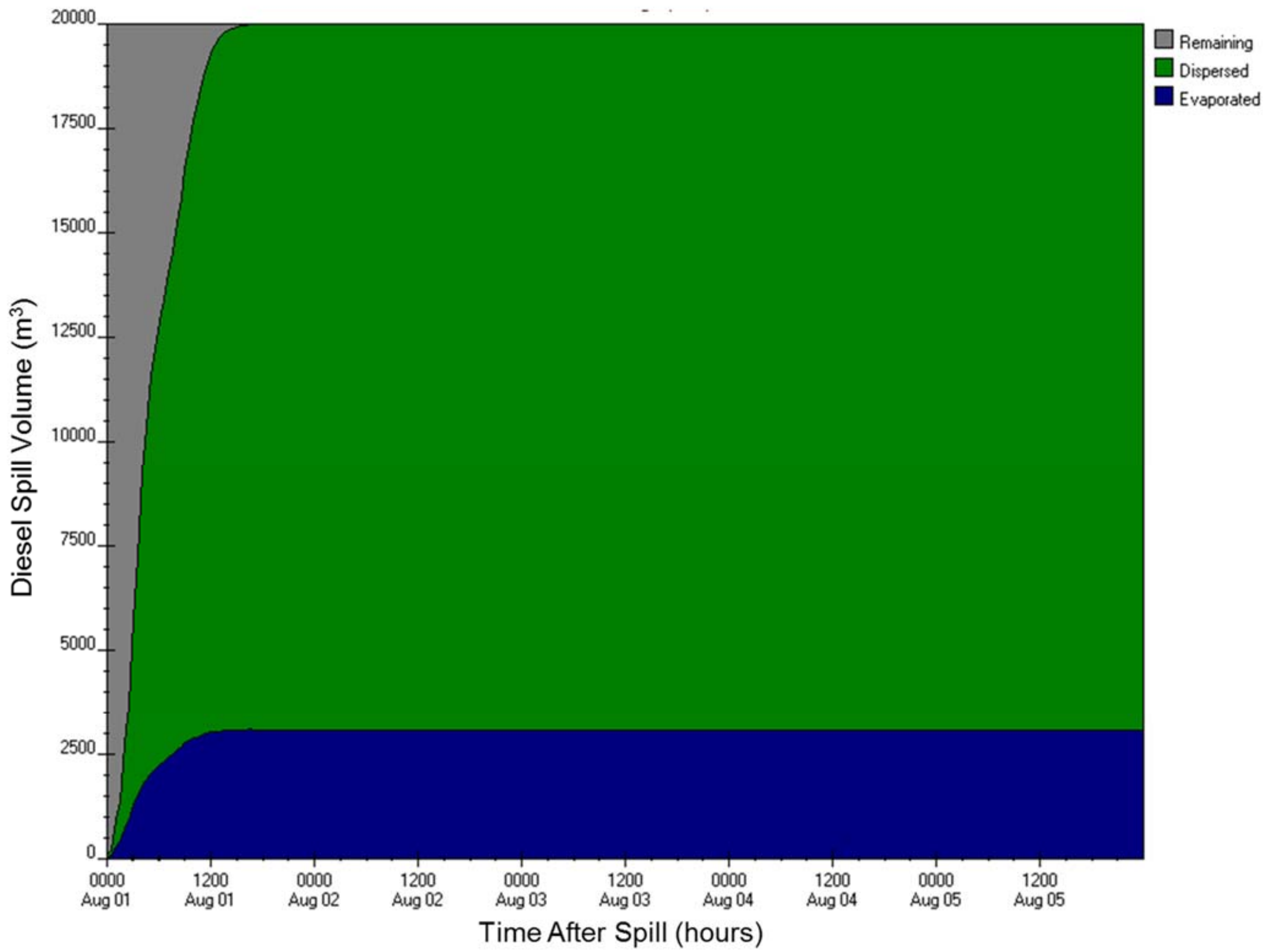

Figure E-A-15: ADIOS2 diesel fuel budget output for Walrus Island station (3) for 20,000 m^3, 50-yr wind speed scenario

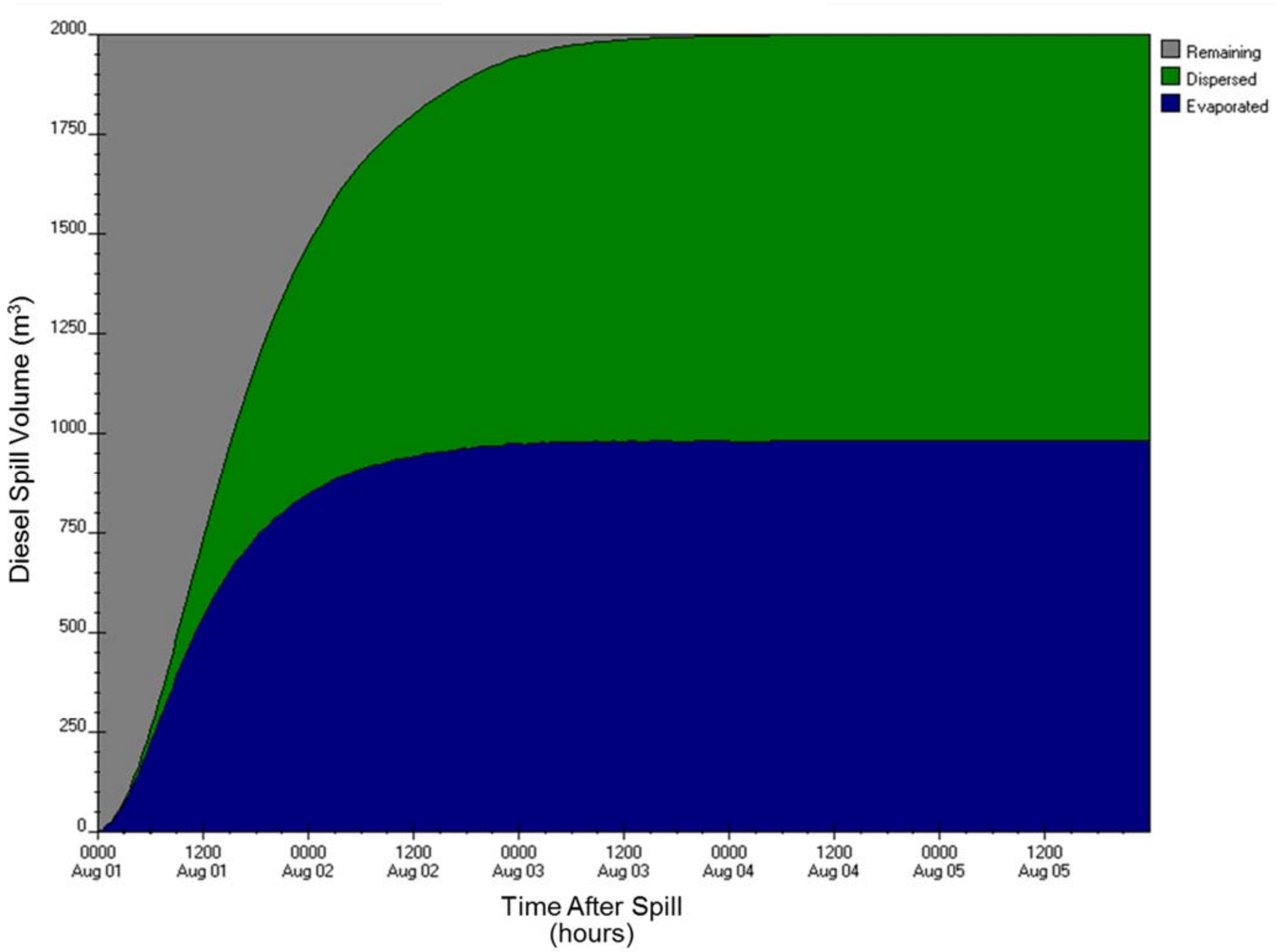

Figure E-A16: ADIOS2 diesel fuel budget output for Coats Island station (4) for 2,000 m^3, mean wind speed scenario

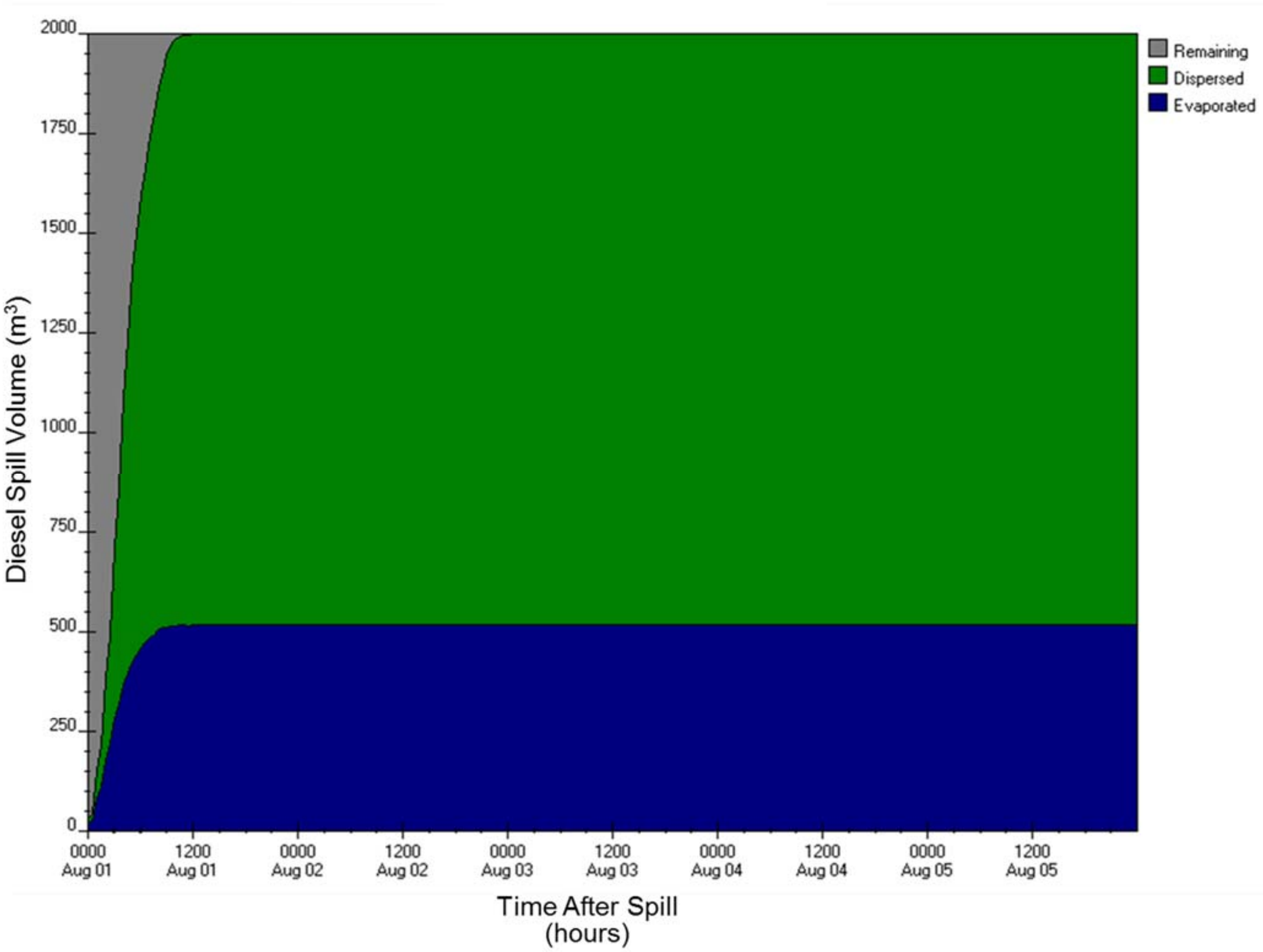

Figure E-A17: ADIOS2 diesel fuel budget output for Coats Island station (4) for 2,000 m^3, 2-yr wind speed scenario

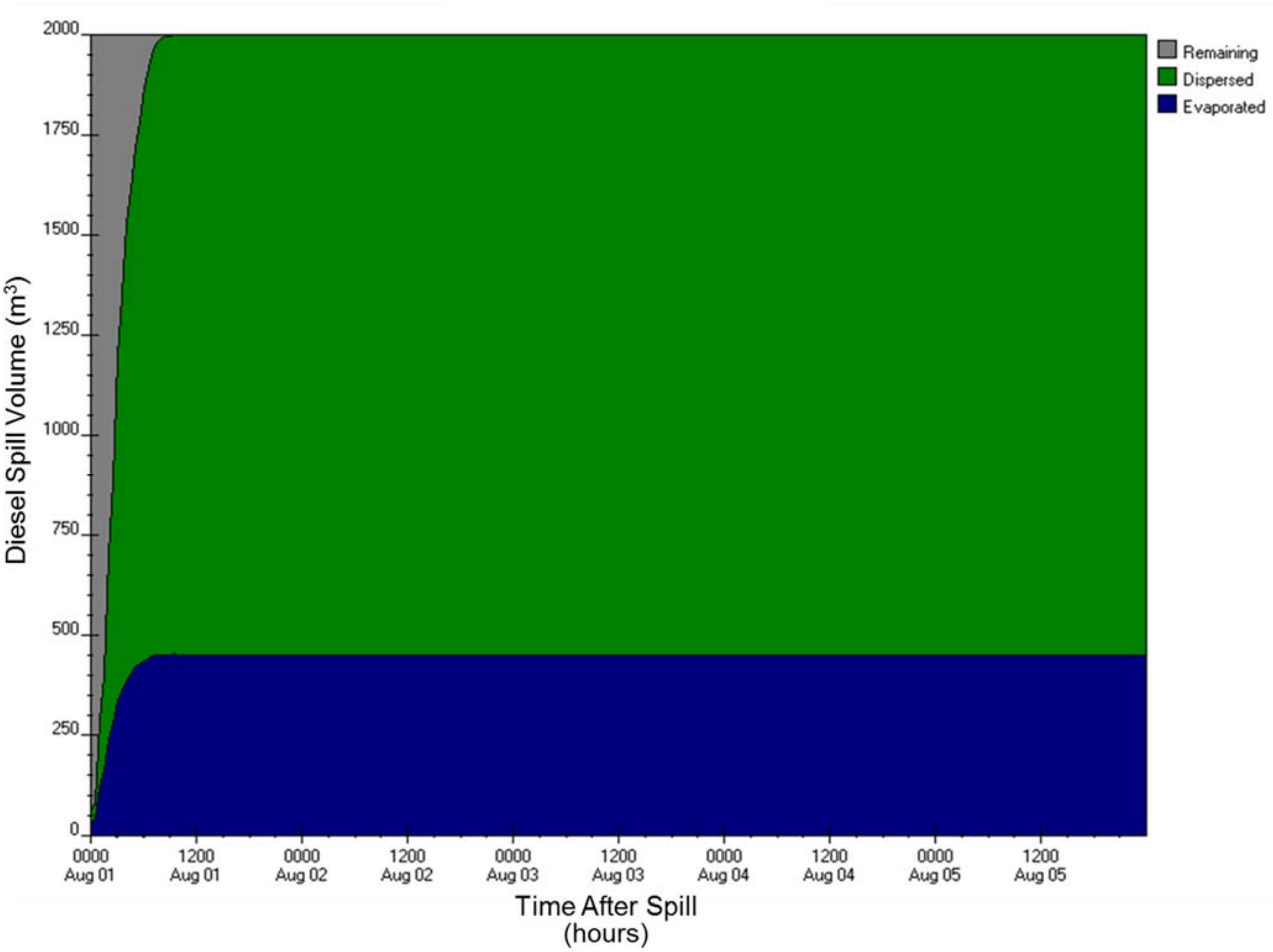

Figure E-A18: ADIOS2 diesel fuel budget output for Coats Island station (4) for 2,000 m^3, 50-yr wind speed scenario

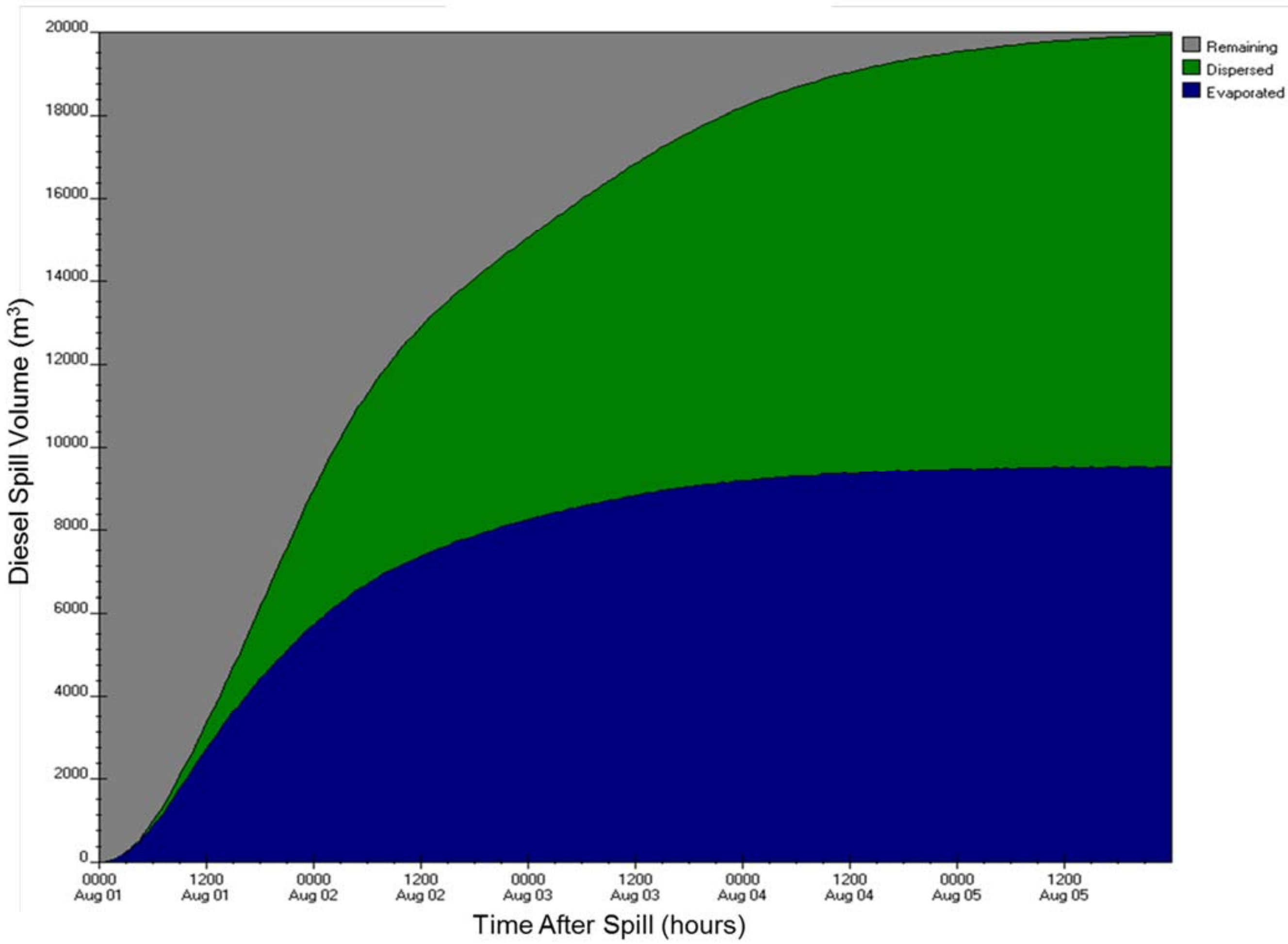

Figure E-A19: ADIOS2 diesel fuel budget output for Coats Island station (4) for 20,000 m^3, mean wind speed scenario

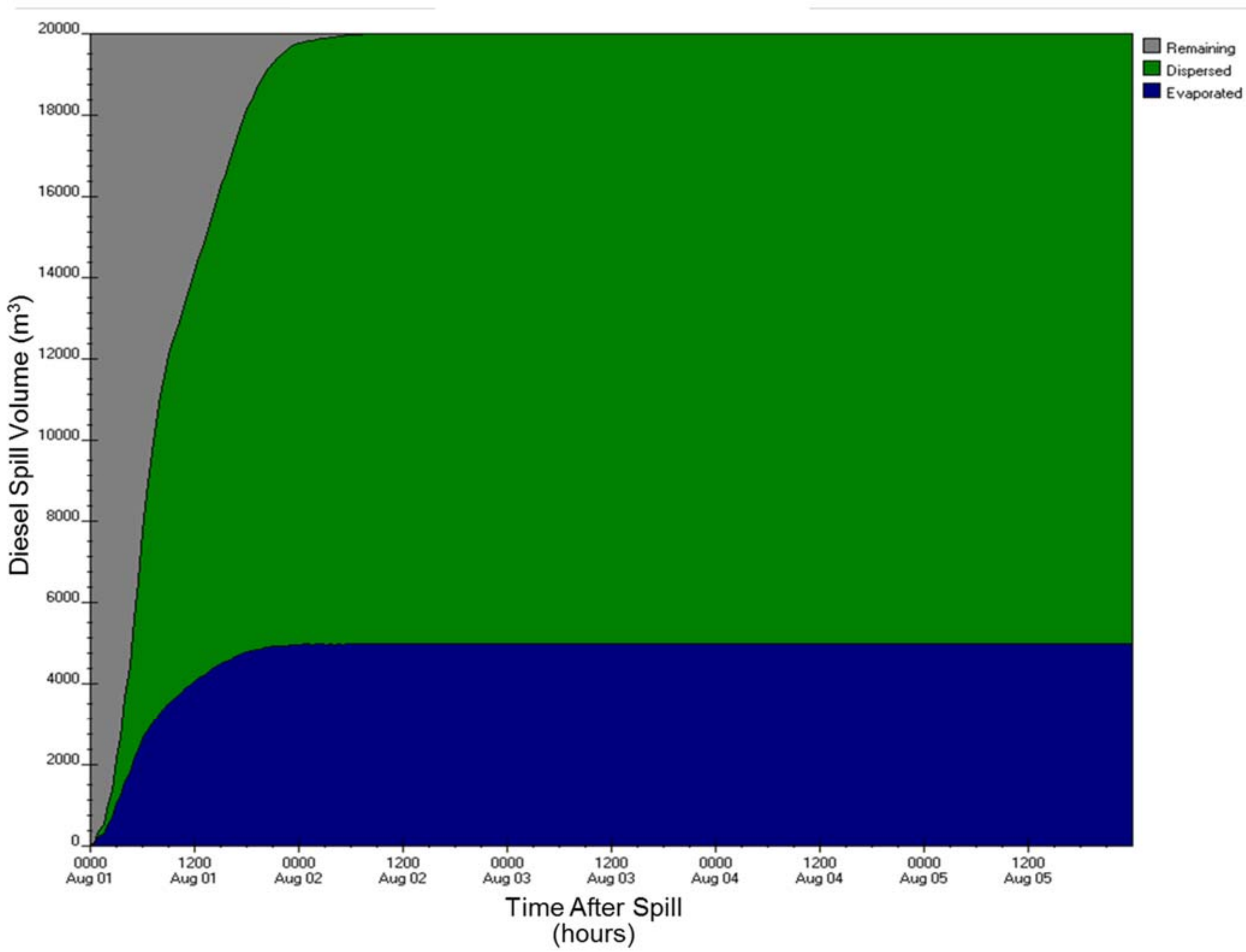

Figure E-A20: ADIOS2 diesel fuel budget output for Coats Island station (4) for 20,000 m^3, 2-yr wind speed scenario

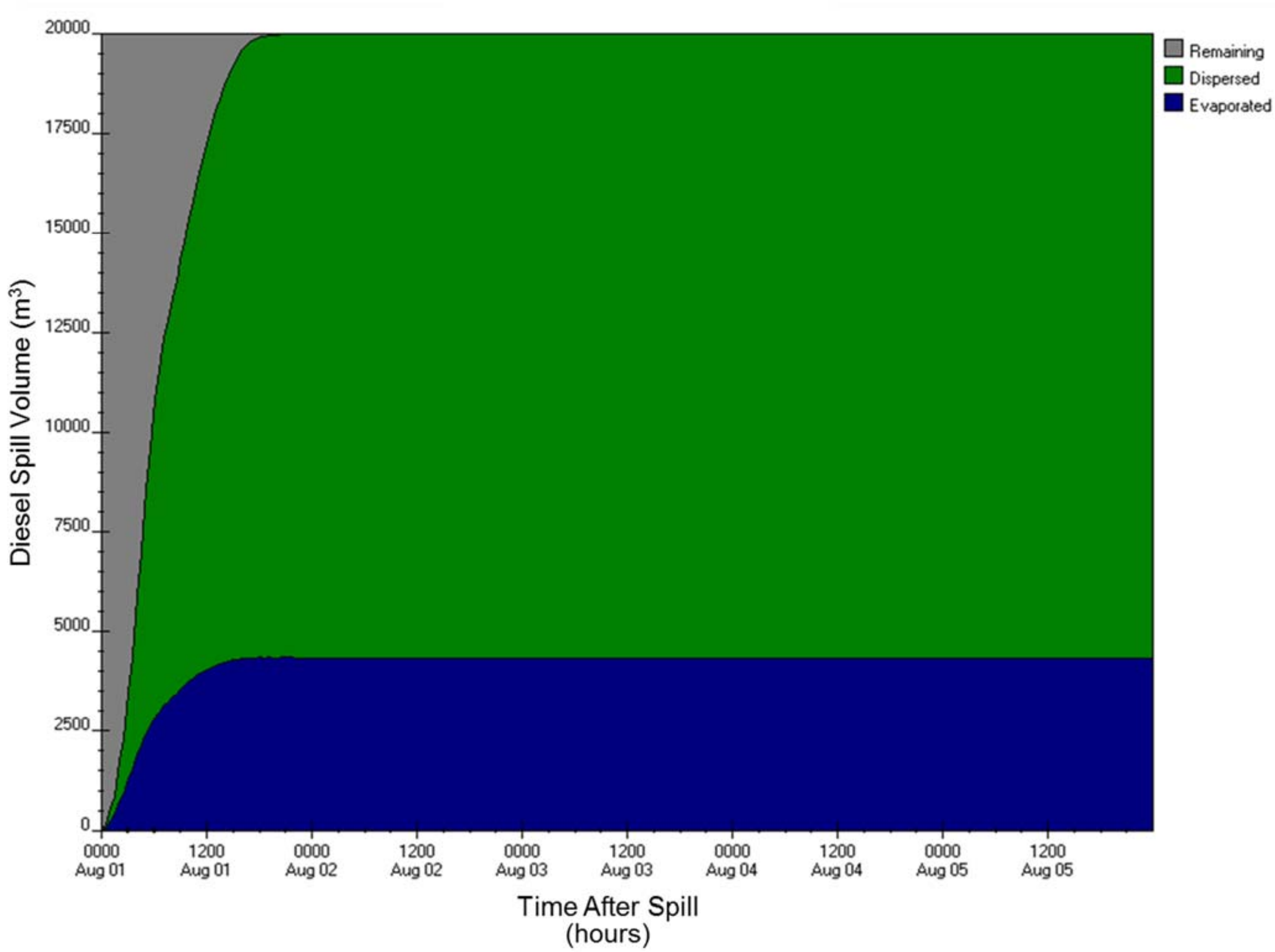

Figure E-A21:ADIOS2 diesel fuel budget output for Coats Island station (4) for 20,000 m³, 50-yr wind speed scenario

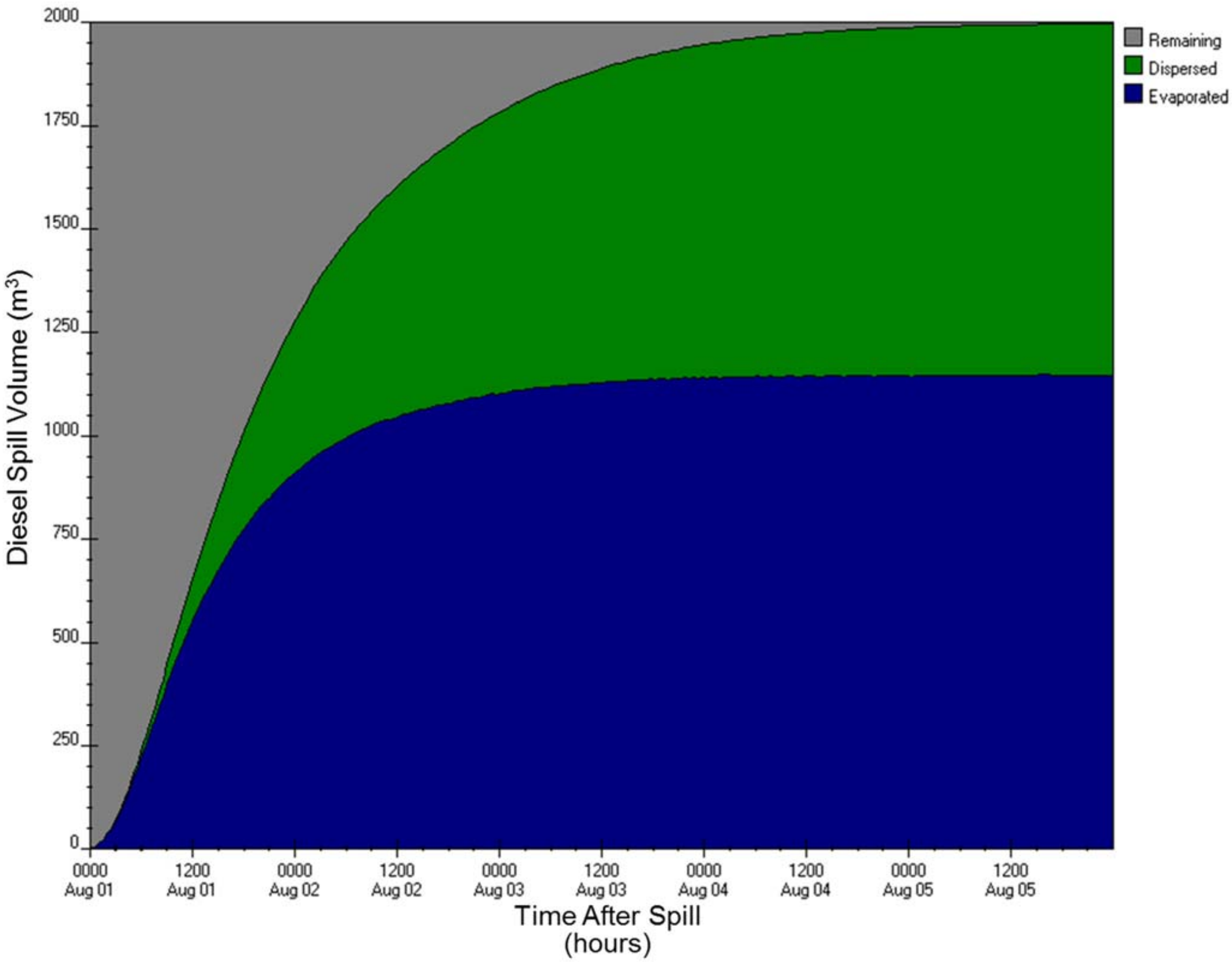

Figure E-A22:ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 2,000 m^3, mean wind speed scenario

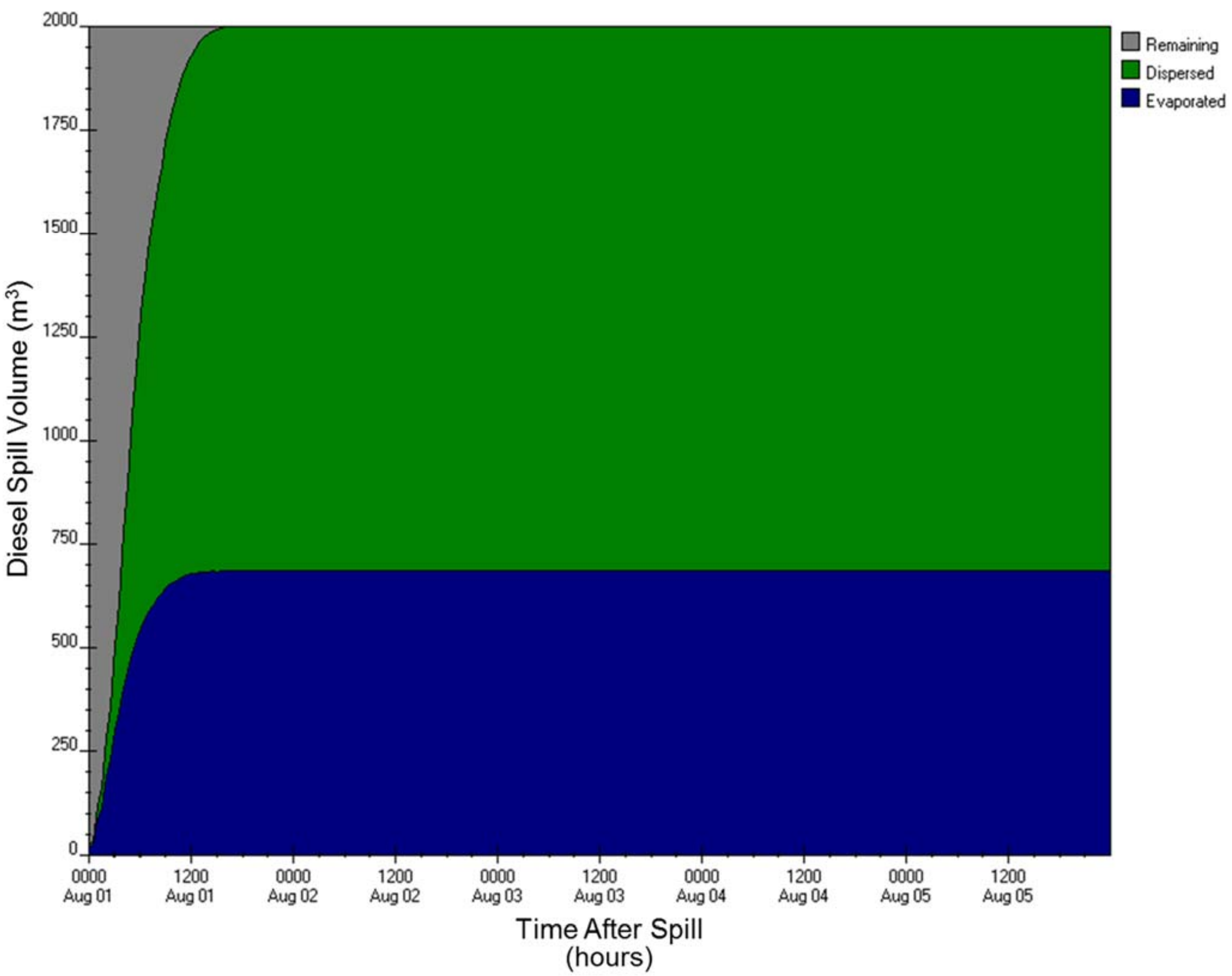

Figure E-A23: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 2,000 m^3, 2-yr wind speed scenario

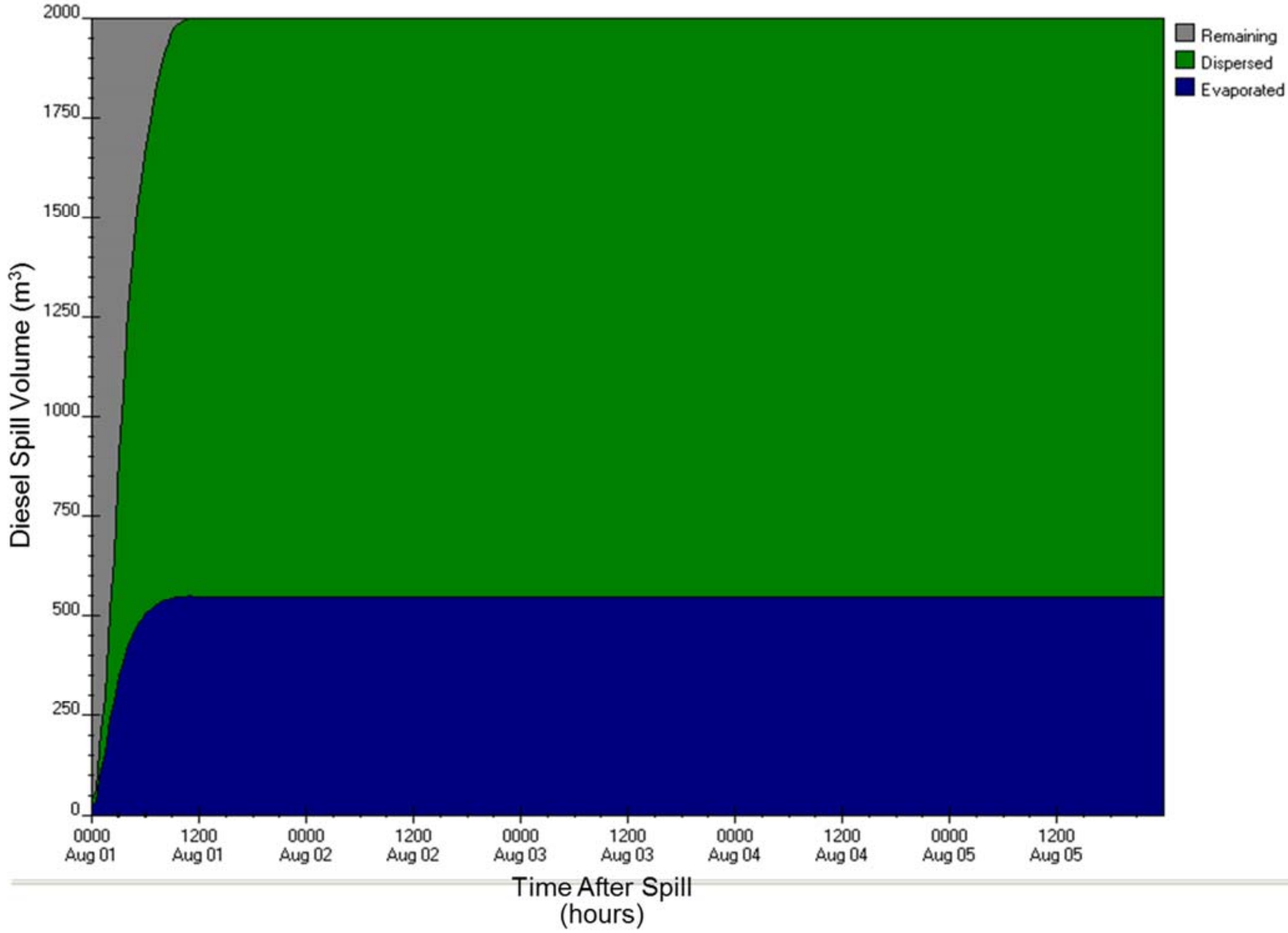

Figure E-A24: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 2,000 m^3, 50-yr wind speed scenario

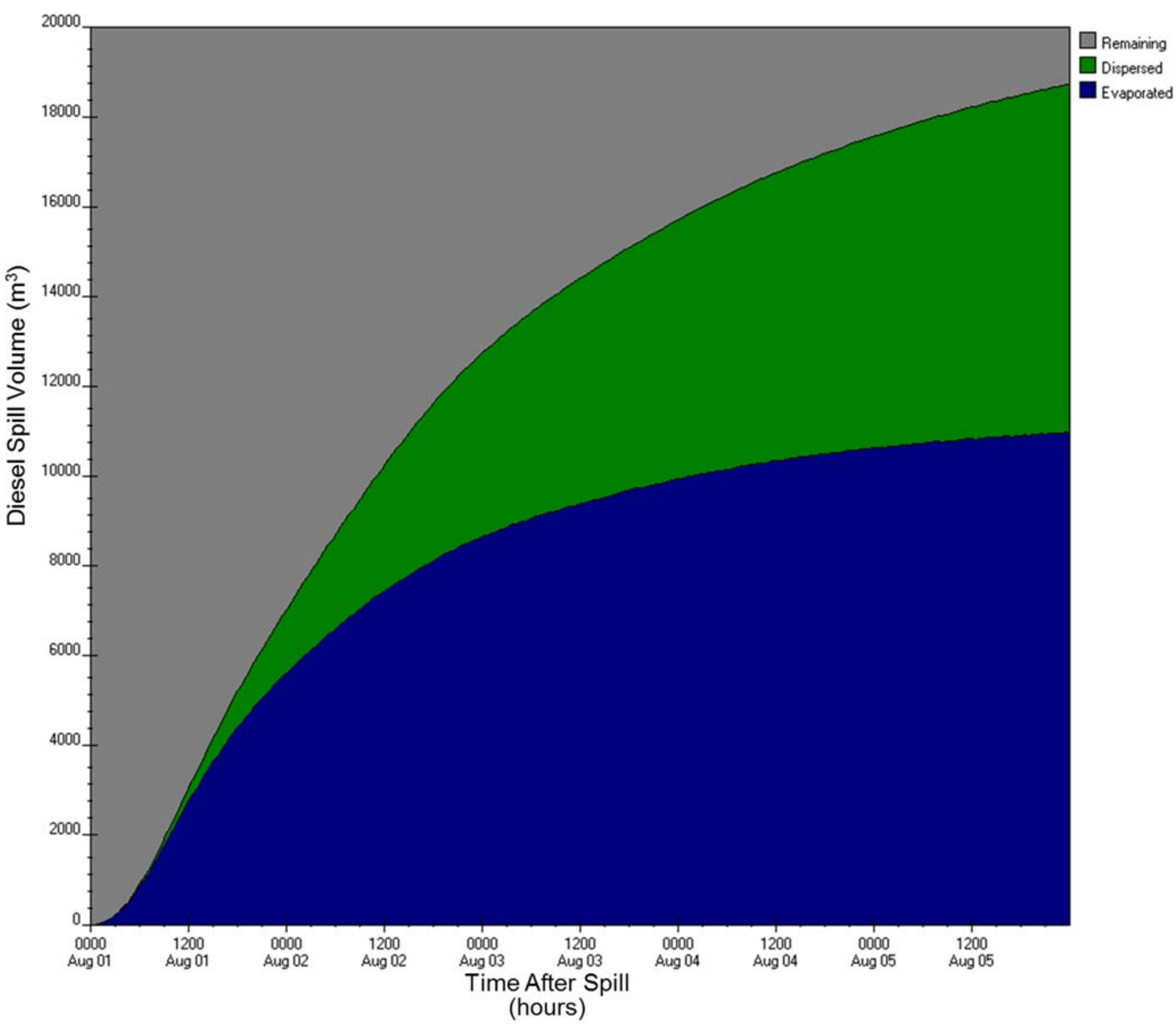

Figure E-A25: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 20,000 m^3, mean wind speed scenario

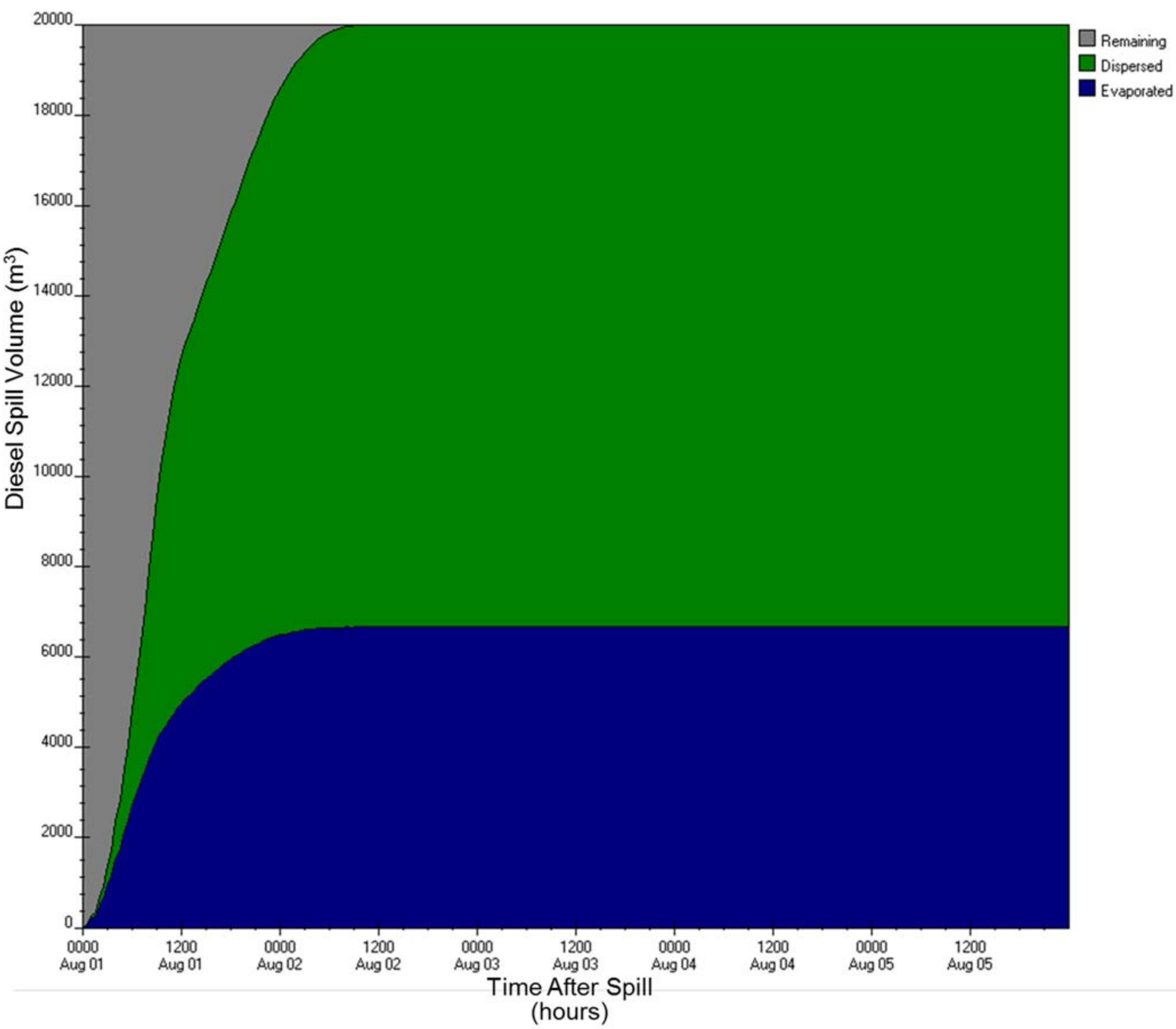

Figure E-A26: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 20,000 m^3, 2-yr wind speed scenario

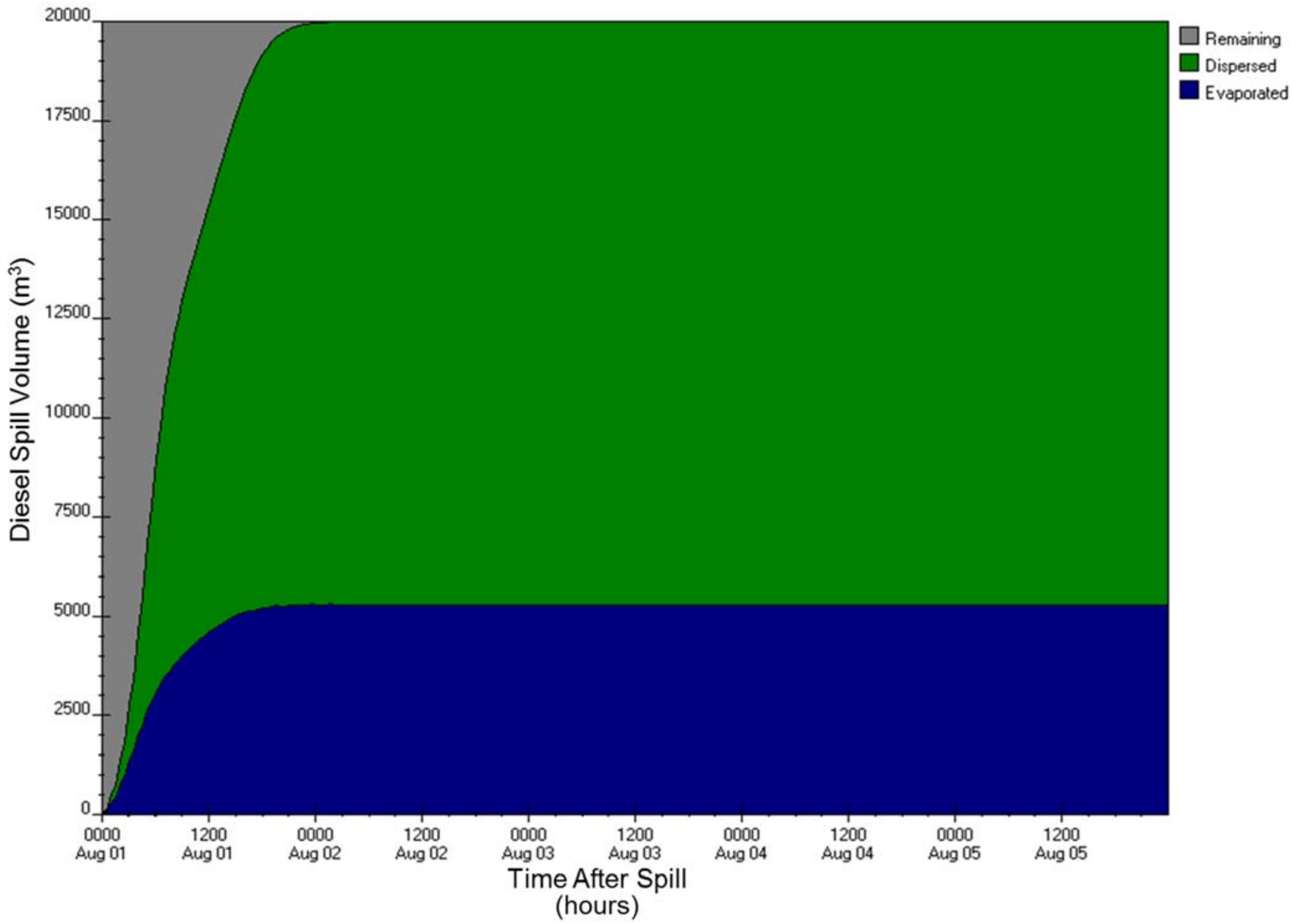

Figure E-A27: ADIOS2 diesel fuel budget output for Ungava Peninsula station (5) for 20,000 m^3, 50-yr wind speed scenario

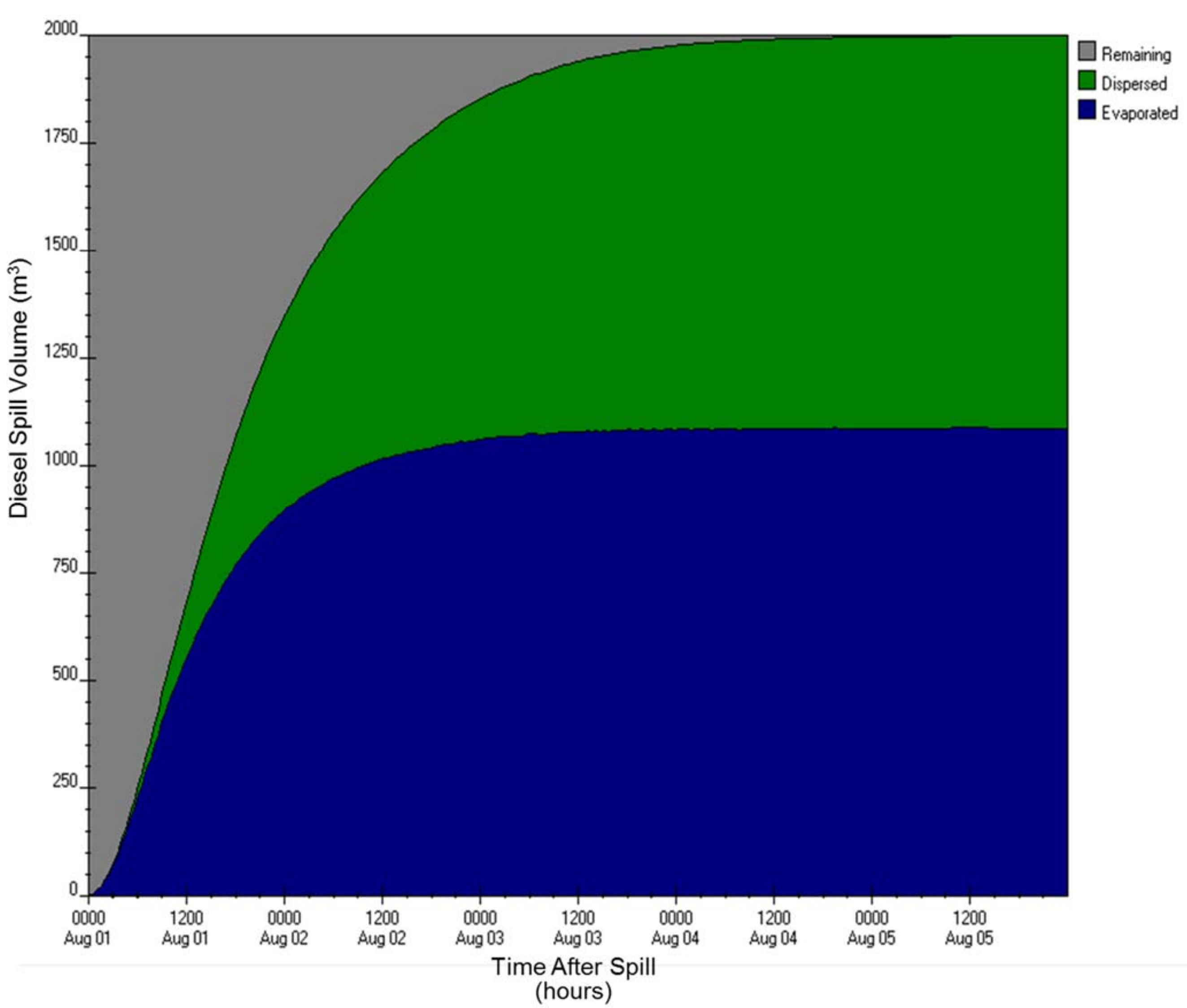

Figure E-A28: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 2,000 m^3, mean wind speed scenario

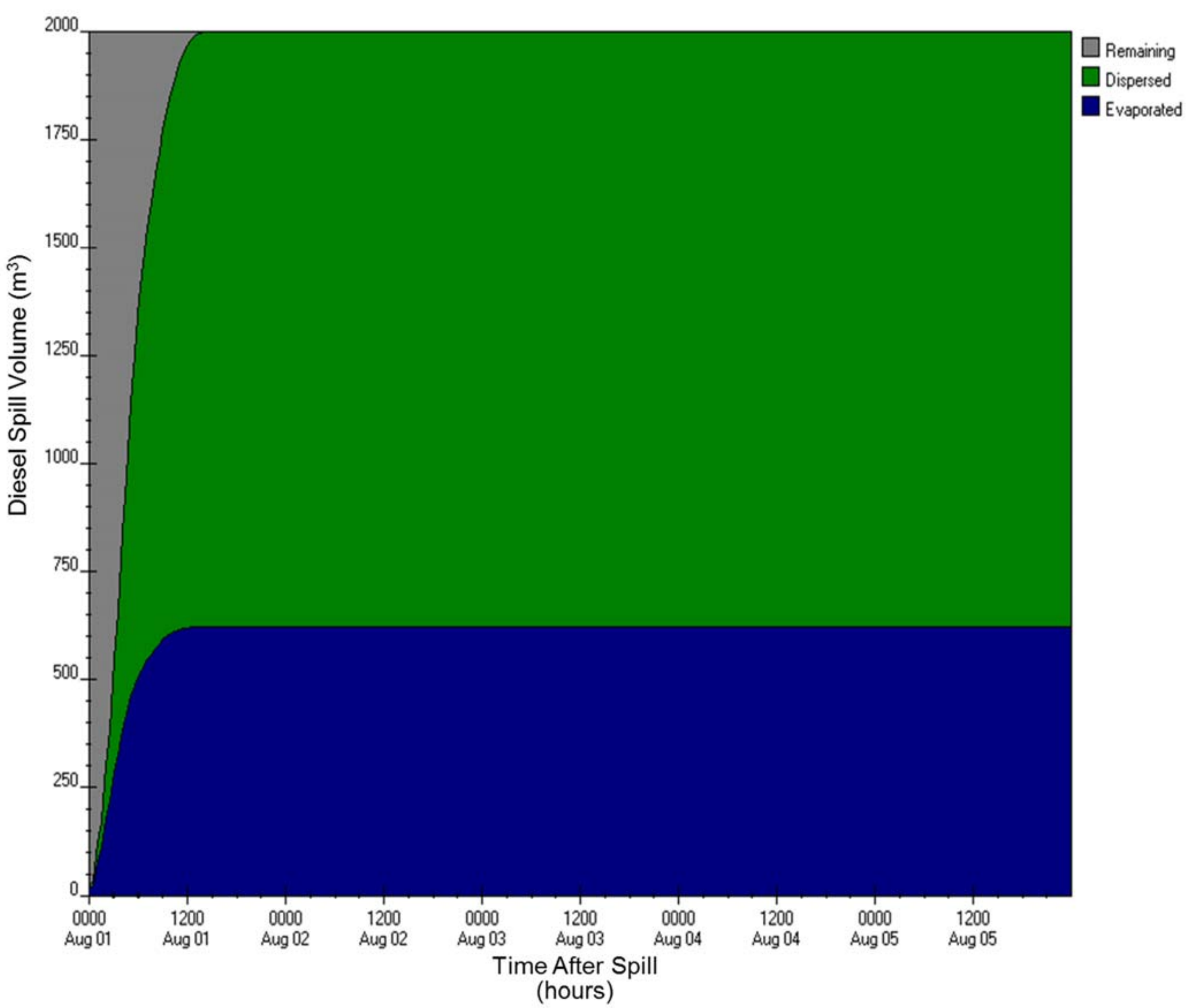

Figure E-A29: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 2,000 m^3, 2-yr wind speed scenario

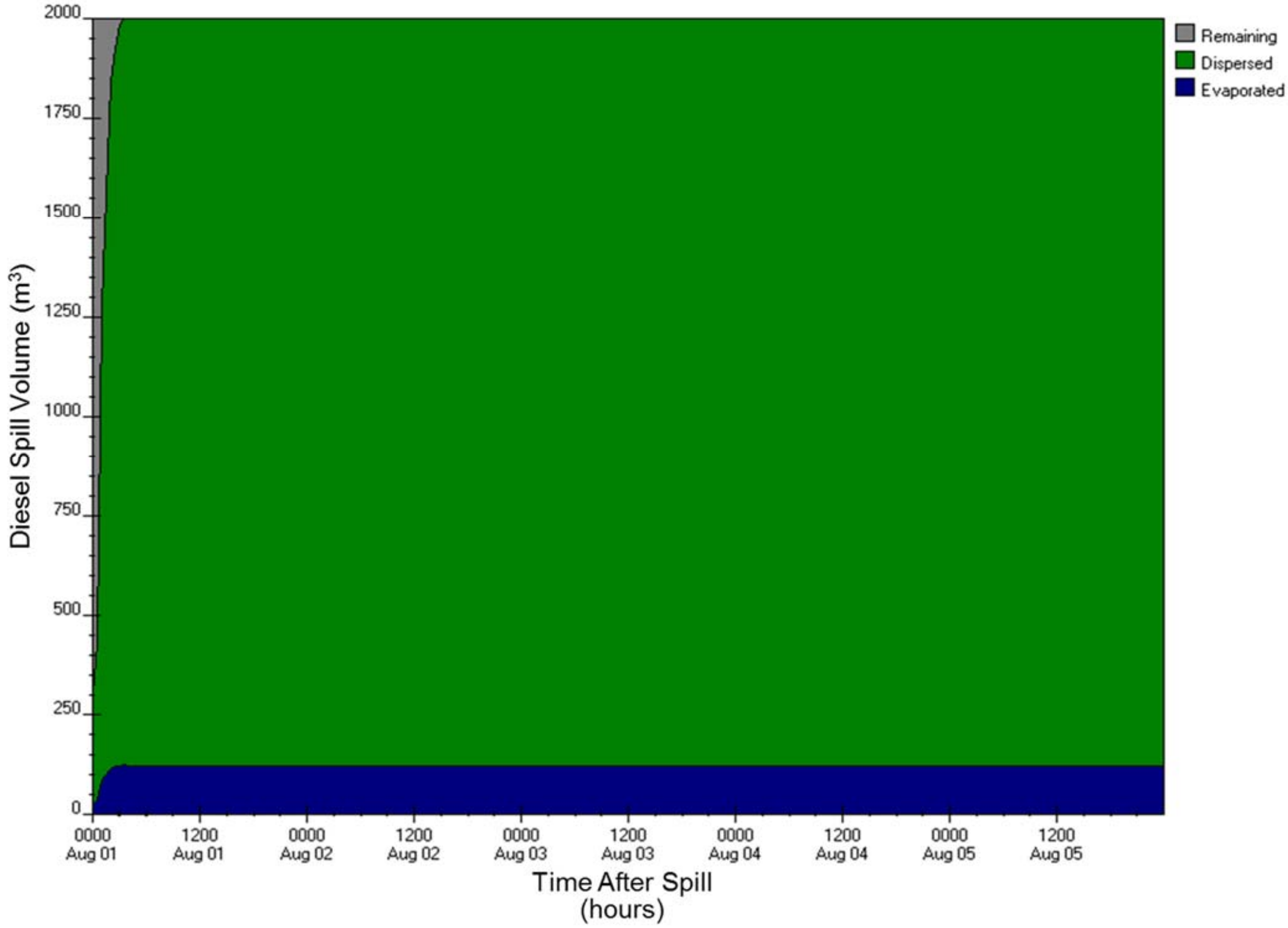

Figure E-A30: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 2,000 m^3, 50-yr wind speed scenario

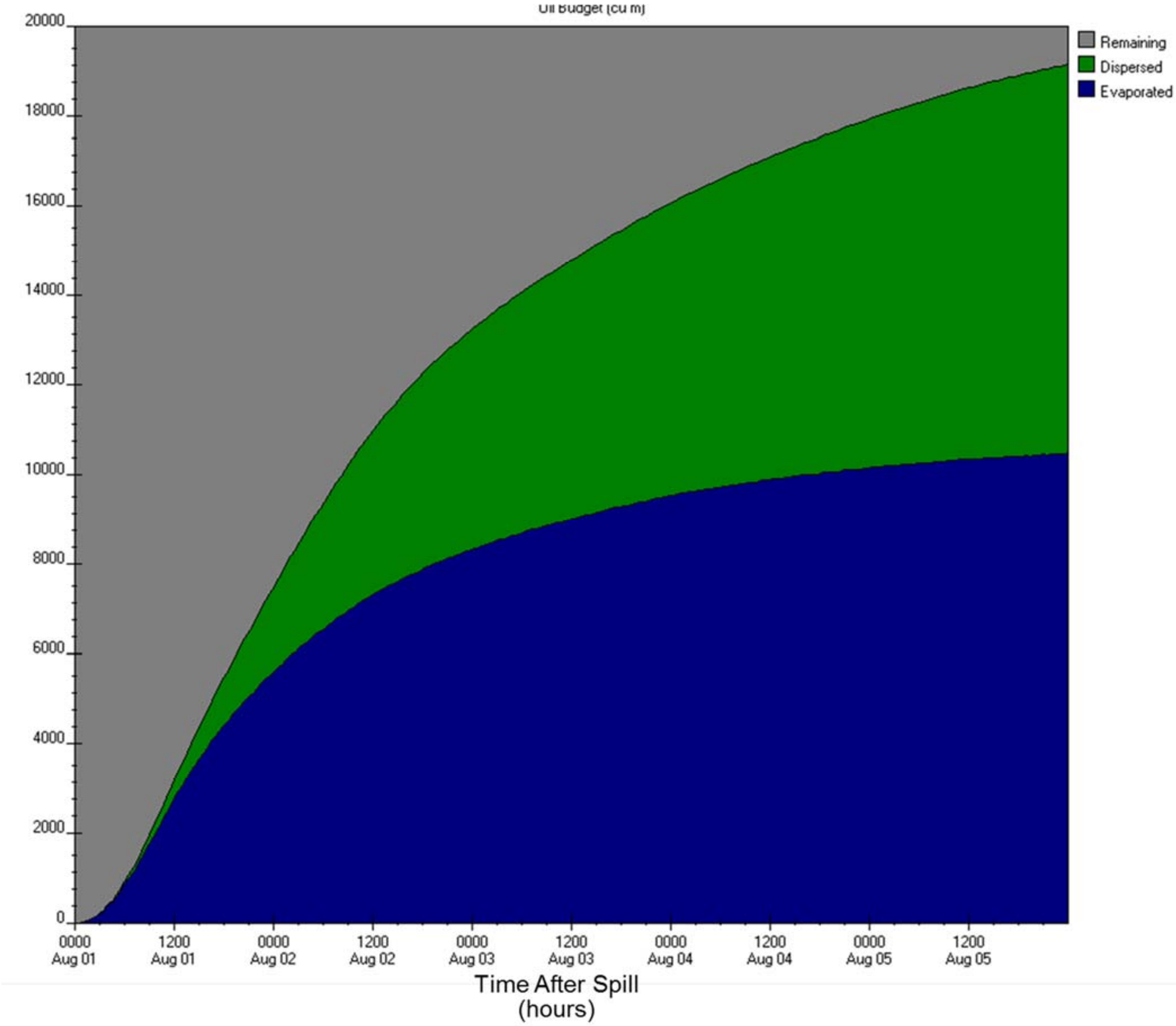

Figure E-A31: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 20,000 m^3, mean wind speed scenario

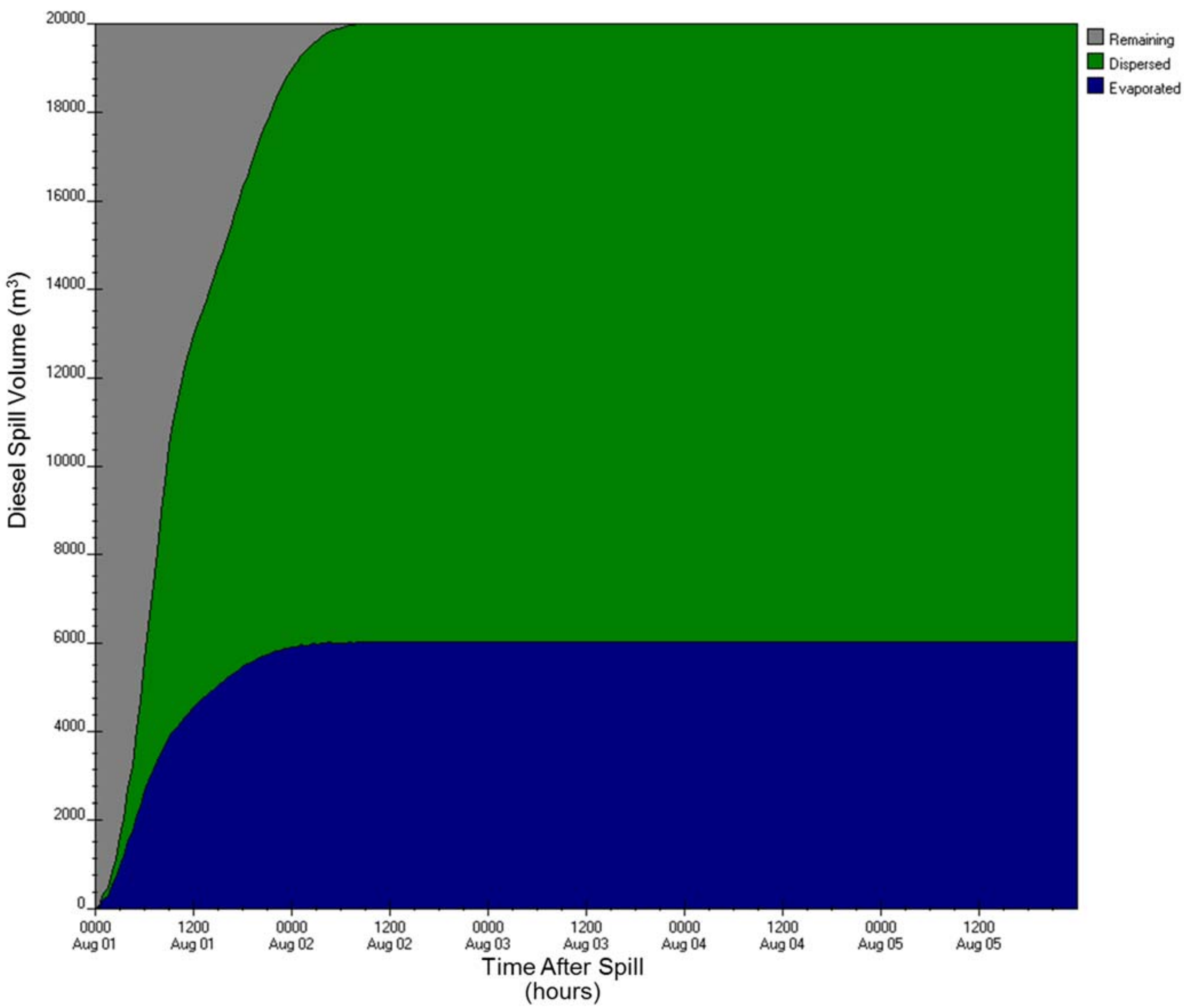

Figure E-A32: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 20,000 m³, 2-yr wind speed scenario

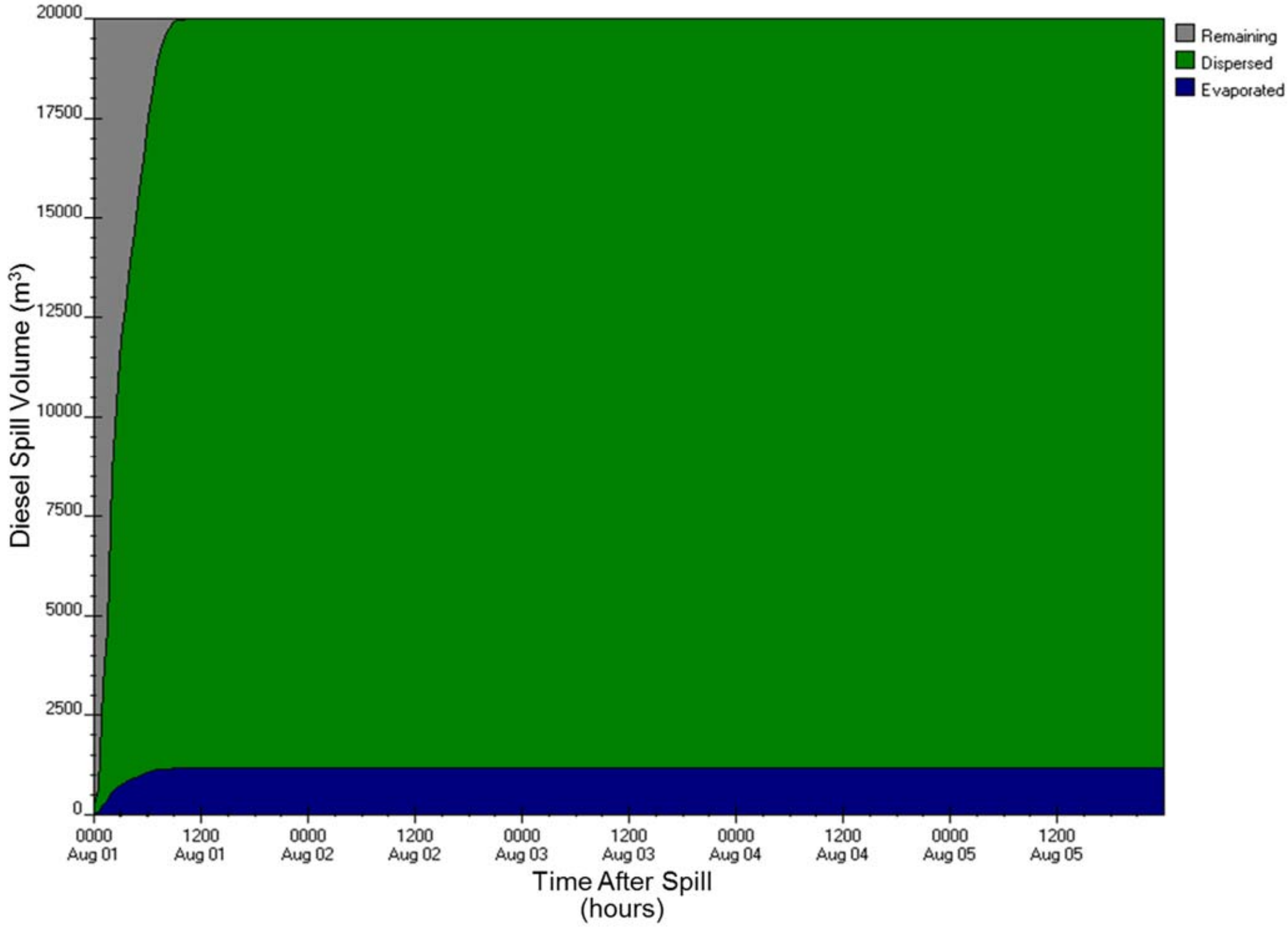

Figure E-A33: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (6) for 20,000 m^3, 50-yr wind speed scenario

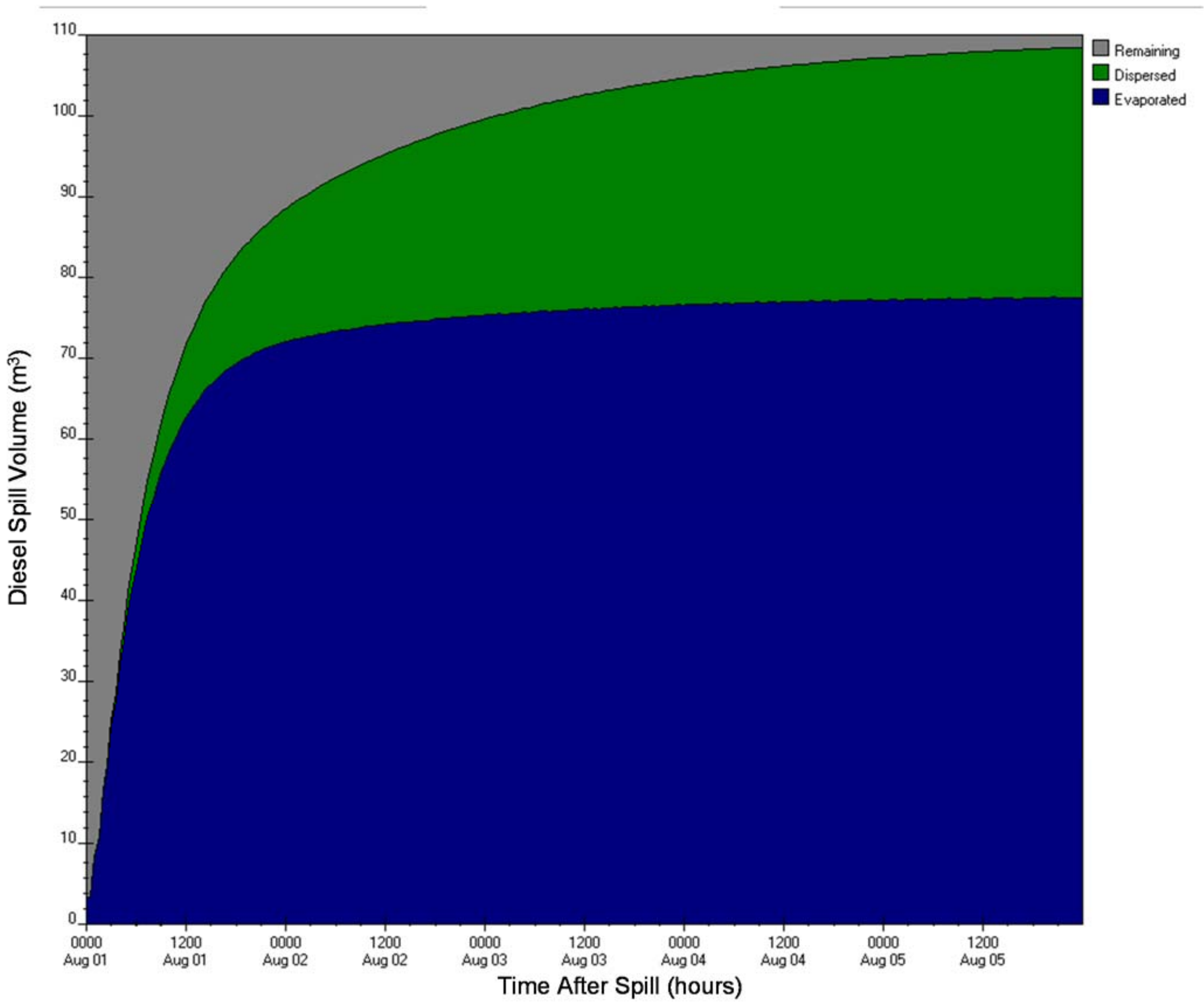

Figure E-A34: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 100 m^3, mean wind speed scenario

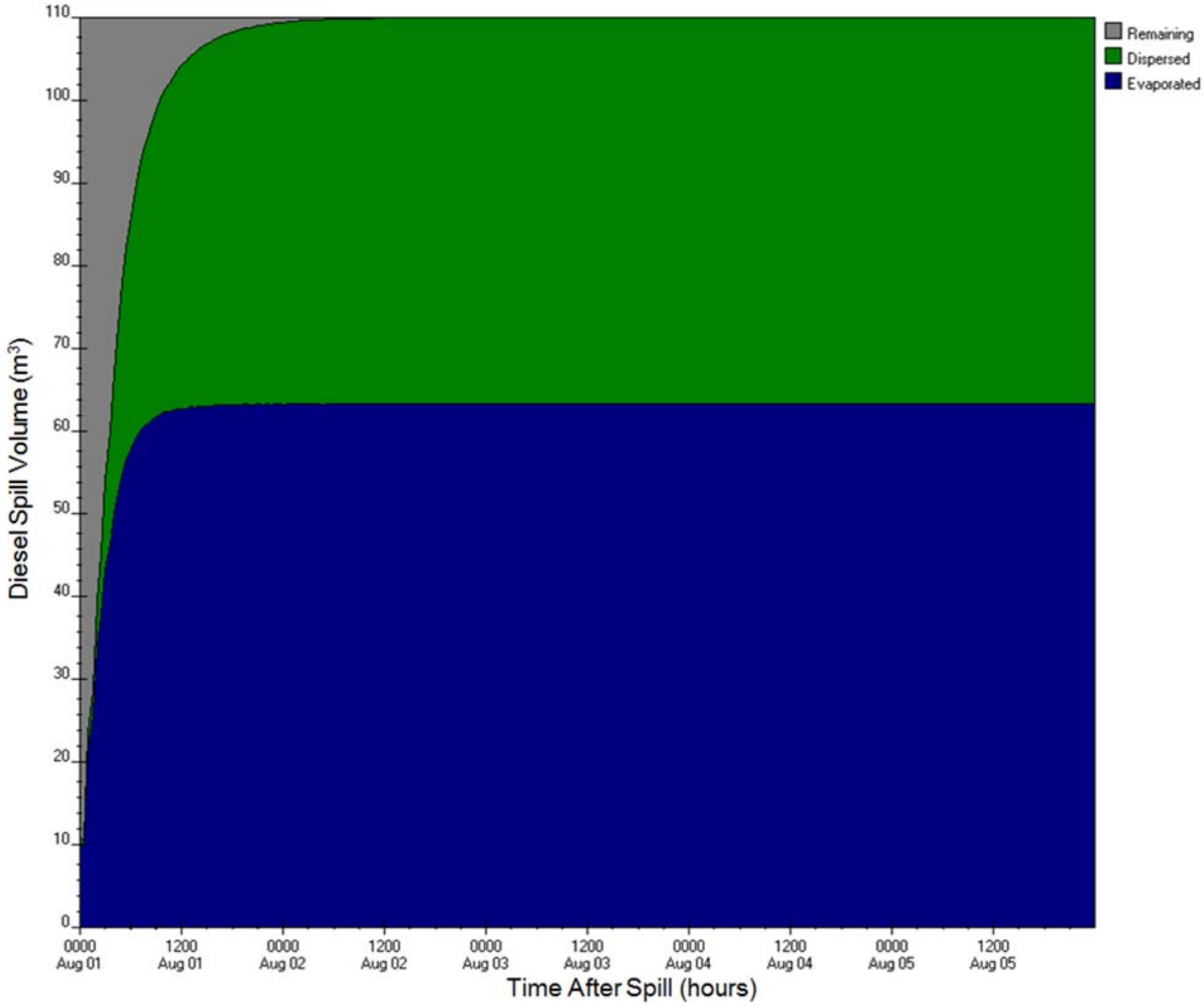

Figure E-A35: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 100 m^3, 2-yr wind speed scenario

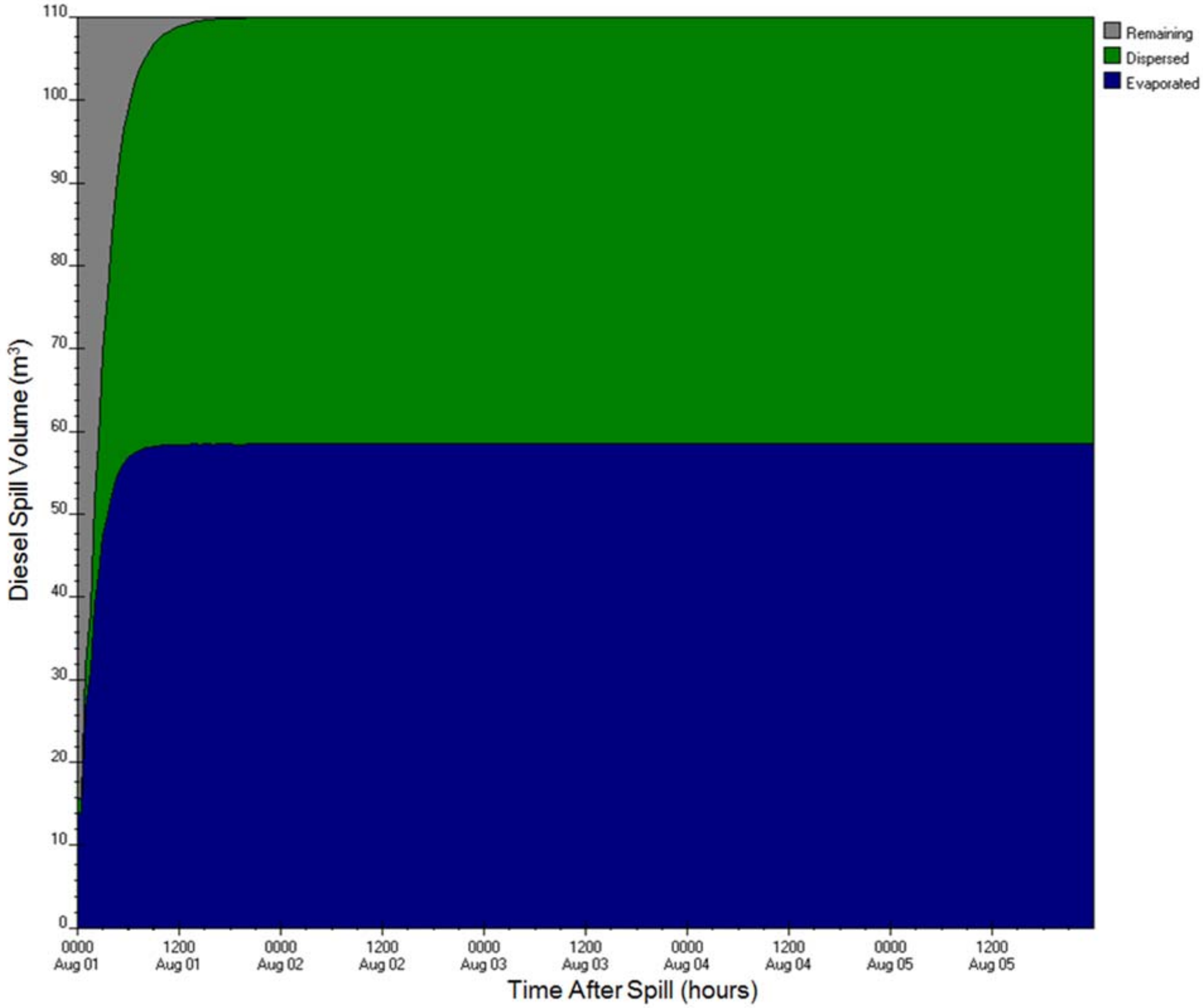

Figure E-A36: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 100 m^3, 50-yr wind speed scenario

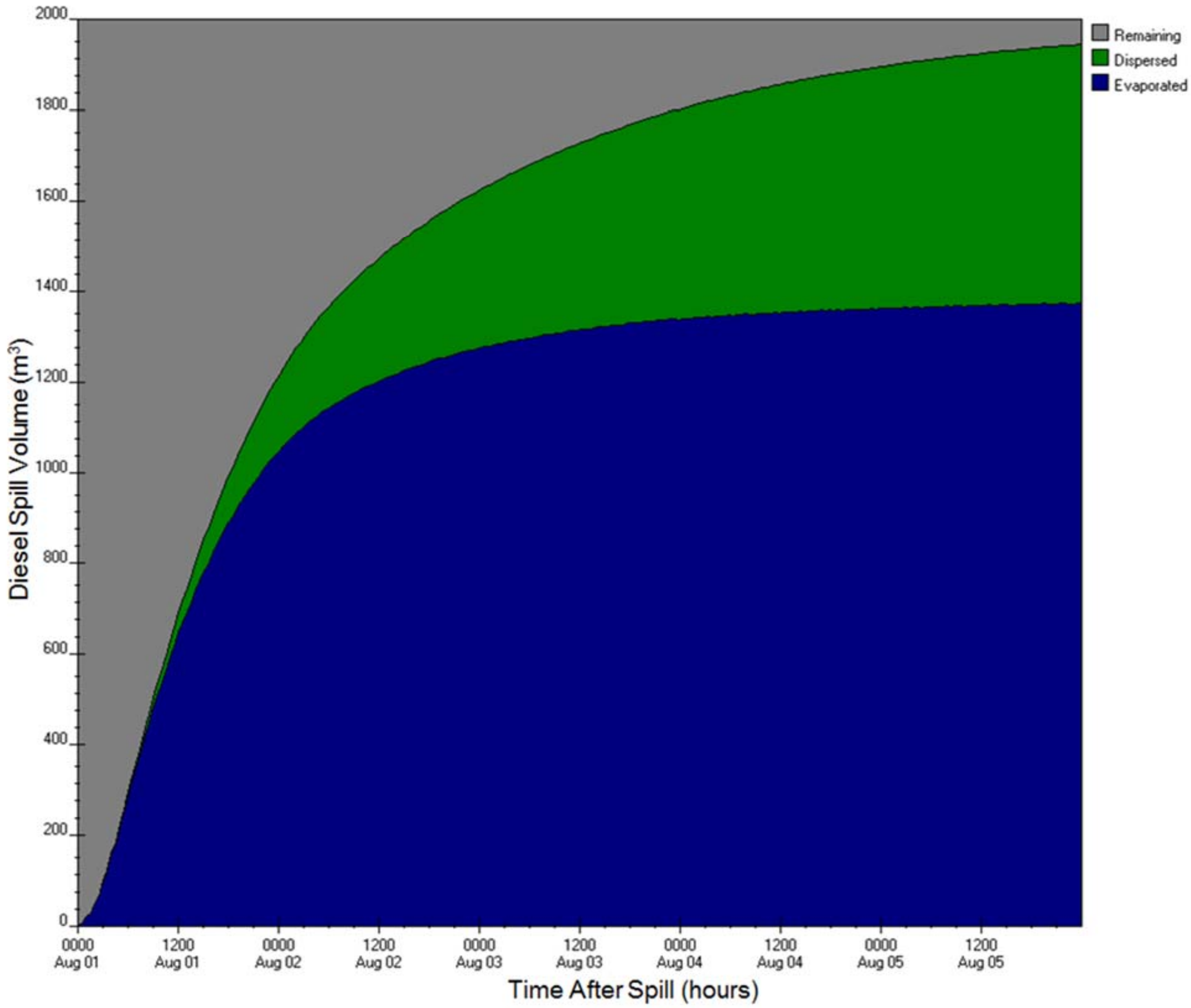

Figure E-A37: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 2,000 m^3, mean wind speed scenario

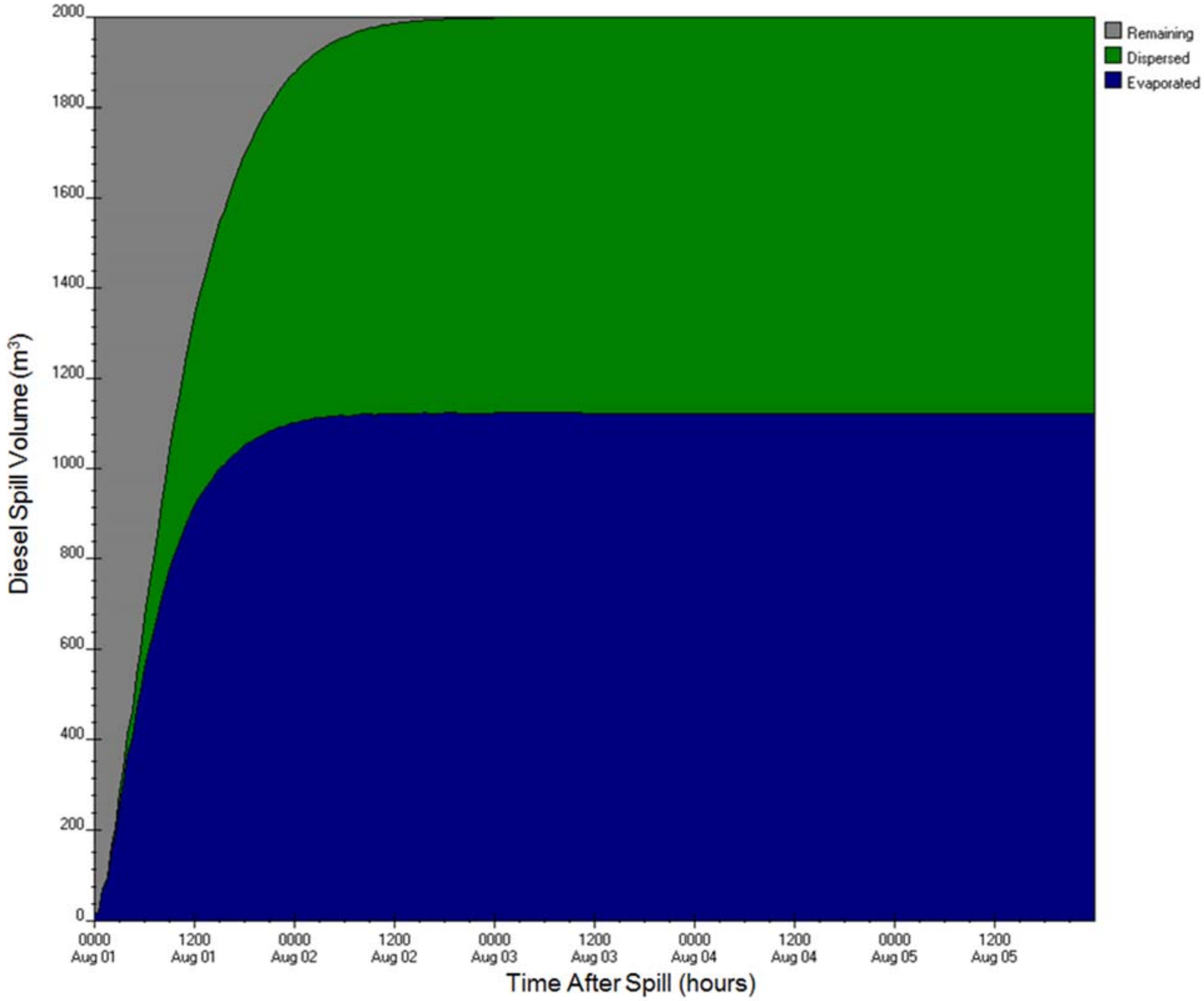

Figure E-A38: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 2,000 m^3, 2-yr wind speed scenario

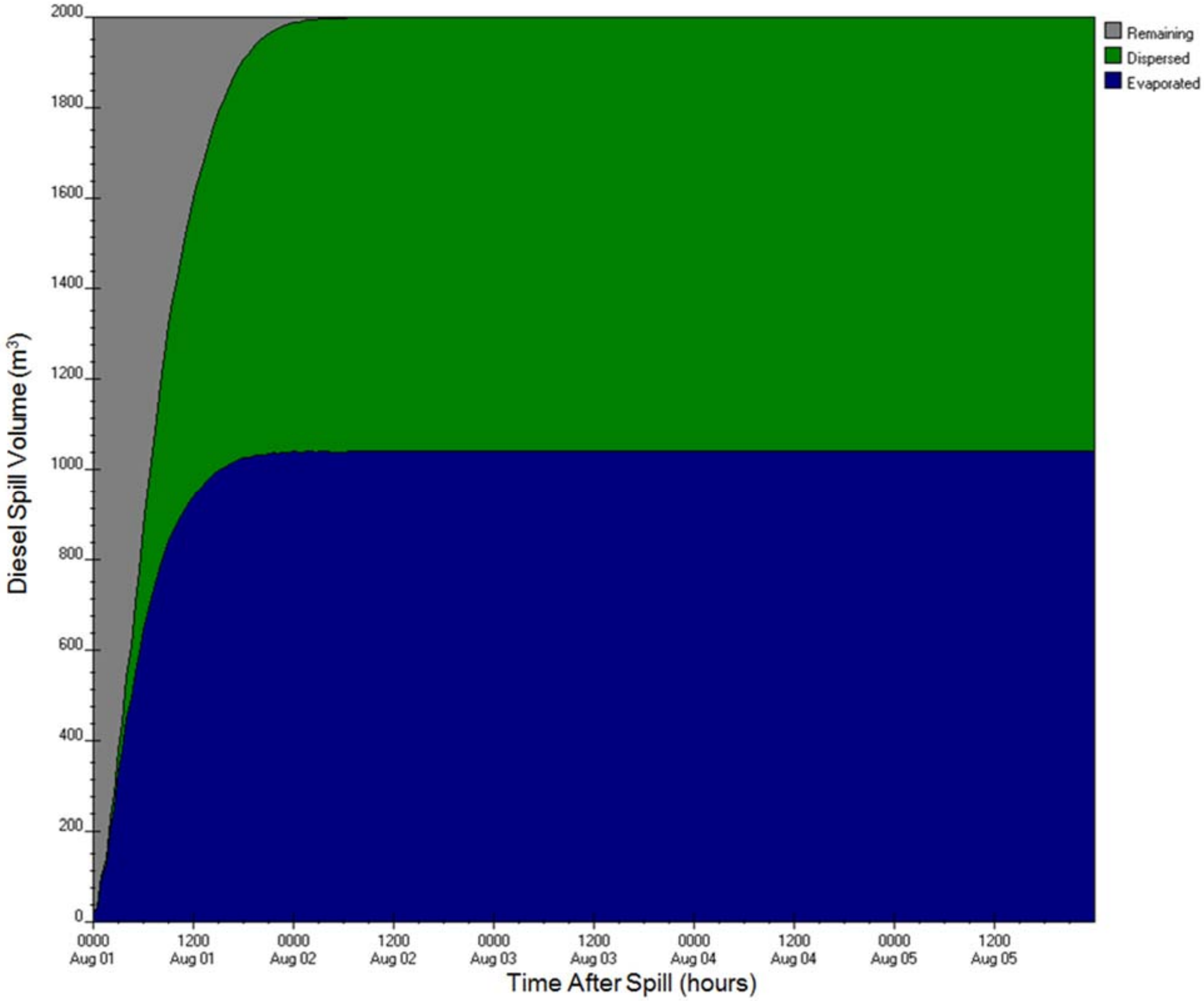

Figure E-A39: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 2,000 m^3, 50-yr wind speed scenario

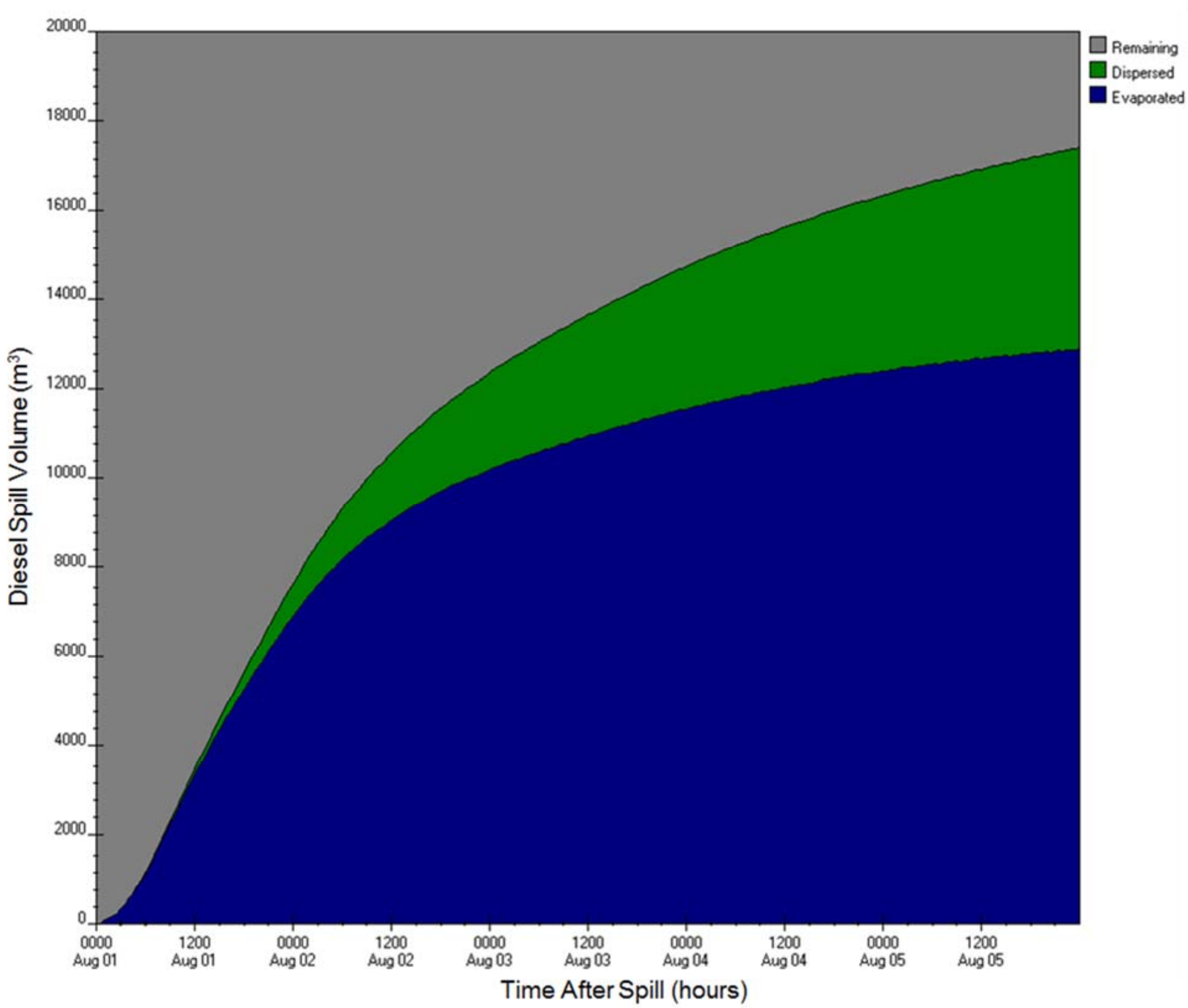

Figure E-A40: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 20,000 m^3, mean wind speed scenario

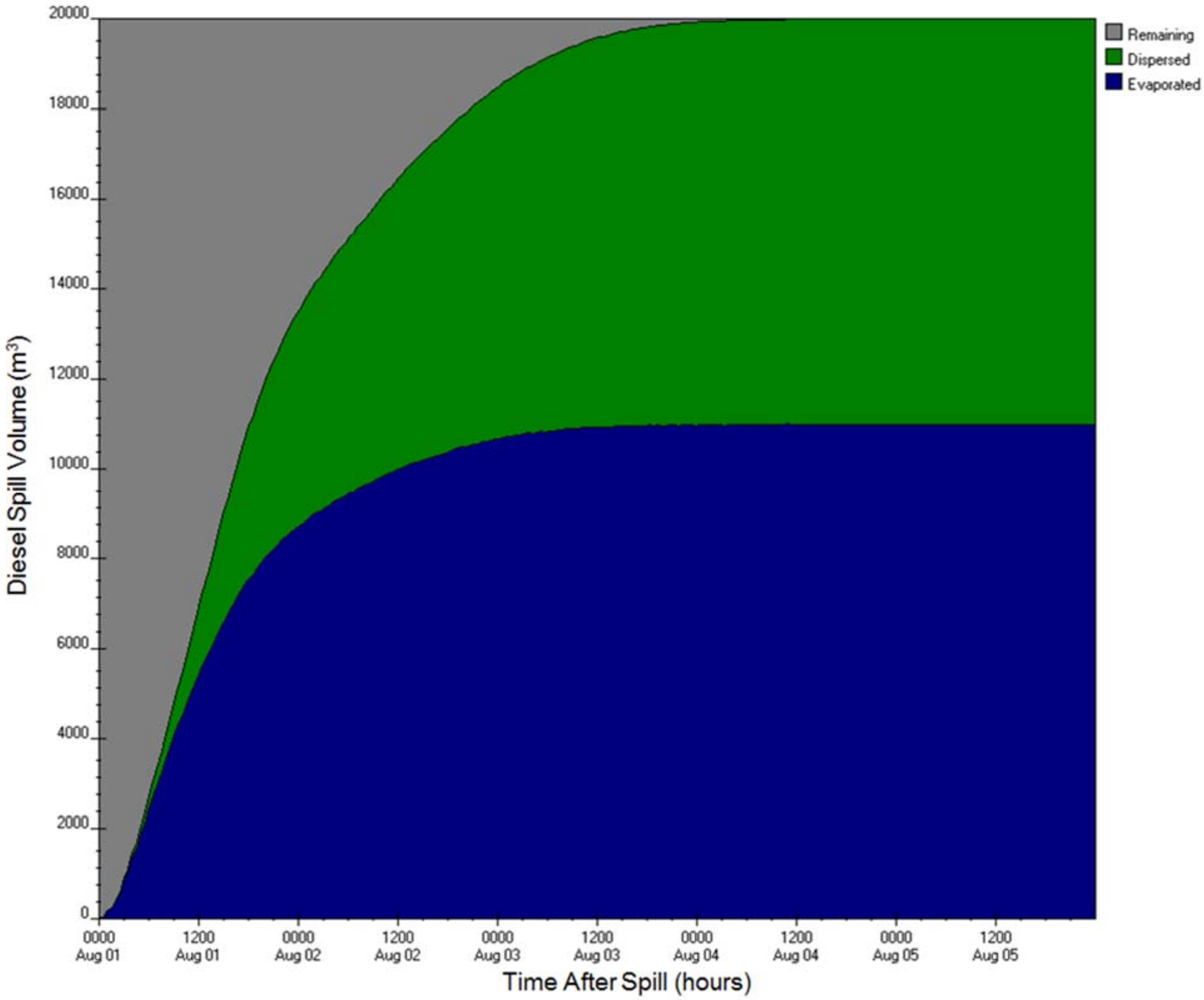

Figure E-A41: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 20,000 m^3, 2-yr wind speed scenario

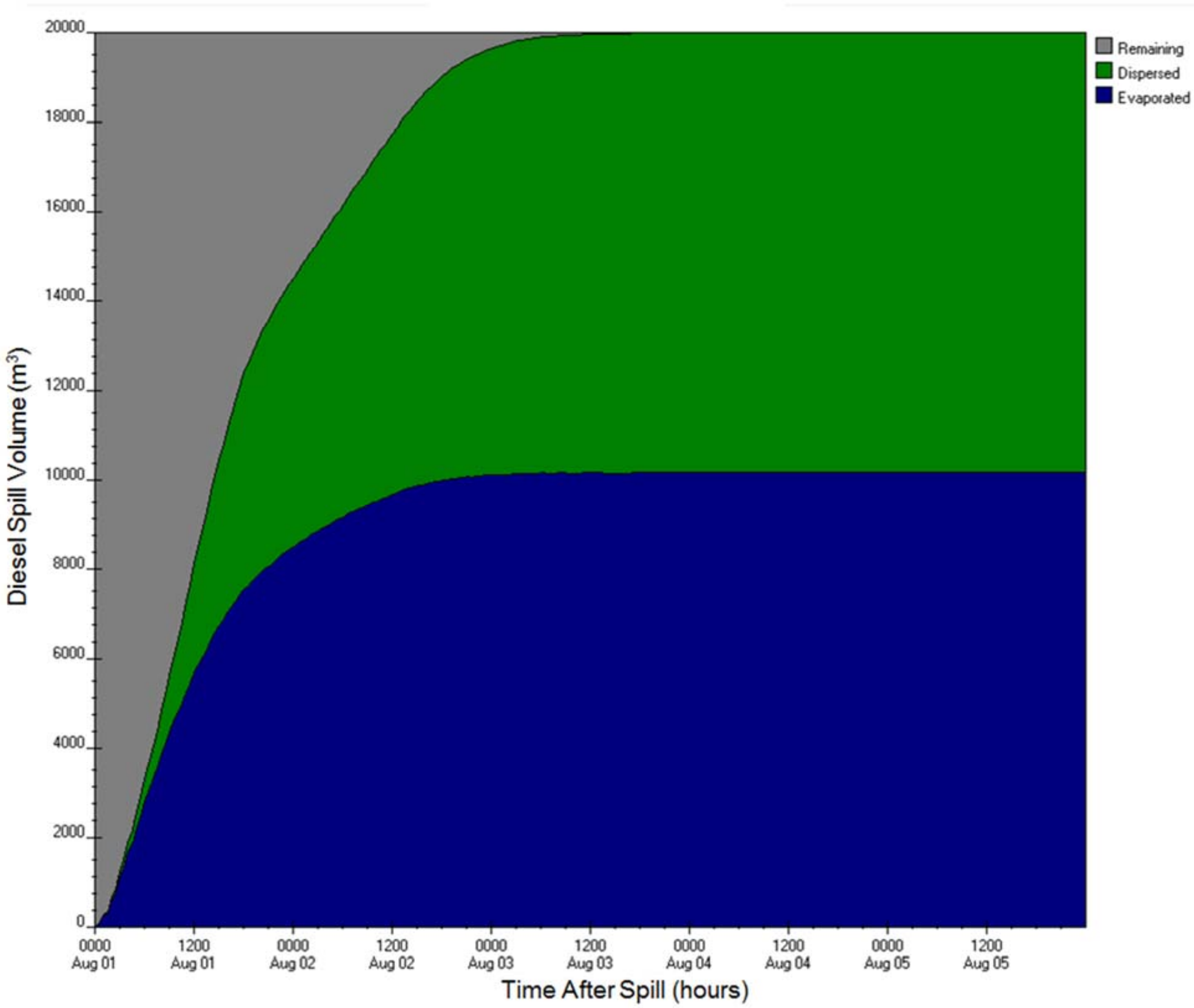

Figure E-A42: ADIOS2 diesel fuel budget output for West and East Melvin Bay stations (1A and 2A) for 20,000 m^3, 50-yr wind speed scenario

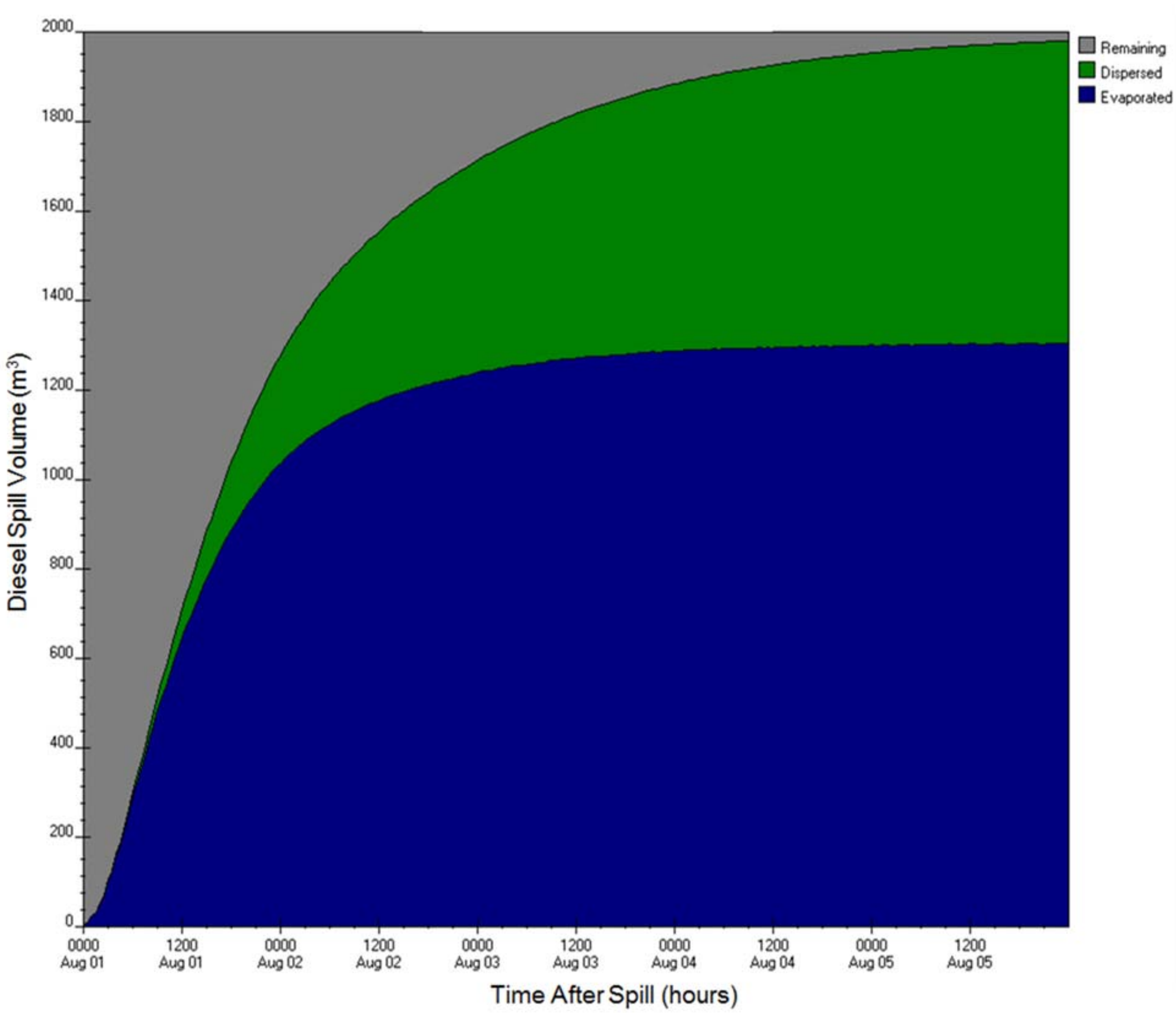

Figure E-A43: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 2,000 m^3, mean wind speed scenario

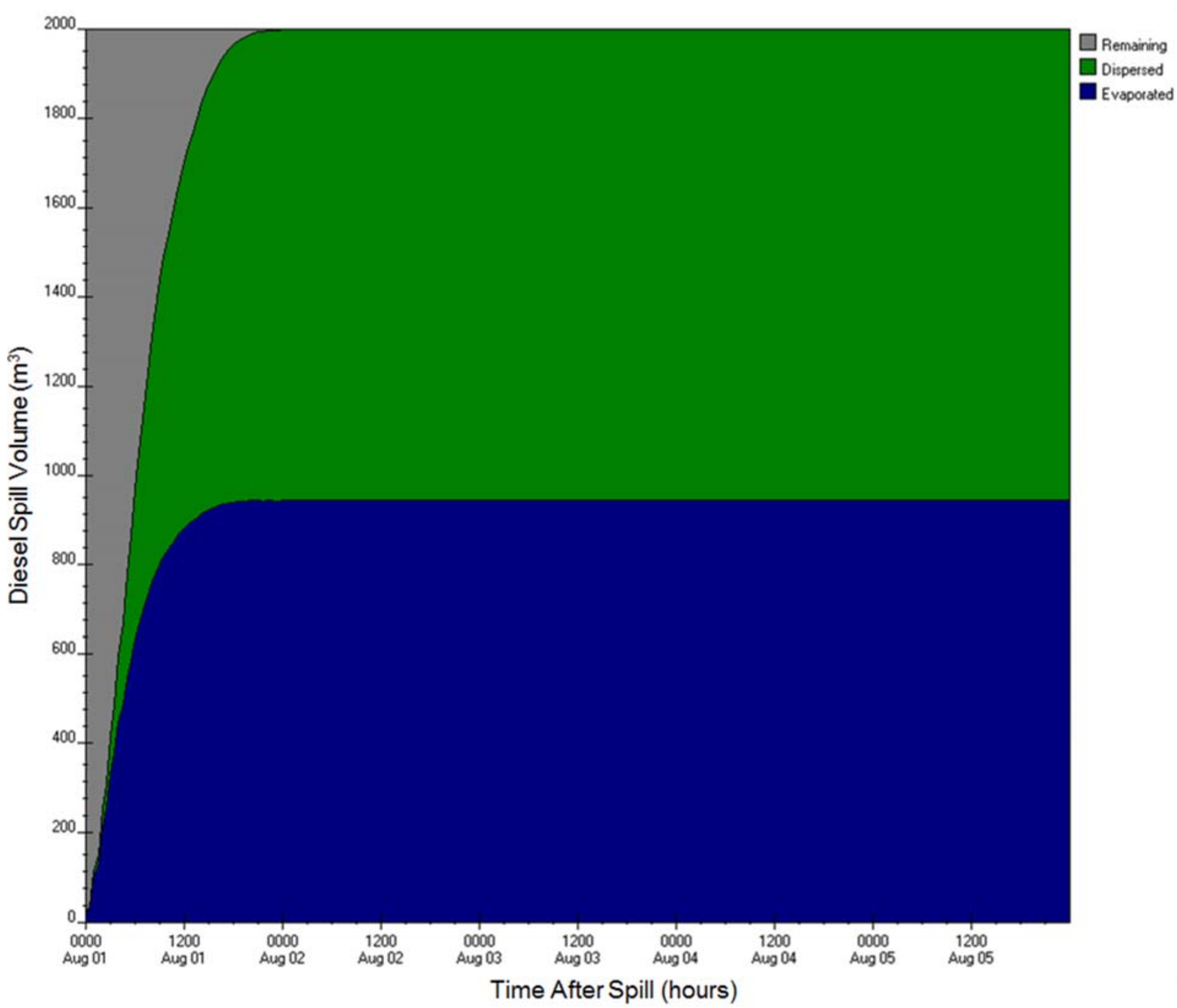

Figure E-A44: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 2,000 m^3, 2-yr wind speed scenario

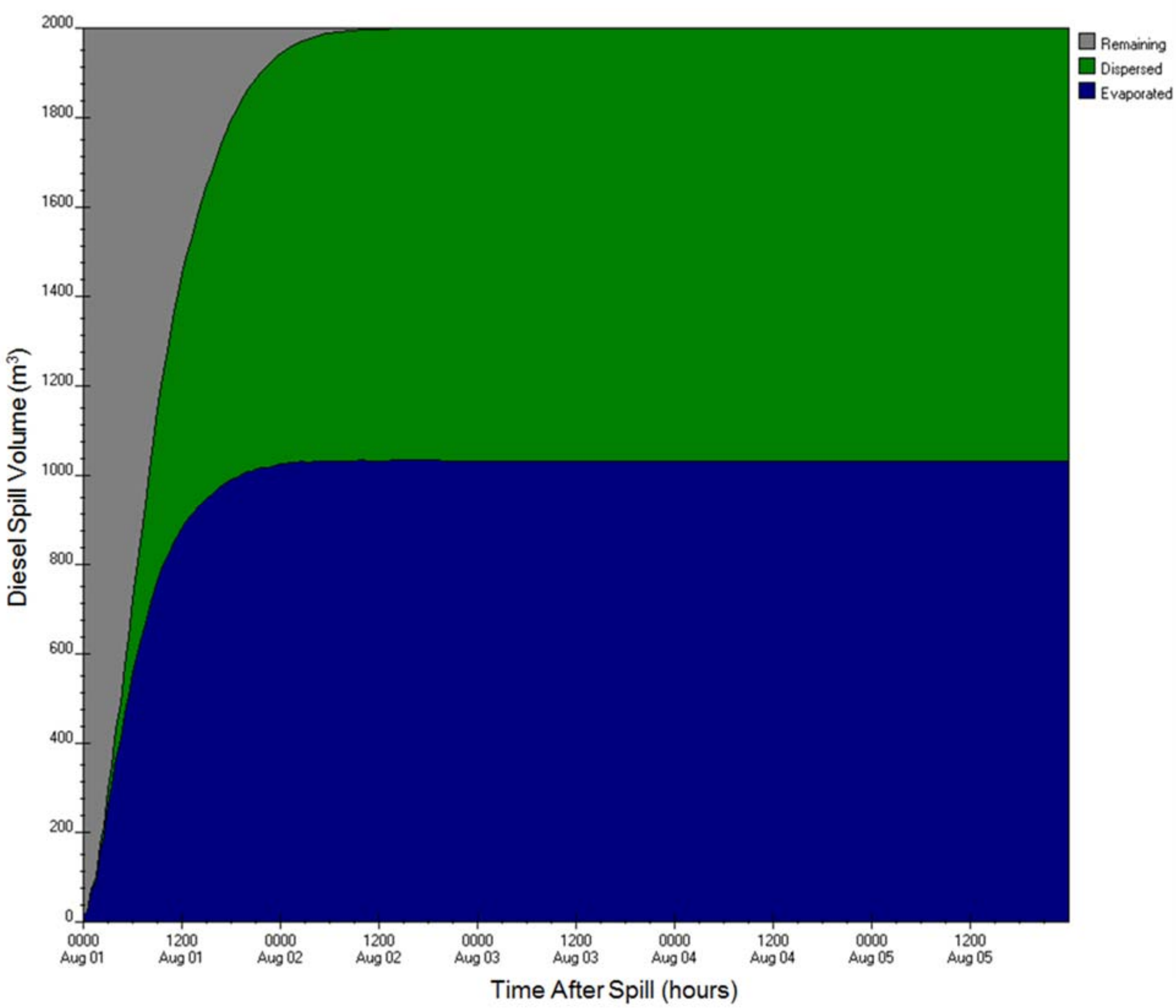

Figure E-A45: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 2,000 m^3, 50-yr wind speed scenario

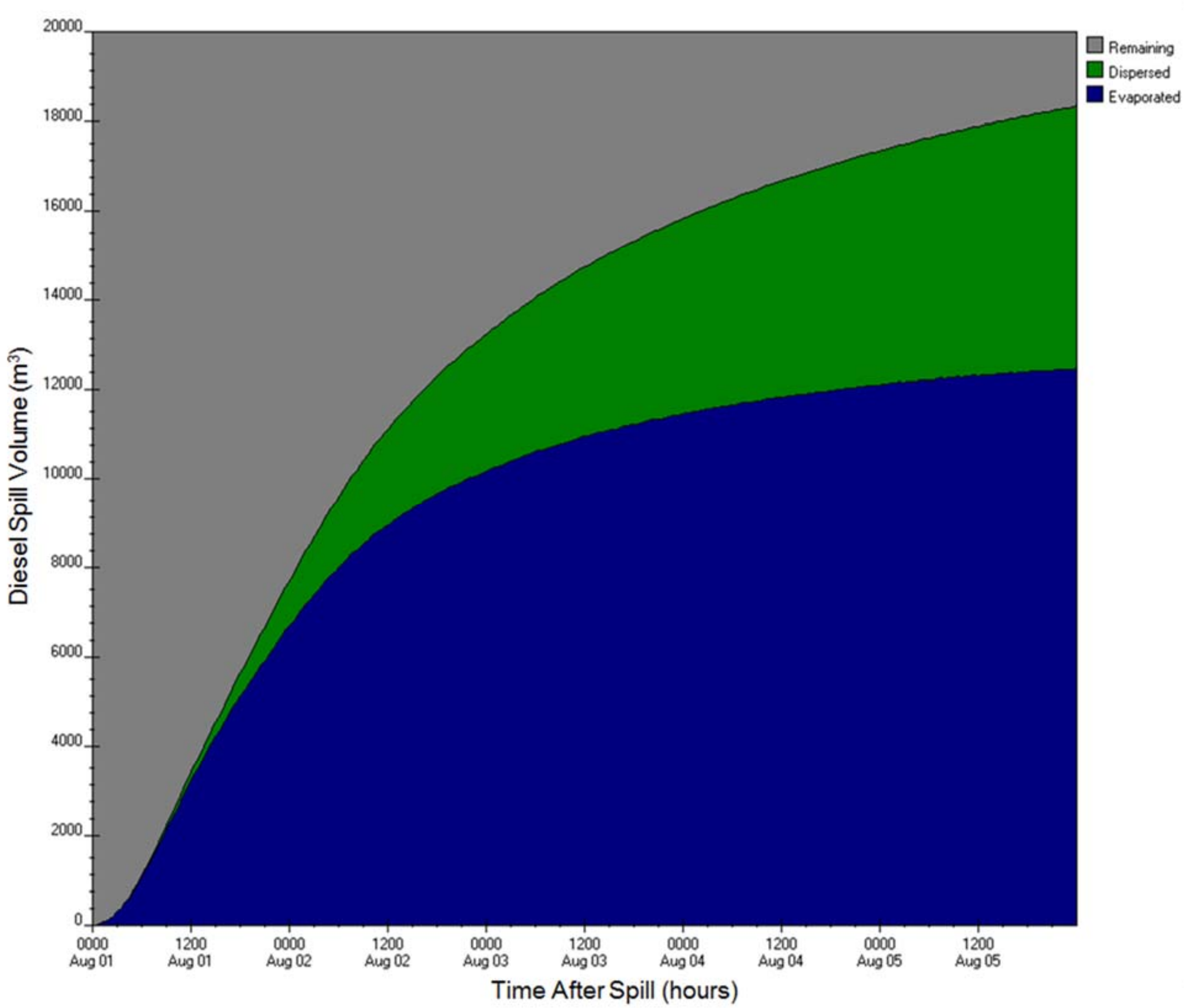

Figure E-A46: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 20,000 m³, mean wind speed scenario

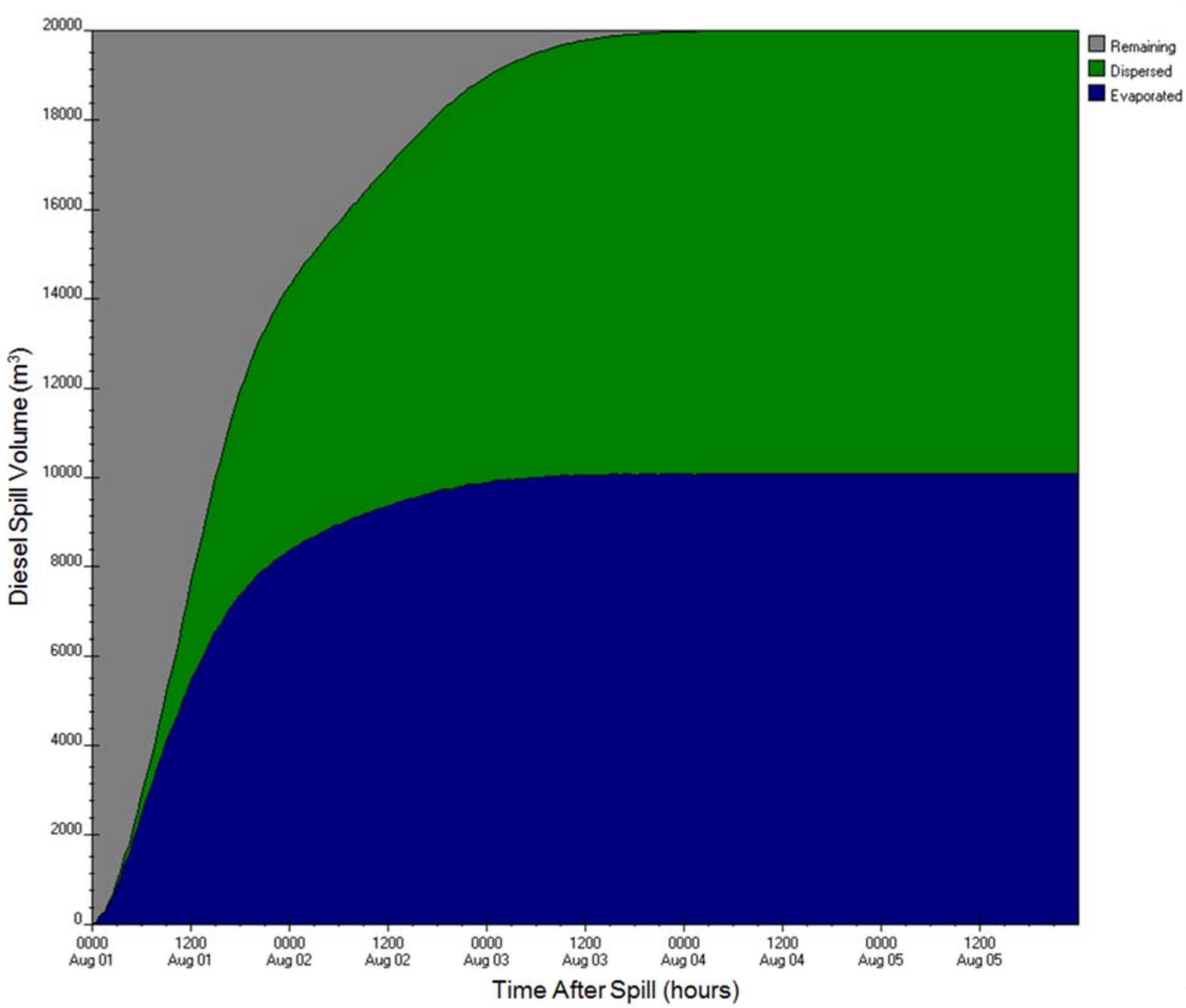

Figure E-A47: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 20,000 m^3, 2-yr wind speed scenario

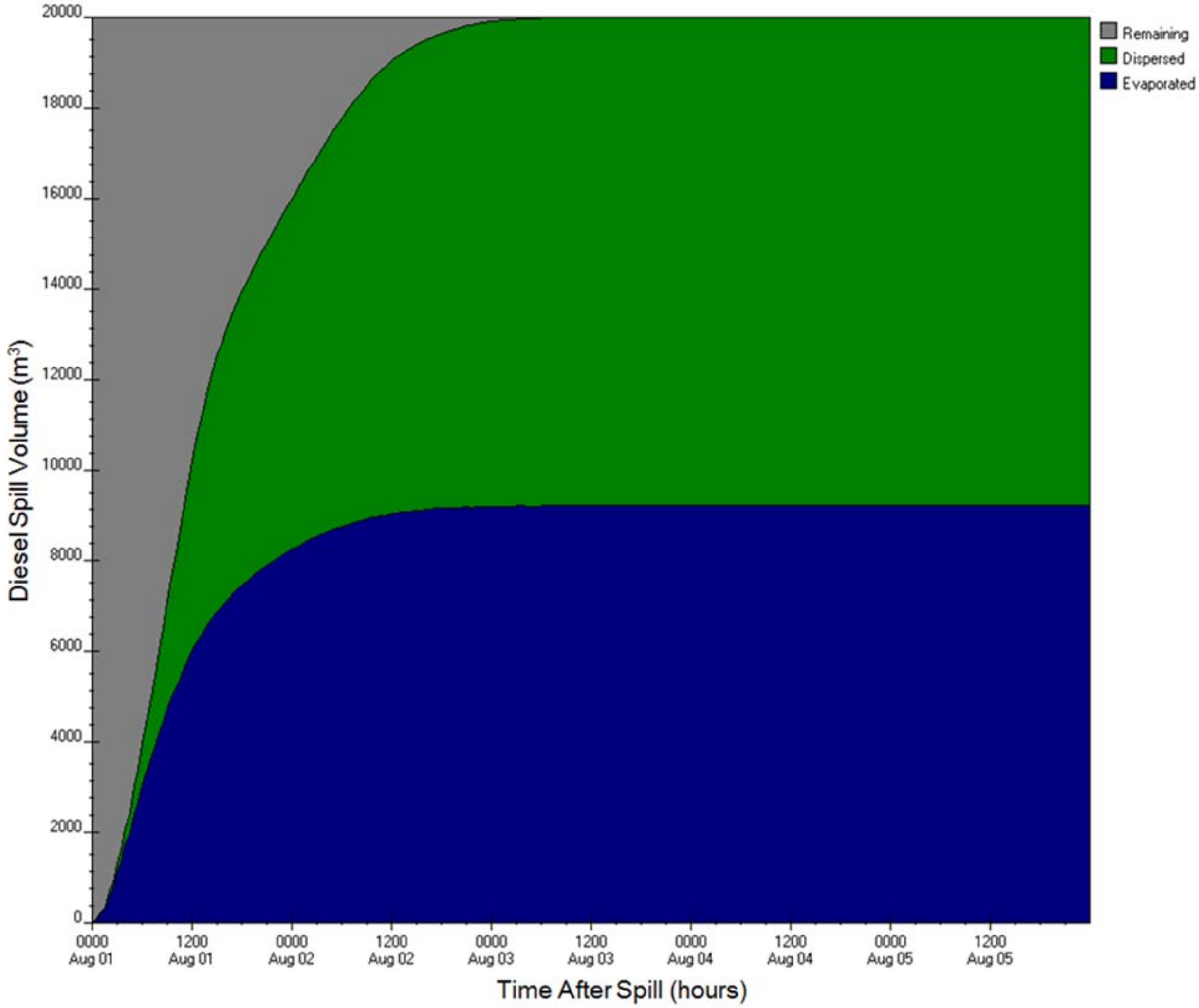

Figure E-A48: ADIOS2 diesel fuel budget output for Entrance to Melvin Bay station (3A) for 20,000 m³, 50-yr wind speed scenario

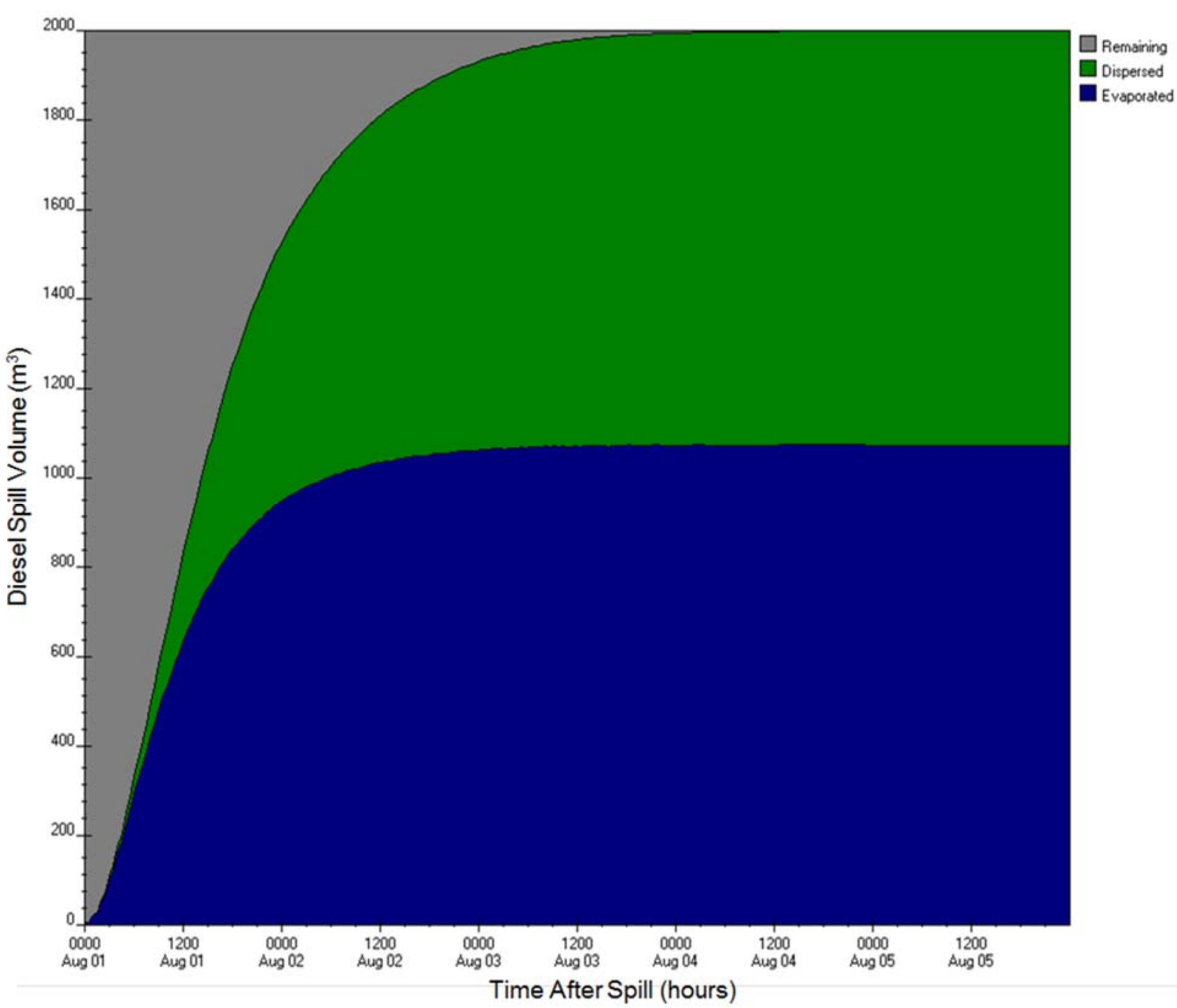

Figure E-A49: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 2,000 m^3, mean wind speed scenario

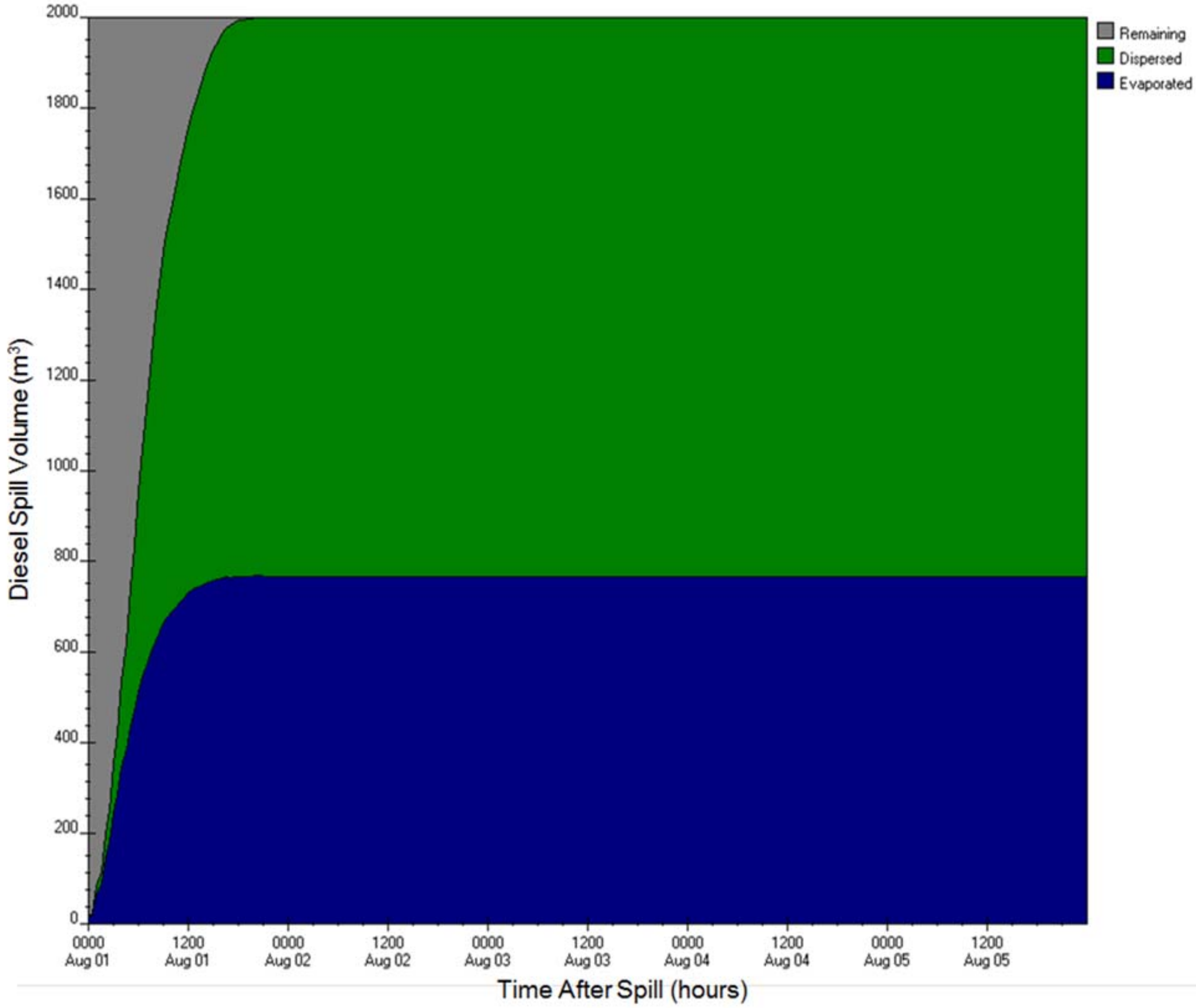

Figure E-A50: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 2,000 m^3, 2-yr wind speed scenario

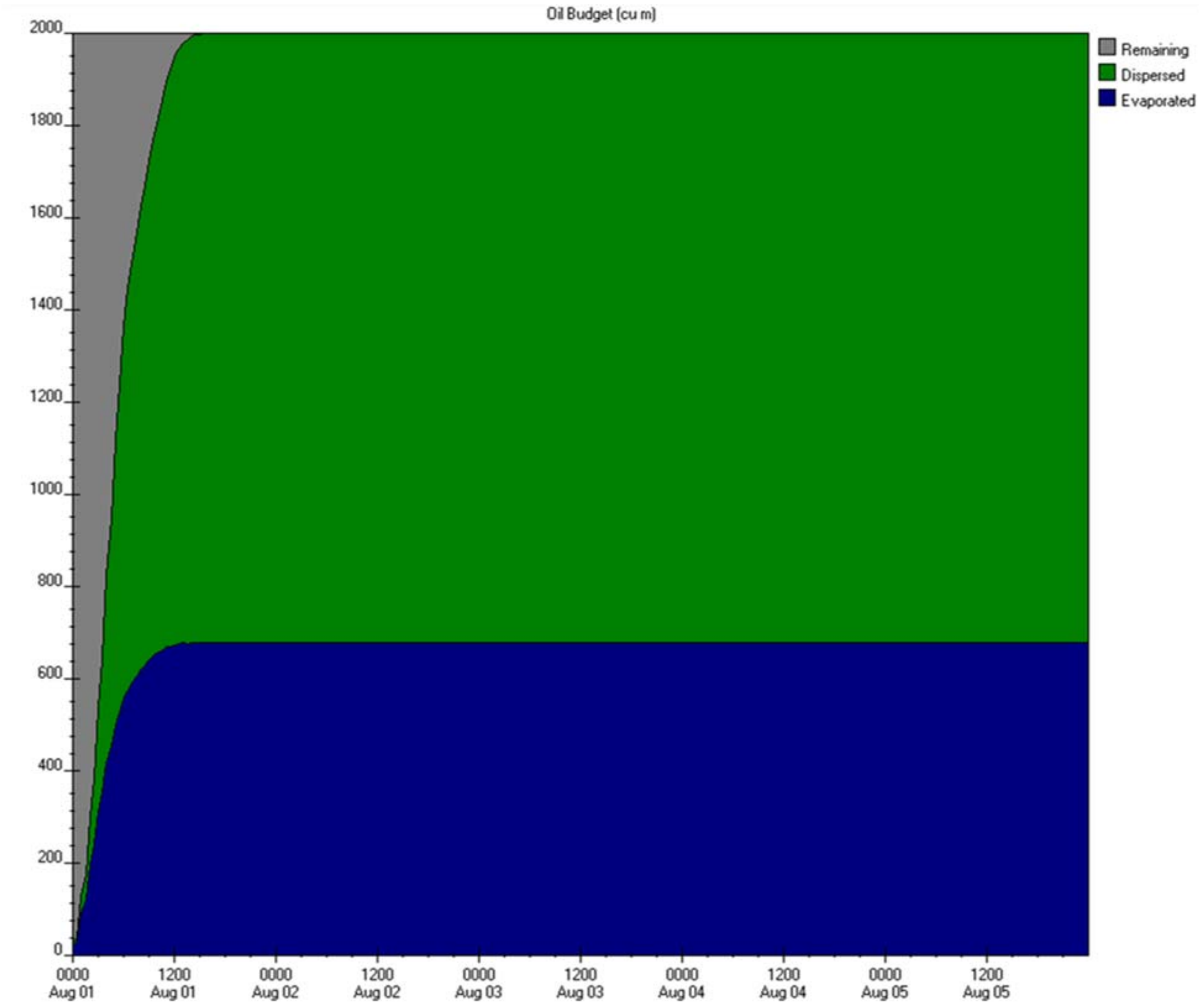

Figure E-A51: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 2,000 m^3, 50-yr wind speed scenario

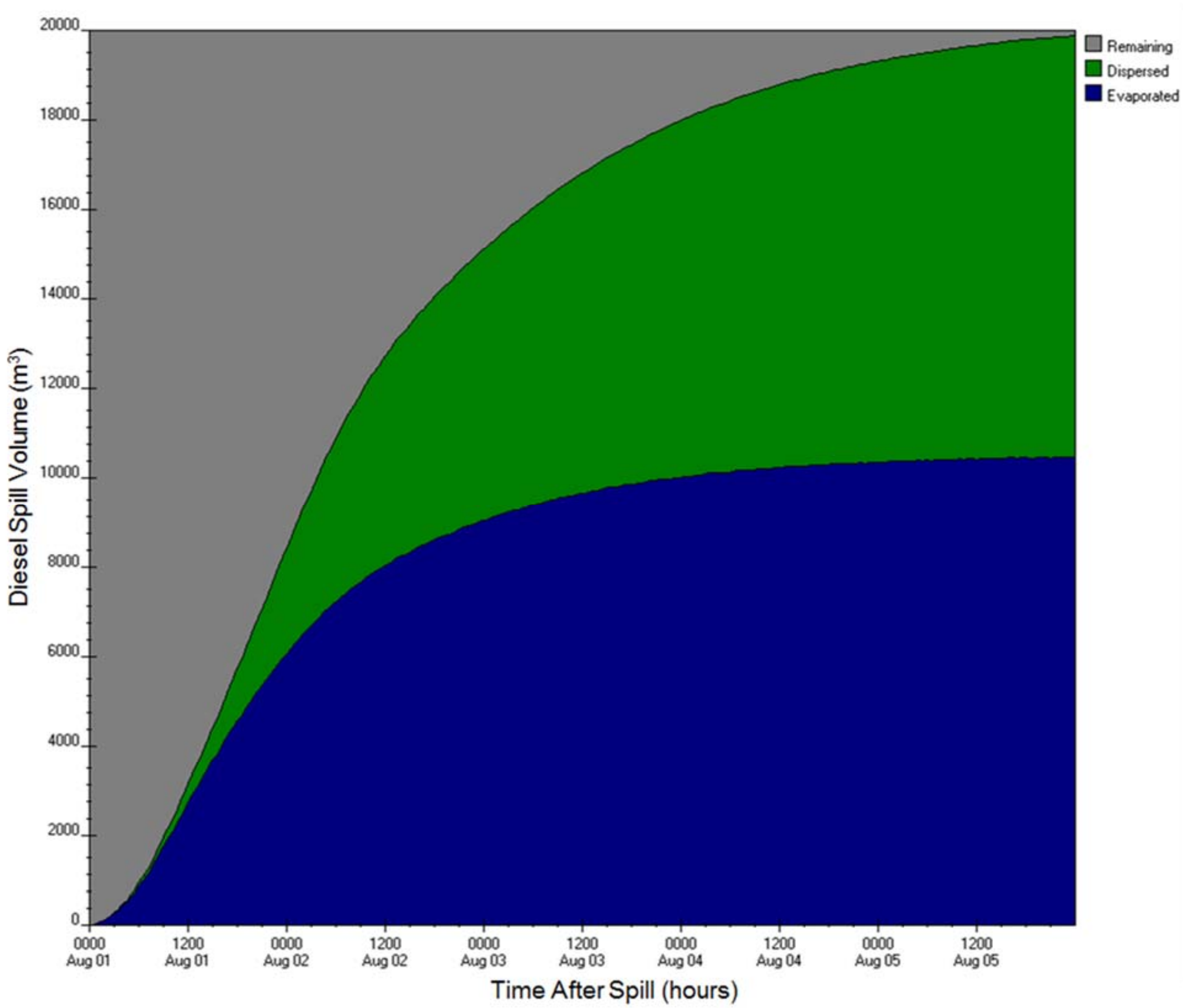

Figure E-A52: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 20,000 m³, mean wind speed scenario

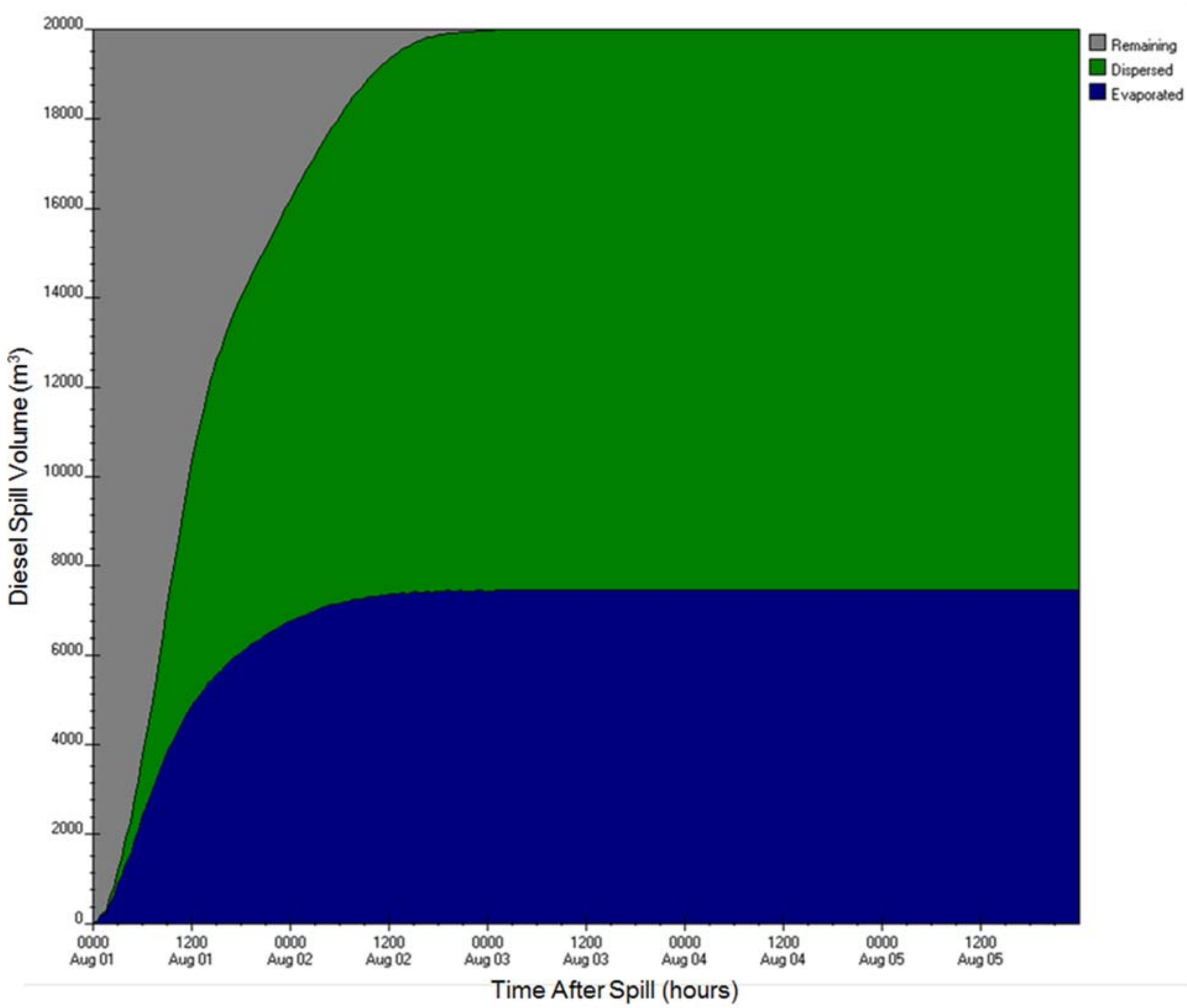

Figure E-A53: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 20,000 m^3, 2-yr wind speed scenario

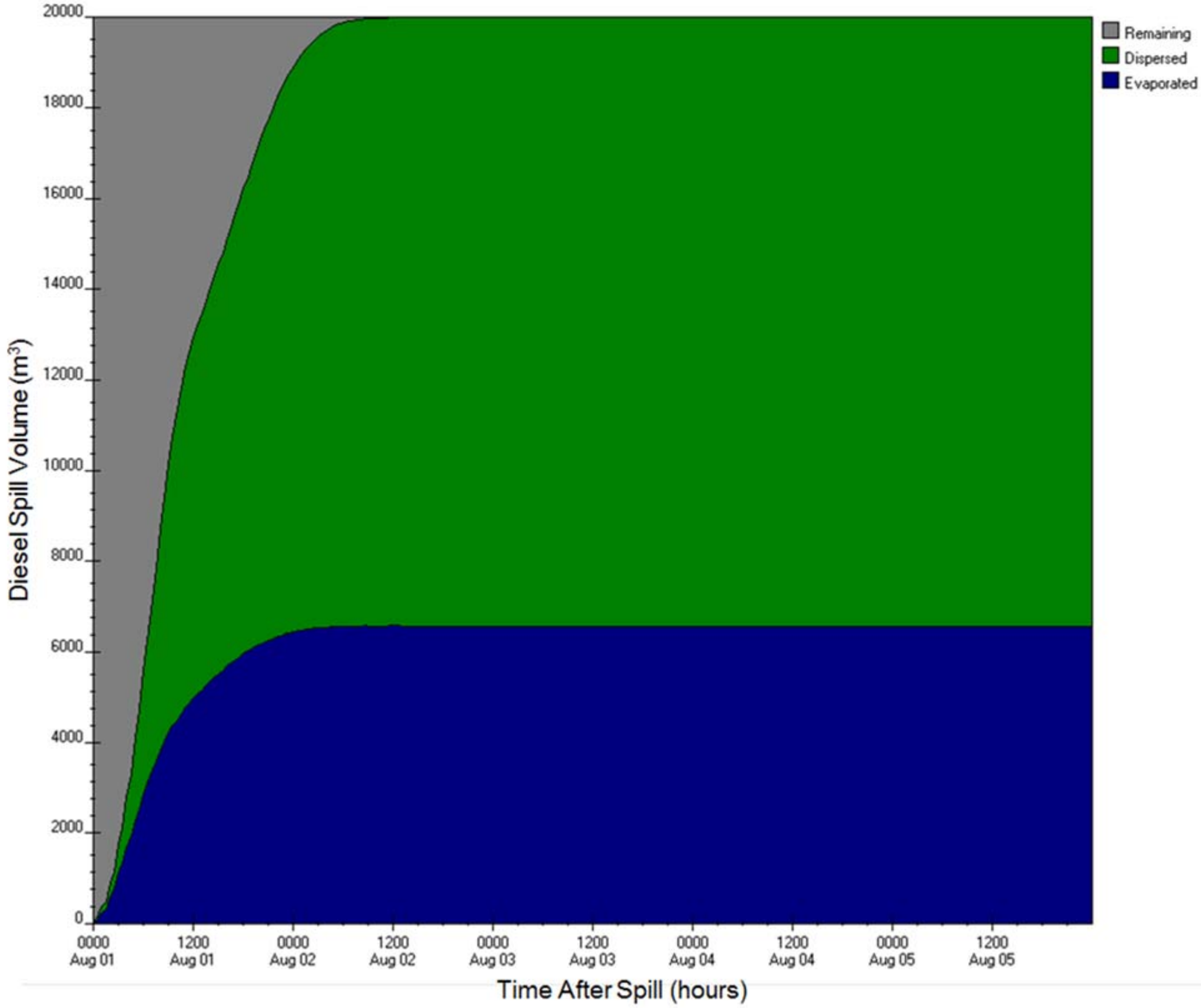

Figure E-A54: ADIOS2 diesel fuel budget output for West Hudson Bay station (4A) for 20,000 m^3, 50-yr wind speed scenario

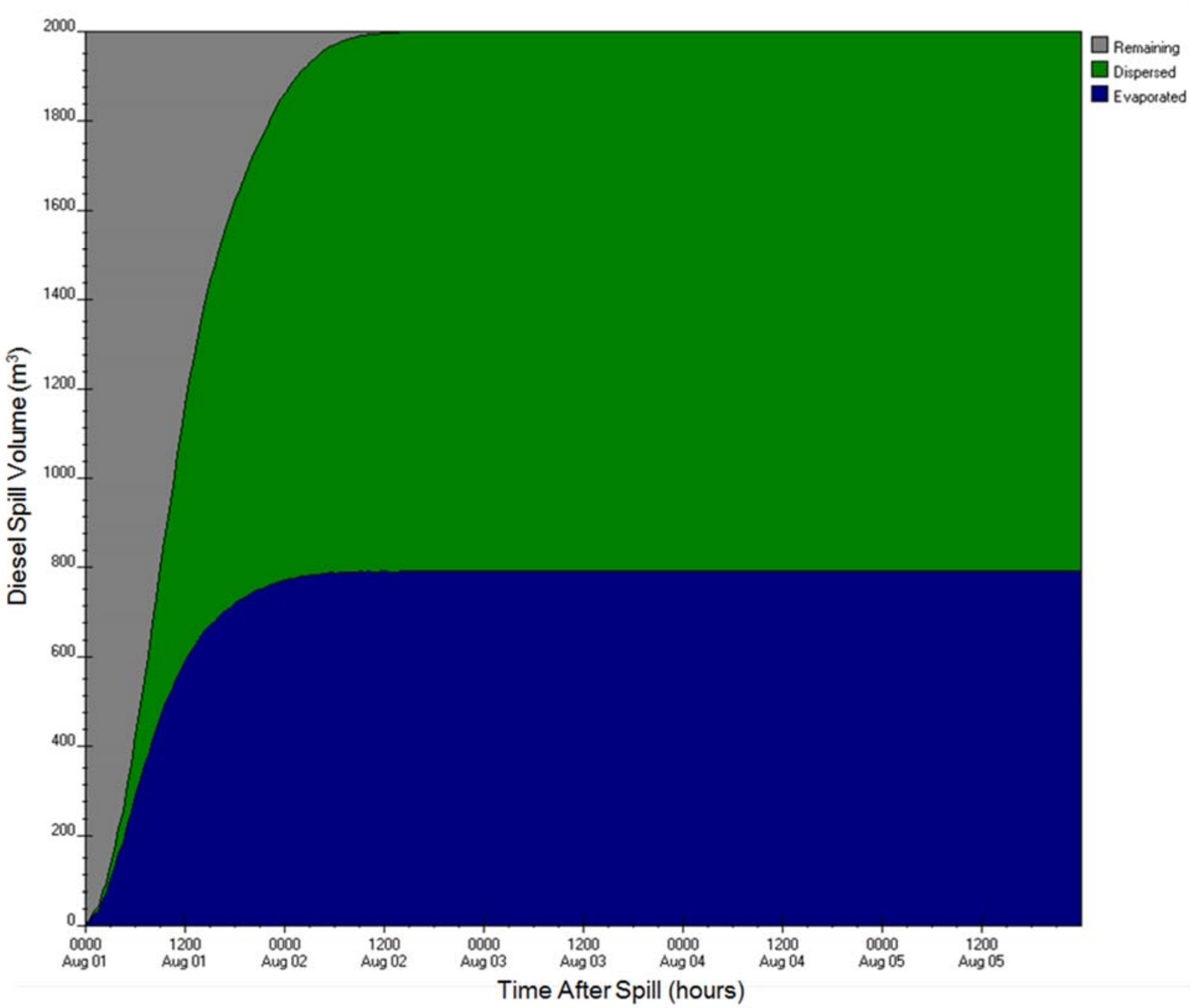

Figure E-A55: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 2,000 m³, mean wind speed scenario

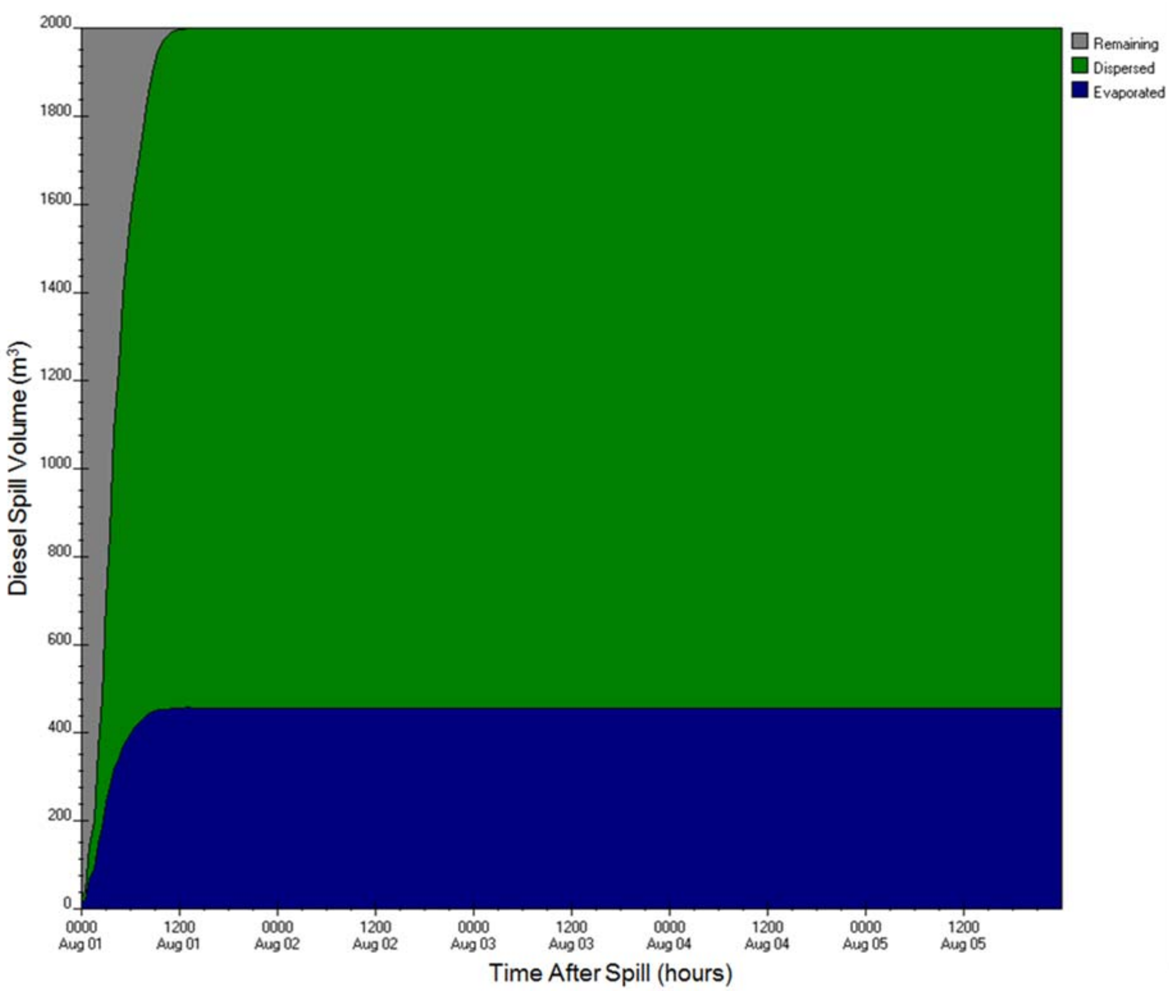

Figure E-A56: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 2,000 m^3, 2-yr wind speed scenario

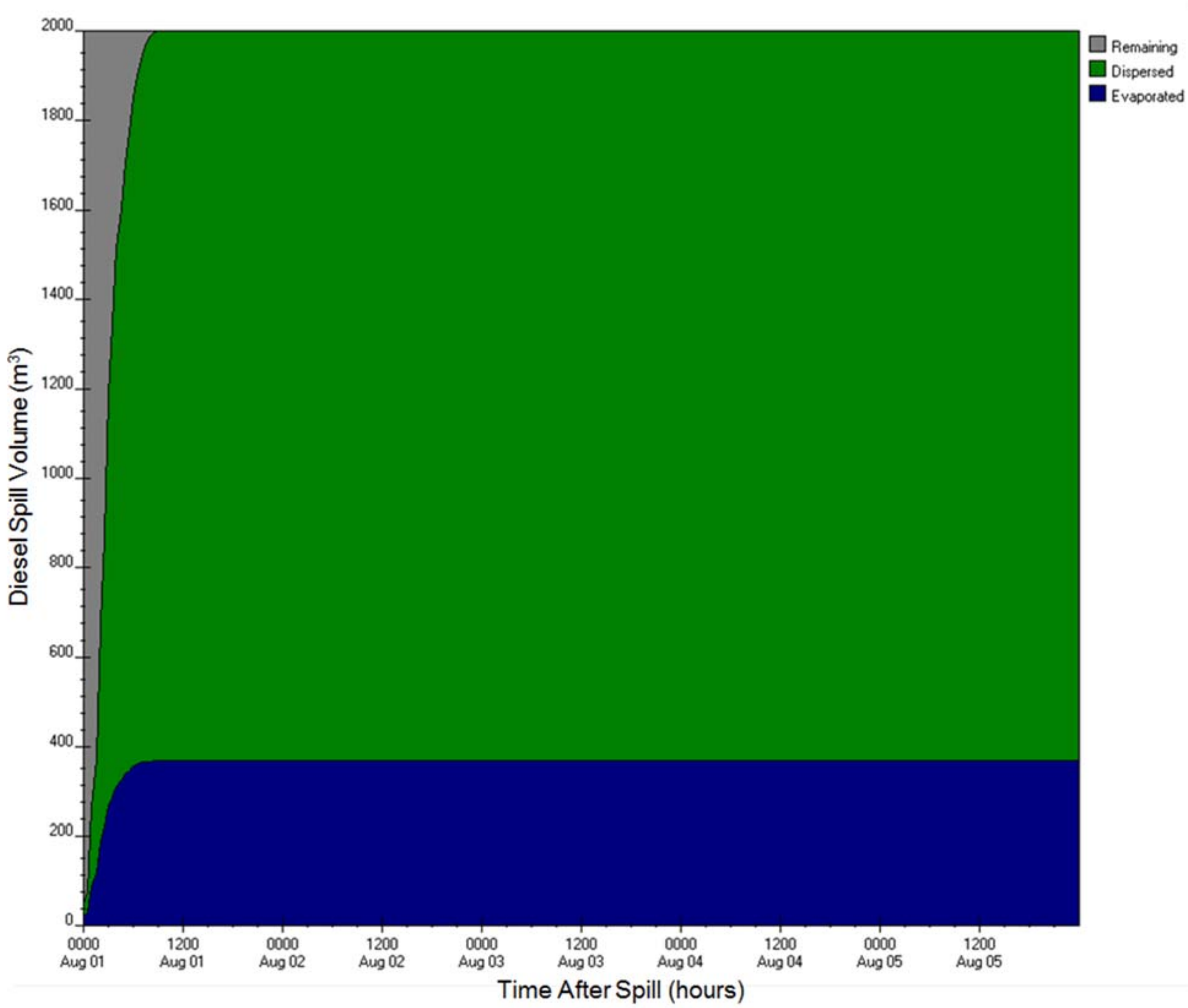

Figure E-A57: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 2,000 m^3, 50-yr wind speed scenario

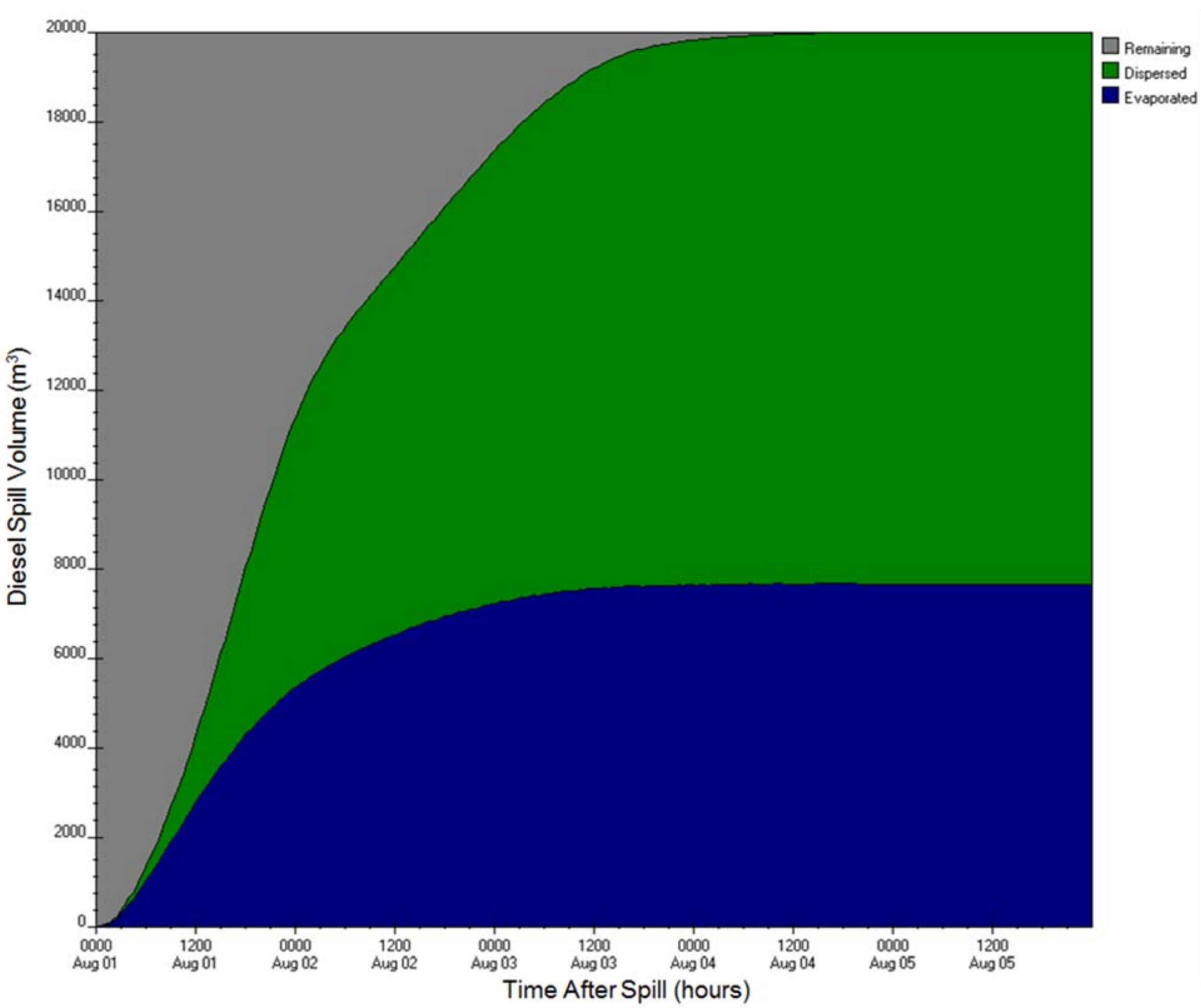

Figure E-A58: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 20,000 m^3, mean wind speed scenario

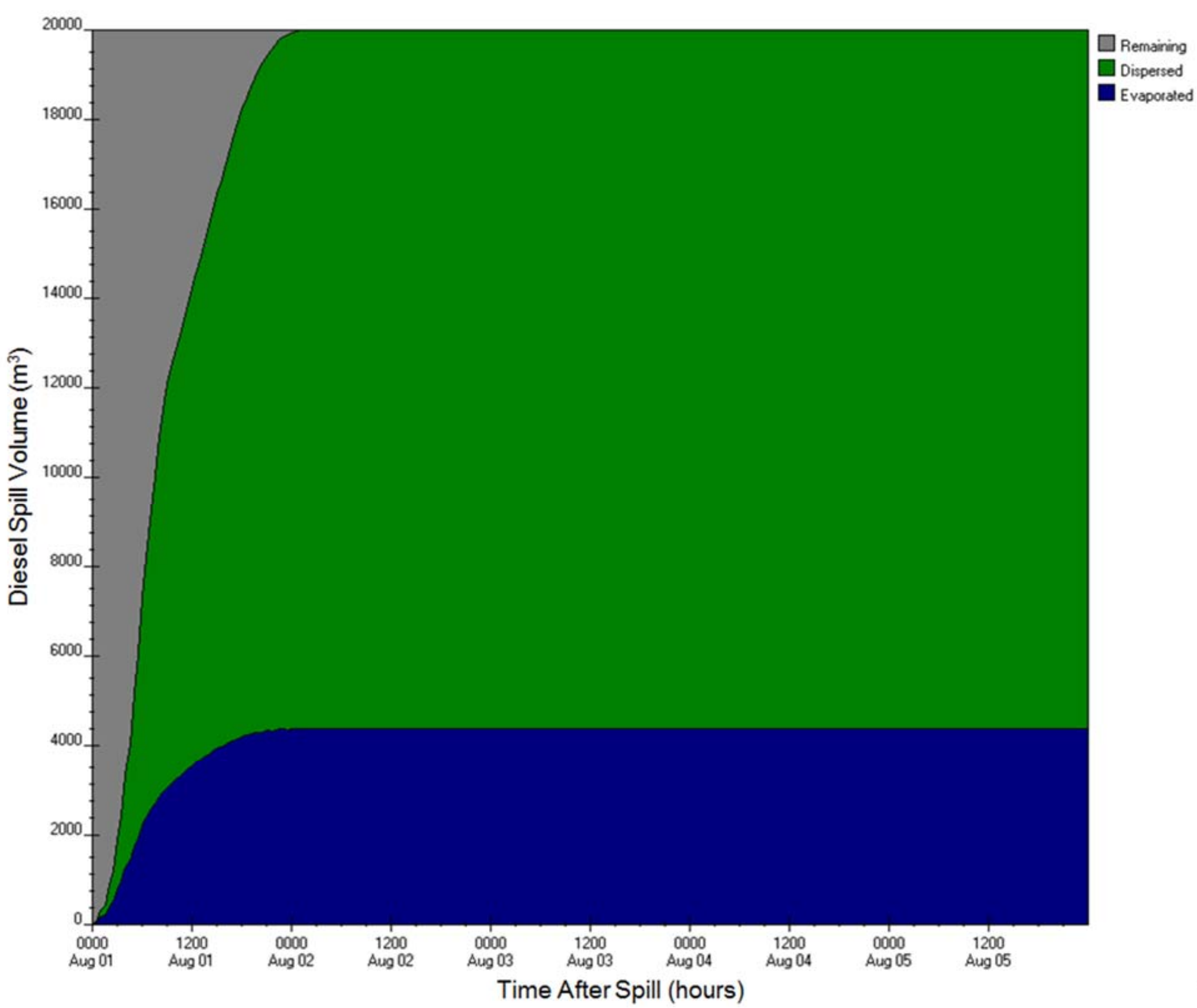

Figure E-A59: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 20,000 m^3, 2-yr wind speed scenario

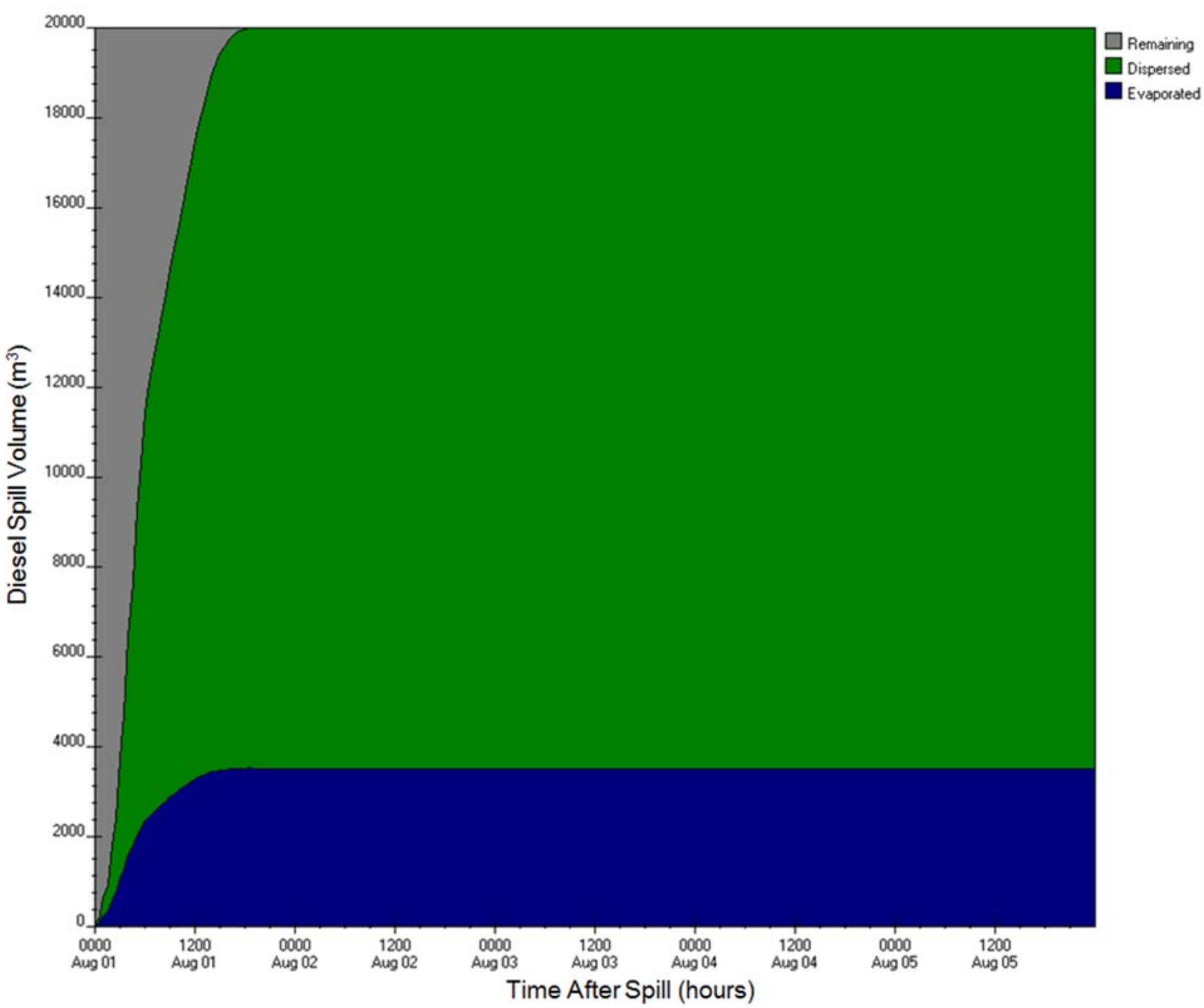

Figure E-A60: ADIOS2 diesel fuel budget output for Hudson Bay crossing station (5A) for 20,000 m^3, 50-yr wind speed scenario

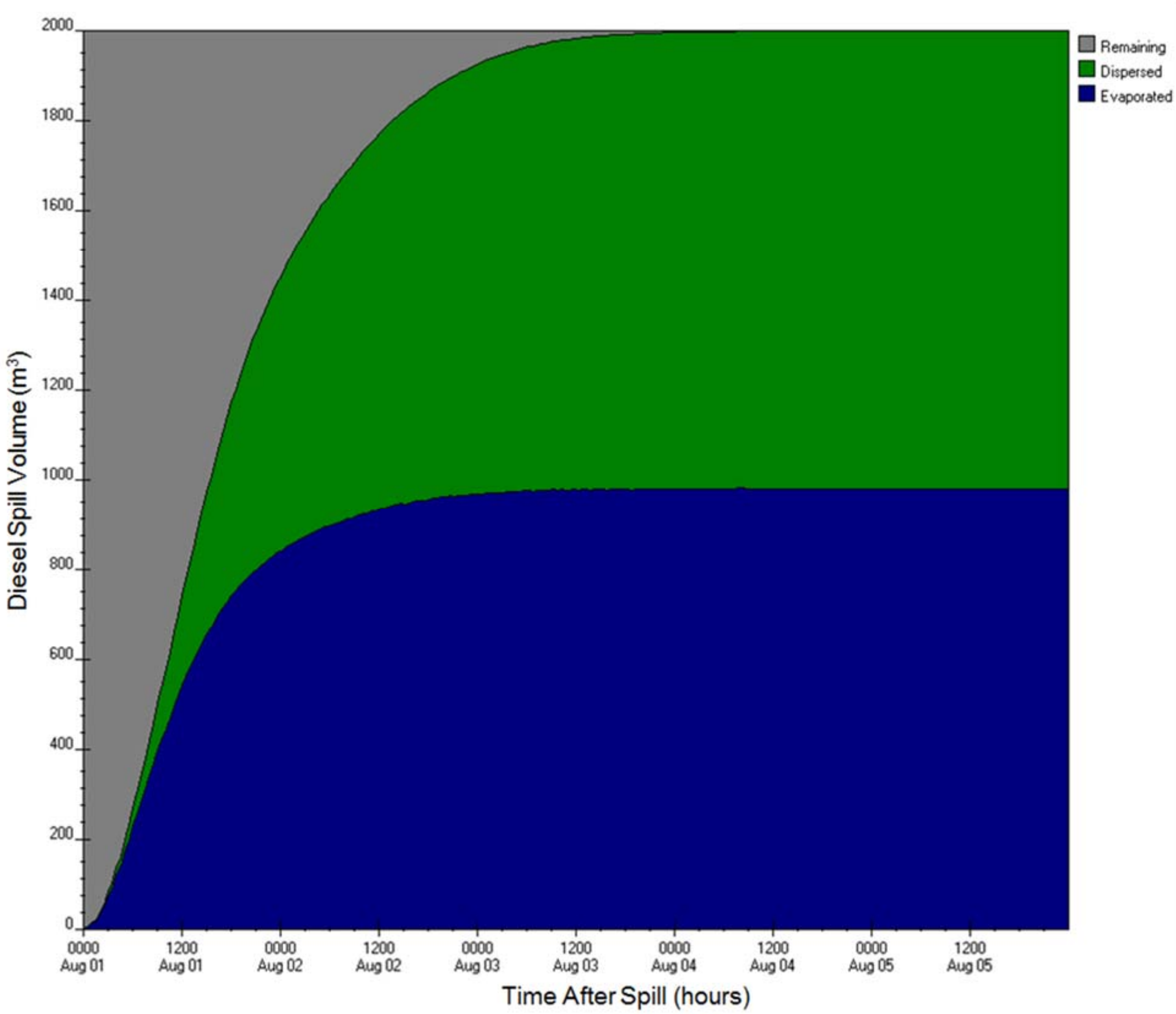

Figure E-A61: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 2,000 m^3, mean wind speed scenario

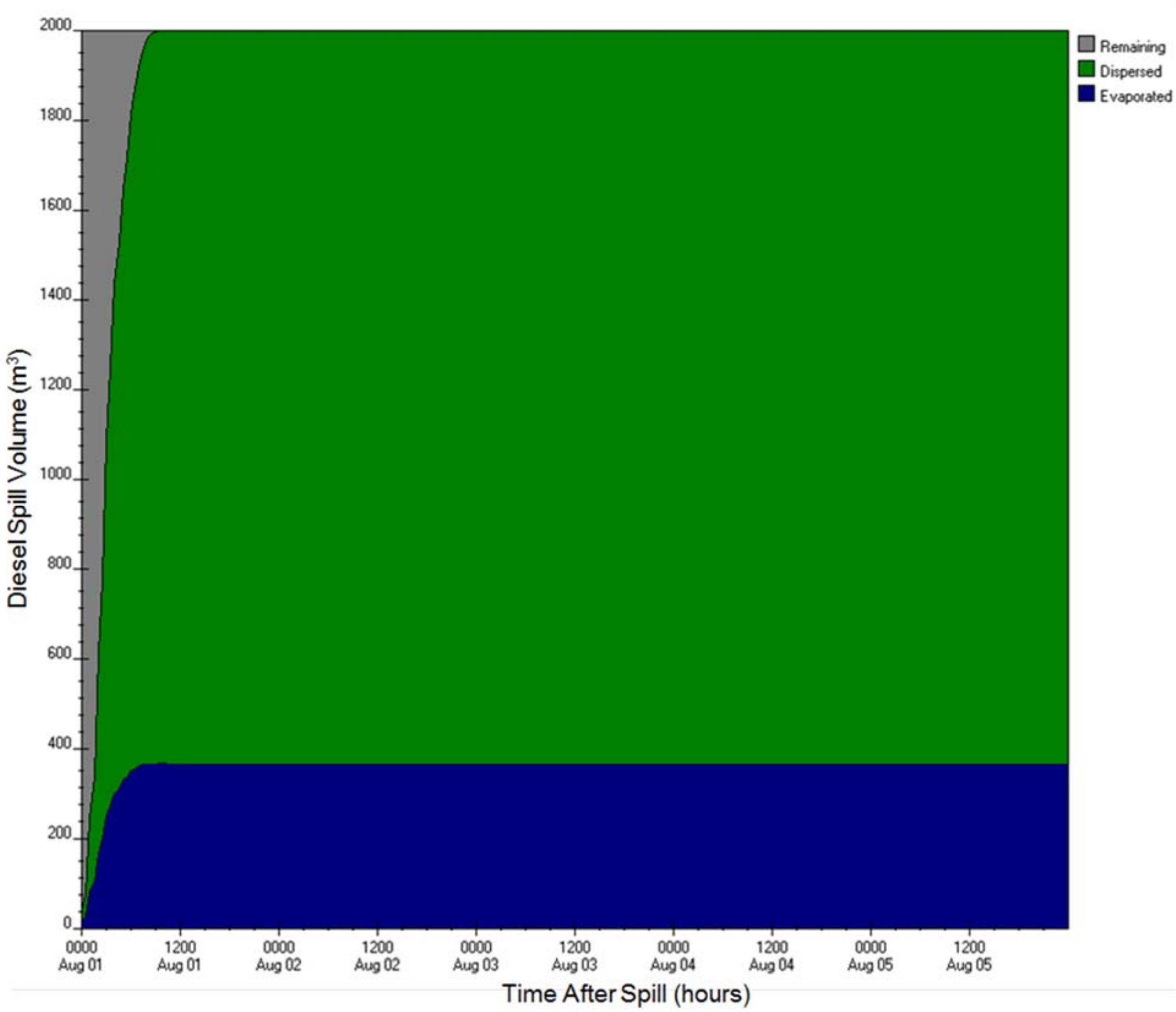

Figure E-A62: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 2,000 m^3, 2-yr wind speed scenario

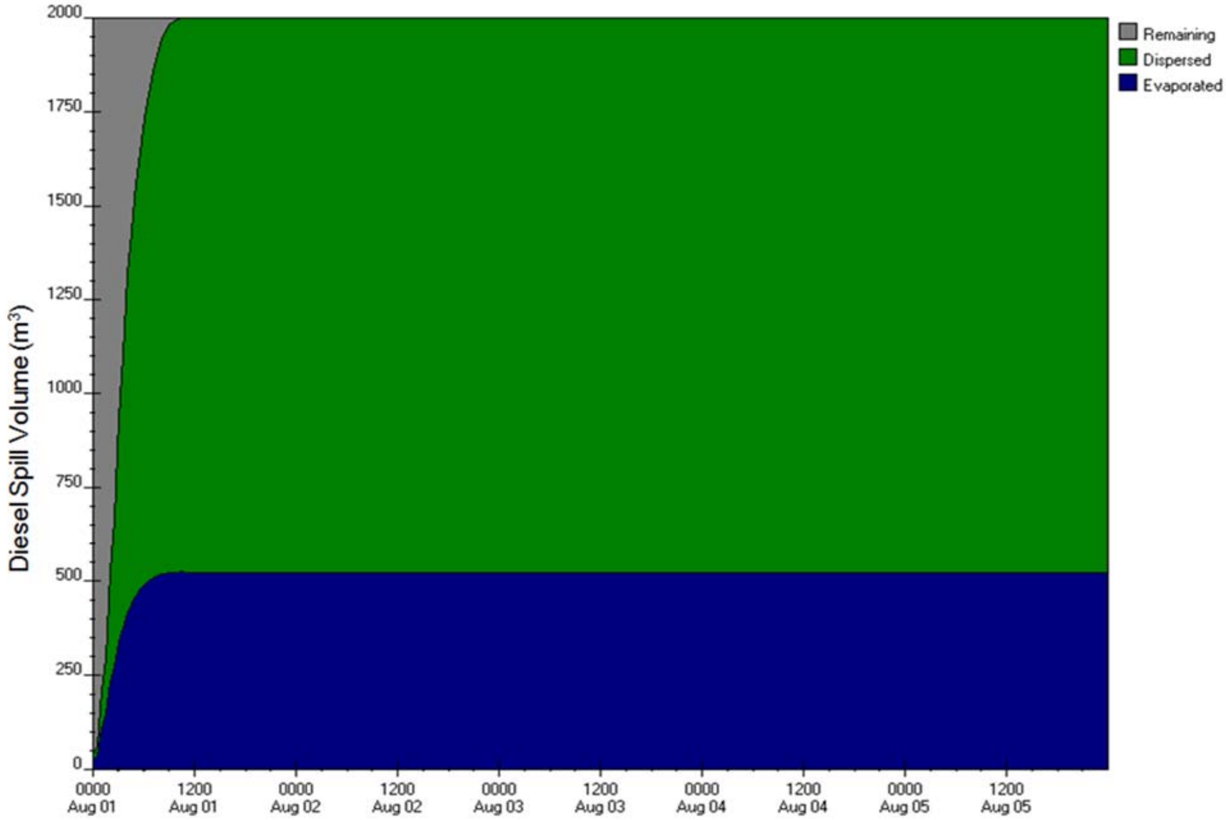

Figure E-A63: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 2,000 m³, 50-yr wind speed scenario

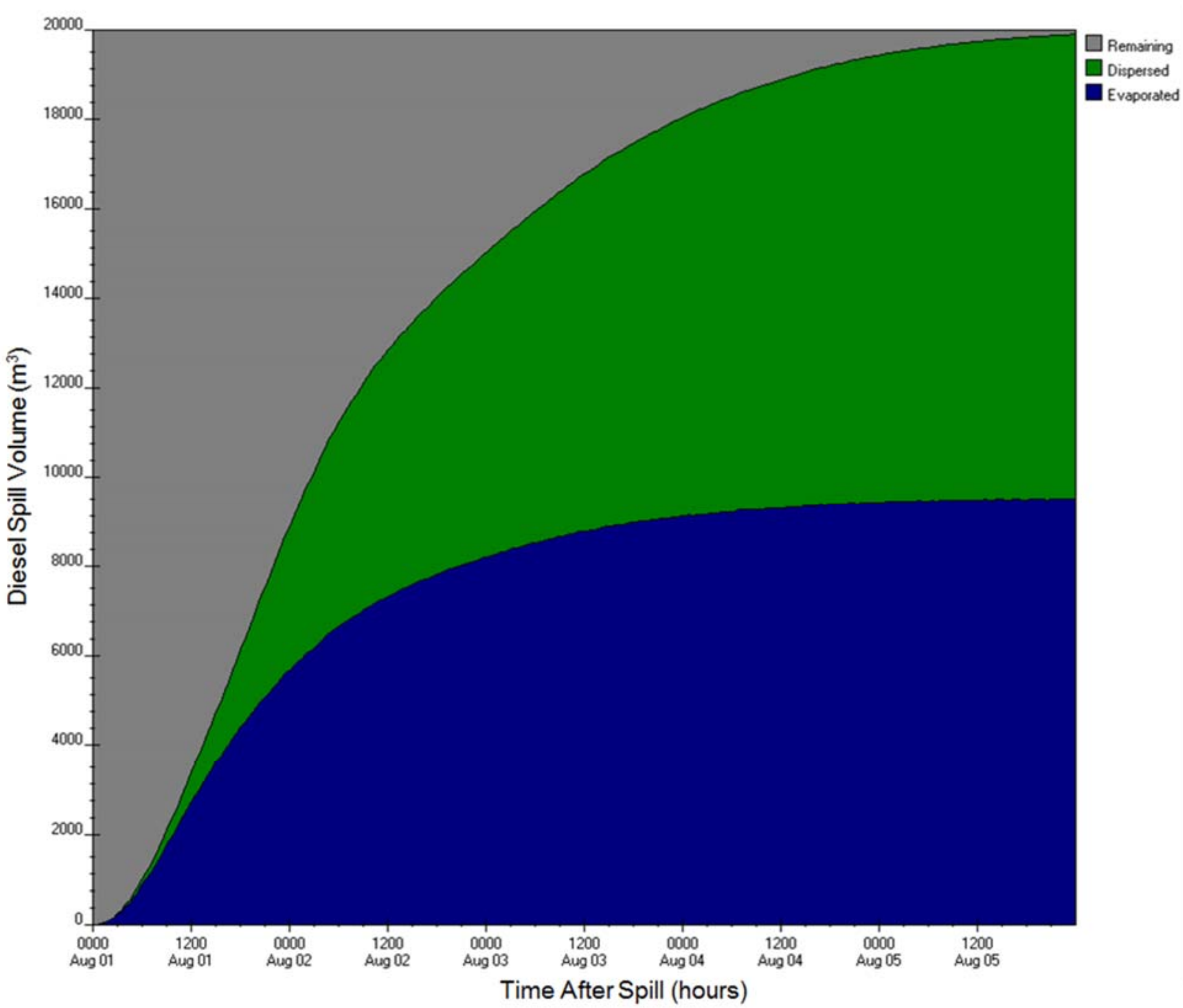

Figure E-A64: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 20,000 m^3, mean wind speed scenario

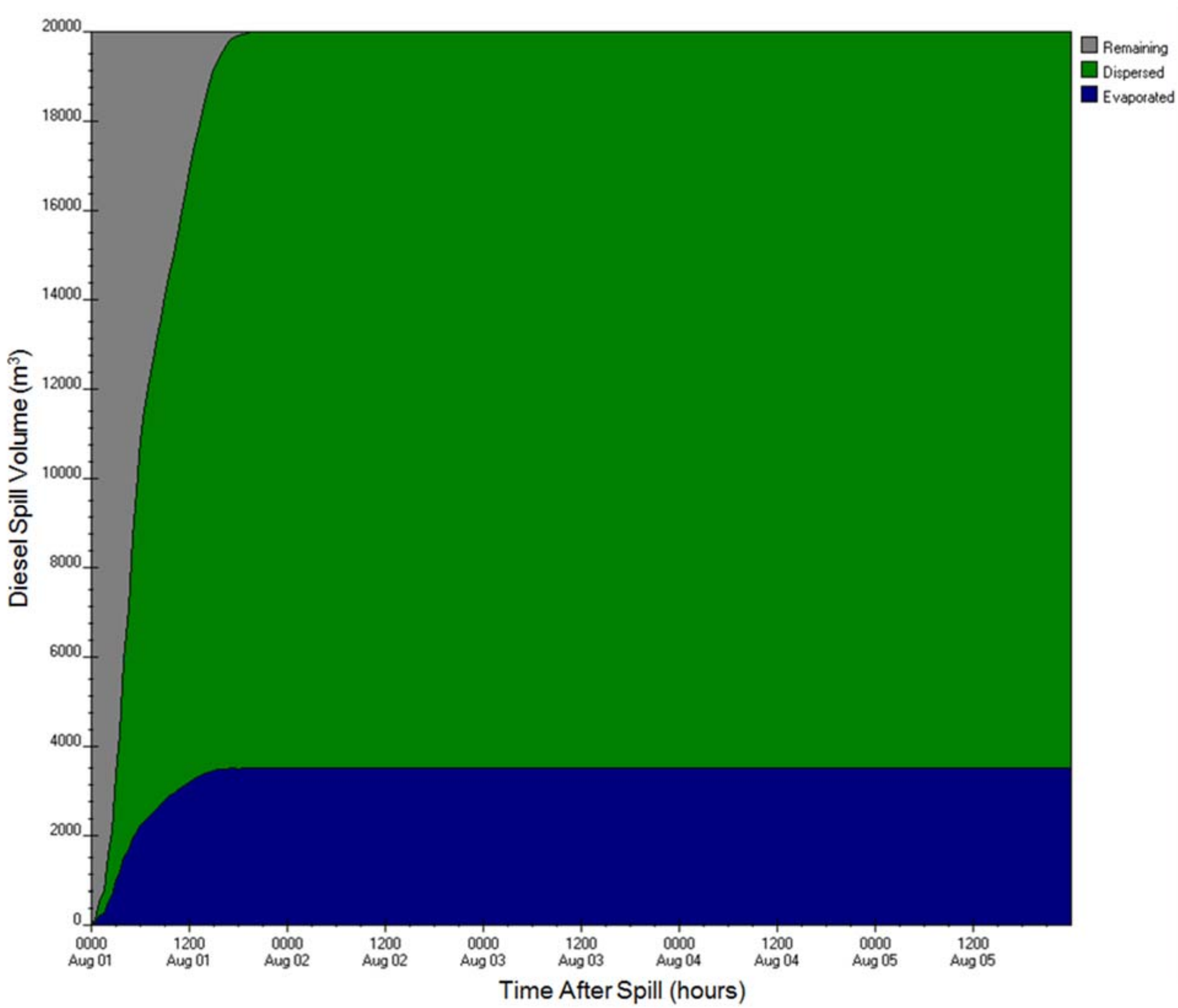

Figure E-A65: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 20,000 m^3, 2-yr wind speed scenario

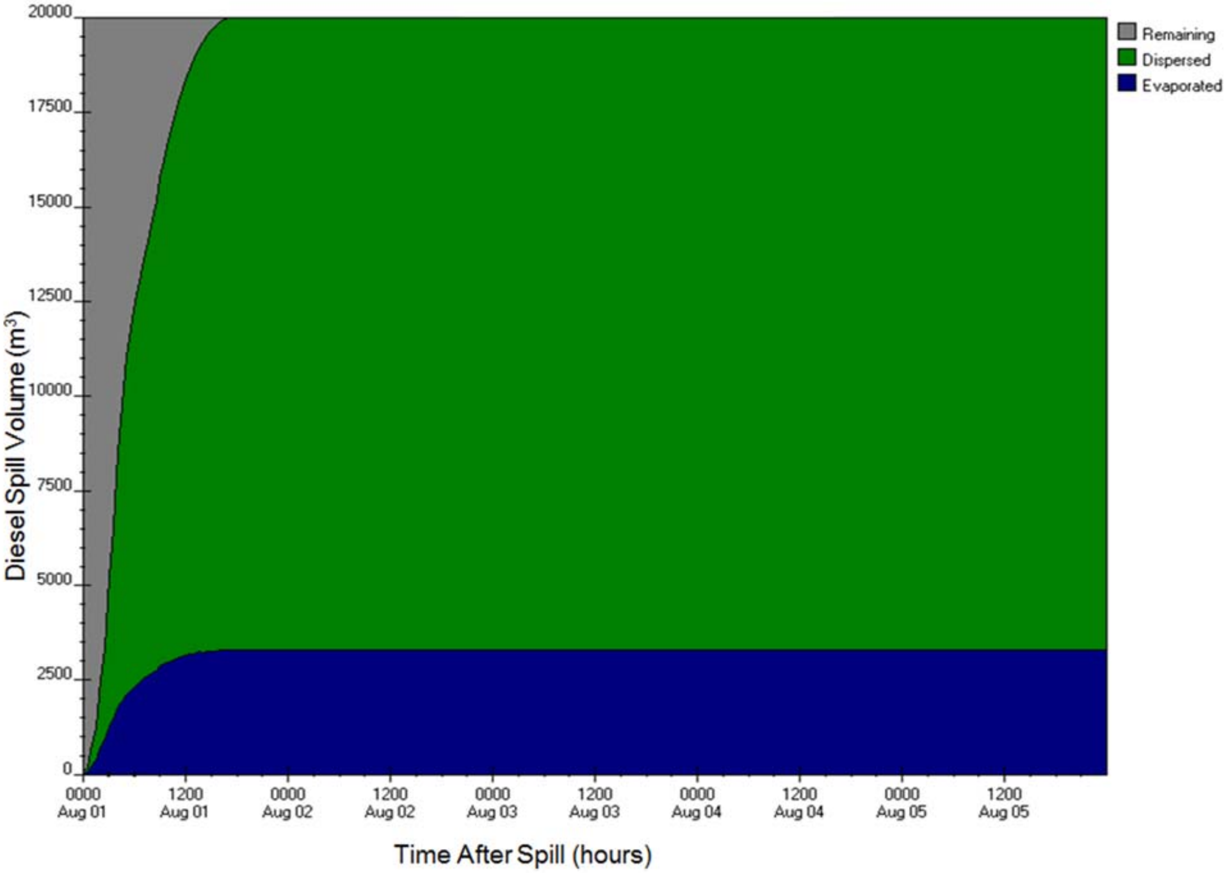

Figure E-A66: ADIOS2 diesel fuel budget output for Western Hudson Strait, Charles Island station (6A) for 20,000 m^3, 50-yr wind speed scenario

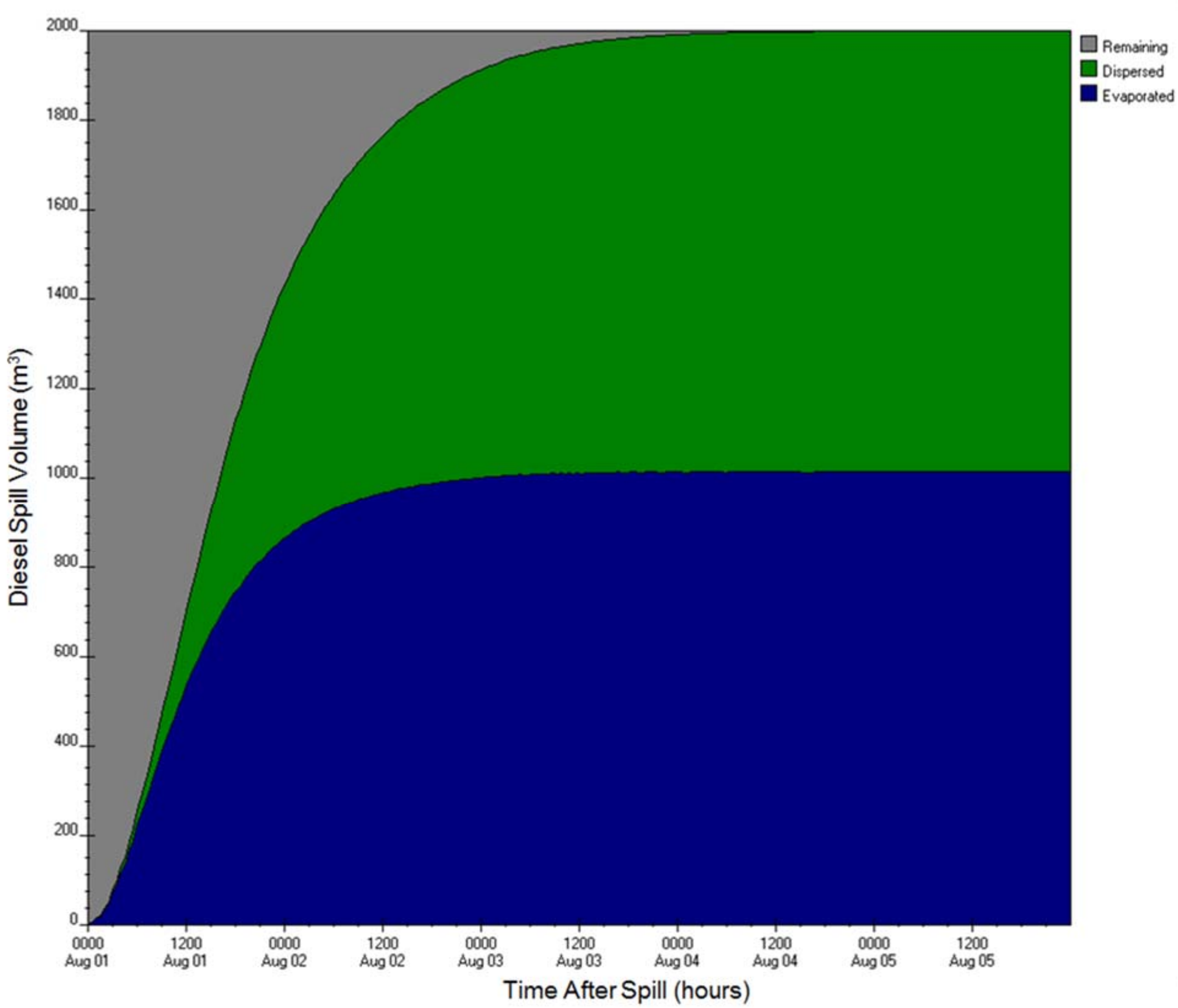

Figure E-A67: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 2,000 m^3, mean wind speed scenario

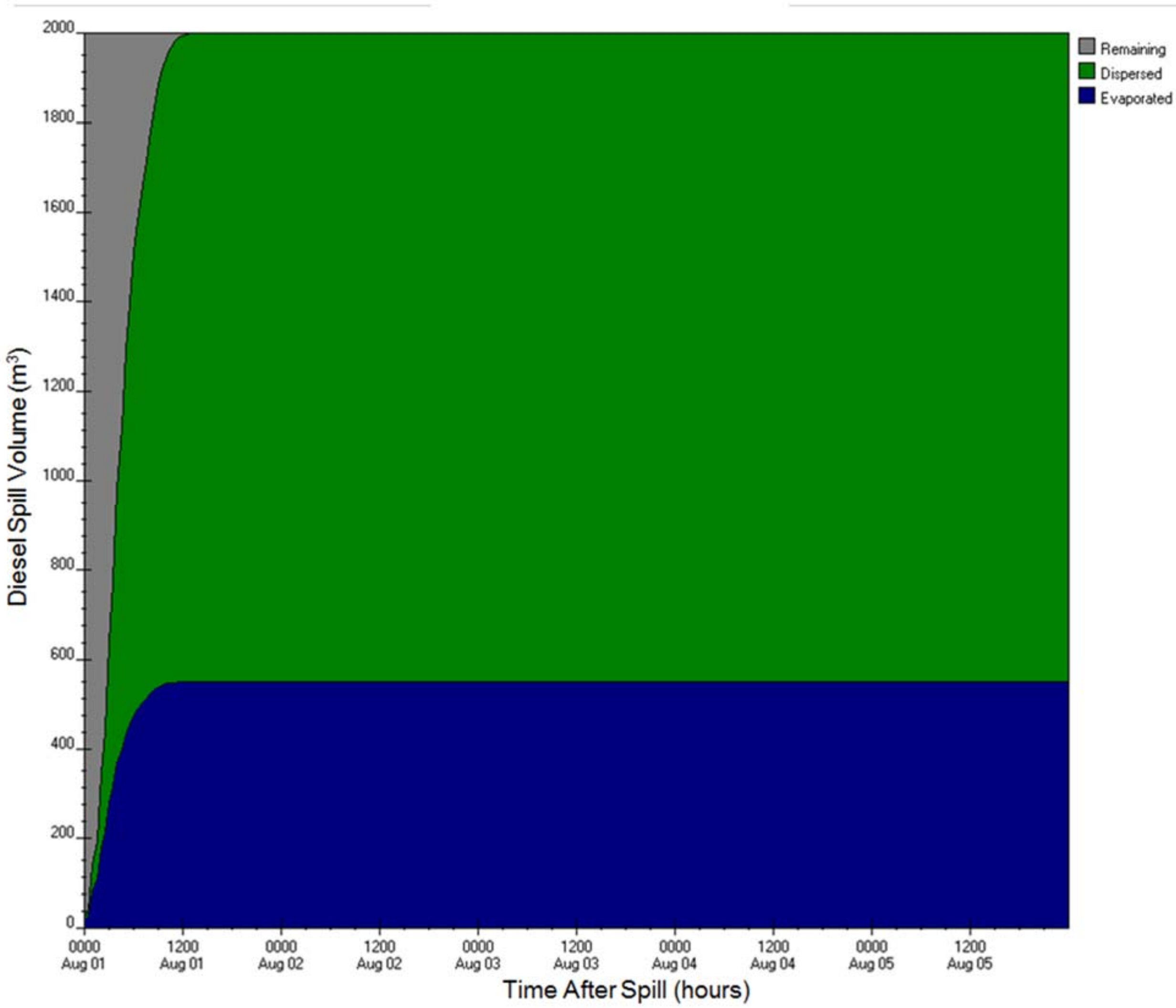

Figure E-A68: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 2,000 m³, 2-yr wind speed scenario

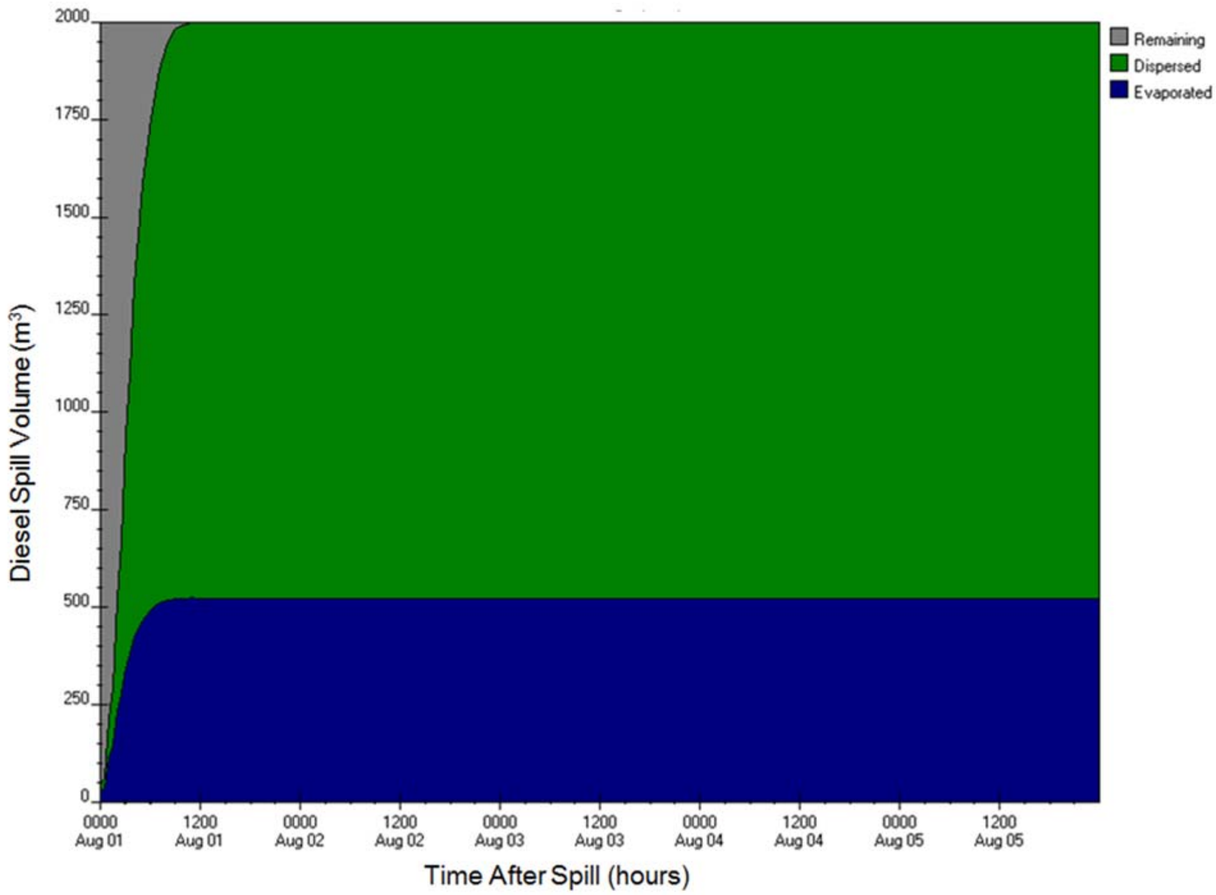

Figure E-A68: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 2,000 m^3, 50-yr wind speed scenario

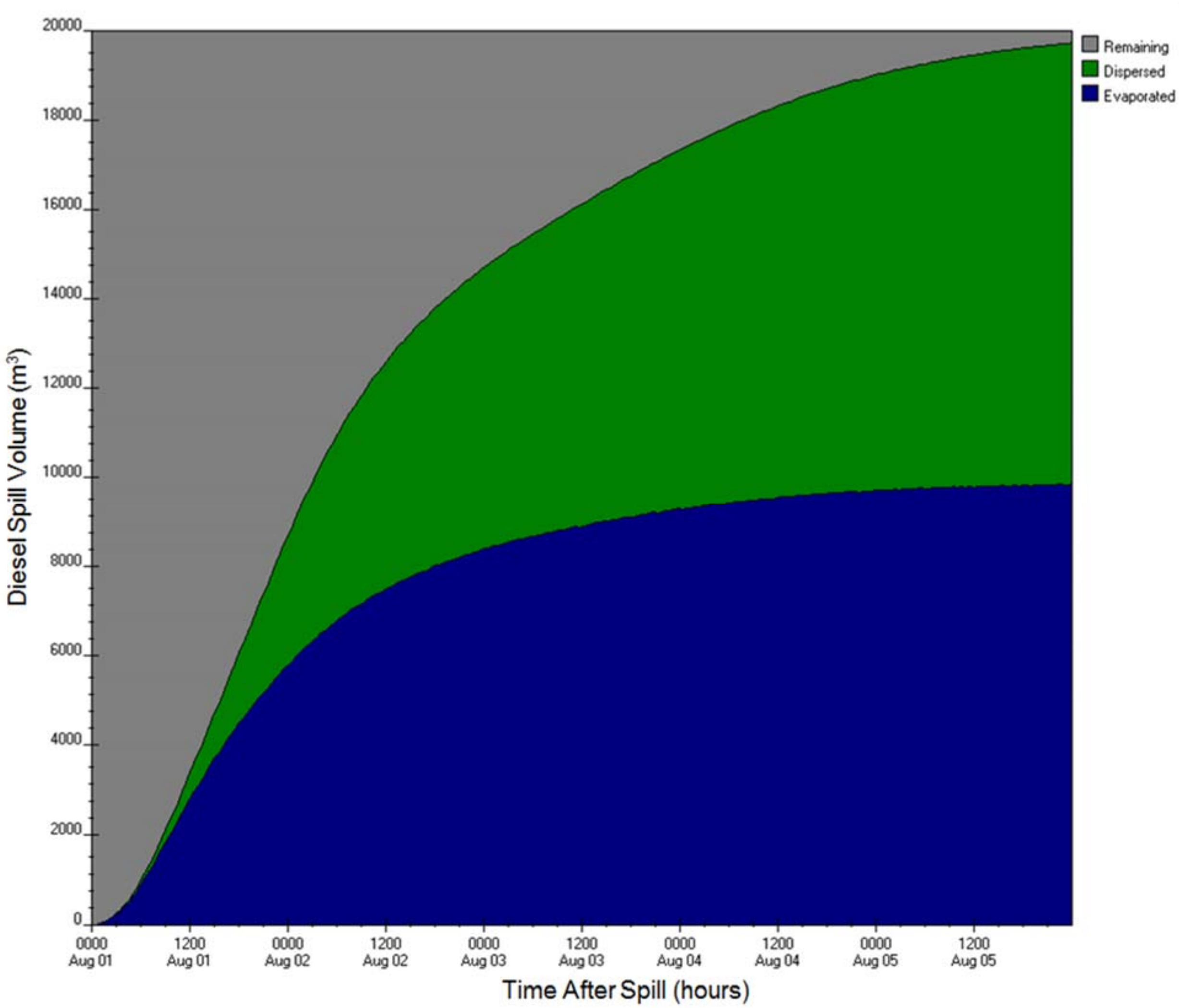

Figure E-A69: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 20,000 m^3, mean wind speed scenario

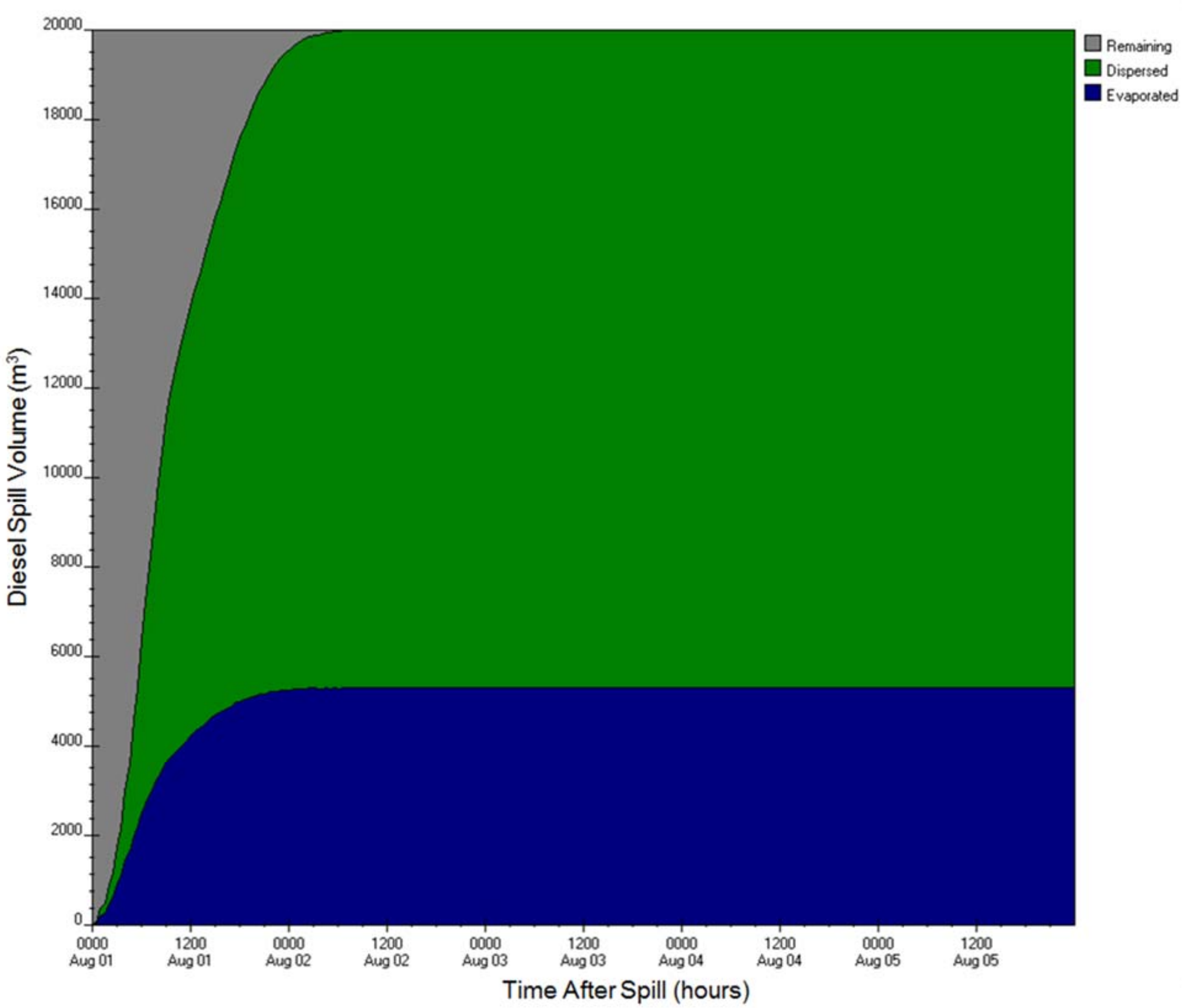

Figure E-A70: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 20,000 m³, 2-yr wind speed scenario

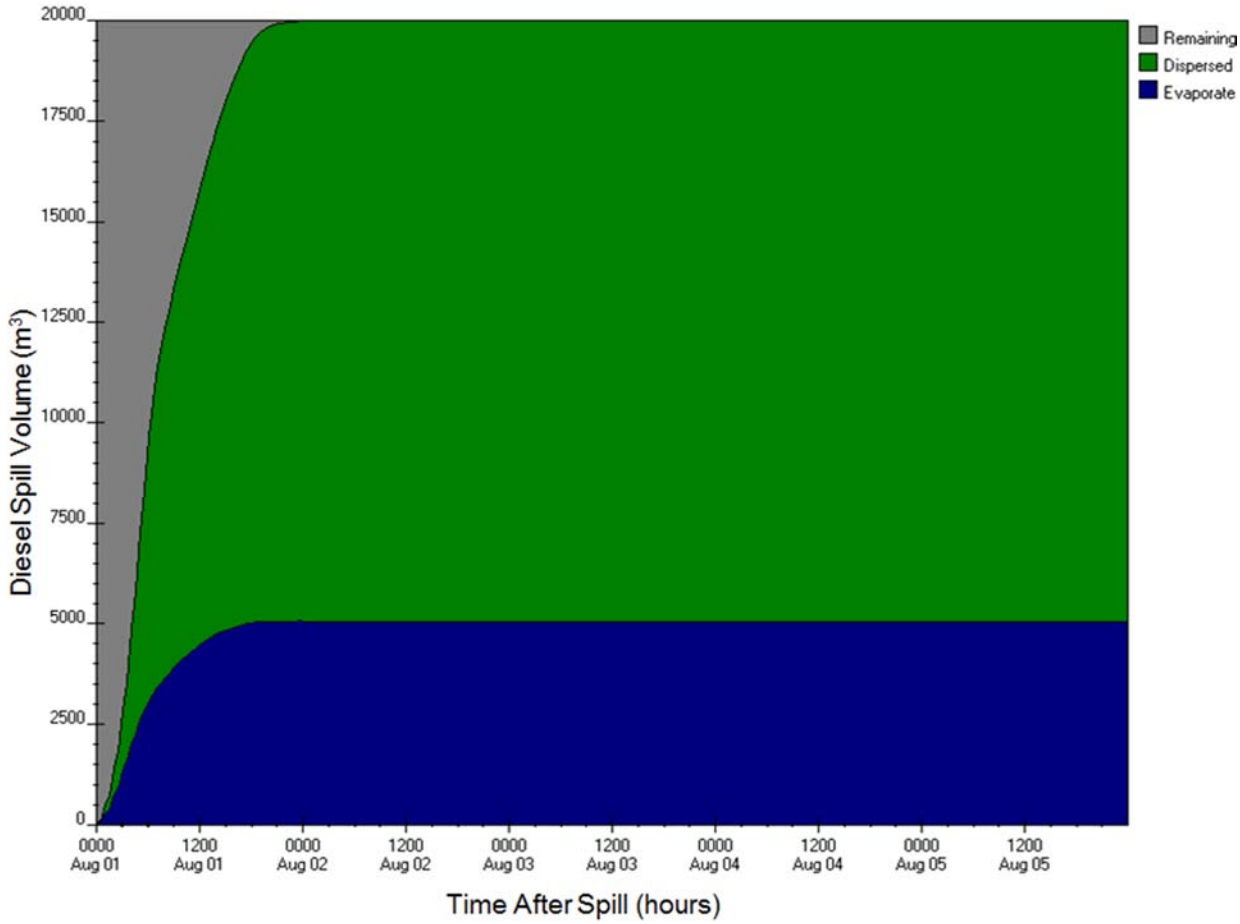

Figure E-A71: ADIOS2 diesel fuel budget output for Mid Hudson Strait station (7A) for 20,000 m^3, 50-yr wind speed scenario

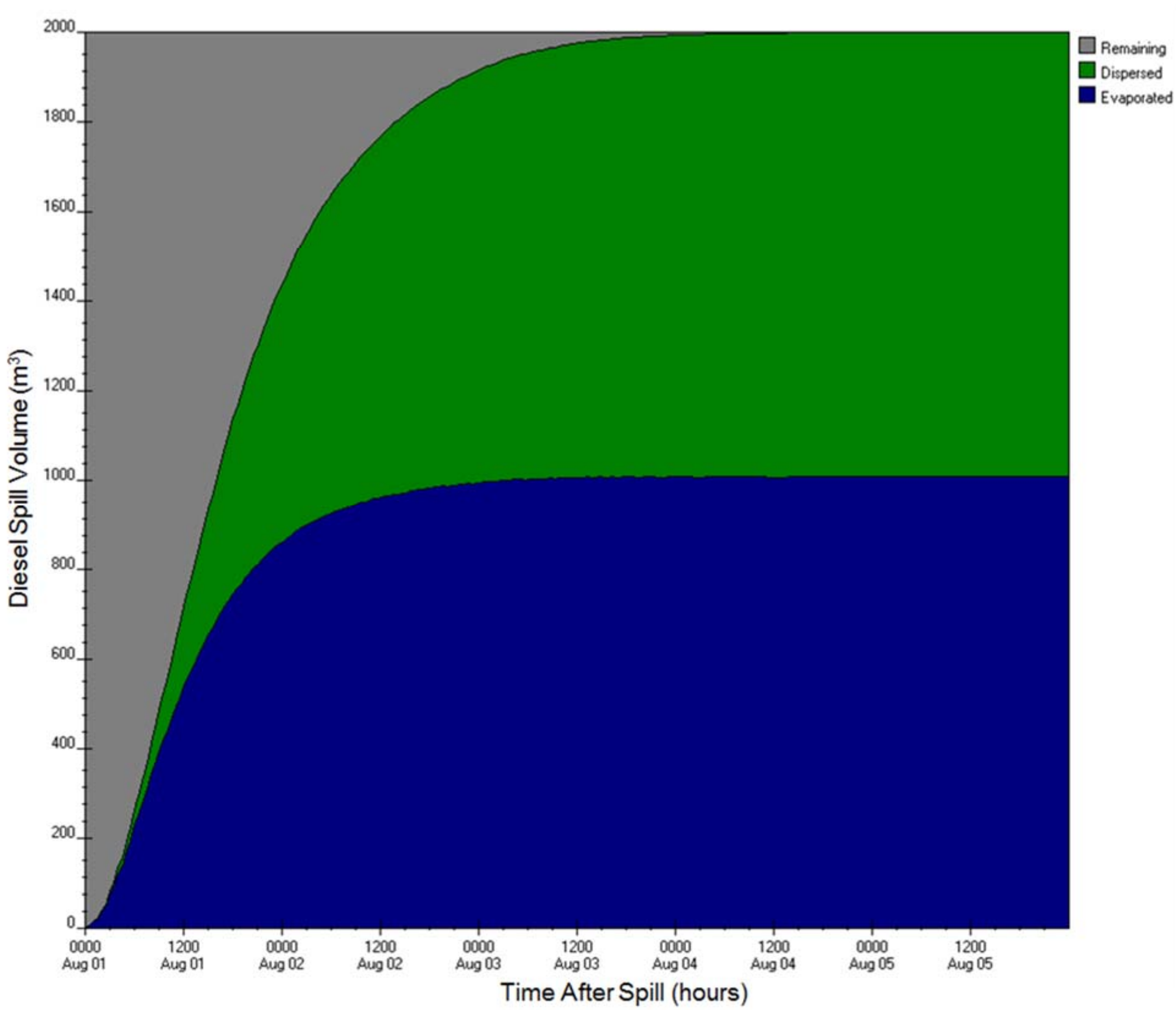

Figure E-A72: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 2,000 m^3, mean wind speed scenario

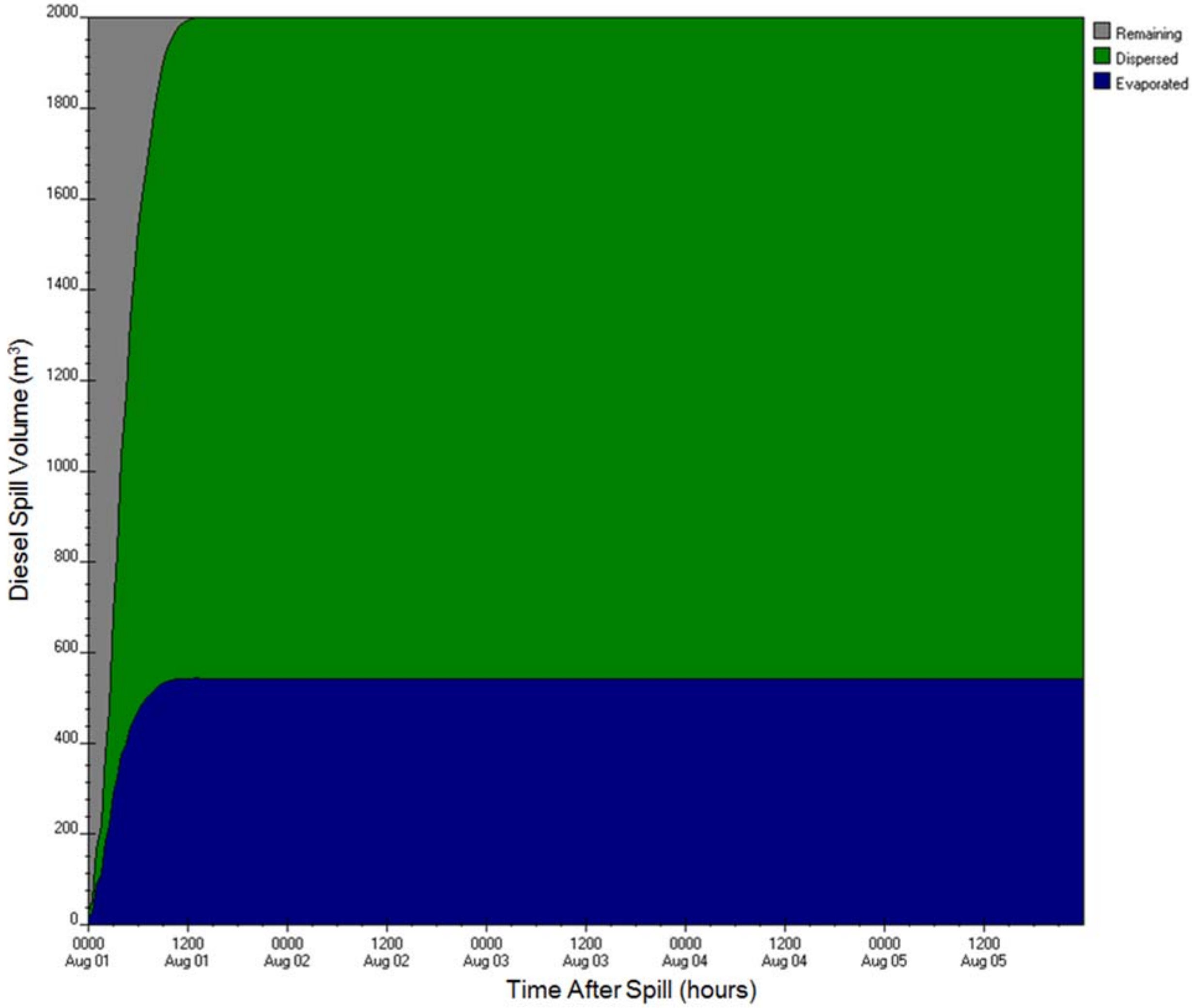

Figure E-A73: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 2,000 m^3, 2-yr wind speed scenario

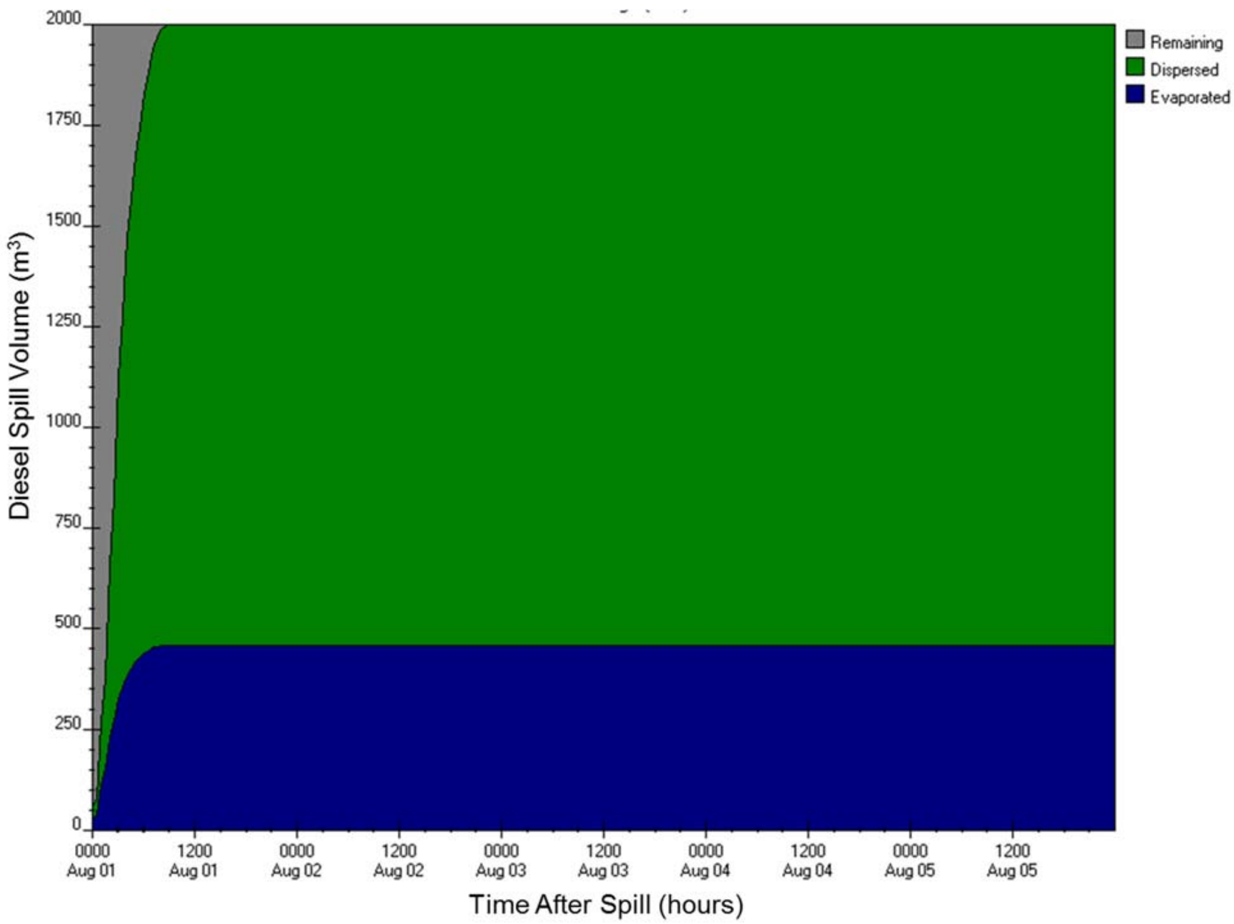

Figure E-A74: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 2,000 m^3, 50-yr wind speed scenario

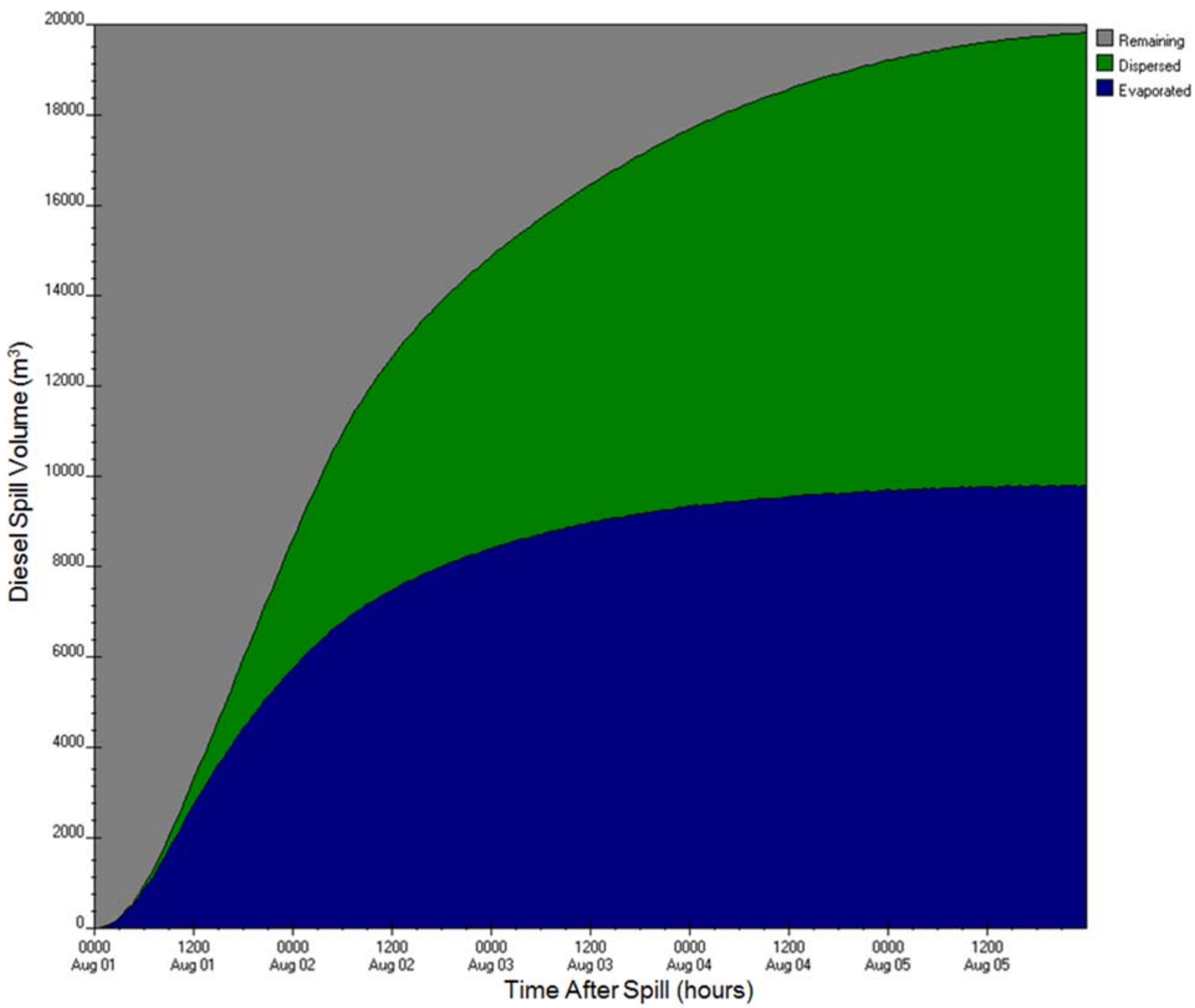

Figure E-A75: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 20,000 m^3, mean wind speed scenario

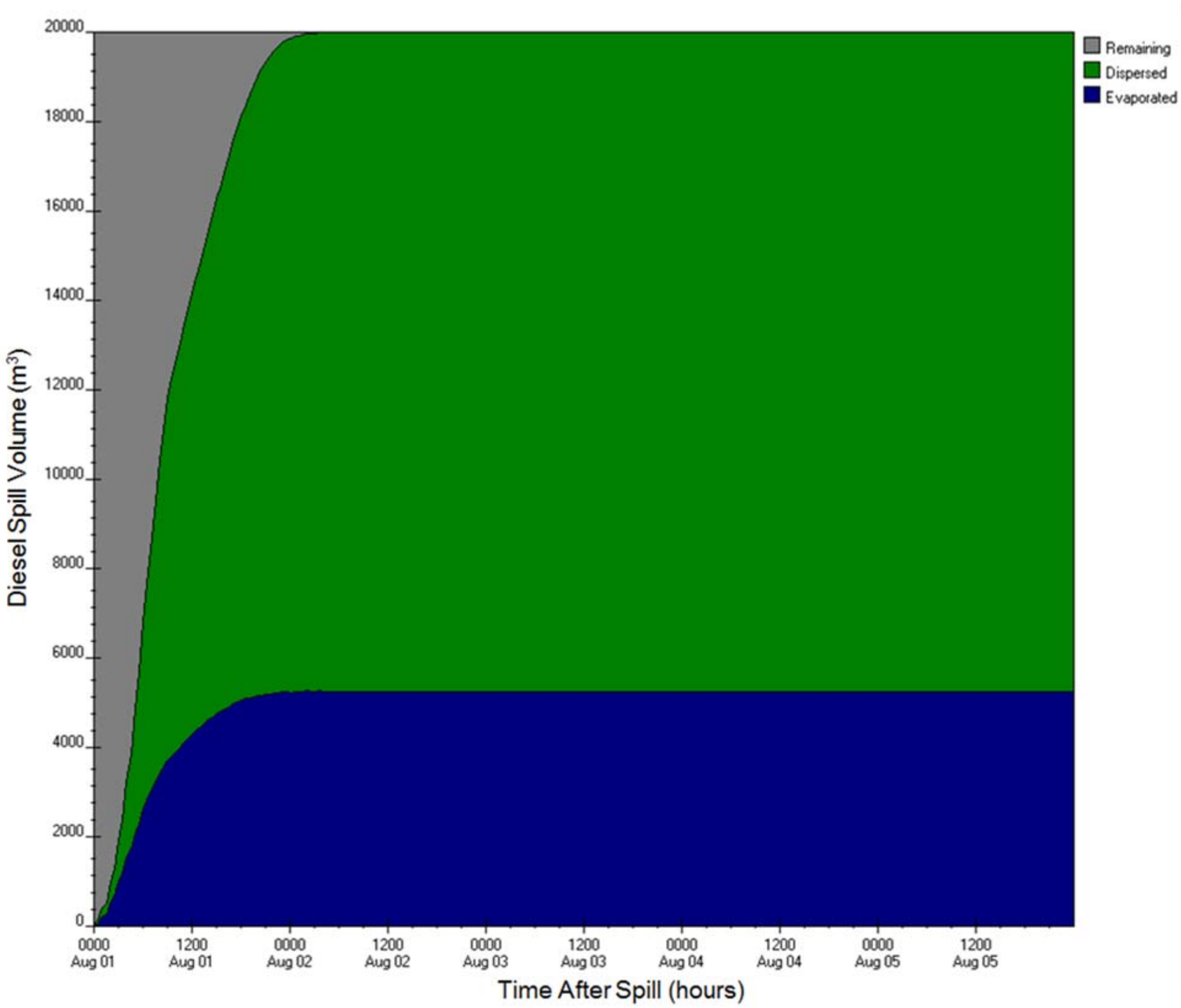

Figure 8.2-B-B-76: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 20,000 m^3, 2-yr wind speed scenario

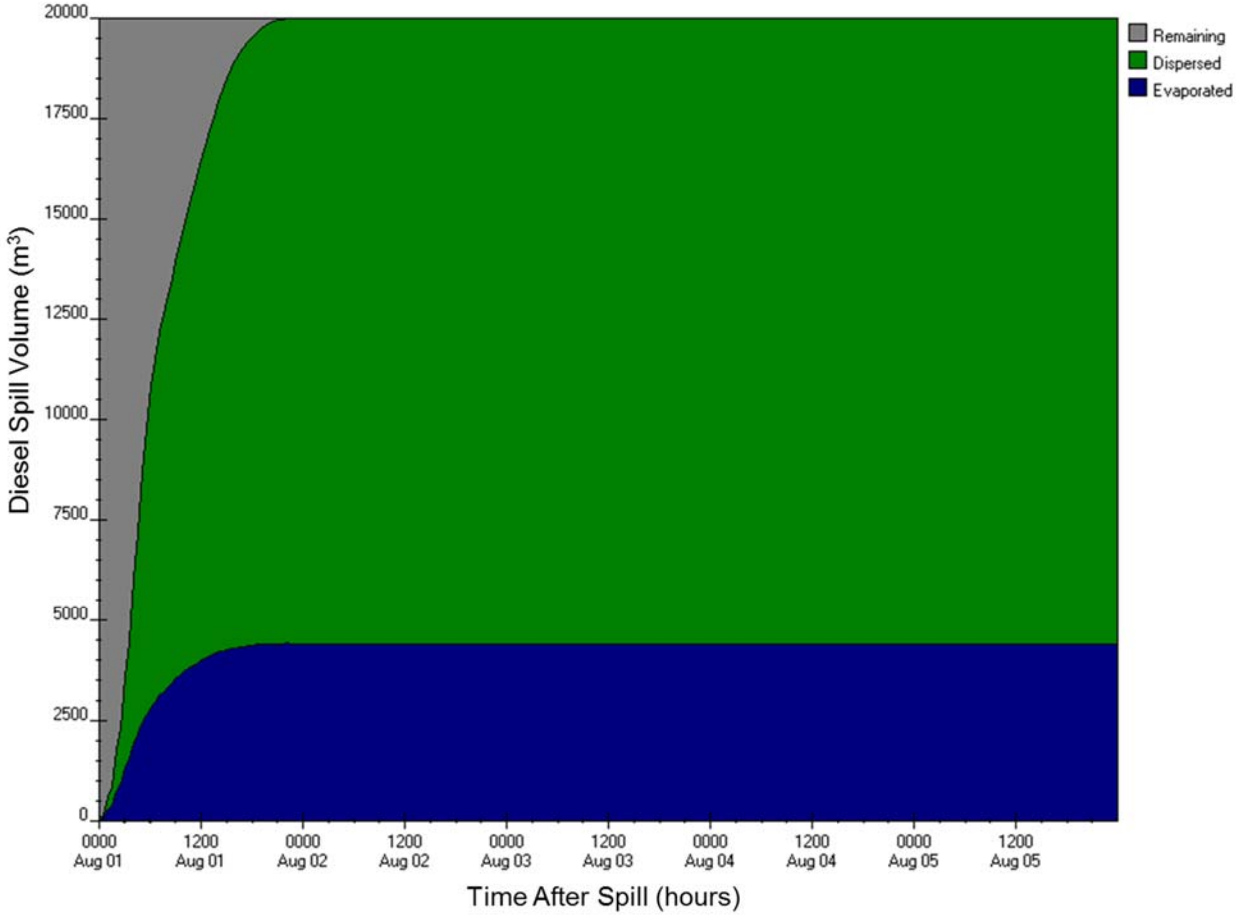

Figure E-A77: ADIOS2 diesel fuel budget output for Eastern Hudson Strait station (8A) for 20,000 m^3, 50-yr wind speed scenario

https://capws.golder.com/sites/capws2/1114280011meliadine/type a water license/5_post-submission/project certificate conditions/shipping management plan/appendix e - spill risk assessment/att a.docx