



APPENDIX 8C

UNDERWATER NOISE MODELLING

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Final Environmental Impact Statement Ø^àluary 2012

APPENDIX 8C-1

UNDERWATER NOISE MODELLING FOR STEENSBY INLET,

FOXE BASIN AND HUDSON STRAIT



Assessment of Underwater Noise for the Mary River Iron Mine

Construction and Operation of the Steensby Inlet Port Facility.

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1. Introduction

JASCO Applied Sciences has performed an acoustic modelling study of the underwater noise expected from construction and operation of the Steensby Inlet Port Facility for the Mary River Iron Mine.

The proposed Mary River Iron Mine is located on North Baffin Island, Nunavut. A large dock facility will be built in Steensby Inlet for year round shipping operations of the iron ore with large ore-carriers. The proposed shipping route is from Steensby Inlet, through the Fox Basin, along the northern shore of Hudson Strait, and into the Atlantic.

The construction of the main ore-loading dock will require deepening of the sea bottom. The seabed at Steensby Island is represented by granites with thin cover of coarse sediments. Before the bottom material can be removed, blasting with pre-drilling for the blasting, is required. The loose materials after blasting will be removed by a dredge. The drilling and blasting operations are proposed to be carried out from ice, while the dredging is expected to be performed during open water season. The modelling location for the construction was chosen at the proposed location of the ore-loading jetty.

The operation of the port facility will involve tug manoeuvres in the vicinity of the port (ore-carriers assisted docking, ice management during ice season) and ore-carriers passing along the shipping route. Two types of tugs are expected to operate at the port: summer tugs and winter tugs with higher ice-class. Ore-carriers with $\pm 190,000$ DWT are planned to be used on the route. One modelling location for the tug operations was chosen in the vicinity of the ore-loading jetty. Three locations for the noise modelling from the ore-carriers were chosen along the shipping route after consultations with LGL Limited.

The modelling for the port operation was performed for three seasons: open water (August), thin ice conditions (February), and thick ice conditions (May). Each of the specific construction activities was modelled only for the season, during which it was expected to be carried out.

The modelling was performed for an extended frequency range — 10–20,000 Hz. The source levels for each of the modelled noise sources were estimated based on an extensive literature review as well as JASCO's own source level database.

The seasonal changes were considered in the model in three ways:

- 1. Variation of the sound speed profile
- 2. Increased source levels (e.g. as the vessels have to push their way through ice)
- 3. Increased attenuation of the sound energy due to interaction with the ice cover

The results of the modelling are presented in different forms suitable for further noise impact assessment. For each modelling scenario the following output produced:

- Areal map of Sound Pressure Level (SPL) field distribution contoured with 10 dB step
- Tables of threshold distances to the broadband levels, calculated based on flat-weighted as well as M-weighted (4 different curves) result
- Tables of estimated maximum sound levels at specified distances for 1/3 octave band central frequency from 10 Hz to 20,000 Hz. The tables are presented in a separate Excel spread sheet document.

2. Source Levels

2.1. Port Construction and Operation

2.1.1. Drilling

Drilling is required to install blast charges into the rock. The drilling of blast holes is expected to be performed from ice, i.e. during the late winter, when the ice cover is the thickest. In the absence of final design, reasonable assumptions were made about the drilling operation and specifications of the drill rig., e.g. that drilling will occur through hard rock with a drill bit diameter of about 100 mm or less suitable to install charges of 50–75 mm diameter.

Two datasets were considered for estimating possible source levels of the drilling operation:

Mann et al. (2009) published a study on under-ice anthropogenic noise at a winter-based diamond exploration project on Kennady Lake (Northwest Territories, Canada). This publication presents an acoustic spectrum from a small diameter (63.5 mm) coring drill bit. The drill rig was installed on top of ice with thickness of 1.63 m. The water depth was 15 m. During acoustic recordings the hydrophone was placed at a distance of 5 m from the source. The spectrum graph (frequency range 10–20,000 Hz) was digitized, converted into third-octave bands, and back-propagated to 1 m using spherical spreading law. The resultant source levels for the coring drilling in 1/3 octave bands are presented on Figure 1 with black line.

JASCO's recordings of a Beatle drill (Mouy and Zykov, 2009) were also used to provide alternative source levels. This drilling was performed through a metamorphic rock with a drill bit diameter of 610 mm. The drill rig was installed on a temporary metal frame, which was resting on the river bottom. The water depth at the drill site was 9 m, hydrophone was placed 10 m from the rig, mid-water column. The range of the recorded frequencies was from 1 Hz to 24,000 Hz. The received levels were adjusted using spherical spreading law to obtain source levels. The resultant source levels for the drilling with hammering action in 1/3 octave bands are presented on Figure 1 with black line.

The two presented source level spectrums differ by more than 40 dB. It is believed that such a large difference can be attributed to the fact that the hammering action produces more noise than normal rotary drilling and sounds from associated machinery.

Since the type of drilling that will be used is not finalized at the time of this report preparation, both source types were modelled. When the drill method is determined, the results for the more appropriate source can be selected.

The source depth for the modelling of the coring drill was chosen to be 1 m below the sea surface, as it is believed that the loudest noise source for this type of drill rig is the machinery installed on the ice. The source depth for the modelling of the drill with hammering action was chosen to be 1 m above the sea bottom, as it is believed that most of the acoustic energy is emitted at the point of contact of the drill bit with the rock.

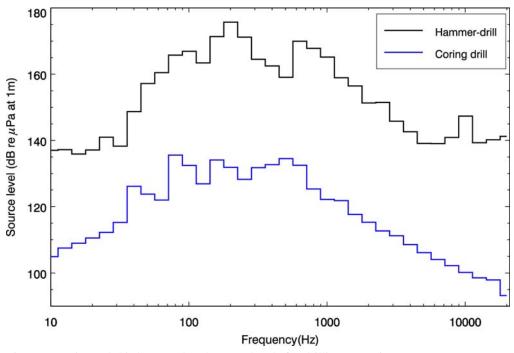


Figure 1: Estimated third-octave band source levels for drilling operation.

2.1.2. Blasting

In-water blasting will likely be carried out during late winter when ice cover is present and marine mammal presence is expected to be lowest. Only ringed seals are expected to be present during that time. Removal of the blast rock will take place during the following open water season. As a result it will be necessary to perform blasting up to 1 m deeper than the target elevation to ensure the required elevation is achieved (Knight Piésold Ltd., 2009, p. 52).

We used Conventional Weapons Effects (ConWep) software to model blast overpressure levels. ConWep was developed by the US Army Engineer Waterways Experimental Station for the US Army Corps of Engineers (Hyde, 1988). It is a collection of conventional weapons effect calculation tools derived from the equations and curves of TM 5-855-1, "Fundamentals of Protective Design for Conventional Weapons." We employed ConWep v2.0 released in August 1992.

ConWep predicts ground shock overpressures for specified charge sizes and detonation depths below the ground surface (Hyde, 1988). It includes a database of the yield and detonation rates for a number of explosive compounds, including Pentolite and TNT. The code employs a set of empirical equations that were developed based on a large number of experiments conducted by the US Army. In the ground shock modelling mode, ConWep predicts the peak pressure and peak pressure time-history curve (P-T history curve) envelope. The input parameters of ConWep include type and weight of the explosive charge, geometry of the blast (depth of the charge, distance to the target, and depth of the target), and geo-acoustic parameters of the substrate (density, P-wave velocity, and attenuation coefficient).

ConWep predicts the peak pressure in the substrate. In order to obtain the peak pressure values in the water, the pressure transfer coefficient has to be calculated using the impedance values for the water and substrate layers (Wright and Hopky, 1998, Equation A, p. 18).

Almost all input parameters to the ConWep code can be assessed with relatively high accuracy based on the anticipated blasting setup and the geology of the substrate. The attenuation coefficient is site-specific and is the only parameter about which there is considerable uncertainty. The influence of this parameter on the modelling results cannot be ignored, so it has to be estimated with sufficient accuracy.

In a previous blasting noise propagation study conducted by JASCO in an area of reasonably similar bulk geological properties (Zykov, Deveau, and Hannay, 2010), a ground-truthing measurement program combined with ConWep modelling revealed that a ConWep attenuation coefficient of 1.9 is the best choice for this type of geology.

A technique of multiple delay charges is used to improve blast efficiency and also to meet the DFO marine habitat noise guidelines of a maximum 100 kPa waterborne acoustic overpressure. Each charge is detonated after a short delay from its predecessor. This approach avoids the summation of pressures that can arise from simultaneous detonation of multiple charges.

The explosives contractor will design and conduct blasting operations at Mary River to ensure that the 100 kPa waterborne acoustic overpressure threshold zone is limited. A setback distance corresponding to this threshold will be defined based on the specific blast design. A method for calculating setback distance is given in the DFO Guidelines (Wright and Hopky, 1998, Equation D, p. 19).

The final charge sizes and delay sequence are not yet defined. As a starting point for modelling using ConWep, we assume the weight of a single delay charge is 10 kg Pentolite. Charges used for trench blasting in bedrock of the Athabasca River were 8.2 kg (Zykov, Deveau, and Hannay, 2010). The model parameters also assumed charge burial depth of 1.5 m, substrate density of 3.5 g/cm³ and a compressional sound speed of 2400 m/s. ConWep calculates a setback distance of 37.1 m for the 100 kPa waterborne peak acoustic overpressure with these input parameters. The method of Wright and Hopky (1998) yields a setback distance of just 5 m in this case. The Wright and Hopky method also underestimated the waterborne overpressures measured during the Athabasca River blast.

Explosive charge detonations generate impulsive acoustic events. There is a zone in the immediate vicinity of the blast that is dominated by non-elastic strain, fracture, and bulk material transport within the medium. At some distance from the blast, the acoustic overpressure has sufficiently dissipated so that the medium can retain its integrity and respond elastically to the overpressure disturbance; at greater distances the propagation is described well by linear compressional and shear wave theory. Impulsive acoustic events are characterized by broad frequency band energy. However, as sound propagates away from the source certain frequencies become attenuated (diminished in amplitude) with distance more quickly than others. Sound propagation models can predict the frequency dependence of attenuation. We carried out sound modelling in third-octave frequency bands with centre frequencies between 10 Hz and 2 kHz.

The ConWep model predicted the 100 kPa (220 dB re 1 μ Pa) peak overpressure threshold would occur at a horizontal distance of 37.1 m from the source.. This distance was obtained by using ConWep to compute the distance to a threshold of 230 dB re 1 μ Pa just below the surface of the exposed bedrock . The 10 dB difference represents the level difference between pressure in the seabed and in the water and was predicted using the impedance matching technique from the DFO guidelines (Wright and Hopky, 1998, Equation A, p. 18).

In order to obtain an equivalent source level at 1 m from the source, for the purpose of acoustic propagation modelling, we back-propagated the pressure field according to cylindrical spreading loss, or $10 \cdot \log(r)$. The purpose of the back-propagation step is to determine the effective source level at 1 m that is used to initialize the forward acoustic propagation model. The equivalent compressional wave peak overpressure source level in the substrate was 246 dB re 1 μ Pa @ 1 m.

If it were assumed that the acoustic energy generated by each detonation was equally distributed among the 24 third-octave frequency bands (10 Hz to 2 kHz), the third octave band source levels would be 218 dB re 1 μ Pa @ 1 m. These source levels would have to be adjusted for charge masses different than 10 kg.

Effect of bubble curtain

Bubble curtains are commonly used to reduce acoustic energy emissions from high-amplitude sources. Bubble curtains can be generated by releasing air through multiple small holes drilled in a hose or manifold deployed on the seabed near the source. The resulting curtain of small air bubbles in the water provides significant attenuation for sound waves propagating through the curtain. The bubble curtain is often use as a mitigation choice for underwater pile driving and blasting activities at construction sites.

Research has been performed to quantify the effectiveness of bubble curtains at attenuating impulsive sounds (eg. Koschinski & Kock, 2009; Schmidtke, 2010; Nützel, 2008). Nützel (2008) established that the reduction of peak pressures of explosion shockwaves depends on the air flow rate. An average of 15.4 dB decrease in the peak pressure was measured with the bubble curtain air flowrate of 20 m³/min. In another experiment with 25 charges Grunau (2008) estimated the reduction of the peak pressure of the shock wave by as much as 17 dB.

The effect of a bubble curtain was included in the modelling results by applying a flat reduction of 15.4 dB (average of the above-listed attenuations) to the non-mitigated source levels.

2.1.3. Dredging

The construction of the Ore Loading Dock in Steensby Port will involve blasting and dredging of the level pads for the dock caissons and leveling of the seabed at the 25 m contour line. The dredging phase is expected to occur during the open water season, and the dredged material is likely to be contained on barges until future use. However, the exact specification of the dredging equipment was unknown at the time of the study.

There are several types of dredges that could be used here: suction dredges, clamshell bucket dredges, and continuous bucket dredges. It is most likely that a suction dredge or clamshell bucket dredge will be used here.

A clamshell bucket dredge uses a bucket that is being hoisted by a crane. The bucket grabs sediment material from the bottom and dumps it into a barge. One duty cycle of a clamshell bucket dredge lasts 1–2 minutes and involves the following events:

- Bucket striking the bottom
- Bucket digging into the bottom/bucket closing
- Winching up
- Dumping the material from the bucket

Dickerson et al. (2001) identified the "bucket striking the bottom" as the noisiest event of the sequence. They recorded the dredge *Viking* operating in Cook Inlet (Alaska), at a distance of 158 m from the dredging location, where the water depth was 10 m. The reported received levels were back-propagated to 1 m assuming spherical spreading for the first 20 m from the source and the cylindrical spreading thereafter. This event happens once per duty cycle and is very short in duration. The source levels for other events of the clamshell bucket dredge operation are at least 6 dB lower. The next loudest event is winching, which, has the longest duration.

Suction dredges utilize a wide pipe (up to 1 m in diameter) and a high power pump to suck water and loose material from the bottom into a hopper or directly to a discharge location. Often a cutter head is used to help with loosing up the sediments. The intake pipe with the cutter head can be steered by winches or thrusters. The dredge vessel itself can be moved by main thrusters or winches. Cutter-suction dredge operates in more or less continuous mode. The noise sources for the cutter suction dredge include the power plant, the suction pump, the cutter head, and the cutter head thrusters.

A collection of source levels for clamshell bucket and suction dredges are presented on Figures 2 and 3 (various events). Figure 2 shows that the source levels of clamshell bucket dredges are appreciably lower than those of suction dredge at frequencies below 100 Hz and similar levels for higher frequencies. It is assumed that material dumping operation results in the same amount of noise regardless of the type of dredge involved. The noise level from the dumping operation depends on whether the receiving barge is empty or if there is some dredged material already in the barge. The dumping operation is expected to be the loudest if the receiving barge is empty and the dumping material consists of large rocks. The source levels for exactly such event are presented on Figure 2 (*Gerardus Mercator*, dumping).

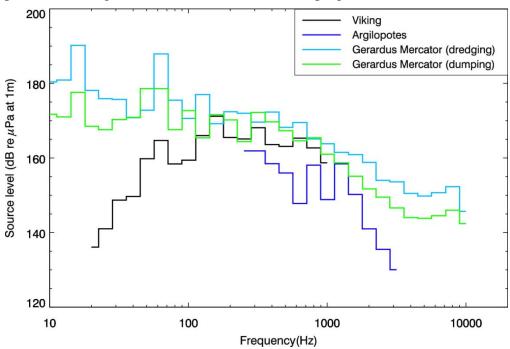


Figure 2: Estimated source levels for clamshell bucket and suction dredges. *Viking* – clamshell dredge, bucket striking bottom event (Dickerson et al. (2001); *Argilopotes* – clamshell dredge (Miles et al., 1987); *Gerardus Mercator* – trailing suction dredge (Hannay et al., 2007).

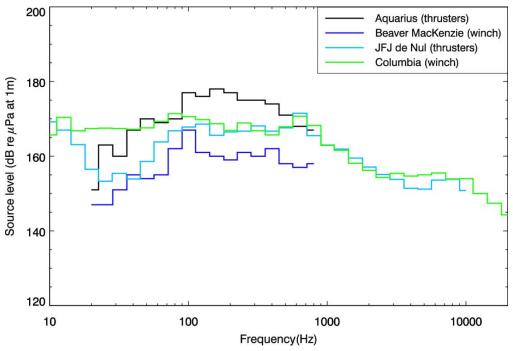


Figure 3: Estimated source levels for cutter-suctions dredges with winch and thruster steering mechanisms. Aquarius – thrusters, Beaver Mackenzie – winch (Malme et al., 1989); JFJ de Nul – thrusters (Hannay et al., 2007); Columbia – winch (Zykov et al., 2007).

The noisiest suction dredges are those which use thrusters to steer the intake pipe (Figure 3).

Since the type of dredging for this project has not yet been selected, two surrogate source level spectra were created using the available data for the modelling of the dredging operations. For the clamshell bucket dredge source level the maximum values of the "bucket striking the bottom" levels and the "material dumping" levels were used in each 1/3 octave band to produce a conservative estimate. The vertical position of the source is assumed to be 3 m below the sea surface. For the suction dredge the maximum levels were extracted from the four spectra presented on Figure 3. The vertical position of the source is assumed to be 1 m above the sea floor.

In case the available data did not provide the source levels for higher frequencies, extrapolation was used by taking the level for the highest available band and reducing the value by 10 dB per decade (or 1 dB per 1/3 octave band) as suggested by Ross, 1976. The resultant source levels to be used for modelling of the dredging operation are presented in Figure 4.

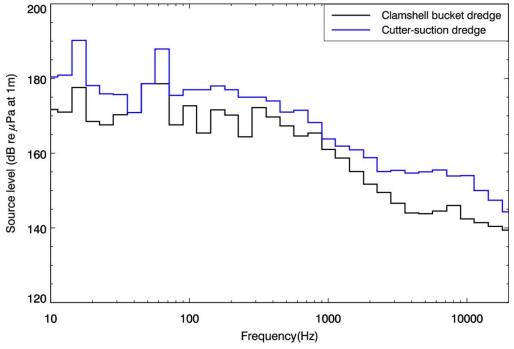


Figure 4: Assumed 1/3-octave band source levels for modelling the dredging operation.

2.1.4. Tugs

Summer (Ice Class 1A) and winter (Polar Class) tugs are expected to operate in the Steensby Port area to assist with the docking operations of the ore carrier fleet as well as in the ice management operations around the dock. The vessel specifications presented in Table 1 were provided by LGL Limited as representative of the vessels expected to perform these operations. We derived surrogate source levels from measurements made by JASCO on tugs performing a variety of typical operations (Hannay et al., 2007). The specifications of the recorded tugs are presented in Table 2.

Table 1: Mary River Project Tugs specifications.

	Summer tug	Winter tug
Class	Ice class 1A	Polar class
Number of screws or thrusters	2	3
Number of propeller blades	4	4
Nozzled?	yes	no
Propeller diameter	2.4 m	2.6 m
Propeller depth	4.0 m	5.5 m
Propeller RPM	190	190
Vessel speed	13.5 kn	14.5 kn

Table 2: Specifications of tugs, for which source level measurements are available.

	Britoil 51	Katun	Kuparuk
Class	Anchor handling tug	Anchor handling tug	River tug
Length (m)	45	68	19.5
Tonnage (metric tonne)	605	1982	105
Total power (hp)	6600	12240	1095
Number of screws or thrusters	2	2	3
Propeller diameter (m)	3.2	_	1
Vessel speed (kn)	13	13	_
Nozzled	yes	no	no
Number of propeller blades	4	_	5
Propeller RPM	190	_	450
Monitored activity	Anchor pull operation, full speed transit	Anchor pull operation, transit	Barge pushing
Reference	Hannay et al., 2007	Hannay et al., 2007	Zykov et al., 2008

The operating conditions include open water and water covered by thin and thick land-fast ice. The available source level measurements for tugs were only representative of operations in open water. The available measurements for the *Britoil 51*, *Katun*, and *Kuparuk* were compared to the ramming noise levels from the icebreaker *CCGS Henry Larson*, a medium gulf/river icebreaker used by the Canadian Coast Guard (Erbe and Farmer, 2000).

Table 3: CCGS Henry Larsen available specifications (www.ccg-gcc.gc.ca).

Class	Medium Gulf/River Icebreaker – Arctic Class 4
Length	100 m
Beam	19.6 m
Draft	7.3 m
Displacement	6,166 tons
Propulsion system	Diesel electric (12,174 kW)
Propellers	2 x fixed pitch
Vessel cruise speed	13.5 kn

In general, there is a direct relation of the produced noise level with the size of the vessel. Larger vessels produce higher sound levels. In case of the tugs however, the relation is different

from the one of freight vessels, as tugs are equipped with significantly larger power plants than a freight vessel of the similar size. Tugs performing a docking operation on a large vessel or doing ice management often work at higher power output rates. Moreover, in such conditions the cavitation process at the propeller blades is significantly more extensive. Considering this, tugs can produce noise levels comparable of those from larger vessels, like the *CCGS Henry Larson*.

Erbe and Farmer (2000) defined a ramming-mode of the *CCGS Henry Larson* as "when the ship tried to break the ice-ridge after building up momentum, but failed and was stopped by the ice with the propeller still turning at full speed". The published 1/12 octave band levels for *CCGS Henry Larson* were for the frequency range 100 Hz to 20 kHz (Figure 5). The levels for frequencies below 100 Hz were assumed to be constant and equal to the one at 100 Hz in the third-octave band spectrum presented, and this is believed to be a conservative assumption.

Figure 5 presents the comparison between spectra from the different tugs and the *CCGS Henry Larsen* engaged in ramming.

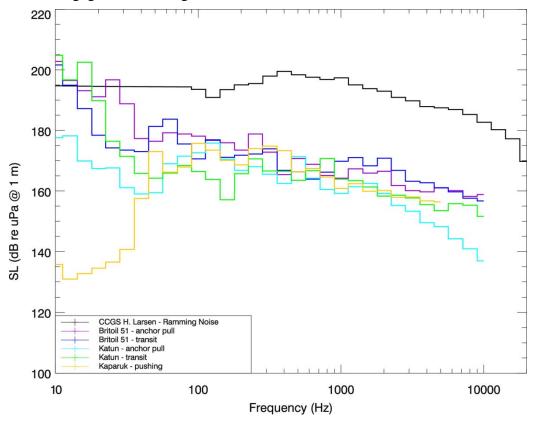


Figure 5: Measured third-octave band source levels for tugs and the icebreaker *CCGS Henry Larsen* engaged in ramming.

The reliability of sound levels at frequencies below 50 Hz is less than for higher frequencies. The reliability also decreases with the distance from which the source was measured. The reduced reliability is attributed to the following factors:

- Higher noise contamination of the recording at low frequencies (e.g. flow noise, self-noise of the system)
- Higher amplification of low frequencies during the back propagation process using transmission loss modelling.

Three separate source level spectra were prepared to represent noise from a tug operating at the port (Figure 6) in three scenarios: open water, presence of thin ice, and presence of thick ice. The open water source levels were calculated as the maximum value of the presented spectra for tugs in each 1/3 octave band. The source levels for the thick ice conditions were calculated as the maximum between the open water source levels and estimated source levels for *CCGS Henry Larsen*. The thin ice source levels were estimated as the mean value of the previous two spectra.

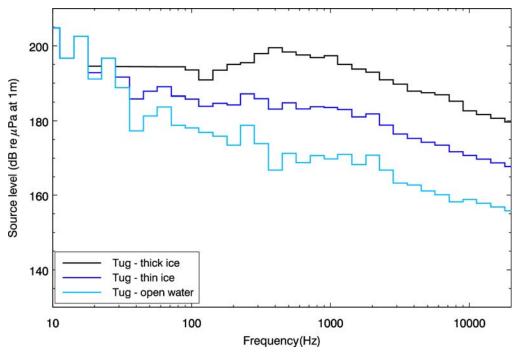


Figure 6: Assumed third-octave band source levels for tugs operating in open water, thin ice, and thick ice conditions.

2.2. Shipping – Icebreaker Ore Carrier in Transit

Ore material is expected to be carried out by a fleet of ore carriers with icebreaking capacity. The vessel conceptual design and specifications were provided by LGL Limited (Table 4).

The vessels' source levels were estimated based on the literature review of the reported measurements of similar ships. Source density spectra were estimated using empirical equations and digitized spectra from several publications.

Table 4: Specifications for a proposed $\pm 190,000$ DWT ore carrier with icebreaking capability.

Proposed Icebreaking Ore Carrier Characteristics				
Length overall	329 m			
Beam	52 m			
Depth	27 m			
Draft	20 m			
Displacement	248,000 t			
Ore Cargo	±190,000 t			
Propulsion system	2 x controllable pitch nozzled propellers, 4 blades, 8.3 m diameter.			
Propeller / vessel speed	60 rpm / 14 kn (open water) 60 to 78 rpm / 3 to > 7 kn (ice cover)			
Depth of the propeller	13.5 m below water line			

While in transit, ships emit underwater noise from their various components, including onboard machinery and propellers underwater. Noise spectra from large ships are generally dominated by propeller cavitation noise. Vessels transiting through ice also create noise from the ice breaking process. Ross (1976) has shown that the intensity of propeller cavitation noise depends on the total number of blades, the propeller diameter, and the propeller tip speed. Based on multiple recordings of large merchant ships, he developed an equation to estimate the overall (broadband and omnidirectional) noise level of ships over 100 m in length, operating in calm open waters:

$$L = 175 + 60\log(u/25) + 10\log(B/4),\tag{1}$$

where L is the reference level, u is the propeller tip speed (m/s), and B is the number of propeller blades. This equation gives the total energy produced by the propeller cavitation at frequencies between 100 Hz and 10 kHz. This equation is valid for propeller tip speed between 15 and 50 m/s (Ross, 1976).

Based on Ross' equation and the examination of recorded spectra, Scrimger and Heitmeyer (1991) and Hamson (1997) developed the following equation to provide an estimate source level spectrum for very large merchant ships:

$$SL = SV(f) + 60\log(V/12) + 20\log(Le/300),$$
 (2)

where V is the vessel speed in knots, Le is the vessel length in feet, and SV(f) is the reference level for merchant ship noise spectrum based on 50 recorded spectra. The reference spectrum was provided in Hamson (1997).

The source levels referred to as "Hamson, 1997" in Figure 8 were obtained as follows. First, the reference spectrum from Hamson (1997) was adjusted to provide the broadband level as calculated with Equation (1) using specified propeller diameter and propeller tip speed. The spectrum was further adjusted for the vessel speed and vessel length using Equation (2).

Another approach for modelling the source levels from large ships transiting in ice-covered waters was proposed by Leggat et al. (1981), which is based on Brown's (1977) formula for prediction of the propeller noise spectrum for a heavily loaded merchant ship:

$$SL_B = 163 + 40\log(D) + 30\log(N) + 10\log(B) - 20\log(f) + 10\log(A_c/A_D),$$
 (3)

where D is the propeller diameter (meters), N is the propeller revolution rate per second, B is the number of blades, A_c is the area of the blades covered by cavitation, and A_D is the total propeller disc area. Brown's formula applies to frequencies between 100 Hz and 10 kHz, and the density spectrum may be assumed constant at frequencies below 100 Hz. Leggat et al. (1981) tested the validity of this method and showed that Equation (3) should be used with a values of $A_c/A_D=1.0$. The source levels representing the Ore Carrier transiting in thin- and thick-ice conditions were estimated using Brown's formula with propeller revolution rates of 69 and 78 rpm, respectively.

Measured spectra from large ships presented in several publications were also digitized and translated into third-octave band levels. Table 5 and Figure 7 present a comparison between characteristics and third-octave band source levels from the discussed source levels. Figure 7 also present the spectrum of ice breaking under the weight of the bow of a bulk carrier. This spectrum was derived from recordings on hydrophones positioned close to the bow of the ice-capable concentrate carrier *MV Umiak I* (mentioned in Table 5) transiting in land-fast ice conditions (Sikumiut, 2008).

Table 5: Ships characteristics.

Vessel	Length (m)	Displacement (metric tons)	Speed (knots)	Operation & Condition	source
CCGS Henry Larsen (icebreaker)	100	6,167	variable	ramming	Erbe and Farmer, 2000
Icebreaking bulk carrier MV Umiak I	178	31,992	3	transit in land-fast ice	Sikumiut, 2008
CCGS Louis S. St. Laurent (icebreaker)	120	11,345	14.5	transit in open water	Leggat, 1985
CCGS Louis S. St. Laurent (icebreaker)	120	11,345	10 to 0	deceleration in open water	Leggat, 1985
Container ship Hanjin Marseilles	289	62,623	21	transit in open water	Hildebrand, 2006
Cruise ship Norwegian Wind	230	50,760	19	transit in open water	Hildebrand, 2006
10 merchant vessel average	89 to 320	3,500 to 201,000	7.5 to 14.6	exiting harbor in open water	Hallet, 2004
Ore Carrier (modelled)	329	248,000	14	transit in open water	Hamson, 1997
Ore Carrier (modelled)	329	248,000	14	transit in open water	Brown, 1977
Ore Carrier (modelled)	329	248,000	14	transit in thin ice	Brown, 1977
Ore Carrier (modelled)	329	248,000	14	transit in thick ice	Brown, 1977

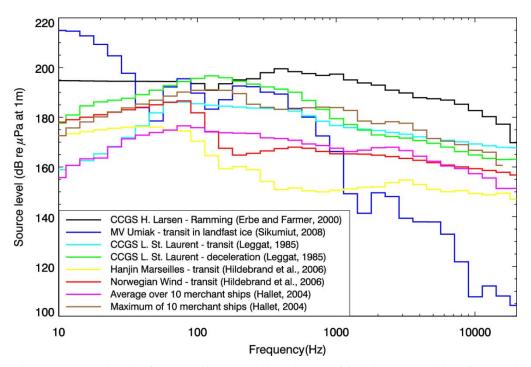


Figure 7: Source levels of large marine vessels based on empirical data. See Table 5 for vessel details.

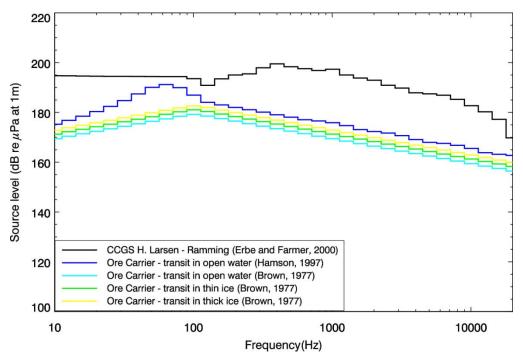


Figure 8: Source levels of large marine vessels calculated using empirical equations (except for CCGS H. Larsen provided for easier comparison between the two figures). See Table 5 for vessel details.

Figure 7 shows that the source levels of land-fast ice breaking at the bow of a large carrier are much lower than the source levels from propeller cavitation. Consequently, in estimating the source levels for the proposed Ore Carrier transiting in ice-covered water, only the sound from the ship propulsion system was considered.

Figure 7 also shows that Brown's formula, Equation (3), produce estimates of sound levels (pink, brown, and mustard line) comparable to those of the *Hanjin Marseilles* (yellow line) and the *Norwegian Wind* (red line), although this is a much larger, heavily-loaded vessel, transiting in open and ice-covered waters. It was therefore assumed that Brown's formula underestimates the expected source levels of the proposed icebreaker ore carrier and was not used in estimating the final ore carrier sound levels.

Table 5 and Figure 7 show that (smaller) vessels with icebreaking capability produce higher sound levels then much larger vessels. For example, the transiting container ship *Hanjin Marseilles* (yellow line) and the cruise ship *Norwegian Wind* (red line) produce lower source levels than the much smaller *CCGS Louis St. Laurent* (light blue line) at all frequencies, and the smaller icebreaker carrier *MV Umiak* (dark blue line) at frequencies below 1 kHz.

Hamson's equation, Equation (2), produces estimated source levels (fuchsia line) higher than Brown's equation. It is therefore believed that Hamson's equation produces a better estimate of source levels representing the Mary River ore carrier transiting in open water.

In studying reactions from marine mammals to ice-breaking ships, Finley et al. (1990) estimated that higher source levels are produced when ships operates in "backing-up" mode. He pointed out that the *MV Arctic*, a icebreaking carrier approximately half the size of the proposed ore carrier, produces broadband source levels 7 dB higher in backing-up than in ramming mode. Leggat (1985) reported on the recordings of the *CCGS Louis S. St. Laurent* while operating in various modes. Although the recordings were done in open water, the different modes were set

to represent icebreaking operations, *e.g.* high propeller revolution rate while making no headway, rapid acceleration, and rapid deceleration. This study agrees with Finley's (1990) statement by showing that the source levels from the *CCGS Louis S. St. Laurent* are higher in deceleration mode than for high propeller revolution rate while making no headway. There are no measurements for the source levels of the *CCGS Louis S. St. Laurent* in backing-up mode. However, the highest source levels at frequencies above 200 Hz were produced by the *CCGS Henry Larsen*, recorded by Erbe and Farmer (2000). It is believed that this is due to more extensive cavitation process, much more than during a normal transit, occurring due to higher rpm of the propellers and, at the same time, slower vessel forward movement.

2.2.1. Modelled Source Levels

The source levels from the Ore Carrier had to be estimated for operations in three different conditions: transiting in open water, thin ice, and thick ice condition. Figure 9 presents the final source levels for the Mary River Ore Carrier transiting under these three conditions.

The source levels for open water were modelled using combination of equations by Ross (1976) and Hamson (1997), Equations (1) and (2) respectively, for operating parameters as presented in Table 4 (open water conditions).

It is believed that thick-ice conditions will lead to using higher rpm on the propellers while the vessel velocity will be reduced by the ice resistance. To account for all the additional factors, the source levels of the Ore Carrier transiting in thick-ice conditions was assumed to be the maximum value of all presented levels, *i.e.* the maximum values of the measured levels from the *CCGS Louis S. St. Laurent* in deceleration mode, the *MV Umiak* transiting in land-fast ice, and the *CCGS Henry Larsen* in ramming mode.

Finally, the source level of the Ore Carrier transiting in thin-ice conditions was modelled as the mean between the thick-ice levels, and the calculated levels using Equations (1) and (2) for operating parameters as presented in Table 4 (iced conditions).

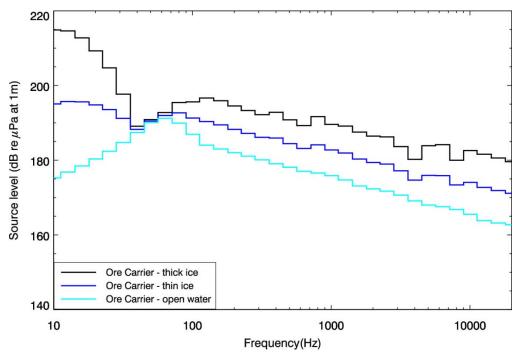


Figure 9: Assumed third-octave band source levels for the Mary River ore carrier transiting through open water, thin ice, and thick ice conditions.

3. Modelling Sound Propagation

3.1. Modelling Locations

Underwater sound resulting from construction and operations related to the Mary River Iron Mine was modelled at the Steensby Intel Port Facility and along the nominal shipping route. More specifically, the sound resulting from the drilling, blasting, and dredging operations was modelled at the expected ore loading dock construction site; the sound levels resulting from various tug operations were modelled approximately 450 m southwest of the drilling, blasting, and dredging location; shipping noise was modelled at 3 locations along the shipping route through Steensby Inlet, Foxe Basin and Hudson Strait (Table 6, Figure 10, and Figure 11).

Table 6: Modelling Locations.

Activities		Water Depth(m)		
Drilling, blasting, and dredging	Ore Loading Dock	70°16'47.18" N	78°33'01.92" W	20
Tug operations	In the vicinity of the Ore Loading Dock	70°16'54.93" N	78°32'24.17" W	65
Ore Carrier in transit	Southern Steensby Inlet	70°06'57.46" N	78°17'22.53" W	74
	Central Foxe Basin	66°51'17.01" N	79°20'00.00" W	70
	Hudson Strait	64°02'24.80" N	76°08'47.78" W	115

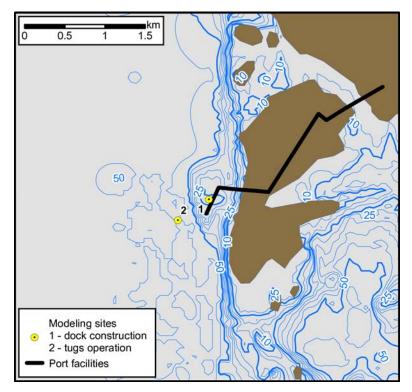


Figure 10: Modelling sites at the Steensby Port.

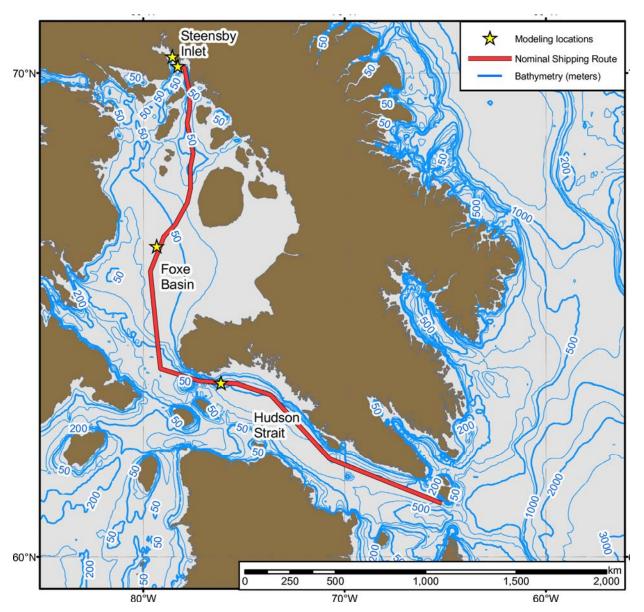


Figure 11: Overview of modelling locations along the shipping route.

Bathymetry data for the Foxe Basin and Hudson Strait areas were obtained from a data series referred to as SRTM 30+, version 6.0 (Becker et al., 2009). The resolution of this bathymetry grid is 30 geographical seconds or approximately 900 x 300 m at the study location. The bathymetric data in the vicinity of the Steensby Port combines the SRTM30+ version 6.0 data with higher resolution single-beam and multi-beam data provided by LGL Limited.

The area is characterized by shallow depths (approximately 50 m) from Steensby Inlet to central Foxe Basin; depth increases to 100 m in the central part of Foxe Basin and to 200 m at the entrance to Hudson Strait. The water depths in Hudson Strait vary 200 m in the west part to 500 m at the mouth of the strait.

The first site along the shipping route is located in the southern area of Steensby Inlet. This region of the route is characterized by relatively shallow waters and close proximity to the shoreline which allows the presence of land-fast ice in the winter and spring months. The second

site is located in central Foxe Basin where the bathymetry slowly increases from 50 m to 200 m in a northeast-southwest direction. The third site is located where the shipping route presents its closest point of approach to the shoreline, approximately 20 km southeast of Cape Dorset.

3.2. Environment Sea-Ice Cover

The study area is nearly completely covered by ice between the months of November and June and is ice-free in late summer and early fall (Saucier et al., 2004). Figure 12 (b) from Saucier et al. (2004) presents modelled ice thickness in the region at different time of year, which compares very well to observed sea-ice coverage from the 1996-97 seasons. These results, presented in Figure 12, were used to estimate the ice coverage at the modelling locations.

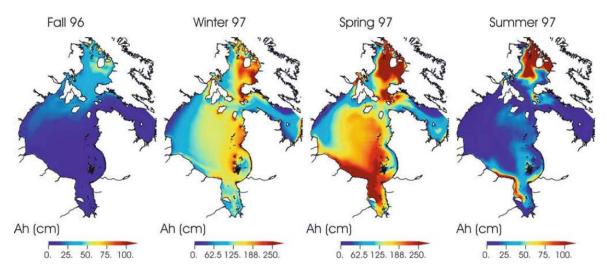


Figure 12: Modelled seasonal averaged sea-ice, 1996-1997 (Figure 12(b), Saucier et al., 2004).

For all modelling locations the maximum ice thickness is reached in early May, after which the amount of solar radiation rapidly increases in the regions and ice starts to melt. In August open water conditions develop throughout the area. In October-November ice start slowly forming on the sea surface reaching the highest growth rate in February.

At Steensby Port and in the northern section of Foxe Basin, land-fast ice grows on average up to 2 m thick and may reach a thickness of 2.5 m in the Inlet (Saucier et al., 2004; Knight Piésold Ltd., 2009). In central Foxe Basin, pack ice thickness can also reach 2 m, but this number decreases towards the southwest. The chosen modelling location in Hudson Strait, south of Cape Dorset, accumulates the thickest ice-coverage in the Strait, which can also reach 2 to 2.5 m in the spring.

3.2.1. Geoacoustics

Drillhole logs from the Steensby Inlet area were provided by LGL Limited. The logs suggest that the surficial sediment in the vicinity of Steensby Port is composed of silty sand, transitioning to mainly gravel and cobbles with increasing depth below the seafloor (bsf). This information is consistent with the data from Deck41 (NGDC, 2003), which suggests that the surficial sediments in Foxe Basin consist of stilt and sand. A top layer of silty sand is found throughout Foxe Basin, increasing in thickness with increasing range from Steensby Inlet. This layer changes to silty

clay to the south of Foxe Basin and in Hudson Strait (St-Onge and Lajeuness, 2007), where it covers a layer of glacial drift (MacLean et al., 1991).

At Steensby Port, the provided drillhole logs show that granite and granitic gneiss is found at less than 10 metres below seafloor (mbsf). Information about the geological characteristics of the deeper (Cretaceous to pre-Cambrian) layers found in Foxe Basin and Hudson Strait are described by Sanford and Grant (2000). Following the described stratification, P-wave velocity and attenuation for the surficial layers were estimate using Hamilton (1980), Ellis and Hughes (1989), and Buckingham (2005); P-wave velocity and attenuation for the deeper layers were estimated using Barton (2007) and Ellis and Hughes (1989); S-wave velocity and attenuation were estimated based on the sediment type and porosity values through the grain-shearing model (Buckingham, 2005). The estimated geo-acoustic parameters representing the four modelling locations are presented in Tables 7 to 10.

Table 7: Geoacoustic parameters – Steensby Port Area.

Layers	Depth [m bsf]	P-wave velocity [m/s]	Density [g/cm³]	P-attenuation [dB/λ]	S-wave velocity [m/s]	S-attenuation [dB/λ]
silty sand to gravel to cobles	0 – 5	1650 – 2000	1.8 – 2.1	0.85 – 1.00	150	1.5
granitic gneiss	5 – 330	3500 – 5000	2.4 - 2.6	0.35	-	-
pre-Cambrian basement	>330	5500	2.6	0.275	-	-

Table 8: Geoacoustic parameters – Southern Steensby Inlet.

Layers	Depth [m bsf]	P-wave velocity [m/s]	Density [g/cm ³]	P-attenuation [dB/λ]	S-wave velocity [m/s]	S-attenuation [dB/λ]
silty sand to gravel to cobles	0 – 5	1650 – 2000	1.8 – 2.1	0.85 – 1.0	200	1.6
granitic gneiss	5 – 330	3500 – 5000	2.4 – 2.6	0.35	-	-
pre-Cambrian basement	>330	5500	2.6	0.275	-	-

Table 9: Geoacoustic parameters – Central Foxe Basin.

Layers	Depth [m bsf]	P-wave velocity [m/s]	Density [g/cm ³]	P-attenuation [dB/λ]	S-wave velocity [m/s]	S-attenuation [dB/λ]
silty sand to gravel to cobles	0 – 20	1566 – 2000	1.8 – 2.1	0.2 – 1.0	200	1.6
Cambrio- Sillurian limestone to granitic gneiss	20 – 330	3200 – 5000	2.4 – 2.6	0.35	-	-
pre-Cambrian basement	>330	5500	2.6	0.275	-	-

Table 10: Geoacoustic parameters – Hudson Strait.

Layers	Depth [m bsf]	P-wave velocity [m/s]	Density [g/cm ³]	P-Attenuation [dB/λ]	S-wave velocity [m/s]	S-Attenuation [dB/λ]
silty clay	0 – 5	1566 – 1725	1.8 – 2.0	0.200 - 0.525	200	0.1
sand to gravel	5 – 30	1725	2.0 – 21	0.525 - 1.000	-	-
glacial drift	30 – 130	1725 – 2000	2.1 – 2.3	1.00 - 0.23	-	-
Evens formation (stanstonce – cretaceous)	130 – 360	2000 – 3200	2.3 – 2.4	0.23 - 0.35	-	-
Cambrio- Sillurian limestone to granitic gneiss	630 – 880	3200 – 5000	2.4 – 2.6	0.35	-	-
pre-Cambrian basement	>880	5500	2.6	0.275	-	

3.2.2. Sound Speed Profile

Sound speed profiles for the different modelling locations were obtained from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM) database (Teague et al. 1990). The latest release of the GDEM database (version 3.0, October 2003) (Naval Oceanographic Office, 2003) provides average monthly profiles of temperature and salinity for the World's oceans on a latitude/longitude grid with 0.25° resolution. Profiles in GDEM are provided at 78 fixed depth points up to a maximum depth of 6800 m. The profiles in GDEM are based on historical observations of global temperature and salinity from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS).

Temperature/salinity profiles were extracted from the GDEM database for the every month of the year and converted to speed of sound in seawater using the equations of Coppens (1981):

$$c(z,T,S) = 1449.05 + 45.7T - 5.21t^{2} - 0.23t^{3} + (1.333 - 0.126t + 0.009t^{2})(S - 35) + \Delta$$

$$\Delta = 16.3Z + 0.18Z^{2} ,$$

$$Z = (z/1000)(1 - 0.0026\cos(2\phi))$$

$$t = T/10$$
(4)

where z is depth in meters, T is temperature in degrees Celsius, S is salinity in psu, and ϕ is latitude (in radians). Resulting monthly sound speed profiles for the four modelling locations are presented in Figure 13.

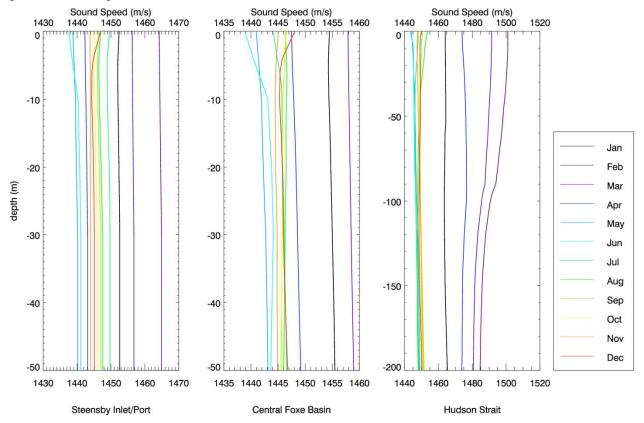


Figure 13: Monthly averaged sound speed profiles for the Steensby Inlet and Port area, the central Foxe Basin area, and Hudson Strait.

All profiles present nearly isothermal conditions, which are favorable for sound propagation. There is a large decrease in sound speed (between 18 and 60 m/s) between the months of February and May.

In accordance with the ice thickness study (Saucier et al., 2004), the sound speed profile for the month of August was used to model sound propagation during the time of year when open water prevails over the studied area, the month of February when thin ice covers the area, and the month of May when thick ice covers the area.

3.3. Sound Propagation Modelling

3.3.1. Vessel and construction noise

The acoustic propagation model used to model the acoustic sources at frequencies below 10 kHz is JASCO's Marine Operations Noise Model (MONM). MONM computes received Sound Exposure Levels (SEL) for impulsive sources if SEL source levels are input. For a continuous source, such as a vessel, dredge or drill rig, MONM outputs RMS levels.

MONM treats sound propagation in range-varying acoustic environments through a wide-angled parabolic equation (PE) solution to the acoustic wave equation. The parabolic equation code used by MONM is based on a version of the Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for an elastic seabed. The Parabolic Equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins, 1993).

MONM computes acoustic fields in three dimensions by modelling transmission loss along evenly spaced 2-D radial traverses covering a 360° swath from the source, an approach commonly referred to as N×2-D. The model fully accounts for depth and/or range dependence of several environmental parameters including bathymetry and sound speed profiles in the water column and the sub-bottom. It also accounts for the additional reflection loss at the seabed that is due to partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces. It includes wave attenuations in all layers. The acoustic environment is sampled at a fixed range step along radial traverses.

MONM treats frequency dependence by computing acoustic transmission loss at the center frequencies of 1/3-octave bands between 10 Hz and 10 kHz. This frequency range includes the important bandwidth of noise emissions for the operating vessel or construction activity. 1/3-octave band received levels are computed by subtracting band transmission loss values from the corresponding directional source levels. Broadband received levels are then computed by summing the received band levels. MONM's sound level predictions have been extensively validated against experimental data (Hannay & Racca, 2005).

The modelling of the sources at frequencies from 10 kHz to 20 kHz was done using the BELLHOP acoustic raytrace model (Porter and Liu, 1994). BELLHOP also computes received Sound Exposure Levels (SEL).

BELLHOP models transmission loss in the ocean using the Gaussian beam tracing technique. In addition to other types of attenuation, BELLHOP accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water (Fisher and Simmons, 1977). This type of attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeable effect on the modelling results at longer distances from the source.

Similar to MONM, BELLHOP computes sound propagation along a single 2-D radial profile in range and depth. In order to obtain the 3-D spatial distribution of the sound field around the source, a series of 2-D profiles is projected from the source covering a 360° swath in azimuth.

The acoustic models take into account the variability of the sound levels emitted in different directions from the source. This variability is referred to as source directivity. Source directivity is specified to the model as a function of both azimuthal and depression angle where azimuthal angle is the sideways direction relative to north, and depression angle is the vertical angle

relative to horizontal. The BELLHOP modelling code estimates sound pressure levels at various horizontal distances from the source as well as at different depths.

3.3.2. Blasting

The current DFO guidelines suggest that an fish exposes to instantaneous pressure change of 100 kPa is expected to lead to 50% fish mortality (Wright and Hopky, 1998). A Pentolite equivalent charge weight of 10 kg was used for source modelling, with a burial depth of 1.5 m (assuming rock as the substrate).

Detonation of a buried explosive generates an in-ground pressure shock wave, which propagates through the substrate and into the water column. The blast effects model ConWep (Hyde, 1992) was used to predict the shape of the in-ground shock wave pressure at distance from the detonation site. ConWep produces a pressure-time history function at some distance from the source for a given explosive type and weight, source-receiver geometry, and substrate.

Because the physics of explosive detonation are complex in the immediate vicinity of the blast, a blast effects model such as ConWep cannot be used to directly yield sound levels at or very near the source. Instead, ConWep was run for a range well outside the non-linear region near the detonation, and the equivalent third-octave band source levels (similar to those presented in the preceding sections) were back-propagated using a sound propagation model. The specific steps were:

- ConWep was run using the explosive setup and geometry described above, for a horizontal range of 37.1 m. This was the setback distance for which ConWep produced a peak waterborne overpressure of 100 kPa for a 10 kg charge weight.
- Third-octave band SPLs at a range of 1 m were computed by back-propagating the peak pressure from 37.1 m to 1 m under a cylindrical spreading assumption and equally dividing the resultant equivalent broadband source level into 24 third-octave bands (i.e., BL = SL 20·log(24), in dB) assuming that an impulse (pressure delta function) equally excites all frequencies.
- The sound propagation model MONM (discussed in Section 3.3.1) was used to compute the transmission loss in each third-octave band, to a maximum range of up to 200 km for receivers in the water column. The blasting equivalent acoustic source depth was set to 1 m above the sea floor for an equivalent in-water acoustic source.

The equivalent source levels: 218 and 208 dB re 1 μ Pa at 1 m respectively for sources in the substrate and in the water column, are not the actual levels that would be measured at the detonation site; rather, they represent "equivalent" source levels, which when forward-propagated in a realistic acoustic environment (as outlined in Section 3.3.1) yield the same received levels at a horizontal range of 37.1 m as is predicted using ConWep.

3.4. Attenuation of Sound

As sound waves propagate they interact at a molecular level with the constituents of sea water through a range of mechanisms, resulting in absorption of some of the sound energy (Thorp, 1965; Fisher and Simmons, 1977; Francois and Garrison, 1982a,b; Medwin, 2005). This occurs even in completely particulate-free waters and is in addition to energy losses from scattering by objects such as zooplankton or suspended sediments. The absorption of sound energy by absorption is quantified by the attenuation coefficient in units of decibels per kilometer (dB/km).

This absorption coefficient is computed from empirical equations and increases generally with the square of frequency.

The present study used the equation developed by Fisher and Simmons (1977) for the propagation of sound in open water:

$$a = 8.686 \left[\frac{A_1 f_1 f^2}{f_1^2 + f^2} + \frac{A_2 P_2 f_2 f^2}{f_2^2 + f^2} + A_3 P_3 f^2 \right],$$
where
$$A_1 = 1.03 \times 10^{-8} + 2.36 \times 10^{-10} T - 5.22 \times 10^{-12} T^2,$$

$$f_1 = 1.32 \times 10^3 (T + 273.1) \exp[-1700/(T + 273.1)],$$

$$A_2 = 5.62 \times 10^{-8} + 7.52 \times 10^{-10} T,$$

$$f_2 = 1.55 \times 10^7 (T + 273.1) \exp[-3052/(T + 273.1)],$$

$$P_2 = 1 - 10.3 \times 10^{-4} P + 3.7 \times 10^{-7} P^2,$$

$$A_3 = (55.9 - 2.37T + 4.77 \times 10^{-2} T^2 - 3.48 \times 10^{-4} T^3) \times 10^{-15},$$
and
$$P_3 = 1 - 3.84 \times 10^{-4} P + 7.57 \times 10^{-8} P^2.$$

where, f is the frequency in Hz, T is the temperature in degrees centigrade, and P is the pressure in atmospheres.

Thiele et al. (1990) later developed a general equation for the attenuation coefficient which applies to propagation of sound in ice-covered water.

$$a = \frac{0.235 f^3}{0.0023 + f^3} + \frac{0.11 f^2}{1.0 + f^2} + \frac{43.7 f^2}{4,100 + f^2} \quad , \tag{6}$$

where, a is the attenuation coefficient, f is the frequency in kHz. This equation was used in the present study to calculate loss from scattering and absorption of sound propagation under a thin or a thick ice cover. Figure 14 compares the attenuation coefficient values in open water and ice conditions using equations (5) and (6). In this example water temperature was set to 1° C and the results represent the coefficient value at 15 m depth.

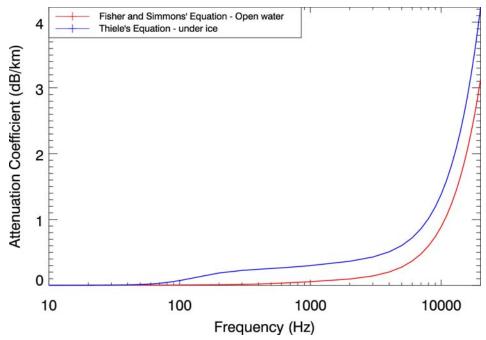


Figure 14: Comparison between attenuation coefficients for propagation in water with no ice cover (Fisher and Simmons, 1977) and with ice cover (Thiele, 1990). This example was produced for a water temperature of 1°C and a water depth of 15 m.

3.5. M-weighting

The potential for seismic survey noise to affect marine species depends on how well the species can hear the sounds produced (Martin et al., 2010). Noises are less likely to disturb animals if they are at frequencies that the animal cannot hear well. An exception is when the sound pressure is so high that it can cause physical injury. For non-injurious sound levels, frequency weighting curves based on audiograms may be applied to weight the importance of sound levels at particular frequencies in a manner reflective of the receiver's sensitivity to those frequencies (Nedwell and Turnpenny, 1998).

A NMFS-sponsored Noise Criteria Committee has proposed standard frequency weighting curves — referred to as M-weighting filters — for use with marine mammal species (Gentry et al., 2004). M-weighting filters are band-pass filter networks that are designed to reduce the importance of inaudible or less-audible frequencies for four broad classes of marine mammals:

- 1. Low-frequency cetaceans,
- 2. Mid-frequency cetaceans,
- 3. High-frequency cetaceans, and
- 4. Pinnipeds.

The amount of discount applied by M-weighting filters for less-audible frequencies is not as great as would be indicated by the corresponding audiograms for these groups of species. The rationale for applying a smaller discount than would be suggested by the audiogram is in part due to an observed characteristic of mammalian hearing that perceived equal loudness curves increasingly have less rapid roll-off outside the most sensitive hearing frequency range as sound levels increase. This is the reason that C-weighting curves for humans, used for assessing very loud sounds such as blasts, are flatter than A-weighting curves used for quiet to mid-level

sounds. Additionally, out-of-band frequencies, though less audible, can still cause physical injury if pressure levels are very high. The M-weighting filters therefore are primarily intended to be applied at high sound levels where effects such as temporary or permanent hearing threshold shifts may occur. The use of M-weighting should be considered precautionary (in the sense of overestimating the potential for an effect) when applied to lower level effects such as onset of behavioral response. Figure 15 shows the decibel frequency weighting of the four standard underwater M-weighting filters.

These filters have unity gain (0 dB) through the pass band and their high and low frequency roll off is approximately –12 dB per octave. The amplitude response of the M-weighting filters is defined in the frequency domain by the following function:

$$G(f) = -20\log_{10}\left[\left(1 + \frac{f_{lo}^{2}}{f^{2}}\right)\left(1 + \frac{f^{2}}{f_{hi}^{2}}\right)\right] , \qquad (7)$$

The roll off and pass band of these filters are controlled by the two parameters f_{lo} and f_{hi} ; the parameter values that are used for the four different standard M-weighing curves are given in Table 11.

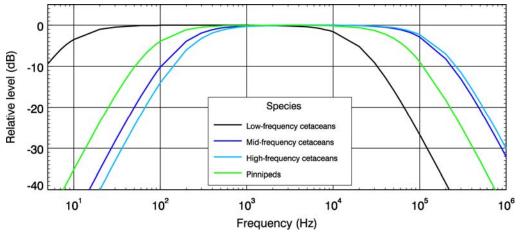


Figure 15: Plot of standard M-weighting curves for low-frequency, mid-frequency, and high-frequency cetaceans and for pinnipeds in water.

Table 11: Low frequency and high frequency cutoff parameters for standard marine mammal M-weighting curves.

M-weighting filter	f _{lo} (Hz)	f _{hi} (Hz)		
Low frequency cetaceans	7	22 000		
Mid-frequency cetaceans	150	160 000		
High-frequency cetaceans	200	180 000		
Pinnipeds underwater	75	75 000		

4. Results

Sound propagation modelling was performed using two geographic coverage methods: (a) areal coverage over a 200 km x 200 km zone centered on each modelling location, using a 5 m

modelling step size in horizontal range, for frequencies between 10 Hz and 2 kHz, and (b) along three individual profiles in the direction of the maximum sound field extension (as determined with the results from the areal modelling) up to the distance where the broad band levels drop below 100 dB re μ Pa for frequencies between 10 Hz and 20 kHz. The regime (a) provides high resolution area map of the sound field around each source, while regime (b) provides a full-band, high resolution assessment of the sound field in the directions of maximum sound propagation. The extent of the frequency range used in regime (b) would make the modelling at all azimuths around the source too computationally intensive for approach (a).

Processing of the output data from the modelling code involved gridding of the data points in horizontal planes corresponding to multiple receiver depths. The resulting stack of grids was collapsed to a single grid using a maximum-over-depth rule; that is, the sound level at each geographic location was taken to be the maximum value that occurred over all modelled depths for that location.

Four M-weighting filters (Table 11) were applied to the modelled sound fields by weighting the modelled sound levels according to Equation (7). M-weighting is applied to each third-octave band separately. After the filter is applied the individual values in each band are summed to compute the broadband sound levels.

The presented maps of ensonification levels were calculated using the results from the geographic approach (a). Consequently, these maps represent the maximum-over-depth levels in the 10 to 2000 Hz band.

The calculations of maximum distances to specific broadband sound levels were performed based on the grids of the broadband $(10-2000~{\rm Hz})$ levels from areal modelling results complemented with modelling along three profiles if the threshold level extended beyond the modelling area. Since the source levels for frequencies higher than 2000 Hz are significantly lower than the ones for lower frequencies, the usage of reduced band (only up to 2000 Hz, rather than 20,000 Hz) for calculation of the broadband levels did not affect the results.

For each level, two distances are reported: (1) R_{max} – the maximum distance at which the specific sound level was registered in the modelled field; (2) $R_{95\%}$ – the maximum distance to a grid point at which the specific sound level was registered after exclusion of 5% furthest points.

The calculations of maximum-over-depth sound levels in each third-octave band at specific distances were performed using the results of the modelling along three extended profile exclusively for the full frequency range (from 10 Hz to 20,000 Hz). These threshold levels are reported in Appendix B (separate document).

4.1. Drilling

Drilling sound levels were modelled at 20 depths between 1 m and 150 m below the surface. The modelling was performed using a source depth of 2 m below the surface, representing coring drilling, and a source depth of 19 m, representing drilling using hammering action as discussed in Section 2.1.1. The associated source levels are presented in Figure 1.

The maximum distances to specific sound levels produced by the coring drilling and hammer-drilling operations are presented in Table 12. The resultant sound field maps are presented in Figures A-1 and A-2. The black lines in these figures originating at the source location indicate the direction of the modelling profiles (modelling of frequencies between 10 and 20,000 Hz

using geographic method (b)). Tables B-1 and B-2 present the R_{max} and R_{95%} distances calculated with and without M-weighting filters applied for each sources.

Table 12: Threshold distances from drilling operations at the Ore Loading Dock, calculated from broadband (10 - 2000 Hz) sound fields.

	Drilling operation Maximum distance (m)					
RMS SPL (dB re 1 µPa)	Coring drilling	Hammer- drilling				
170		< 10				
160		20				
150		130				
140		800				
130	< 10	3,800				
120	20	18,000				
110	170	28,500				
100	1,125	74,500				

4.2. Blasting

Sound levels from blasting were modelled at 20 receiver depths between 1 m to 150 m below the surface. This modelling was performed using a source location at 1 m above the bottom (or 19 m below the sea surface).

Radii are shown in Table 13 for blasting in the area of the Ore Loading Dock of the Mary River port upgrading project; the corresponding sound field is mapped in Figure A-3 and Figure A-4. As expected given the source levels presented in Section 2.1.2, the radii for this activity are greater than those for the other port construction operations analyzed in this report. There is significant sound transmission through the sea bottom as well as through the water.

As discussed in Section 2.1.2, the scenario described below is illustrative of a single charge of 10 kg and an offset distance of 37.1 m results from the DFO 100 kPa overpressure guideline (Wright and Hopky, 1998). In practice, various approaches may be used to reduce the effect for a given overall explosive charge, including sub-dividing a large charge into a series of smaller, time-delayed charges or using additional mitigation measures such as bubble curtains (Wright and Hopky, 1998).

The accuracy of the prediction for the actual sound field produced by the proposed blasting operation is not high because the assumptions regarding charge weights and blast design are not yet determined (and therefore not available). Generic specifications were selected as the input for the model based on our previous experience at modelling and measuring an underwater blasting operation. The results provided here can be adjusted later to account for differences between the assumed parameter values and finalized blasting specifications once those are available. The assumptions used here are provided in Section 2.1.2. A bubble curtain attenuation factor of 15.4 dB was applied. If the actual bubble curtain effectiveness differs from this value then that difference should be taken into account.

Table 13: Threshold distances from blasting operations at the Ore Loading Dock, calculated from broadband (10 – 2000 Hz) sound fields.

RMS	Blasting operation					
SPL (dB	no	with				
re 1 μPa)	curtain	curtain				
200	25					
190	170	< 10				
180	885	45				
170	3,650	460				
160	14,000	1,680				
150	26,000	7,300				
140	60,000	20,700				
130	80,500	43,900				
120	85,600	75,000				
110	86,000	80,500				
100	86,250	85,600				

4.3. Dredging

Sound levels from dredging were modelled at 20 receiver depths between 1 m to 150 m below the surface. This modelling was performed using a source depth of 3 m below the surface, representing the dumping of material into an empty barge, and for a source depth of 19 m, representing cutter-suction dredging with thrusters.

The maximum distances to specific sound levels produced by dredging operations are presented in Table 14. The resulting ensonification field maps are presented in Figures A-5 and A-6. Again the black lines in these figures indicate the direction of the geographic method (b) extended frequency band modelling profiles. Tables A-5 and A-6 present the R_{max} and $R_{95\%}$ distances calculated with and without M-weighting filters applied for each source.

Table 14: Threshold distances from dredging operations at the Ore Loading Dock, calculated from broadband (10 – 2000 Hz) sound fields.

RMS SPL (dB	Maximum	Dredging operation Maximum distances (m)					
re 1 µPa)	Basket	Cutter					
180		< 10					
170	< 10	35					
160	15	260					
150	130	1,700					
140	900	5,800					
130	5,300	16,500					
120	16,500	29,000					
110	43,000	75,000					
100	80,500	80,500					

4.4. Port Operation - Tugs

The sound levels produced by tug operations were modelled at 20 depths between 1 m and 150 m below the sea surface. This modelling was performed using a source depth of 3 m below the surface, in the vicinity of the ore loading dock, during open water, thin-ice, and thick-ice conditions.

The maximum distances to specific sound levels produced by tug operations in different water conditions are presented in Table 15. The resulting ensonification field maps are presented in Figures A-7 to A-9. The black lines in these figures indicate the directions of the geographic method (b) extended bandwidth modelling profiles. Tables A-7 to A-9 present the R_{max} and $R_{95\%}$ distances calculated with and without M-weighting filters applied for each source.

Table 15: Threshold distances from tugs operating in the vicinity of the Ore Loading Dock, calculated from broadband (10 - 2000 Hz) sound fields.

	Tug operations maximum radius (meter)							
RMS SPL (dB re 1 µPa)	Open water	Thin ice cover	Thick ice cover					
200			< 10					
190		< 10	15					
180	< 10	15	35					
170	25	30	450					
160	100	250	1,750					
150	800	1,500	5,800					
140	3,600	5,100	17,000					
130	9,200	13,500	43,000					
120	20,000	25,000	75,500					
110	75,500	58,000	107,500					
100	109,000	81,000	109,000					

4.5. Shipping – Icebreaker Ore Carrier

Shipping and icebreaker sound levels were modelled at 20, 26, and 31 different depths, ranging from 1 m to 700 m below the surface, depending on the modelling location. The modelling was performed using a source depth of 9 m below the surface, representing the icebreaking ore carrier draft during transit through Steensby Inlet, Foxe Basin, and Hudson Strait, during open water, thin-ice, and thick-ice conditions.

The maximum distances to specific sound levels produced by the ore carrier transiting through the three modelling locations, in different water conditions are presented in Table 16. The resulting ensonification field maps are presented in Figures I-10 to I-18. The black lines in these figures indicate the directions of the extended bandwidth modelling profiles. Tables J-10 to J-18 present the R_{max} and $R_{95\%}$ distances calculated with and without M-weighting filters applied for each source.

Table 16: Threshold distances from Ore Carrier transiting at the 3 modelled locations, calculated from broadband $(10-2000~{\rm Hz})$ sound fields.

RMS SPL		Steensby Inle		maxim	Foxe Basin num radius (meter)	Hudson Strait maximum radius (meter)			
(dB re 1 μPa)	Open water	Thin ice cover	Thick ice cover	Open water	Thin ice cover	Thick ice cover	Open water	Thin ice cover	Thick ice cover	
200			< 10			< 10			< 10	
190		< 10	20		< 10	20		< 10	20	
180	< 10	15	60	< 10	15	85	< 10	15	70	
170	35	55	450	35	60	720	35	55	280	
160	290	450	3,500	270	450	3,500	125	350	2,100	
150	1,700	2,700	11,000	1,700	3,000	9,500	1,000	2,000	7,500	
140	7,000	10,500	27,500	6,200	7,000	20,500	6,000	8,300	23,000	
130	23,500	26,500	48,000	15,000	20,500	38,500	21,000	26,000	91,500	
120	70,000	51,500	70,500	40,000	47,500	85,500	97,000	132,000	153,000	
110	178,500	84,500	105,500	108,000	104,000	123,500	215,000	239,000	> 250,000	
100	> 250,000	108,500	142,500	> 250,000	150,000	208,000	240,000	> 250,000		

5. Discussion

There are several factors that define the difference in the ensonification field between the open water and ice seasons. First, the vessel source levels for the thin and thick ice conditions are much higher than for the open water season due to the additional power required to break ice. In case of the Ore Carrier the most notable increases (by up to 40 dB) occur for frequencies below 30 Hz. A second factor is the additional attenuation of acoustic energy due to ice cover. This attenuation is greatest for higher frequencies: 7.5 dB per 100 km at 100 Hz, 30 dB per 100 km at 1000 Hz. The attenuation due to ice cover has virtually no effect for frequencies below 30 Hz.

Tables 15 and 16 show that in Steensby Inlet, broadband threshold distances for sound pressure levels of 120 dB re 1 μ Pa and less can be greater during open water conditions (120 dB - 70 km; 110 dB - 178 km) than in thin- (120 dB - 51 km; 110 dB - 84 km) or thick-ice (120 dB - 70 km; 110 dB - 105 km) conditions.

Although the vessels have higher source levels while operating in ice versus open water conditions, additional attenuation for frequencies above 100 Hz due to presence of ice on the sea surface leads to marked reduction at long ranges (more than 50 km) of the received sound levels and threshold distances in thin and thick ice conditions relative to open water conditions. The shallow depth and hard bottom in Steensby Inlet do not support propagation of low frequencies. Higher levels of low frequency acoustic energy for thick-ice conditions do not contribute enough to affect the extent of the broadband threshold distances. On the other hand, the deeper depths in Hudson Strait allow long-range propagation of frequencies below 50 Hz which do influence the broadband threshold distances. These low frequencies are less affected than high frequencies by sound energy absorption in the water and attenuation due to ice cover. The increase of the acoustic energy in the lower frequencies for the thick-ice conditions leads to a large increase in the threshold distances for Hudson Strait modelling location. The increase can be as much as 17 times: 160 dB re $1 \mu\text{Pa}$ at 125 m open water; at 350 m thin ice; 2100 m thick ice. Such a dramatic increase in the threshold distance at this location can be attributed exclusively to the increase in the levels for the frequency bands below 30 Hz (Figure 9).

Propagation conditions in Hudson Strait for the month of February (thin ice) and May (thick ice) are slightly different due to variation in the sound speed profile. For February the profile is downward refracting and directs the acoustic energy into the bottom. In May the sound speed profile is slightly upward refracting, i.e. promotes better sound propagation by avoiding bottom reflections.

The effect of M-weighting on broadband threshold distances depends directly on the long-range propagating frequencies. Thus, the effect of M-weighting depends on the locations of the source and the water conditions.

Because of large attenuation levels at high frequencies, acoustic energy at frequencies above 5000 Hz has a limited contribution to the broadband threshold distances. Consequently, the high frequency cutoff parameters for M-weighting filters have little to no effect on the calculated broadband threshold distances.

Again, because of the water depth and the seabed geology, long-range propagating frequencies in Steensby Inlet and Foxe Basin are mainly found above 100 Hz. Thus, at this location, the low frequency cutoff parameters for M-weighting filters contribute to slightly reduce the broadband threshold distances. For example, in Steensby Inlet, the frequency bands propagating farthest from the ore carrier during transit in thin-ice conditions extends from 63 to 1000 Hz, while in

thick-ice condition the corresponding bands are from 400 to 1000 Hz, and from 600 to 1000 Hz in open water conditions. Consequently, the ore carrier broadband threshold distances for 110 dB re 1 μ Pa are reduced by up 24% in thin-ice conditions (Table A-11), 4% in thick-ice conditions (Table A-12) and 3% in open water (Table A-10).

In Hudson Strait, however, the M-weighting filters do cut off long-range propagating frequencies and result in a greater reduction of the broadband threshold distances. Consequently, the ore carrier broadband threshold distances for 110 dB re 1 μ Pa are reduced by up 66% in thin-ice conditions (Table A-17), 50% in thick-ice conditions (Table A-18) and 30% in open water (Table A-16).

The modelled sound field maps representing the operations in vicinity of the port indicate that some acoustic energy can be detected behind land masses. This energy is real and results from propagation through the ground and back to the water column on the far side of the land mass.

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Appendix A.

A.1. Unweighted Sound Fields – Drilling operations

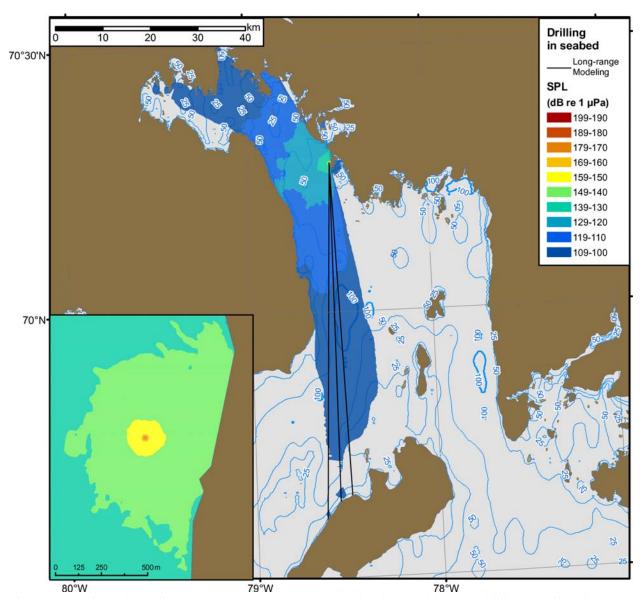


Figure A-1: Estimated broadband (10 - 2000 Hz) sound pressure levels around hammer-drilling operations in the seabed at the Ore Loading Dock, in open water conditions.

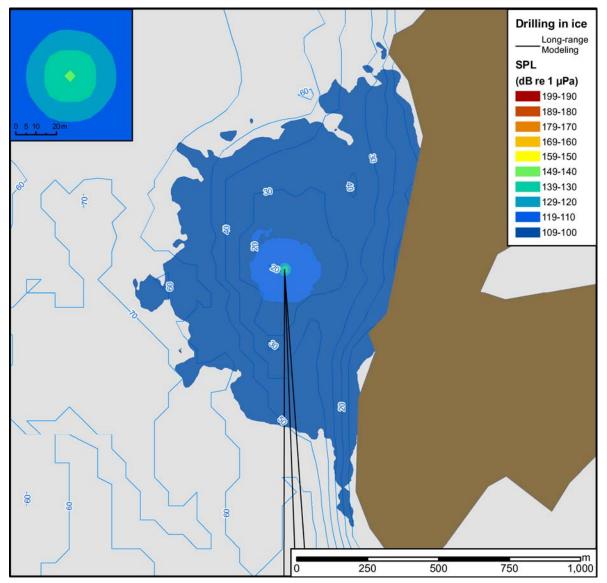


Figure A-2: Estimated broadband (10 - 2000 Hz) sound pressure levels around drilling operations in the surface ice at the Ore Loading Dock, in open water conditions.

A.2. Threshold Distances - Drilling operations

Table A-1: Comparison between predicted m-weighted and unweighted threshold distances from drilling operations in the seabed at the Ore Loading Dock, in open water conditions. Distances calculated from broadband $(10 - 2000 \, \text{Hz})$ sound field.

RMS										
SPL	No wei	ghting		Dinningdo						
(dB re 1	appl	lied	Low-free	quency	Mid-free	quency	High-fre	quency	Pinnipeds	
μPa)	R_{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}	R _{max}	R _{95%}
170	< 10	< 10	< 10	< 10					< 10	< 10
160	20	20	20	20	< 10	< 10	< 10	< 10	15	15
150	130	110	130	110	75	65	60	50	100	90
140	800	600	800	600	510	400	460	350	730	500
130	3,800	2,600	3,800	2,600	3,200	1,400	1,650	1,200	3,400	2,100
120	18,000	11,500	18,000	11,000	12,500	7,000	8,000	6,000	16,500	9,000
110	28,500	23,000	28,500	22,500	26,500	20,000	24,500	18,000	27,000	22,000
100	74,500	54,500	74,500	54,000	57,000	42,500	52,500	38,000	74,000	52,000

Table A-2: Comparison between predicted m-weighted and unweighted threshold distances from drilling operations in the surface ice at the Ore Loading Dock, in open water conditions. Distances calculated from broadband (10 - 2000 Hz) sound field.

RMS				Threshold distances (meters)							
SPL	No wei			Dinnir	Pinnipeds						
(dB re 1	appl	ied	Low-frequency		Mid-fre	quency	High-fre	quency	1 1111114	Jeus	
μPa)	R_{max}	R _{95%}	R_{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	
130	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	
120	20	20	20	20	15	15	15	15	20	15	
110	170	130	170	130	165	105	155	85	165	120	
100	1,125	625	1,125	625	910	565	885	520	1,125	625	

A.3. Unweighted Sound Fields – Blasting operations

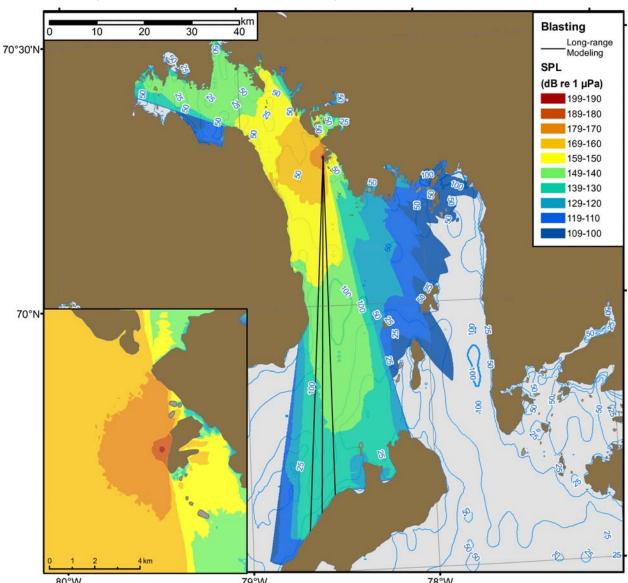


Figure A-3: Estimated broadband (10 - 2000 Hz) sound pressure levels around blasting operations in the seabed at the Ore Loading Dock, in open water conditions.

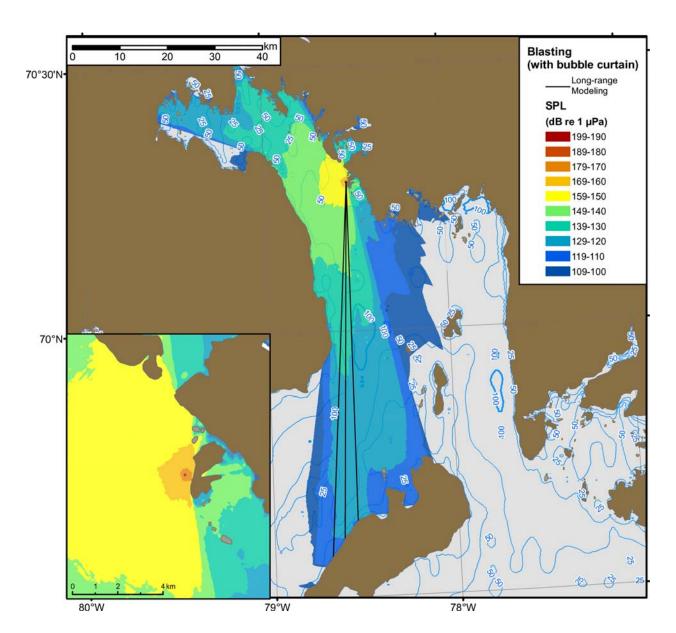


Figure A-4: Estimated broadband (10 - 2000 Hz) sound pressure levels around blasting operations in the seabed at the Ore Loading Dock, in open water conditions, using a bubble curtain.

A.4. Threshold Distances – Blasting operations

Table A-3: Comparison between predicted m-weighted and unweighted threshold distances from drilling operations in the seabed at the Ore Loading Dock, in open water conditions. Distances calculated from broadband $(10 - 2000 \, \text{Hz})$ sound field.

RMS				Thr	eshold dista	ances (mete	ers)			
SPL	No wei	ghting		Pinnipeds						
(dB re 1	арр	ied	Low-fre	quency	Mid-free	quency	High-fre	quency	i illiipeus	
μPa)	R _{max}	R _{95%}								
200	25	25	25	25	< 20	< 20	< 20	< 20	< 20	< 20
190	170	130	165	120	65	55	55	50	75	65
180	885	640	850	625	520	400	480	365	600	460
170	3,650	2,800	3,650	2,675	1,880	1,300	1,600	1,200	3,200	1,500
160	14,000	10,400	14,000	10,100	9,000	7,000	8,650	6,400	13,000	7,900
150	26,000	24,300	26,000	24,300	27,000	20,200	24,600	19,500	27,000	21,300
140	60,000	56,900	60,000	56,900	57,250	42,800	47,000	40,700	57,600	46,000
130	80,500	68,500	80,500	68,500	80,500	68,000	80,500	67,700	80,500	68,500
120	85,600	70,000	85,600	70,000	85,600	70,000	85,600	70,000	85,600	70,000
110	86,000	73,500	86,000	73,500	86,000	73,500	86,000	73,500	86,000	73,000
100	86,250	75,000	86,250	75,000	86,250	74,400	86,250	74,750	86,250	73,600

Table A-4: Comparison between predicted m-weighted and unweighted threshold distances from drilling operations in the seabed at the Ore Loading Dock, in open water conditions, using a bubble curtain. Distances calculated from broadband (10 - 2000 Hz) sound field.

RMS		Threshold distances (meters)								
SPL	No wei			Pinnipeds						
(dB re 1	арр	lied	Low-free	quency	Mid-free	quency	High-fre	quency	i iiiiipeus	
μPa)	R_{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}
190	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
180	45	45	45	45	25	25	25	25	30	30
170	460	340	450	300	200	150	200	130	220	170
160	1,680	1,225	1,600	1,180	1,100	700	950	650	1,300	800
150	7,300	6,000	7,200	5,900	5,500	3,000	5,500	2,700	5,800	4,000
140	20,700	16,300	24,000	16,000	19,600	12,100	19,600	11,800	19,600	13,500
130	43,900	30,800	42,800	30,700	37,600	27,200	37,000	24,500	42,700	29,200
120	75,000	63,000	75,000	63,000	74,900	60,500	74,900	59,000	74,900	62,500
110	80,500	69,000	80,500	69,200	80,500	69,600	80,500	69,500	80,500	69,600
100	85,600	70,700	85,600	69,700	85,600	70,700	85,600	70,700	85,600	70,600

A.5. Unweighted Sound Fields – Dredging operations

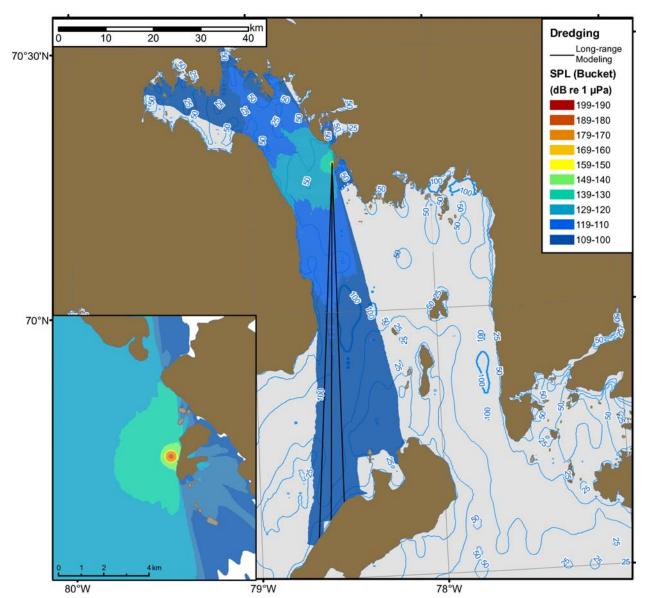


Figure A-5: Estimated broadband (10 - 2000 Hz) sound pressure levels around dredging operation (basket) at the Ore Loading Dock, in open water conditions.

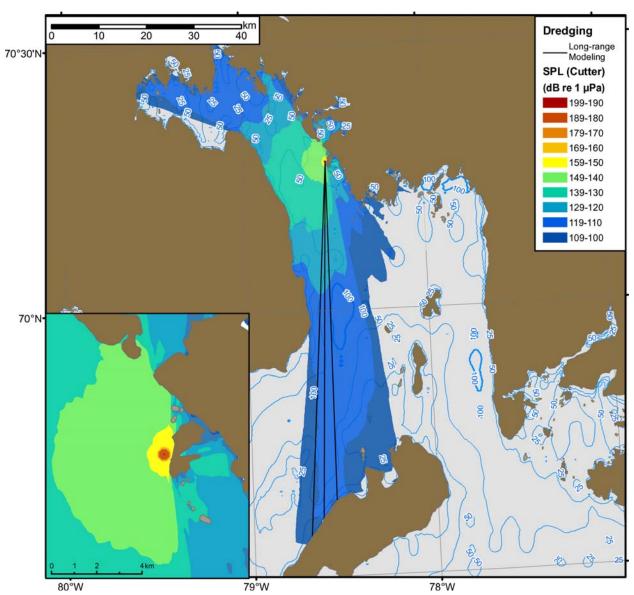


Figure A-6: Estimated broadband (10 - 2000 Hz) sound pressure levels around dredging operation (cutter) at the Ore Loading Dock, in open water conditions.

A.6. Threshold Distances – Dredging operations

Table A-5: Comparison predicted between m-weighted and unweighted threshold distances from dredging operations (basket) at the Ore Loading Dock, in open water conditions. Distances calculated from broadband $(10 - 2000 \, \text{Hz})$ sound field.

RMS				Threshold distances (meters)								
SPL	No wei	ghting		Dinningdo								
(dB re 1	app	lied	Low-free	quency	Mid-free	quency	High-fre	quency	Pinnipeds			
μPa)	R_{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}		
170	< 10	< 10	< 10	< 10	< 10	< 10			< 10	< 10		
160	15	15	15	15	10	10	< 10	< 10	10	10		
150	130	120	130	120	65	60	50	50	85	75		
140	900	600	900	600	500	350	400	250	750	450		
130	5,300	2,700	5,300	2,600	3,000	1,300	1,650	1,150	3,400	1,800		
120	16,500	12,000	16,000	12,000	14,500	8,000	13,500	3,500	15,000	12,000		
110	43,000	27,000	43,000	27,000	34,000	23,000	32,500	21,500	40,000	25,500		
100	80,500	74,500	80,500	74,500	80,500	74,000	80,500	74,000	80,500	74,500		

Table A-6: Comparison predicted between m-weighted and unweighted threshold distances from dredging operations (cutter) at the Ore Loading Dock, in open water conditions. Distances calculated from broadband (10 - 2000 Hz) sound field.

RMS				Threshold distances (meters)							
SPL	No wei	ghting		Cetaceans							
(dB re 1	app	lied	Low-free	quency	Mid-free	quency	High-fre	quency	Pinnipeds		
μPa)	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	
180	< 10	< 10	< 10	< 10							
170	35	35	30	30	< 10	< 10	< 10	< 10	< 10	< 10	
160	260	230	250	200	30	30	20	20	50	50	
150	1,700	1,100	1,400	950	200	150	130	100	450	350	
140	5,800	4,800	5,600	4,500	1,100	700	850	600	1,650	1,200	
130	16,500	13,000	16,500	13,000	5,600	3,500	3,500	2,400	12,500	6,000	
120	29,000	22,500	28,500	22,500	24,000	14,500	24,000	12,000	26,500	19,500	
110	75,000	62,000	75,000	62,000	75,000	45,000	74,500	36,000	75,000	60,000	
100	80,500	75,000	80,500	75,000	80,500	75,000	80,500	75,000	80,500	75,000	

A.7. Unweighted Sound Fields – Tug operations

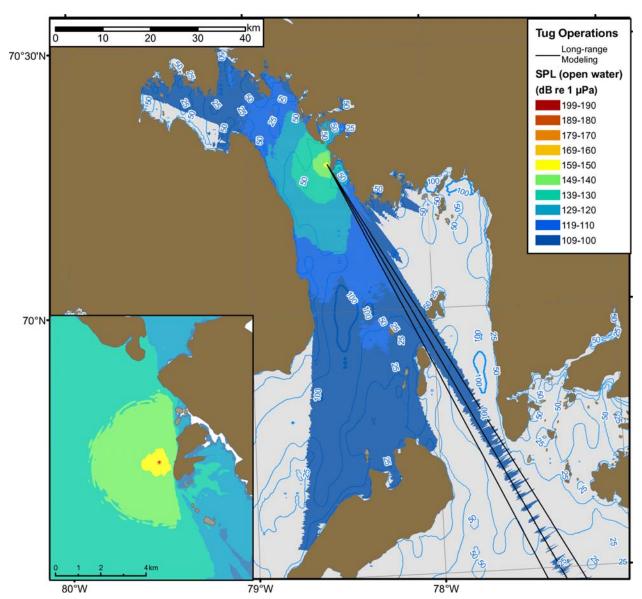


Figure A-7: Estimated broadband (10 - 2000 Hz) sound pressure levels around a tug operating in the vicinity of the Ore Loading Dock, in open water conditions.

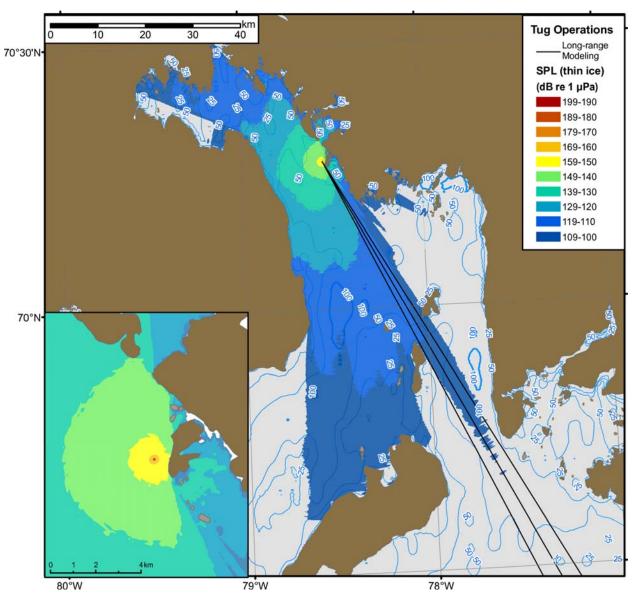


Figure A-8: Estimated broadband (10 - 2000 Hz) sound pressure levels around a tug operating in the vicinity of the Ore Loading Dock, in thin ice conditions.

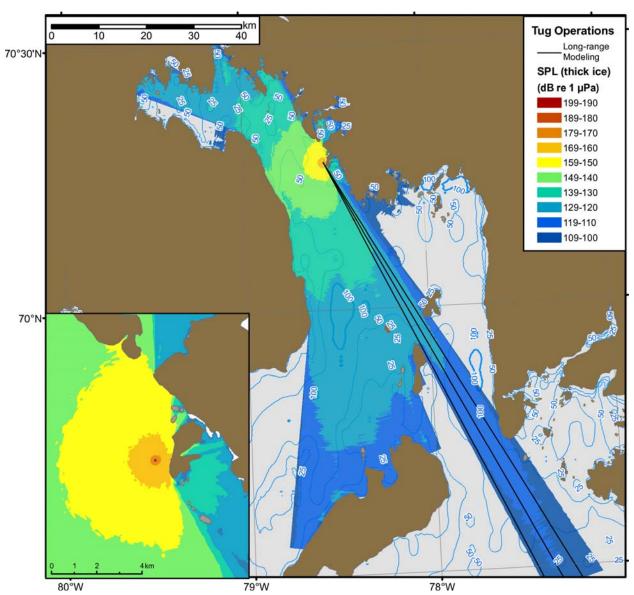


Figure A-9: Estimated broadband (10 - 2000 Hz) sound pressure levels around a tug operating in the vicinity of the Ore Loading Dock, in thick ice conditions.

A.8. Threshold Distances – Tug Operations

Table A-7: Comparison between predicted m-weighted and unweighted threshold distances from the tugs operating in the vicinity of the Ore Loading Dock, in open water conditions. Distances calculated from broadband $(10 - 2000 \, \text{Hz})$ sound field.

D140										
RMS SPL	PL No weighting dB applied			Pinnipeds						
(dB re 1			Low-frequency		Mid-frequency		High-frequency		i iiiiipeus	
μPa)	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}
180	< 10	< 10	< 10	< 10						
170	25	25	20	20	< 10	< 10	< 10	< 10	< 10	< 10
160	100	100	90	90	20	20	15	15	20	20
150	800	700	800	600	120	100	100	50	160	150
140	3,600	3,000	2,800	2,300	950	550	650	450	1,200	800
130	9,200	7,500	7,700	6,500	3,400	2,200	2,650	1,900	3,800	2,800
120	20,000	16,000	16,500	13,800	12,500	7,000	13,000	6,400	13,500	7,500
110	75,500	34,000	75,500	30,000	75,500	24,500	75,500	34,000	75,500	26,500
100	109,000	105,500	109,000	105,500	109,000	105,500	109,000	105,500	109,000	105,500

Table A-8: Comparison between predicted m-weighted and unweighted threshold distances from the tugs operating in the vicinity of the Ore Loading Dock, in thin ice conditions. Distances calculated from broadband (10 - 2000 Hz) sound field.

RMS SPL				Thre	eshold dista	inces (mete	ers)			
	No weighting applied		Cetaceans							Pinnipeds
(dB re 1			Low-frequency		Mid-frequency		High-frequency		i iiiiipcus	
μPa)	R_{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}
190	< 10	< 10	< 10	< 10						
180	15	15	15	15	< 10	< 10	< 10	< 10	< 10	< 10
170	30	30	30	30	20	20	20	20	25	25
160	250	200	250	200	150	125	120	80	170	150
150	1,500	1,100	1,300	1,000	1,100	650	950	550	1,200	800
140	5,100	4,000	4,600	3,600	3,500	2,500	3,500	2,200	3,900	2,800
130	13,500	9,400	13,500	8,500	12,500	7,000	12,500	7,000	13,000	7,500
120	25,000	20,500	25,000	20,000	24,000	19,000	24,500	18,500	25,000	20,000
110	58,000	43,000	58,000	43,000	50,500	42,000	50,500	41,000	51,000	43,000
100	81,000	65,000	81,000	65,000	81,000	65,000	81,000	65,000	81,000	65,000

Table A-9: Comparison between predicted m-weighted and unweighted threshold distances from the tugs operating in the vicinity of the Ore Loading Dock, in thick ice conditions. Distances calculated from broadband $(10 - 2000 \, \text{Hz})$ sound field.

RMS SPL (dB re 1											
	No weighting applied		Cetaceans							Diaminada	
			Low-frequency		Mid-frequency		High-frequency		Pinnipeds		
μPa)	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	
200	< 10	< 10	< 10	< 10							
190	15	15	15	15	< 10	< 10	< 10	< 10	< 10	< 10	
180	35	35	35	35	30	30	30	30	35	35	
170	450	250	450	250	370	180	360	170	425	225	
160	1,750	1,200	1,750	1,200	1,500	1,000	1,350	950	1,700	1,100	
150	5,800	4,500	5,800	4,500	5,500	3,800	5,500	3,700	5,700	4,200	
140	17,000	12,000	17,000	12,000	17,000	11,500	17,000	11,500	17,000	11,500	
130	43,000	26,000	43,000	26,000	38,000	24,500	38,000	24,000	40,000	25,500	
120	75,500	54,000	75,500	54,000	75,500	53,000	75,500	52,500	75,500	54,000	
110	107,500	97,000	107,500	97,000	107,500	95,000	107,500	90,500	107,500	97,000	

A.9. Unweighted Sound Fields - Ore Carrier Transiting

A.9.1. Steensby Inlet

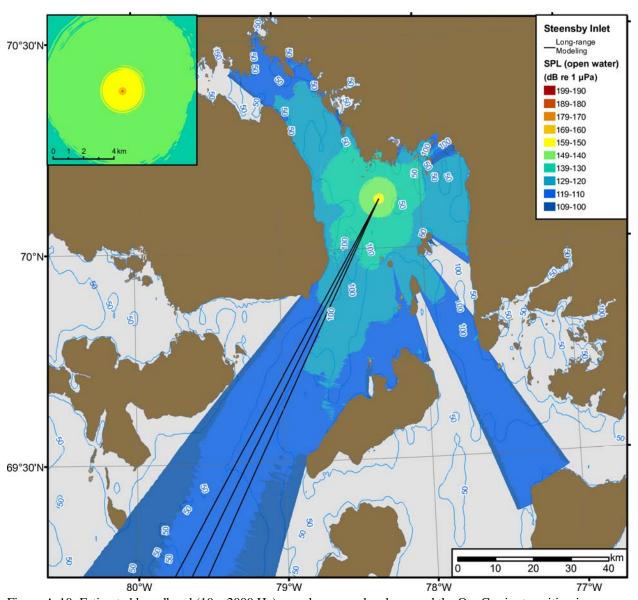


Figure A-10: Estimated broadband (10-2000~Hz) sound pressure levels around the Ore Carrier transiting in Steensby Inlet, in open water conditions.

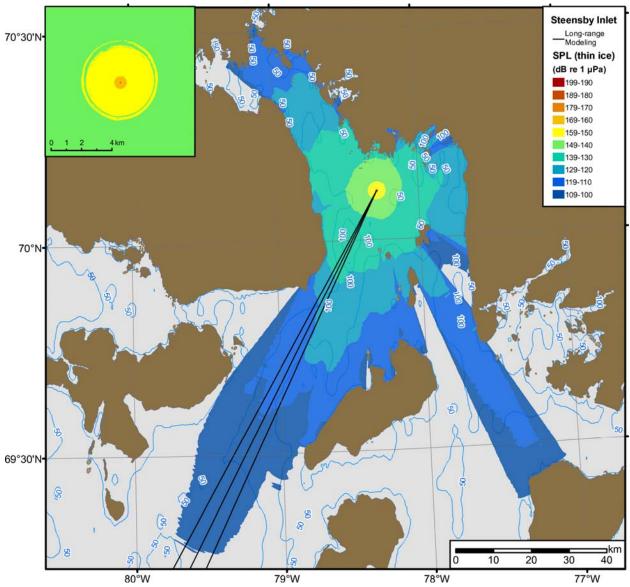


Figure A-11: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Steensby Inlet, in thin ice conditions.

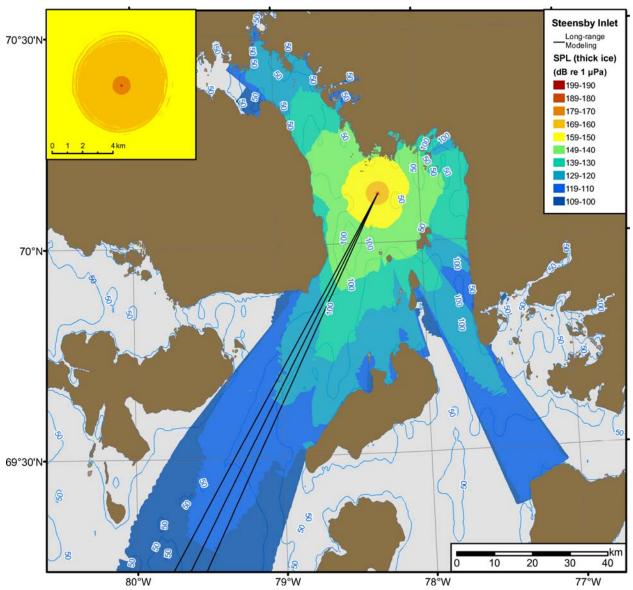


Figure A-12: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Steensby Inlet, in thick ice conditions.

A.9.2. Foxe Basin

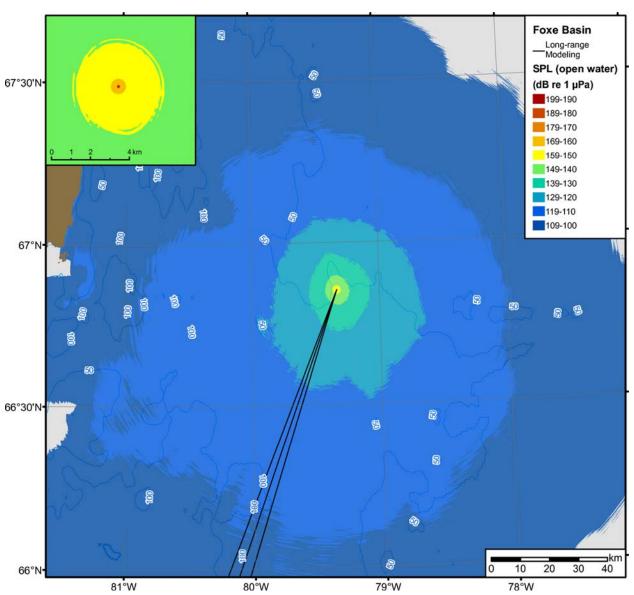


Figure A-13: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Foxe Basin, in open water conditions.

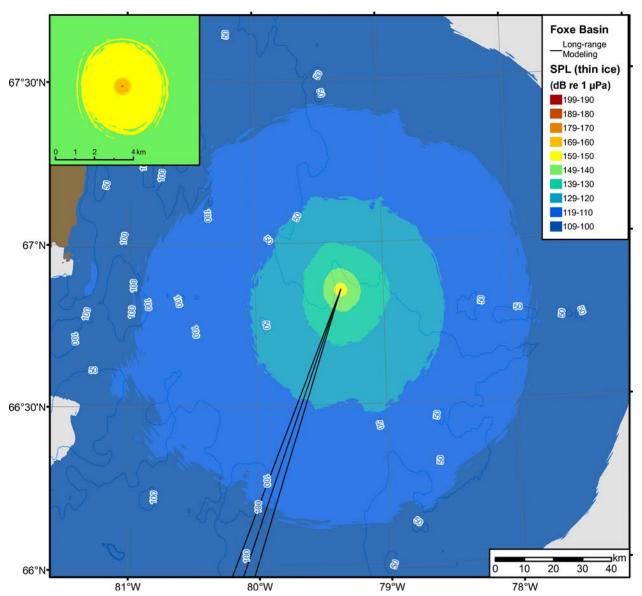


Figure A-14: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Foxe Basin, in thin ice conditions.

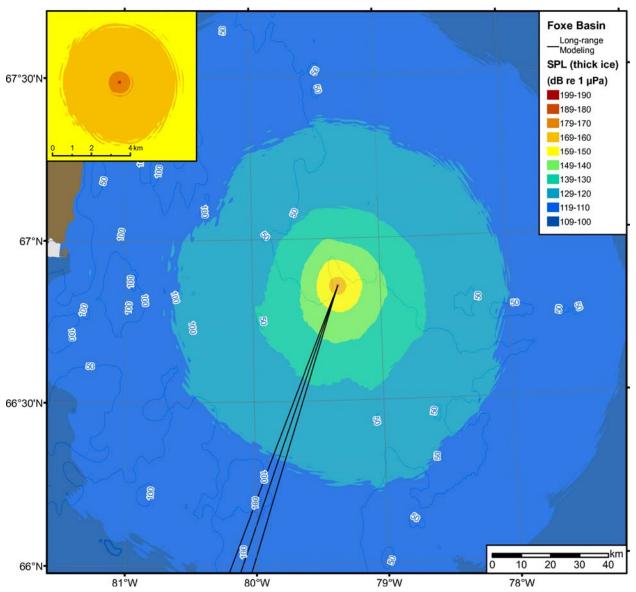


Figure A-15: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Foxe Basin, in thick ice conditions.

A.9.3. Hudson Strait

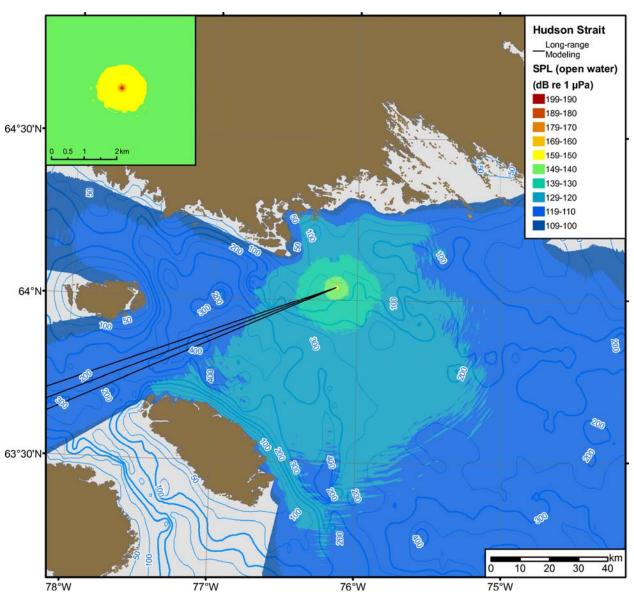


Figure A-16: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Hudson Strait, in open water conditions.

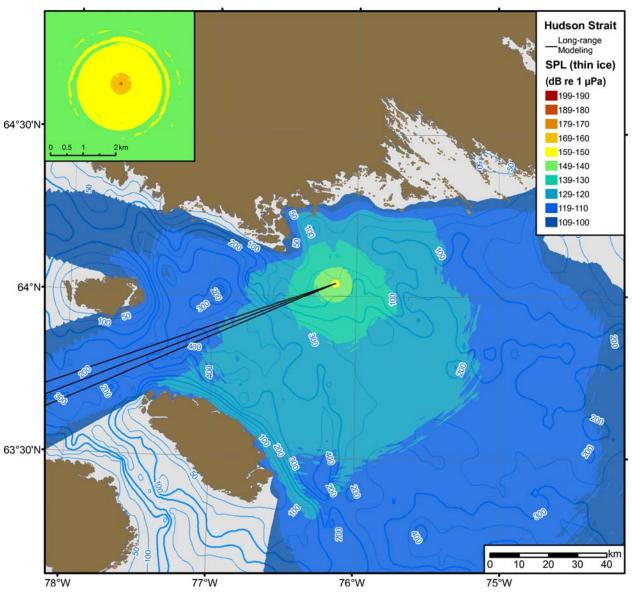


Figure A-17: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Hudson Strait, in thin ice conditions.

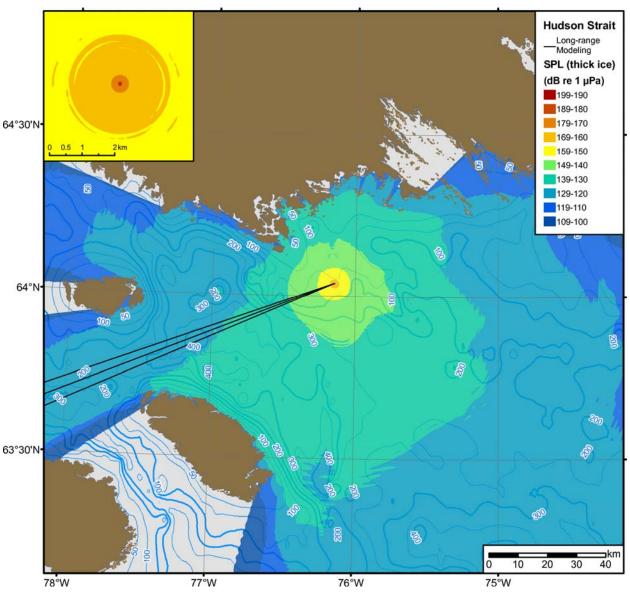


Figure A-18: Estimated broadband (10 - 2000 Hz) sound pressure levels around the Ore Carrier transiting in Hudson Strait, in thick ice conditions.

A.10. Threshold Distances – Shipping Operation

A.10.1. Steensby Inlet

Table A-10: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Steensby Inlet, in open water conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS										
SPL	No weighting applied			Pinnipeds						
(dB re 1			Low-frequency		Mid-frequency		High-frequency		i iiiiipeus	
μPa)	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}
180	< 10	< 10	< 10	< 10					< 10	< 10
170	35	35	35	35	< 10	< 10	< 10	< 10	15	15
160	290	280	290	280	40	40	30	30	60	60
150	1,700	1,550	1,700	1,550	225	200	200	200	500	500
140	7,000	5,000	7,000	5,000	1,700	1,350	1,200	950	3,350	2,800
130	23,500	16,000	23,500	16,000	13,500	7,500	11,000	6,000	18,500	10,500
120	70,000	41,000	70,000	41,000	62,000	29,500	55,000	29,000	69,000	36,500
110	178,500	139,000	178,500	139,000	173,500	137,000	172,000	136,000	178,500	138,500
100	> 250,000	244,000	> 250,000	244,000	> 250,000	244,000	> 250,000	244,000	> 250,000	244,000

Table A-11: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Steensby Inlet, in thin ice conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS SPL										
	No weighting applied			Dinninada						
(dB			Low-frequency		Mid-frequency		High-frequency		Pinnipeds	
re 1 µPa)	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}
190	< 10	< 10	< 10	< 10						
180	15	15	15	15	< 10	< 10	< 10	< 10	< 10	< 10
170	55	55	55	55	25	25	20	20	35	35
160	450	400	400	360	85	85	75	75	220	210
150	2,700	2,400	2,700	2,400	650	600	500	450	1,600	1,200
140	10,500	8,000	10,000	7,500	4,500	3,600	3,900	2,700	6,100	5,000
130	26,500	20,500	26,500	20,000	19,000	13,000	18,500	11,500	22,000	16,500
120	51,500	39,000	51,500	38,500	48,000	30,000	45,000	29,000	49,000	35,500
110	84,500	65,500	84,500	65,000	65,000	60,000	64,500	58,500	69,500	61,500
100	108,500	104,000	108,500	104,000	106,000	102,000	105,000	101,000	108,500	103,500

Table A-12: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Steensby Inlet, in thick ice conditions. Distances calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thre	eshold dista	ances (mete	ers)			
SPL	No wei	ghting			Cetac	eans			Pinni	nede
(dB re 1	appl	lied	Low-fre	quency	Mid-fred	quency	High-fre	quency	1 111111	Jeus
μPa)	R_{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R_{max}	R _{95%}
200	< 10	< 10	< 10	< 10						
190	20	20	20	20	< 10	< 10	< 10	< 10	< 10	< 10
180	60	60	60	60	15	15	15	15	20	20
170	450	400	450	400	55	55	50	50	80	80
160	3,500	3,000	3,000	2,500	330	300	280	260	550	500
150	11,000	9,000	10,000	8,000	2,700	2,000	2,000	1,600	4,000	3,300
140	27,500	21,000	26,000	19,500	13,500	9,000	13,500	8,200	16,000	11,500
130	48,000	35,000	48,000	34,000	45,000	26,000	32,000	24,500	45,000	28,500
120	70,500	54,500	70,500	54,500	70,500	51,500	70,500	50,500	70,500	53,000
110	105,500	103,000	105,500	102,000	103,000	98,000	102,500	95,500	105,000	101,000
100	142,500	136,000	142,500	136,000	140,000	135,500	139,500	135,000	140,000	136,000

A.10.2. Foxe Basin

Table A-13: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Foxe Basin, in open water conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thre	shold dista	nces (mete	ers)			
SPL	No weig	ghting			Cetace	eans			Pinnip	ade
(dB re 1	appli	ed	Low-fred	luency	Mid-free	quency	High-fre	quency	1 111111	eus
μPa)	R _{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R _{max}	R _{95%}
180	< 10	< 10	< 10	< 10					< 10	< 10
170	35	35	35	35	< 10	< 10	< 10	< 10	20	20
160	270	260	270	260	40	40	30	30	65	65
150	1,700	1,500	1,700	1,500	250	225	200	200	580	480
140	6,200	4,800	6,200	4,700	2,000	1,600	1,350	1,050	3,400	2,700
130	15,000	12,500	15,000	12,000	8,000	6,500	7,000	5,500	11,500	9,000
120	40,000	34,500	40,000	34,500	27,500	24,000	26,500	21,000	34,000	28,500
110	108,000	100,000	108,000	99,500	93,000	69,000	70,000	67,000	99,000	90,000
100	> 250,000	230,000	> 250,000	230,000	233,000	204,000	212,000	199,000	> 250,000	207,000

Table A-14: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Foxe Basin, in thin ice conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thre	shold dista	nces (mete	rs)			
SPL	No wei				Cetace	eans			Pinni	neds
(dB re 1	арр	lied	Low-fre	quency	Mid-fred	quency	High-free	quency		ocus
μPa)	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}
190	< 10	< 10	< 10	< 10						
180	15	15	15	15	< 10	< 10	< 10	< 10	< 10	< 10
170	60	60	55	50	25	25	20	20	35	35
160	450	450	450	425	100	85	75	75	200	200
150	3,000	2,400	2,700	2,300	725	575	550	500	1,500	1,250
140	7,000	6,000	7,000	6,000	4,500	3,500	3,800	3,000	6,000	5,000
130	20,500	17,000	19,500	16,500	13,500	11,500	12,500	10,500	17,000	14,000
120	47,500	37,500	47,500	37,500	38,000	29,500	34,000	27,500	39,500	33,500
110	104,000	76,500	101,500	76,000	94,000	61,000	85,500	58,500	96,000	66,500
100	150,000	144,500	150,000	144,500	123,000	100,500	123,000	99,000	126,500	119,500

Table A-15: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Foxe Basin, in thick ice conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thr	eshold dista	ances (mete	ers)			
SPL	No wei				Cetac	eans			Dinni	nade
(dB re 1	appl	ied	Low-fre	quency	Mid-fred	quency	High-fre	quency	Pinni	peus
μPa)	R_{max}	R _{95%}	R_{max}	R _{95%}						
200	< 10	< 10	< 10	< 10						
190	20	20	15	15	< 10	< 10	< 10	< 10	< 10	< 10
180	85	85	65	60	15	15	10	10	20	20
170	720	680	450	380	55	55	50	50	80	70
160	3,500	3,000	3,000	2,300	350	300	275	250	580	480
150	9,500	8,500	8,500	7,500	3,000	2,200	2,300	1,700	4,000	3,200
140	20,500	17,500	19,000	16,000	10,500	8,500	9,500	7,500	13,000	10,500
130	38,500	32,000	37,500	31,000	31,000	24,000	28,500	22,500	33,500	27,000
120	85,500	61,000	85,500	61,000	65,500	52,500	61,500	50,500	85,500	57,000
110	123,500	101,000	123,000	101,000	119,500	95,000	119,500	93,000	123,000	106,000
100	208,000	181,000	208,000	180,500	155,000	148,000	152,000	143,500	177,000	161,000

A.10.3. Hudson Strait

Table A-16: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Hudson Strait, in open water conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thre	eshold dista	ances (mete	ers)			
SPL	No wei				Cetac	eans			Pinni	node
(dB re 1	appl	lied	Low-fre	quency	Mid-free	quency	High-fre	quency	FIIIII	peus
μPa)	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}	R_{max}	R _{95%}
180	< 10	< 10	< 10	< 10					< 10	< 10
170	35	35	35	35	< 10	< 10	< 10	< 10	15	15
160	125	110	125	110	40	40	30	30	60	60
150	1,000	900	1,000	900	150	125	100	100	380	360
140	6,000	4,300	6,000	4,200	1,200	1,000	960	750	3,000	2,300
130	21,000	14,500	21,000	14,500	9,500	6,000	6,200	4,500	12,500	10,000
120	97,000	68,000	97,000	68,000	67,500	21,500	28,000	18,000	80,000	39,000
110	215,000	171,500	214,500	171,000	155,000	147,000	151,000	91,500	176,000	153,000
100	240,000	234,000	239,500	233,500	239,500	233,500	239,500	233,500	239,500	233,500

Table A-17: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Hudson Strait, in thin ice conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thres	hold distan	ices (meter	rs)			
SPL	No weig	ghting			Cetace	eans			Pinni	neds
(dB re 1	appli	ed	Low-fred	quency	Mid-free	quency	High-fre	quency	1 11111	pcus
μPa)	R_{max}	R _{95%}								
190	< 10	< 10	< 10	< 10						
180	15	15	15	15	< 10	< 10	< 10	< 10	< 10	< 10
170	55	55	50	50	20	20	20	20	35	35
160	350	300	325	300	80	80	70	70	100	100
150	2,000	1,500	2,000	1,500	500	450	400	375	900	750
140	8,300	6,600	8,300	6,500	4,000	3,000	3,500	2,200	6,000	4,500
130	26,000	19,500	25,500	19,500	14,500	11,500	13,000	10,500	20,500	14,500
120	89,000	60,500	84,000	60,000	40,000	30,500	38,000	26,500	69,000	41,500
110	127,500	104,000	127,500	103,500	90,000	68,000	83,500	61,500	106,000	85,500
100	207,500	184,000	207,500	183,500	131,000	111,000	114,200	98,000	160,000	151,500

Table A-18: Comparison between predicted m-weighted and unweighted threshold distances from the Ore Carrier transiting in Hudson Strait, in thick ice conditions. Distances are calculated from broadband (10 - 2000 Hz) sound field.

RMS				Thre	shold dista	nces (mete	ers)			
SPL	No weig	ghting			Cetace	eans			Pinnip	ade
(dB re 1	appli	ed	Low-free	quency	Mid-fre	quency	High-fre	quency	1 1111111	eus
μPa)	R_{max}	R _{95%}	R_{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}	R _{max}	R _{95%}
200	< 10	< 10	< 10	< 10						
190	20	20	15	15	< 10	< 10	< 10	< 10	< 10	< 10
180	70	70	50	50	15	15	10	10	20	20
170	280	260	250	250	55	55	50	50	70	70
160	2,100	1,500	1,500	1,200	325	300	150	150	450	400
150	7,500	5,700	6,000	5,000	2,100	1,500	1,500	1,200	4,000	2,500
140	23,000	19,000	22,500	16,500	14,000	9,500	10,500	7,500	15,500	12,000
130	91,500	65,500	84,000	60,000	36,000	28,500	35,000	27,500	63,000	34,000
120	153,000	147,500	151,000	135,000	90,000	68,000	83,500	62,500	102,000	82,000
110	> 250,000	221,000	239,000	217,000	150,500	122,000	119,500	100,500	175,500	157,000
100		234,000	> 250,000	233,500	216,000	197,000	185,500	173,000	> 250,000	234,000

Table1a. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during open water conditions.

Range	broad	Frequ	quency	(Hz)																														
(E)	band	16	13	16	20	25	32	40	90	63	80 10	1 00	125 160	50 200	0 250	3	15 400	009 0	630	800	1000	1250	1600	2000	2500	3150	4000	2000	6300	8000	10000	12500	16000	20000
100	161	1 153	3 145	154	149	153	149	140	145 1	149 1	,	145 1	147 14	147 145	150	143	3 136	5 142	138	140	138	139	135	139	134	130	129	127	126	124	123	122	121	120
300	155	5 149	140	146	144	148	145	133 1	140 1	143 1	140 1	140 1	141 14	140 13	139 144	4 139	130	135	134	135	134	136	133	136	133	128	126	124	124	121	119	117	116	115
1,000	149	144	135	140	136	142	135	126	131 1	136 1	132 1:	131 1:	134 13	133 132	138	8 135	5 128	131	128	130	128	130	127	130	126	122	123	120	118	116	112	111	109	107
3,000	135	134	123	122	123	125	125	109 1	116 1	118 1	115 1	112 1	114 11	116 117	`	118 115	5 112	117	115	115	114	118	114	119	112	111	111	109	107	105	101	66	96	91
10,000	122	118	3 107	117	110	111	106	94	97 1	105 1	101	1 66	102 10	104 105	107	7 106	6 102	106	105	105	105	110	107	111	105	104	104	103	102	101	88	81	71	28
30,000	112	101	1 89	87	93	96	92	82	85	96	92	91	6 96	96 100	101	1 100	96 0	101	66	102	101	105	101	105	101	66	100	66	66	96	09	44	16	
100,000	108	3 25	21 2	20	24	33	37	31	40	99	61	89	79 7	8 6/	86 93	92 91	1 90	76 0	88	96	96	102	100	102	100	96	66	26	97	93				

Table 1b. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied

Range	broad	Freque	nency ((zH																														
Ξ	band	10	13	16	20	52	32 4	40 8	9 09	8 8	80 100	0 125	9 160	0 200	1 250	315	400	200	089	800	1000	1250	1600	2000	2500	3150	4000	009 (0 630	1008 0	0 1000	1250	1600	0 200
100	160	150	142	152	148 1	152 14	149 13	139 14	145 14	149 14	145 14	145 147	7 147	7 145	150	143	136	142	138	140	138	139	135	138	134	130	128	127	126	6 123		120	1,	18 1
300	154	145	138	144	143 1	147 14	13	133 14	140 14	143 140	140	14,	1 140	139	144	139	130	135	134	135	134	136	133	136	133	128	126	124	123	3 120	,	11 11	115 11	12 1
1,000	147	141	133	139	135 1	142 13	135 12	126 13	31 136	132	13.	1 134	133	3 132	138	135	128	131	128	130	128	130	127	130	125	121	123	119	11	7 115	5 11	108	105	5 101
3,000	133	130	121	120	122	125 13	124 10	109 11	116 118	ıι	14 112	2 11.	116	111	118	115	112	117	115	115	114	118	114	119	112	111	111	109	901 6	104		26 001		92
10,000	121	115	105	116	109 1	10 10	106	94 6	97 105	101	11 99	9 102	104	4 105	107	106	102	106	105	105	105	110	101	110	105	104	104	102	2 10	1 100		2 98	9 6/	29
30,000	112	86	87	98	92	94	91	81 8	85 9	6 96	92 91	1 96	96 9	9 100	101	100	96	101	66	102	101	105	101	105	101	86	100	66 (86 6	8 95		59 41	Ĺ	12
100,000	108	22	15	18	23	33	37	31 4	40 5	55 61	1 68	20	79 79	98 62	5 92	91	90	94	88	98	96	102	100	102	100	96	66	97	26 2	7 91	1			

Table 1c. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during open water conditions - Mid-frequency cetaceans M-weighting applied

broad Frequency (Hz)	ency (Hz)	(Hz)																															
band 10 13 16 20 25 32 40 50 63 80 100 125 160 200 250	16 20 25 32 40 50 63 80 100 125 160 200	16 20 25 32 40 50 63 80 100 125 160 200	20 25 32 40 50 63 80 100 125 160 200	25 32 40 50 63 80 100 125 160 200	32 40 50 63 80 100 125 160 200	40 50 63 80 100 125 160 200	50 63 80 100 125 160 200	80 100 125 160 200	100 125 160 200	125 160 200	160 200	007		50	٠,	315 4	400	9 009	930 80	800 100)0 1250	160	00 200	0 2500	3150	4000	0009	6300	8000	10000	12500	16000	20000
152 106 102 115 114 122 122 116 125 132 132 135 135 139 141 141 147	102 115 114 122 122 116 125 132 132 135 139 141 141	115 114 122 122 116 125 132 132 135 135 139 141 141	114 122 122 116 125 132 132 135 139 141 141	122 122 116 125 132 132 135 139 141 141	122 116 125 132 132 135 139 141 141	116 125 132 132 135 139 141 141	125 132 132 135 139 141 141	132 135 139 141 141	135 139 141 141	139 141 141	141 141	141	-	147	_	142 ′	135	141 1	138 14	140 13	138 13	139 13	135 139	134	130	129	121	126	124	123	122	121	120
146 102 98 107 109 116 117 110 120 126 127 130 133 135 135 141	98 107 109 116 117 110 120 126 127 130 133 135 135	107 109 116 117 110 120 126 127 130 133 135 135	109 116 117 110 120 126 127 130 133 135 135	116 117 110 120 126 127 130 133 135 135	117 110 120 126 127 130 133 135 135	110 120 126 127 130 133 135 135	120 126 127 130 133 135 135	127 130 133 135 135	130 133 135 135	133 135 135	135 135	135		141		137	129 1	135 1	133 13	135 13	134 13	136 13	133 136	133	128	126	124	124	121	118	117	116	115
. 140 97 93 101 101 111 111 108 103 111 119 119 121 128 128 135 ·	93 101 101 111 118 103 111 119 119 121 121 126 128 128 135	101 101 111 108 103 111 119 119 121 126 128 128 135	101 111 108 103 111 119 119 121 126 128 135	111 108 103 111 119 119 121 126 128 128 135	103 111 119 119 121 126 128 128 135	103 111 119 119 121 126 128 128 135	111 119 119 121 126 128 128 135	9 119 121 126 128 128 135	121 126 128 128 135	126 128 128 135	128 128 135	128 135	135			133	127	130 1	128 13	130 12	128 13	130 12	127 130	126	122	123	120	118	116	112	111	109	106
125 87 81 83 88 94 97 85 96 102 101 102 106 110 113 115	81 83 88 94 97 85 96 102 101 102 106 110 111	83 88 94 97 85 96 102 101 102 106 110 113 1	88 94 97 85 96 102 101 102 106 110 113 1	94 97 85 96 102 101 102 106 110 113 1	97 85 96 102 101 102 106 110 113 1	85 96 102 101 102 106 110 113 1	96 102 101 102 106 110 113 1	101 102 106 110 113 1	102 106 110 113 1	106 110 113 1	110 113 1	113 1	_	115		114	111	117 1	114 1	115 1	14 1	118 11	14 11	119 112	111	111	109	107	105	101	99	96	91
116 71 64 78 74 79 79 71 71 71 89 88 89 94 99 102 105 1	64 78 74 79 79 71 71 89 88 89 94 99 102 105	78 74 79 79 71 71 89 88 89 94 99 102 105	74 79 79 71 77 89 88 89 94 99 102 105	79 79 71 77 89 88 89 94 99 102 105	79 71 77 89 88 89 94 99 102 105	71 77 89 88 89 94 99 102 105	77 89 88 89 94 99 102 105	88 89 94 99 102 105	89 94 99 102 105	94 99 102 105	99 102 105	102 105	105			104	100	106 1	105 10	105 10	105 17	110 10	107 110	0 105	104	104	103	102	101	88	81	11	57
111 54 47 48 58 63 65 58 65 80 79 81 88 90 96 98	47 48 58 63 65 58 65 80 79 81 88 90 96	96 06 88 18 62 98 69 89 80 30	58 63 65 58 65 80 79 81 88 90 96	96 06 88 18 62 80 82 89 96	65 58 65 80 79 81 88 90 96	96 06 88 18 62 08 59 89	96 06 88 18 62 08 99	96 06 88 18 62	81 88 90 96	96 06 88	96 06	96		86		86	95	100	98 10	102 10	L	105 10	105	101	66	100	66	66	96	09	44	15	
108 1 2 10 7 20 39 48 58 71 74 82 89	10 7 20 39 48 58 71 74 82	10 7 20 39 48 58 71 74 82	10 7 20 39 48 58 71 74 82	10 7 20 39 48 58 71 74 82	10 7 20 39 48 58 71 74 82	7 20 39 48 58 71 74 82	39 48 58 71 74 82	39 48 58 71 74 82	58 71 74 82	71 74 82	74 82	82		68		68	89	93	88	35	101	Ĺ	100	100	96 (66	26	26	93				

Table 1d. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during open water conditions - High-frequency cetaceans M-weighting applied

Range	broad	Frequ	uency ((ZH																														
Œ	band	10	13	16	20	25	32	40	90	63	80 1	00	125 16	60 200	0 250	0 31	5 40	0 50(089	800	1000	1250	1600	2000	2500	3150	4000	2000	6300	8000	10000	12500	16000	1 200
100	150	101	46	110	109	117	117 1	111	120 1	128 1	1 82	131 13	136 13	138 139	9 146	6 140	134	4 140	137	139	138	139	135	138	134	130	129	127	126	124	123	122	121	1 120
300	145	26	93	102	104	112	113 1	105 1	115 1	122 1	123 13	126 13	130 13	132 133	3 139	9 136	128	134	133	135	134	136	133	136	133	128	126	124	124	121	118	117	116	5 1.
1,000	139	1 92	88	96	96	106	103	98 1	107 1	115 1	15 1	17 12	123 12	125 126	134	132	126	130	127	130	128	130	127	130	126	122	123	120	118	116	112	111	109	901 6
3,000	124	82	92	28	83	88	93	81	91	26	26	98 10	103 10	11 11	1 113	3 112	111	116	114	115	114	118	114	119	112	111	111	109	107	105	101	66 I	96	6 9
10,000	116	99	69	73	69	74	74	99	73	84	84	3 28	91 6	6 96	99 103	3 103	3 100	105	104	104	105	110	107	110	105	104	104	103	102	101	88	8 81	11	1 57
30,000	111	49	42	43	53	69	09	53	09	. 22	74	3 22	85 8	87 9.	94 97	16 1	7 94	100	86 C	102	101	105	101	105	101	66	100	66	66	96	09	44		91
100,000	108						2	3	16	35	44	54 (2 89	71 8	88 08	88 88	88 8	8 93	88 8	96	96	101	100	102	100	96	66	26	26	66				

Table 1e. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during open water conditions - Pinnipeds M-weighting applied

Pange Frequency (Hz) Anno (Hz) Frequency (Hz) Anno (Hz)		000	120	114	106	90	25		
band 10 13 16 13 16 13 16 13 16 13 16 13 16 1		00 20	21	16		95	17	15	Н
band 10 13 16 20 25 32 40 15 1		1600	1;	١.	1(Ĺ	Ц
Provad Frequency (Hz) Anno (Hz)		12500	`	117	111	66	81	43	
band 10 13 16 20 20 12 16 13 15 16 16 17 16 17 16 17 16 17 16 17 16 17 14 18 14 18 18 16 18 140 18 16 18 16 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 140 18 19 18 19 18 19 18<		10000	123	118	112	101	88	60	
Proad Frequency (Hz) 1		8000			`	105	101	96	92
band 10 13 16 20 25 32 1		6300	126	124	118	107	102	99	97
band 10 13 16 20 31 40 50 80 10 15 12 1		5000	127	124	120	109	103	66	97
band Tolar Frequency (Hz) A A A A A B A A B A B A B A B A B A B A B A A B A A B A A A A B A A A B A A A B A A A A B A A A A B A A A A B A A A A B A A A A B A A A A A A B A		4000	129	126	123	111	104	100	66
band 10 13 16 25 33 12 13 14 1		3150	130	128	122	111	104	66	96
band 10 13 16 20 25 32 40 50 63 80 100 125 160 120		2500	134	133	126	112	105	101	100
band Tolar Frequency (Hz) A 40 63 80 10 11 14 12 12 13 13 14 140 141 144 145 140 10 143 136 143 136 143 136 143 136 143 136 143 138 130 136 130 138 139 138 136 136 136 136 136 138 136 136 136 138 136 138 136 136 136 136 136 136 138 139 138 136 136 136 138 136 <th></th> <th>2000</th> <th>139</th> <th>136</th> <th>130</th> <th>119</th> <th>111</th> <th>105</th> <th>102</th>		2000	139	136	130	119	111	105	102
band 10 13 12 25 32 40 50 63 10 14 1		1600	135	133	127	114	107	101	100
band 10 13 16 13 12 13 13 12 13 1		1250	139	136		,	110	105	102
band 10 13 16 20 26 40 63 80 10 12 16 10 13 13 12 13 14 140 140 140 120 128 120 12		1000	138	134	128	1	105	927 	96
broad Frequency (Hz) 1		800			,		ı`.		Ш
band Tolerate Frequency (Hz) 18 16 20 25 32 12 135 141 140 125 142 144 145 144 149 149 143 136 136 141 140 141 144 145 144 149 143 136		630	138		128			66	
band Tolerate Honorate Honorate <th< th=""><th></th><th>200</th><th></th><th></th><th></th><th>117</th><th>106</th><th>,</th><th></th></th<>		200				117	106	,	
band 10 13 16 20 25 32 40 50 63 80 100 125 146 140 141 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 144 145 145 144 145 144 145 144 145 144 145 144 145 145 144 145 144 145 143		400				111			90
Proad Frequency (Hz) 40 20 25 32 40 50 63 80 100 125 160 175 17		à			- 8	,			90
band 10 13 16 20 25 32 40 50 63 80 100 125 160 175 160 175 160 175 160 175		250	,		137	l			
band Trequency (Hz) 40 13 16 20 25 32 40 63 80 100 125 126 130 141 140 141 141 142 144 142 144 144 145 145 144 144 144 144 145 144 144 144 145 144<		200	144	138	131	116	104	66	85
band 10 13 16 20 25 32 40 50 63 80 100 11 1 54 116 114 127 125 133 133 127 136 141 140 141 140 141 140 141 140 141 140 141 140 141 <		160	145	139	132	114	102	94	
band Total Erequency (Hz) A A A B		125	144	138	•	111	66	66	9/
band Frequency (Hz) 20 25 32 40 60 63 154 118 114 117 125 133 127 135 141 141 142 142 142 143 143 143 143 143 141 143 143 141 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143		100	141	136	127			87	64
band Frequency (Hz) 2 2 3 4 50 1 14 13 15 13 12 12 13 13 12 13 13 12 13 13 12 13 13 12 13 13 12 13 13 12 13 13 12 12 13 12 12 12 12 12		80	140	135	127	109	92	98	
band Frequency (Hz) 26 25 32 40 154 118 114 127 126 133 127 17 1 42 114 119 119 120 128 128 120 120 1 12 109 106 119 113 113 112 119 113 113 120 109 110 108 96 1 90 11 90 9		63	141	135	128	110	86		48
band Tequency (Hz) (Hz) 20 25 32 1 16 118 118 12 13 13 1 14 104 12 126 128 128 1 12 109 105 113 12 19 1 12 109 105 113 12 19 1 12 99 93 95 100 105 106 1 11 66 59 60 69 75 76 1 11 66 59 60 69 75 76 1 108 708 76 76 76 76 76		50	135	130		106	87	75	30
band Frequency (Hz) band 10 13 16 20 25 154 118 114 172 128 133 1 1 42 109 109 119 120 128 1 1 122 109 105 13 13 122 12 1 126 99 93 95 100 105 1 1 11 66 59 60 69 75 1 108 1 108 108 91 1		40	127	120	113	96	81	69	18
broad Frequency (Hz) Property (Hz) P					100		06		
broad Frequency (Hz) band 10 13 16 154 118 114 127 1 48 114 127 1 148 114 115 1 148 114 127 1 12 109 105 113 1 16 83 76 90 1 11 66 59 60 1 108					200				13
broad band Frequency (F) band 10 13 154 114 109 142 109 105 126 99 93 116 83 76 111 66 59 111 66 59 110 108 108				200					Ц
broad Frequent 10 10 10 10 10 10 10 10 10 10 10 10 10	(HZ)		6	8					Ц
broad Freq band 10 154 118 1142 109 116 83 111 66	ē	13	, l	22					Ц
brown brown	Frequ	10		7	7.5			99	
Range (m) 100 300 1000 1000 100000 100000 10000 10000 10000 10000 10000 10000 100000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000	proad	band	8	148	J. 10	8	l)	l	200
	Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000

Table 2a. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thin ice conditions.

Range	broad	Frequ	uency	(Hz)																															
Œ	band	10	13	16	20	52	32	40	20	63	80 1	1 00	125 1	60 20	0	250 31	15 40(0	200 63	08 08	100	1250	0 160	10 200	00 250	3,	150 400	00 20	00 63	08 00.	100 10	000	2500 16	0009	20000
100	166	153	145	153	150	153	152	148	152		153 1	53 1	154 1	56 1	156 1	158 18	55 18	153 15	155 152	153	,	152 157		148 14	149 14	146 14	143 14	141 14	141 1	13 13	138	135	134	133	132
300	161	149	140	146	145	148	147	142	147	148 1	148 1	47 1	147 1	50 1	50 1	152 18	50 14	147 14	148 14	148 14	148 147	7 148	1	44 14	148 14	143 14	141 13	39 1:	37 1	136 1	133	130	129	127	126
1,000	154	144	135	141	138	142	138	135	138	142 1	141	139 1	140 1	142 14	142 14	146 14	146 14	143 14	144 14	142 143	ļ	142 141	١	39 14	13 13	137 13	134 13	134	32 1	130 13	129 1	123	121	119	115
3,000	139	133	123	127	124	124	124	118	120	124 1	122 1	1 02	120 1	122 13	126 13	125 12	126 12	128 13	130 12	128 12	128 12	28 127	1	25 12	27 12	124 12	121 12	122	21 1	119 1	119	111	107	102	95
10,000	126	111	107	117	110	111	108	102	102	111 1	106 1	105 1	108	1 60	115 17	112 17	14 11	116 11	118 11	14 11	116 11	11 117	l	15 11	16 11	13 11	112 11	12 1	13 1	110 11	107	91	82	99	46
30,000	117	100	88	93	92	8	92	88	91	101	96	97 1	00	99 10	107 10	102 10	106 10	109 10	109 10	07 10	108 10	108	1	06 10	07 10	104 10	03 10	102	00	66	93	49	23		
100,000	66	26	18	25	24	27	34	36	4	22	62	69	92	92	82	98	88	93	91 8	85 9	92 9	92 9	93 8	68	91 E	8 98	7	. 6/	75	99	20	H	H	H	

Table 2b. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thin ice conditions - Low-frequency cetaceans M-weighting applied

	20000	127	121	110	90	41		
	0	129	124	115	86	63	_	Н
	1600				2	6	L	Ц
	1250	132	126	119	105	62	,7	
	10000	134	128	122	109	89	47	
	0008	137	132	128	118	106	95	49
	0089	139	135	129	119	109	86	99
	2000	140	137	131	120	112	100	74
	4000	141	139	133	122	112	102	29
	3150	143	141	133	121	112	103	83
	2500	146	143	137	124	113	104	98
	2000	149	148	140	127	116	107	90
	1600	148	144	139	125	115	106	88
	1250	151	148	141	127	117	108	93
	1000	152	147	142	128	118	109	92
	800	153	148	143	127	116	108	92
	089	152	148	142	128	114	107	82
	200	155	148	144	130	118	109	91
	400	153	147	143	128	116	109	93
	315	155	150	146	126	114	106	88
	0 25(158	0 152	2 146	125	115 112	7 102	98 ‡
	0 200	6 156	0 150	2 142	122 126	ı	99 107	76 84
	125 160	154 156	147 150	140 142	120 12	108 109	100	2 92
	100 12	153 18	147 14	139 14	120 12	105 10) 16	69
	80 1	153 1	148 1	141 1	122	106	96	62
	63	154 1	148 1	142	124 1	111 1	101	22
	20	151	146	138	120	102	06	4
	40	147	141	134	118	102	88	36
	32	151	146	138	124	108	92	34
	52	152	147	141	123	110	66	26
	20	149	144	137	123	109	91	. 23
(Hz)	3 16	151	3 144	3 139	125	116	26 /	5 24
quency	0 13	0 142	5 138	1 133	0 120	4 105	8 9	3 16
d Freq	1	36 150	145	141	130	114	96 /	99 23
broad	pand	166	.91	154	138	126	11	300.40
Range	Ξ	100	300	1,000	3,000	10,000	30,000	100,000
					•			_

Table 2c. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thin ice conditions - Mid-frequency cetaceans M-weighting applied

,																																		
Range	broad	Frequ	uency ((zH)																														
(m)	band	10	13	16	20	25	32	40	90	8 69	80 10	00 12	125 160	30 20	0 250	0 315	5 400	0 200	089 (800	1000	1250	1600	2000	2500	3150	4000	2000	6300	8000	1000	12500	1600	0 2000
100	163	106	102	114	115	122	125 1	124 1	132 13	138 14	140 14	143 14	146 15	152	156	6 153	3 152	154	151	153	151	150	148	149	146	143	141	141	140	138	135	134	133	3 132
300	157	102	86	107	110	. 111	119 1	118 1	127 13	131 13	135 13	137 13	139 14	144 146	.6 149	9 149	9 146	147	147	147	147	148	144	148	143	141	139	137	136	133	130	129	127	126
1,000	151	46	93	102	103	111	111	111 1	118 13	126 12	128 13	128 13	133 13	137 138	144	4 144	4 142	143	141	142	142	141	139	140	137	134	133	132	130	129	123	121	119	115
3,000	136	98	8	88	88	93	26		100 10	8	109 1	10 11	112 11	117 122	122	125	127	7 129	127	127	127	127	125	127	124	121	122	120	119	119	111	107	102	2 95
10,000	125	20	25	78	75	80	81	78	82	94 6	93	95 10	100 10	104 11	1 109	113	3 115	117	113	116	118	117	115	116	113	112	112	113	110	107	91	82	99	3 46
30,000	116	53	47	54	25	62	9	65	71 8	84	83 8	87 9	92 9	94 103	13 99	9 105	5 108	8 109	901 6	108	109	108	106	107	104	103	102	100	66	93	49	23		
100,000	98		П	П	Н	H	7	12	24	38 4	49	9 89	2 89	71 8	80 83	3 86	92	2 90	84	92	6	66	88	16	98	28	62	22	99	09				

Table 2d. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thin ice conditions - High-frequency cetaceans M-weighting applied

	20000	132	126	115		46		
	16000	133	127	119	102	99		
	12500	134	129	121	107	82	23	
	10000	135	130	123	111	91	49	
	8000	138	133	129	119	107	93	90
	6300	140	136	130	119	110	66	99
	5000	141	137	132	120	113	100	92
	4000	141	139	133	122	112	102	79
	3150	143	141	134	121	112	103	28
	2500	146	143	137	124	113	104	98
) 200C	3 149	148	140	127	116	107	06 6
	0 1600	148	144	139	7 125	115	901 8	3 89
	0 1250	1 150	7 148	141	7 127	116	8 108	92 93
	100	2 15	7 147	2 142	7 127	118	8 108	Ш
	030 80	51 152	147 147	11 142	127 127	113 116	106 108	84 91
	9 009	154 15	147 14	143 147	129 13	117 1	108 10	8 68
	400 5	151 1	145 1	141 1	126 1	114 1	107 1	91
	315	152	147	143	123	111	104	85
	250	154	148	142	120	107	86	18
	200	150	144	136	120	109	101	8/
	9 160	3 148	141	134	114	101	9 91	89 99
	00 125	139 143	133 136	125 129	106 109	91 97	83 89	9 99
	80 10	136 13	130 13	124 12	105 10	68	3 62	45
	63	133 1	127 1	121 1	103 1	06	08	34
	90	127	122	113	96	28	99	19
	40	119	113	106	06	74	09	8
	32	120	115	106	92	9/	09	2
) 25	117	5 112	3 106	88	75	2 57	
	6 20	110	2 105	86 /	3 83	73 70	49 52	L
cy (Hz)	13 16	97 109	93 102	88 97	75 83	29 73	42 49	
edneuc	10	101	3 /6	92 E	81 7	9 99	48 4	L
broad Freq	pand	162 1	156	151	135	125	116	86
		100	300	1,000	3,000	000'0	000'c	000'0
Range	Ξ			1	9	10	30	100,

Table 2e. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thin ice conditions - Pinnipeds M-weighting applied

Table 3a. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thick ice conditions.

Range	broad	Frequ	uency	(Hz)																															
(m)	band	10	13	16	07	25	32	40	90	63	80	100	125 1	160	200	250 3	315 4	400 5	9 009	8 089	800 10	000 12	1250 1	600 2	000	2500 3	3150 4	4000 5	9 0009	8 0069	1 000	10000	12500	16000	20000
100	117	153	145	154	152	153	155	157	158 ′	160	161	161	160	164	, 191	166 1	167 1	168	168 1	167 1	, 991	166 1	163	161	161	158	157	154	154	153	152	147	146	145	144
300	171	149	140	146	147	148	151	120	153 ′	154	. 991	155	155	158	160	160 1	163 1	162 1	162 1	162 1	. 191	162 1	160	159	159	155	154	152	152	150	147	142	141	140	138
1,000	165	144	135	140	140	142	141	144	144	148	147	147	148 1	150	153 ′	154 1	158 1	160 1	158 1	156 1	155	157 1	154	152	151	150	148	146	146	145	143	136	135	132	129
3,000	151	134	123	124	127	126	130	126	130 ′	129	130	128	128 1	133	138	136 1	140	143 1	144	143 1	141	142 1	141	140	141	138	137	138	136	136	134	124	121	115	109
10,000	140	119	107	118	114	110	111	112	109	115	116	114	116 1	121	, 971	125 1	129 1	131 1	132 1	132 1	. 131	132 1	132	129	130	129	129	129	128	128	122	105	96	80	69
30,000	132	101	88	68	96	96	26	100	86	106	107	, 901	108	111	119	116 1	120 1	124 1	124 1	124 1	122	124 1	123	120	122	120	120	118	116	114	103	62	37		
100,000	114	. 28	16	11	56	32	41	48	54	99	2.2	80	88	88	26	1 26	102 1	108 1	107 1	104 1	105	108 1	107	104	104	103	101	96	95	82	48				
				ĺ												ĺ			ĺ																

Table 3b. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thick ice conditions - Low-frequency cetaceans M-weighting applied

			-				_	_
	20000	139	133	124	104	5 5		
	16000	141	136	128	112	11		
	12500	144	139	132	118	93	34	
	0000	146	141	135	123	103	61	
	8000	150	146	142	132	121	102	47
	6300	152	150	144	136	127	114	81
	5000	153	151	146	136	128	116	91
	4000	154	151	146	138	128	118	96
	3150	157	154	148	136	129	120	101
	2500	158	155	149	137	129	120	103
	2000	160	159	151	141	130	122	104
	1600	161	159	152	140	129	120	104
	1250	163	160	154	141	132	123	107
	1000	166	162	157	141	132	124	108
	008 0	166	161	5 155	3 141	131	122	105
	0 630	167	162	156	4 143	132	124	104
	100 500	168 168	162 162	160 158	143 144	31 132	124 124	108 107
	315 400	167 1	163 11	158 1	140 14	129 13	120 1:	102 11
	250 3	166 1	160 1	154 1	136 1	125 1	116 1	97
	200	167	160	153	138	126	119	46
	160	164	158	150	133	121	111	88
	125	160	155	148	128	116	108	88
	100	161	155	147	128	114	105	90
	3 80	161	3 156	147	130	116	107	9/ 9
	9 09	158 159	153 153	144 148	130 129	109 11	98 106	54 66
	40 5	157 15	150 15	143 14	126 13	112 10	100	47 5
	32	155 1	150 1	141 1	130 1	111 1	1 96	41
	25	152	147	142	125	110 1	94	31
	20	151	146	139	126	113	96	25
(HZ)	16	153	144	139	122	116	88	16
uency	13	142	138	133	121	105	18 87	14
Freq	10	150	1 145	141	1 130	115	2 98	14 24
broad	pand	117	.21	165	15/	140	132	1
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000

Table 3c. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thick ice conditions - Mid-frequency cetaceans M-weighting applied

_	_	_	_	_	_	_	_
20000	144	138	129	109	59		
16000	145	140	132	115	80		
12500	146	141	135	121	96	37	
10000	147	142	136	124	105	62	
8000	152	147	143	133	122	103	48
6300	153	150	145	136	128	114	82
2000	154	152	146	136	128	116	6b
4000	154	152	146	138	129	118	96
3150	157	154	148		129	120	101
2500	158	155	149	137		120	103
2000	160	159	121	141	5	122	104
1600	161	159	152	140	129	120	104
1250	163	160		141	132		106
1000		162	200	8	5.		108
		191			130		105
					1 131	2.3	7 104
			3.3				106 107
		_					101 10
			3 3			14 1	1 76
		156 1	2.5	@	923	115 1	69
160	159	152	145	128	116	106	83
125	152	147	140	120	108	100	BO
100	121	145	137	118	104	96	UŽ
80	8	143	134		103	94	63
)	1	13	131	÷	8		49
	,	5	ш	,	8		26 26
32 4			200	- 25			14 2
25 ;		7.	111 1	95 10	8 62	63 (,
20	117 1		105 1	92	82	61	۲
16	115	107	101	85	62	20	۲
13	102	86	66	81	9	47	l
10	106	102	26	87	72	54	
band	175	170	164	150	140	131	114
(m)	100	300	1,000	3,000	10,000	30,000	100 000
	band 10 13 16 20 25 32 40 50 63 80 100 125 160 250 250 315 400 500 500 500 630 800 1000 1250 160 200 250 315 400 500 500 500 500 1000 1000 1250	band 10 13 16 20 25 32 40 50 63 80 100 125 125 22 25 3	band 10 13 16 20 25 32 40 50 63 80 100 15 100	band 10 13 16 20 25 32 40 60 120 60 120	band 10 13 16 20 25 32 40 50 63 80 100 120 120 100	band 10 13 16 20 25 32 40 50 60 60 60 60 60 100 175 100 176 100 176 100 176 100 100 176 100 176 100 100 176 100 176 100 100 176 100 100 100 100 120 100 <t< th=""><th>bard 10 13 16 20 25 32 40 60 10 12 10 12 10 1</th></t<>	bard 10 13 16 20 25 32 40 60 10 12 10 12 10 1

Table 3d. Estimated sound levels at set radii from the Tug operating in the vicinity of the Ore Loading Dock, during thick ice conditions - High-frequency cetaceans M-weighting applied

Range	broad	Frequ	uency ((zH)																															
Ξ	pand	10	13	16	20	25	32	40	20	63	80 1	1 00	125 16	160 200	00 250	315	15 400	0 20	0 630	008	1000	1250	1600	2000	2500	3150	4000	2000	0089 (0008 (1000	0 1250	0 1600	0 2000	00
100	174	101	46	110	112	117	123 1	129 1	133 1	139 1	144	147 14	149 15	16.	31 162	~	164 166	191	166	166	166	163	161	160	158	157	154	154	153	152	14.	7 146	ر ا	145	144
300	169	26	93	102	107	111	119 1	122 1	129 1	133 1	139 1	141 14	44 15	150 15	154 15	16 16	160 160	16.	1 161	160	162	160	159	159	155	154	152	152	150	147	142	14	1	140	138
1,000	163	92	88	96	100	106	109 1	115 1	120 1	127 1	130 1	133 13	137 14	142 14	147 15	150 15	155 158	157	155	155	156	154	152	121	149	148	146	146	145	143	3 136	6 135	8	132 1	129
3,000	150	82	9/	80	87	90	86	98 1	105 1	108 1	13 1	114 1	117 12	125 13	132 13	Ŀ	137 14	.1 142	2 142	141	141	141	140	141	137	136	138	136	136	133	124	4 12	1 1	15 1	109
10,000	139	29	09	74	73	74	62	84	92	94	99 1	100	105 11	13 12	120 12	_	126 129	13.	1 131	130	132	132	129	130	129	129	129	128	128	122	105	226	8 96	80	29
30,000	131	49	42	46	99	28	92	72	73	92	90	95	97 10	103 11	113 112	12 11	122	123	3 123	122	124	123	120	122	120	120	118	116	114	103	3 62		37	Ц	
100,000	114					-	6	19	29	45	29	. 99	3 22	6 08	91 9	93 10	100 106	106	104	105	108	106	104	104	103	101	96	92	82	48	3				

Table 3e.

_								
	20000	143	138	128	108	69		
	16000	145	139	132	115	80		
	12500	146	141	134	121	96	36	
	0000	147	142	136	124	105	62	
	8000 1	151	147	143	133	122	103	48
	0089	153	150	145	136	128	114	82
	2000	154	152	146	136	128	116	92
	4000	154	152	146	138	129	118	96
	3150	157	154	148	136	129	120	101
	2500	158	155	150	137	129	120	103
	2000	161	159	151	141	130	122	104
	1600	161	159	152	140	129	120	104
	1250	163	160	154	141	132	123	107
	1000	166	162	157	141	132	124	108
	0 800	991 9	161	5 155	3 141	131	122	4 105
	029	166	162	155	143	132	124	104
	0 200	8 168	2 162	158	3 143	1 132	124	7 107
	40	168	162	159	143	13	124	107
	315	167	162	158	139	128	120	102
	250	165	159	154	135	124	116	96
	200	166	159	152	137	125	118	96
	160	162	156	149	132	119	110	87
	125	157	152	145	125	113	106	85
	100	157	151	143	124	110	102	9/
	80	155	121	142	125	111	102	71
	63	152	146	140	121	107	86	58
	90	148	143	134	119	66	87	43
	40	144	137	131	113	66	87	34
	32	139	134	125	114	96	08	25
	25	133	128	122	106	90	15	12
	20	129	124	116	104	06	73	2
cy (Hz)	16	127	119	113	26	16	62	
rency	13	114	109	105	92	92	69	
Frequen	10	118	114	109	66	84	99	
proad	band	176	171	165	150	140	132	114
Range	(m)	100	008	1,000	3,000	10,000	30,000	100,000

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2000	126	119	112	66	99					
16000	127	120	113	104	19	22				
12500	128	121	115	107	88	90				
0000	130	123	117	110	96	89				
8000	132	128	125	121	114	109	100	96	94	91
0089	134	129	126	122	115	109	103	100	100	26
2000	134	130	126	121	116	111	103	66	66	26
4000	135	132	126	123	117	111	104	101	66	86
3150	137	133	129	124	117	112	105	101	100	66
2500	138	134	131	125	119	113	106	102	101	100
2000	138	135	131	127	119	114	106	102	100	66
1600	139	136	132	127	120	114	105	102	101	100
1250	141	137	132	129	121	115	107	104	103	101
1000	142	139	133	130	122	116	108	104	103	102
800	144	139	133	130	122	111	108	104	102	101
630	145	139	135	130	122	118	108	103	101	100
500	145	141	135	130	124	117	107	101	66	26
400	146	141	136	132	124	118	106	66	96	94
315	147	143	137	132	125	118	104	26	66	06
250	148	143	138	133	125	118	103	66	88	83
200	149	145	138	133	126	111	101	35	8	22
160	150	147	141	134	126	111	86	83	14	99
125	151	147	143	136	127	116	46	81	29	53
100	153	149	145	139	129	116	92	73	54	36
80	156	154	149	141	130	119	91	64	39	19
63	159	156	149	141	131	116	85	20	19	
90	157	154	148	140	127	115	28	37		
40	150	148	144	137	124	110	99	17		
32	148	145	140	133	120	105	53			
25	145	141	137	129	116	101	42			
20	143	139	133	125	113	26	33			
16	141	136	130	122	110	98	24			
13	131	128	121	116	107	92	11			
10	130	126	120	114	104	88	19			П
pand	164	161	154	147	137	128	117	112	111	109
(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 1b. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during open water conditions - Low-frequency cetaceans M-weighting applied

	20000	121	114	107	94	09					
	16000	123	116	110	100	75	18				
	12500	125	118	112	105	98	48				
	10000	128	121	115	109	94	99				
	0008	131	121	124	119	113	108	66	96	86	88
	0089	133	129	125	121	114	108	102	66	66	96
	0005 0	133	130	126	121	115	110	102	66	86	3 97
	0 4000	135	3 132	126	123	111	111	104	101	66 0	86 6
	0 3150	136	3 133	1 128	5 124	119 117	113 112	5 105	102 101	1 100	100
	0 2500	138 137	135 133	131	127 125	119 11	114 11	105 105	102 10	100 101	99 10
	00 200	139 13	136 13	132 131	127 12	120 11	114 11	05 10	102 10	101 10	100
	1250 160	141 1	137 1	132 1	129 1	121	115 1	1 07	104	103 1	101
	000 12	142 1	139 1	133	130	122	116	108	104	103	101
	800 1	144	139	133	130	122	117	108	104	102	101
	630	145	139	135	130	122	118	108	103	101	100
	200	145	141	135	130	124	117	107	101	66	97
	5 400	146	3 141	136	132	5 124	18 118	4 106	66 /	96	0 94
	250 31	148 147	143 143	138 137	133 132	125 125	118 11	103 104	93 97	88 93	83 90
	200 2	149 1	145 1	138 1	133 1:	126 1:	1 211	101	95	28	1.1
	160	150	147	141	134	126	117	86	83	74	99
	125	151	147	143	136	127	116	26	81	29	53
	100	153	149	145	139	128	116	96	13	25	36
	93 80	158 156	156 154	149 149	141	131 130	116 119	85 91	50 64	19 39	19
	9 09	156 15	154 15	148 14	140 141	127 13	114 11	8 82	37 5	_	
	40	150 1	148 1	144 1	137 1	123 1	109 1	99	17		
	32	147	145	139	132	119	105	53			
	57	144	141	136	128	116	100	14			
	3 20	142	138	132	124	3 112	96 8	32			
cy (Hz)	13 16	129 140	125 134	119 129	114 120	104 108	60 93	15 22			Ц
Frequency	10 1	127 12	122 12	117 11	111 11	101 10	5 98	15 1	L	L	Н
broad Fr	pand	164 1	161 1	154 1	147 1	137 1	128	116	112	110	109
Range bro	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 1c. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during open water conditions - Mid-frequency cetaceans M-weighting applied

4	Frequen	ncy (Hz	(z																													
10		13	16	20 ;	25 3	32 4	09 0	69 0	3 80	100	125	160	200	250 3	315 4	400 5	200 63(30 80	100	0 1250	0 160	0 2000	0 2500	3150	4000	0009	6300	8000	10000	12500	16000	20000
83	١	89 1	102 10	107 11	14 121	21 126	137	7 142	143	143	144	145	145	145 1	146 1	145 1	144 14	144 14	144 14	142 141	1 139	138	137	137	135	134	134	132	130	128	127	126
	62	92	10 16	104 11	110 11	118 125	134	4 140	141	139	139	142	141	141 1	141	140	140 13	139 13	139 13	139 137	136	5 135	134	133	132	130	129	128	123	121	120	119
	73	62	91	98 10	106 11	113 121	128	8 133	3 136	135	135	135	134	135 1	135 1	134 1	135 13	135 13	133 13	133 132	132	131	131	129	126	126	126	125	117	115	113	112
	29	73	83	3 06	97 10	105 113	3 120	0 125	5 128	129	128	129	129	130 1	130	130 1	130 13	130 130		129 129	127	127	125	124	123	121	122	120	110	107	104	66
	29	22	71	3 82	85 9	92 100	107	114	117	118	119	121	122	123 1	124 1	123 1	123 12	122 122		122 121		119 119	119	117	117	116	115	114	96	68	62	65
126	42	49	99	62 7	2 02	8 84	98	5 100	106	106	109	112	113	116 1	116 1	117 1	116 11	11 11	116 11	115 115	114	114	113	112	111	111	109	109	89	20	22	
116	-	H	H		10 2	26 4	43 58	69 8	8/ 6	98	68	93	, 26	100	103	105 1	106 10	107 108		108 107	7 105	2 106	901 9	105	104	103	103	100				
112							17	7 34	4 51	63	73	2.2	88	90	92	98	100 10	102 104	104	4 104	4 102	2 102	2 102	101	101	66	100	96				
		H	H					Ľ	2 26	43	69	69	80	85	92	36	98 10	100 10	102 10	103 103	3 10	100	101	100	66	66	100	94				
109		-	-						9	25	46	09	73	81	68	93	96	99 100	101	101	1 100	66 0	100	66	86	26	26	06				

Table 1d. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during open water conditions - High-frequency cetaceans M-weighting applied

12500 16000 20	12500 16000 20 128 127	12500 16000 128 127 121 120	12500 16000 20 128 127 121 120 115 113	12500 16000 20 128 127 121 120 115 113 107 104	12500 16000 20 128 127 121 120 115 113 107 104 89 79	12500 16000 200 128 127 1 121 120 1 115 113 1 107 104 89 50 22	12500 16000 200 128 127 1 121 120 1 115 113 1 107 104 89 79 50 22	12500 16000 200 128 127 1 121 120 1 115 113 1 107 104 89 79 50 22	12500 16000 200 128 127 1 121 120 1 115 113 1 107 104 89 79 50 22
434 432 430	6300 8000 10000 134 132 130	134 132 130 129 128 123	6300 8000 10000 134 132 130 129 128 123 126 125 117	6300 8000 10000 134 132 130 129 128 123 126 125 117 122 120 110	6300 8000 10000 134 132 130 129 128 123 126 125 117 122 120 110 115 114 96	139 120 130 130 130 130 130 132 132 132 132 137 137 137 137 137 137 137 137 137 137	134 8000 10000 129 128 123 122 120 110 112 120 110 115 114 96 109 109 68	2300 8000 10000 129 128 133 126 126 117 122 120 110 115 119 68 103 100 68 100 96	2300 8000 10000 129 138 133 126 125 117 122 120 110 115 114 96 103 100 68 100 96 100 96
1	1	,	,	,	,	11111	1	1	'll ll ll ll ll
1070	137	137	133	137 133 129	137 133 129 124 117	133 129 129 117 117	133 129 129 117 117	133 133 124 117 105	133 124 127 117 105 100
ľ	8	32 88	35 5	27 27	19 27 17 6	335 %	33 38 38 39 39 39 39 39 39 39 39 39 39 39 39 39	27	8 2 2 2 2 3 8 8 8 8 8 8 8 8 8 8 8 8 8 8
420	139	136	139 136	139 136 131	139 136 131 127	139 136 127 119	139 136 127 119 114	139 136 127 119 114 105	139 136 137 119 114 105 102
L	Ш				142 133 129 122	142 133 129 122 115	139 133 123 115 108	142 139 129 108 108	104 103 103 103
T`			2 5 5	6 6 6					
111	144	140	144 140 134	144 134 129	144 140 134 122	144 140 134 122 116	140 140 123 122 116	144 134 129 129 116 106	144 134 122 122 116 106 100
L		8 8							
ľ	,	I , I , I							- - - - - -
	1	139	139	133	139 126 118	133 133 118 109	139 139 109 109 109 109 109 109 109 109 109 10	139 133 126 109 90 75	133 133 109 109 90 75
133 140		135 136							
100	1	137	132	132	132 124 113	132 124 113 102	132 124 113 102 74	137 132 113 102 74 47	132 132 1132 102 74 47 22
136	136	4	1						
77 7	13 120	2	116	109	116	116 109 95 81	116 109 95 81	116 109 95 81 38	116 109 81 38
50.0	90,	3	101	101	101 1	101 1	5 6 80 92 1	101 101 101 1	55 2 1
1	42	┙							
┸	6	l	Ш	1 1	1 1 1			1 1 1 1 1 1 1	1 1 1 1 1 1 1 1
	149 74								1 1 1 1 1 1 1
	300		1,000 14		30 30 30	31 31 31 31			

Table 1e. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during open water conditions - Pinnipeds M-weighting applied

	16000	127	120	113	103	78	21				Г
	-		100	1	1	•	• •				l
	12500	128	121	114	107	88	20				
	10000	129	123	116	110	95	89		55 -4		l
	0008	132	128	125	120	114	109	100	96	94	90
	6300	133	129	126	122	115	109	103	100	100	
	2000	134	130	126	121	116	111	103	66	86	-0
	4000	135	132	126	123	117	111	104	101	66	90
	3150	137	133	129	124	117	112	105	101	100	90
	2500	138	134	131	125	119	113	106	102	101	,
	2000	138	135	131	127	119	114	106	2 102	1 100	9
	0 1600	139	7 136	132	127	1 120	114	7 105	4 102	3 101	, ,
	1250	141	137	3 132	129	121	116 115	107	104	103	,,,,
	1000	142	139 139	133 133	130 130	122 122	117 11	108 108	104 104	102 103	, , ,
	630 800	144 14	139 13	135 13	130 13	122 12	117 11	108 10	103 10	101	,0,
	9 009	145 1	141 1	135 1	130 1	123 1	117 1	107	101	99 1	
	400	146	141	135	131	124	118	106	66	96	٠,٠
	315	147	143	136	132	125	118	104	96	66	90
	250	147	143	137	132	5 125	3 118	102	1 92	87	3
	0 200	148 148	5 143	139 137	132 132	125	115 116	96 100	81 91	72 83	
	125 160	149 14	144 145	140 13	133 13	124 125	114 11	94 6	8 62	64 7	
	100	149 1	145 1	141	135 1	125 1	112 1	91	69	20	٥٥
	80	151	148	143	135	125	114	98	69	33	Ļ
	63	151	149	141	134	123	109	78	43	11	
	50		144	1		117	104	89	. 26		
	2 40	137	135	131	124	3 111	9 97	7 53	4		
	25 32	125 132	121 129	117 124	109 116	96 103	81 89	22 37			L
	20	119 12	115 12	110 1	102 10	68	73 8	10		_	L
Hz)	16	114 1	109	103 1	95 1	83	29		_		
uency (F	13	101	26	16	82	92	19				ŀ
Freque	10	96	16	98	64	69	54				t
broad	band	159	155	149	143	134	127	116	112	110	00,
Range	Œ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	000 000

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	2000	135	127	116	100	9					
	16000	136	128	119	106	71					
	12500	137	129	121	111	98	27				H
	000	138	131	123	115	92	23	-	-	-	Н
	00 10	139	134	129	125	115	86	53	23		Н
	08 00	142 1	137 1	134 1	127 1	118 1	105	69	46	56	4
	2000 630	142 1	138 1	133 1	128 1	119 1	108	2.2	28	41	24
	00 20	141 1	136 1	132 1	127 1	18 1	107	80	64	49	35
	150 40	143 1	139 1	135 1	130 1	120 1	11 1	28	11	69	45
	3,	145 1	140 1	137 1	130 1	123 1	114 1	06	92	64	53
	2000 2500	146 1	141 1	137 1	133 1	123 1	114 1	91	82	29	29
	_	146	142 1	138 1	132 1	125 1	115 1	94	81	11	61
	1600	148 1	144 1	140 1	133 1	125 1	116 1	96	84	74	64
	1000 1250	150 1	146 1	140 1	135 1	126 1	117 1	86	84	22	99
	800 10	151 1	146 1	141 1	137 1	127 1	118 1	86	85	92	99
	8 089	150 1	145 1	140	136 1	126 1	118 1	26	84	22	99
	200	151	147	141	137	127	119	26	83	73	63
	400	153	148	142	138	129	121	26	81	72	62
	315	154	149	142	137	130	119	96	80	69	69
	250	154	149	143	139	129	120	96	82	69	89
	200	155	151	144	139	131	119	94	17	64	51
	9 160	157	3 153	147	140	2 131	120	2 95	17 77	2 61	35 46
	125	158	153	9 148	3 142	132	118 120	92 92	12 99	42 52	20 3
	80 100	159 157	157 154	152 149	143 143	133 132	120 11	6 88	9 /9	28 4	5 2
	83 8	160 15	158 15	150 15	141 14	131 13		81 8	44	8	Н
	90	157 1	155 1	148 1	140 1	127 1	114 17	74	58	H	Н
	40	151	148	146 1	136 1	124	109	64	11	H	Н
	32	154	152	146	138	126	112	99			H
	25	156	152	148	139	127	112	49			H
	20	157	153	148	140	127	111	43			
(HZ)	16	158	152	147	139	126	111	39			
uency	13	150	146	140	134	125	110	35	L	L	Ц
l Fredt	10	150	5 146	140	134	124	109	98 98	2	2	3
proad	band	169	165	158	151	141	130	106	76	82	73
Kange	Œ.	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
Ŗ	Ĭ					1	3	10	15	20	25

Table 2b. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thin ice conditions - Low-frequency cetaceans M-weighting applied

_	-			_					_	_	_
	20000	129	122	111	96	46					
	00091	132	125	115	103	29					
	12500 1	134	127	118	109	83	24				
	0000	136	129	121	113	93	51				
	8000	138	133	128	124	114	26	52	22		
	8 0069	141	136	133	127	117	104	89	46	25	3
	2000	141	137	133	128	119	108	22	89	41	24
	4000	140	136	131	121	118	101	08	19	48	98
	3150	143	139	135	130	120	110	87	02	89	45
	2500	144	140	137	130	123	113	06	3 75	19	23
	2000	145	141	137	133	123	114	,6 t	8/ C	19 1	1 57
	1600	146	4 142	138	3 132	5 125	115	6 94	80	1/2 1	4 6'
	1250	9 148	6 144	.0 140	5 133	125	116	96 86	84 84	75 74	66 64
	1000	149	146 146	.1 140	137 135	127 126	118 117	6 86	8 98	2 92	9 99
	030 800	150 15	145 14	140 147	136 13	126 12	18 11	3 /6	84 8	1 91	99
	9 009	151 1	147 1	141 1	137 1	127 1	119 1	26	83	73	63
	400	153	148	142	138	129	121	26	81	72	62
	315	154	149	142	137	130	119	96	80	69	69
	250	154	149	143	139	129	120	96	18	69	28
	0 200	7 155	3 151	144	139	1 131	119	5 94	LL L	1 64	46 51
	125 160	158 157	153 153	148 147	142 140	132 131	120 120	95 95	71 77	52 61	35 40
	100 12	157 18	154 16	149 17	143 14	132 13	118 12	92 0	99	42	20
	80 1	159 1	157 1	152 1	143 1	133 1	120 1	88	22	28	2
	63	159	157	150	141	131	117	81	44	8	
	09	157	154	148	140	121	114	44	58		
	40	151	148	146	136	124	109	9 9	11		
	5 32	5 153	1 151	146	137	126	111	8 55			
	20 25	156 155	52 15	147 147	139 138	26 126	111	42 48			
(2	16 2	157 15	151 152	145 14	137 13	125 126	110 110	37 4			
ncy (Hz)	13	148 1	144 1	138 1	132 1	123 1	108 1	32			
Frequenc	10	147	142	137	131	120	105	34			
broad F	band	168	165	158	151	141	130	106	92	82	73
Range b	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
								8	8	563	563

Table 2c. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thin ice conditions - Mid-frequency cetaceans M-weighting applied

Range	broad	Frequ	luency ((Hz)																													
Έ)	band	10	13	16	20	25	32	40	9 09	93 80	0 100	125	160	200	250	315	400	9 009	8 089	800 10	000 12	1250 16	600 2000	00 2500	00 3150	004 09	0 2000	0069 0	0008 0	10000	12500	16000	2000
100	162	103	108	119	122	124	127 1	128 13	137 14	43 146	147	150	151	121	151	152	152	150	150 1	151 1	149 1	148 1	146 14	145 14	144 14	143 147	1 142	2 142	139	138	136	135	134
300	157	66	104	113	118	121	124 1	125 13	135 14	11 144	4 144	146	148	147	146	147	147	147	144	146 1	146 1	144	142 14	141 14	140 13	139 136	138	137	134	131	129	128	127
1,000	151	66	86	108	113	116	119 1	122 13	128 13	34 139	9 139	141	141	140	141	140	141	140	140 1	141 1	140 1	139 1	138 1:	137 13	137 13	135 132	2 133	3 134	129	123	121	119	116
3,000	145	48	6	100	105	108	111 1	112 13	120 12	25 130	0 132	134	135	135	136	135	136	136	136 1	137 1	135 1	133 1	132 1:	133 13	130 13	130 127	7 128	127	125	115	111	106	100
10,000	136	22	85	87	92	96	99 1	100 10	107 11	15 120	0 122	124	126	127	127	128	128	126	126 1	127 1	126 1	125 1	125 13	123 12	123 120	118	8 119	118	3 115	96	85	1.2	9
30,000	127	. 62	89	72	9/	80	84	38	94 10	107	108	3 113	114	115	117	117	120	118	117 1	118 1	117 1	116 1	115 1	114 1	114 111	107	108	8 105	96 9	9 23	27		
100,000	105				8	17	28	40	54 6	29	75 82	82	88	06	94	93	96	96	96	86	86	96	94	91 8	8 06	87 80	22 0	69 /	9 53				
150,000	91					Н	Н	Н	9 2	0.000	44 56	9 9	1.1	23	92	28	80	82	83	84	84	84	. 08	. 87	75 7	71 6	64 58	8 46	6 23				
200,000	82					Н	Н	Н	Ц	1	15 32	2 44	22	09	29	89	7.1	72	75	92	75	74	7.1	9 29	64 5	59 4	49 41	1 26	3				
250,000	72					H	H	L	L		11	10 27	41	47	22	29	61	62	9	99	99	64	61	25	53 4	45 3	35 24		4				

Table 2d. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thin ice conditions - High-frequency cetaceans M-weighting applied

Ì		8	135	127	116	100	51					Г
		2000						Ц	Ц		L	L
		16000	135	128	119	106	71					
		12500	136	129	121	111	98	27				ľ
		1 000	138	131	123	115	96	23	Н			ŀ
		8000 10	139	134	129	125	115	86	53	23	H	L
		0	142 1	137 1	134	127 1	18 1	105	69	46	26	ķ
0		00 00	142 1	138 1	133 1	128 1	119 1	108	2.2	28	41	1/6
		0009 00	141 1	136 1	132 1	127 1	18 1	1 07	80	64	49	35
		90 40	143 14	139 13	135 13	130 13	120 1	111 11	87	20	, 65	15
		0 3150	`	_	Ĺ		`	,	8 06	75 7	64 5	53
		0 2500	5 144	140	137	3 130	3 123	114		78 7		L
		2000	145	141	137	133	123	114	16 1		19	47
f		1600	146	142	138	132	124	115	94	80	1.1	61
1		1250	148	143	139	133	125	116	96	84	74	3
		1000	149	146	139	135	126	111	86	84	92	99
		008	150	146	141	136	127	118	86	84	92	33
		089	149	144	140	135	126	117	96	83	74	99
,		009 0	150	5 146	140	135	126	118	96 9	79 82	72	69 6
1		5 400	1 151	5 146	141	136	127	5 119	2 95	77 79	02 99	25 50
		0 315	151	5 146	139	4 134	5 127	115 116	92 92	74 7	9 59	5.4
		200 250	149 150	145 145	138 139	133 134	125 125	113 11	6 88	71 7	9 89	AE E
		160 20	148 14	145 14	139 13	132 13	123 12	112 11	3 /8	69	53 €	30
,		125 10	147 12	142 14	137 13	131 13	121 13	109 1	81	09	41	, VC
		1001	143 1	140 1	135 1	129 1	118 1	104 1	62	52	28	4
		80 1	142 1	140	135 1	126 1	116	103	7.1	40	11	┞
4		63	139	137	129	120	110	96	09	23	Н	┝
		90	133	130	124	115	103	88	20	5	Н	ŀ
		40	123	120	118	108	96	81	35		Н	l
		32	122	119	114	106	94	42	24		Г	ľ
		52	120	116	111	103	16	92	13			ľ
		20	111	113	108	100	28	11	3			
	(Hz)	16	114	108	103	96	83	19				Ĺ
	Frequency	13	103	66 1	93	28 i	8/	63				L
		10	1 98	94	88 6	1 82	5 72	29 2	Ĺ	L	Ĺ	Ļ
	broad	band	161	156	149	144	135	126	104	91	81	42
	Range	Œ	100	300	1,000	3,000	10,000	30,000	000'00	150,000	200,000	250 000
	Rai	٤			ľ	ľ	1	3(100	15(200	250

Table 2e. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thin ice conditions - Pinnipeds M-weighting applied

	20000	5 134		115	99	09 0					
	1600(135	128	118	106	02					L
	12500	136	129	121	111	85	27				L
	10000	138	131	123	115	96	53				l
	8000	139	134	129	125	115	86	53	23	L	ļ
	0089 (142	137	134	127	118	105	69	3 46	1 26	ļ
	0005 0	142	138	133	128	3 119	108	77 0	4 58	9 41	l
	400	3 14,	136	132	127	118	107	08	19	9 49	
	3150	143	139	135	130	120	111	87	2 71	69 1	l
	1 2500	145	140	137	130	123	114	8	15	, 64	ļ
	2000	145	141	137	133	123	114	9	18	29	
	1600	146		138	132	125	115	94	08	7.1	l
	1250	148	144	140	133	125	116	96	84	74	ļ
	1000	149	146	140	135	126	117	86	84	75	Į
	800	151	146	141	137	127	118	86	98	9/	Į
	0 630	150	145	1 140	136	126	118	26 /	83	3 75	l
	0 200	3 15	147	141	7 137	127	119	97 97	80 83	72 73	I
	315 400	153 153	149 148	142 142	137 137	129 129	118 121	92	8 6/	2 69	l
	250 31	153 18	148 14	143 14	138 13	129 12	119 11	96	. 82	69	I
	200 2	153 1	150 1	143 1	138 1	130 1	118 1	93	9/	62	I
	160 2	155 1	151	145 1	138	130 1	118	93	22	29	l
	125	155	151	146	139	129	118	06	89	49	I
	100	153	150	145	139	128	114	68	62	38	I
	08	154	121	146	137	121	115	83	29	23	j
		_	150	l	l	ı	109		36		
) 50	3 147	144	138	130	117	104	1 64	19	L	ļ
	2 40	8 138	5 135	133	123	111	96	9 51		L	ļ
	25 32	138	135	130	9 122	110	92 95	29 39	L	L	۱
	20 2	133 136	130 132	124 128	116 119	104 107	87 9	20 2		L	l
(2	16 2	131 13	125 13	119 12	11 1	99 10	84	12 2	\vdash	\vdash	l
uency (Hz)	13	119 13	116 13	110 1	104	94	80	4	\vdash	H	l
Frequen	10	115 1	111	105 1	99 1	68	74	က	\vdash	H	l
broad FI	pand	164	160	154	148	138	128	106	92	82	I
Range br	(m)	100	300	1,000	3,000	10,000	30,000	000'001	150,000	000,009	

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Table 3a. Estimated sound levels at set radii t

2000	143	135	125	109	9					
	ш		8	523						Ш
16000	144	137	128	116	08					
12500	145	138	131	121	96	37				
10000	147	140	133	124	104	63				
0008	145	142	138	133	120	101	94	4		
6300	150	146	142	137	127	113	28	54	34	11
2000	150	146	141	137	127	115	98	89	20	33
4000	146	142	139	134	123	113	87	11	89	41
3150	149	146	142	136	128	118	94	18	99	54
2500	152	148	146	138	131	121	86	85	74	61
2000	152	148	144	139	130	121	100	98	92	64
1600	153	151	145	141	132	123	101	90	79	89
1250	155	152	146	142	133	125	104	92	83	73
1000	157	153	146	142	134	125	105	94	84	75
008	157	154	148	145	135	127	108	96	28	8/
		152	0			0		6	83	74
500	158	153	148	143	136	126	106	92	84	75
400	160	155	150	145	137	128	106	92	83	75
315	160	155	150	144	136	127	104	88	80	71
250	161	156	150	145	137	128	103	88	28	89
200	162	157	150	146	138	127	103	98	9/	64
160	163	160	153	147	138	128	103	87	74	61
125	164	22	155	149	139	127	103	85	89	52
100	162	158	154	148	137	124	101	11	29	38
08	162	159	154	147	136	8	96	19	42	22
	l	-	Į.	143	-	-			70	
09	121	155	149			1	62	88		
40	121	150	146		126		69	17		
35	191	158	153	145	133	118	19	10		
57		164	159	121	139	123	99			
70			162	155		126	69			
16		170	165	157		129	69			
13	169	991	159	154	144	130	99			
10	170	166	160	154	144	129	69			
band	180	175	169	162	151	139	115	101	92	83
(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
	band 10 13 16 20 25 32 40 50 63 80 100 125 160 250 250 315 400 500 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000 10000	band 10 13 16 20 25 32 40 50 63 80 100 125 100	band 10 13 16 20 25 32 40 50 63 80 100 150 100	band 10 13 16 20 25 32 40 50 63 80 100 150 160 100	band 10 13 16 20 25 32 40 50 62 10 10 12 10 10 12 10 10 10 12 10 10 12 16 10 10 12 16 10 10 12 15 15 15 16 10 10 12 16 10 10 12 16 16 10 16 1	band 10 13 16 20 25 32 40 50 61 15 10 10 125 10 10 125 10 100 125 10 125 150 1	band 10 13 16 20 25 32 40 50 61 15 10 20 250 30 400 100 <t< td=""><td>band 10 13 16 20 25 32 40 60 630 630 100 150</td><td>band 10 13 16 20 25 3 40 60 150 60 150</td><td>band 10 13 16 20 25 3 40 60 630 630 100 150</td></t<>	band 10 13 16 20 25 32 40 60 630 630 100 150	band 10 13 16 20 25 3 40 60 150 60 150	band 10 13 16 20 25 3 40 60 630 630 100 150

Table 3b. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thick ice conditions - Low-frequency cetaceans M-weighting applied

_											
	20000	138	130	120	104	55					
	16000	141	133	125	112	9/					
	12500	143	136	128	119	93	35				
	00001	145	138	131	123	103	61				
	8000	144	141	137	132	119	100	45	9		
	0069	149	145	141	136	126	112	2.2	23	33	11
	9009	149	145	140	137	127	114	85	29	49	33
	4000	146	142	138	43	123	113	87	20	28	41
	3150	149	146	142	136	128	118	94	28	99	54
	2500	152	148	146	138	131	120	86	85	74	61
	2000	152	148	144	139	130	121	100	98	92	64
	1600	153	151	144	141	132	123	101	06	62	89
	1250	155	152	146	142	133	125	104	92	83	73
	1000	157	153	146	142	134	125	105	94	84	75
	800	157	154	148	145	135	127	108	96	87	82
	089	157	3 152	3 148	3 143	133	125	105	26 2	£8 t	5 74
	0 200	0 158	5 153	0 148	5 143	7 136	8 126	901 9	92 92	83 84	75 75
	400	160	155	150	145	137	128	106			Ш
	315	160	155	150	144	136	127	3 104	88 8	80 80	8 71
	250	16	156	150	145	137	128	103	88		89
	200	162	157	150	146	138	127	103	98 /	9/ 1	19
	160	163	160	153	147	138	127	103	28	74	19
	125	164	159	155	149	139	127	103	85	89	52
	100	161	158	154	148	137	124	101	77	22	38
	80	162	159	154	147	136	124	96	29	42	22
	63	160	158	151	143	132	117	98	51	20	
	99	157	155	149	141	128	115	62	38		
	40	151	150	146	138	125	111	89	20		
	32	161	158	153	145	132	118	29	10		
	25	167	163	159	150	138	123	9			
	20	171	167	161	<u>\$</u>	141	125	62			
(HZ)	16	174	169	163	155	143	127	25			
ency	13	167	163	157	152	142	128	23			
Frequency	10	166	162	157	150	140	126	99			
broad	pand	178	173	168	161	150	138	115	101	92	83
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 3c. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thick ice conditions - Mid-frequency cetaceans M-weighting applied

46 26 3 66 68 100 125 11 12 13 14	broad Frequency	Frequency	enco		(HZ)																													
136 136 134 128 137 143 149 156 156 156 156 156 156 157 156 157 156 157 156 157 156 157 156 157 156 157	band 10 13	13			16	20		32 4	19 0:)			125						300	_	,		_	_			4000	2000	6300	8000	10000	12500	16000	20000
131 132 133 131 137 136 141 446 148 162 165 163 163 164 145 142 145 148 145 148 146 148 146 148 146 146 148 147 148 147 148 148 147 147 147 147 147 147 147 147 147 147	168 123 127		127	⊢	137			34 12	13.	٦١.	- 1	,	156	158			,		,	0					Ш		· .	00	150	145	146		144	ð
126 127 128 126 122 129 135 141 144 147 148 147 148 147 148 147 148 147 148 148 147 148 148 148 148 148 149 148 149 148 149 148 149 149 148 149 149 149 149 149 149 149 149 149 149	164 118 12		12	123	Н			ш	2	2	-	,	152	155	ै	_	l	Ì.	`		,				,		,		L	142	140	138	137	135
118 119 119 118 116 121 127 134 137 141 141 142 143 142 144 142 142 144 142 144 142 144 145 144 145 144 145 144 145 144 145 145	157 113 1	113 1	_	17				¥ .	17	100		144	147	148	0	0	,	`	,	0	0	,		0			,		142	138	133	131	128	9
105 107 107 106 102 108 116 123 127 131 133 134 134 134 135 135 135 135 135 135 135 135 135 135	152 107	107	1	111	118					1		5	141	141	9			0	,						8		9		Ĺ	133	124	Ì	116	0
90 91 92 91 88 88 96 101 111 114 120 122 123 125 126 127 126 127 126 127 127 127 127 127 127 127 127 127 127	143 97	26		102	105	ш				1		_	131	133			,	8	,		0	Ĺ				Ĺ	0		`	120	104	96	80	ງ9
20 28 34 40 45 59 70 82 95 99 101 105	134 82	82		87	90	91		Ш		1(9	114	`	122	88	0	8	_	8	Ţ.				,	1	Ù	,	,	ι	101	63	28		
35 54 67 77 82 82 85 87 91 91 92 95 94 92 90 86 85 78 71 68 54 84 29 47 60 68 72 75 75 78 82 83 83 86 84 83 79 76 74 66 58 50 34 84 85 89 44 85 60 65 60 65 60 74 74 74 74 77 75 73 68 64 61 64 74 74 33 11	114 12	12		13	20	28				8	3,372	Comp	98	86	66				0	Ø				Ĺ			2,5%			46				
29 47 60 68 72 75 78 82 83 83 86 84 83 79 76 76 66 56 50 50 8	101					H	Н	Ц	11	0.00		29	2.2	82	82	82		Ш			8788	Ш					8	89		4				
28 44 55 60 65 69 74 74 77 77 75 73 68 64 61 51 54 41 33	92					H	Н	Ц	Ц	4	-100	-55	09	89	72	75		82			183	Ш		8			1000		34					
	82					H	Н	Ц	Ц		6		0330	22	09	9												33						

Table 3d. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thick ice conditions - High-frequency cetaceans M-weighting applied

		20000	143	135	125	109	09					
	40	16000	144	137	128	116	80					
	1000	12500	145	138	131	121	96	37				
	5	100001	147	140	133	124	104	63				_
200		8000	145	142	138	133	120	101	46	2		
9 2		8 0069	150	146	142	137	127	113	82	54	34	11
9		9000	150	146	141	137	127	115	98	89	20	33
ingii ii cqueile) cettecetiis iii weigiitiig applied	1	4000	146	142	139	134	123	113	87	71	28	41
200		3150	149	146	142	136	128	118	94	78	99	54
2		2500	152	148	146	138	131	121	86	85	74	61
400		2000	152	148	144	139	130	121	100	98	92	64
	3	1600	153	150	144	141	132	123	101	88	62	89
		1250	155	152	146	142	133	124	104	92	83	23
daming amon too contained to		1000	157	153	146	141	133	125	105	94	84	22
3		008 (157	153	148	144	135	126	107	95	98 8	22 8
	9	0 630	6 156	2 152	7 147	2 142	5 133	5 124	5 105	1 91	83 83	74 73
5		200	156	152	147	142	135	125	105	9	8	
		400	158	153	148	143	135	126	104	90	18 2	3 73
		315	157	152	147	141	133	124	101	98	22	89
country indicating in occasions inner,		250	3 156	151	146	141	132	123	66 /	84	73	9 63
2		200	156	121	144	140	132	121	26	08	02	89
5		160	155	152	145	139	130	119	96	79	99	53
		125	153	148	144	138	128	116	92	74	29	41
3		100	148	144	140	134	123	110	28	63	43	24
		08	145	142	137	130	119	101	82	09	22	4
		63	`	137	130	122	,	97	65	31		
2		90	133	131	124	117	104	91	54	14		
5		40	123	122	118	110	26	83	40			
5		25 32	129	8 126	3 121	113	101	98 /	35			L
3		20 2	131	8 128	123	114	2 102	86 87	23 29			L
2	3		132	128	122	114	102					L
2	(Hz)	16	132	126	121	113	100	85	15			
3	Frequency	13	122	118	112	106	26	82	8			Ĺ
2	Frequ	10	118	113	108	102	85	11	7			Ĺ
	broad	band	167	163	156	151	142	134	113	100	91	82
able od: Estimated soding levels at set I admitted of	Range	Œ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
-			ı	1	1	1	1	ı	33	92	ंं	٠.

Table 3e. Estimated sound levels at set radii from the Ore Carrier transiting in Steensbe Inlet, during thick ice conditions - Pinnipeds M-weighting applied

		20	<i>i</i>	7 8		, S					
		16000	144	137	128	116	42				
		12500	145	138	131	121	96	37			
		10000	146	140	132	124	104	63			
		0008	145	142	138	133	120	101	46	7	
		9300	150	146	142	137	127	113	82	54	34
		2000	150	146	141	137	127	115	98	89	90
		4000	146	142	139	134	123	113	87	11	99
,		3150	149	146	142	136	128	118	94	28	99
)		2500	152	148	146	138	131	121	86	85	74
		2000	152	148	144	139	130	121	100	98	92
		1600	153	151	145	141	132	123	101	06	62
		1250	155	152	146	142	133	125	104	6	83
		1000	121	153	146	142	134	125	105	94	84
		008	157	153	148	144	135	127	108	66	98 (
		0 630	157	3 152	8 148	3 143	6 133	125	6 105	92 92	84 83
,		400 500	157	155 153	148	144	136 136	128 126	106 106	92 9	83 8
0		315 4	160 16	155 18	149 18	143 14	136 13	126 13	103 10	88	80
		250 3	160 1	155 1	149 1	144	136 1	127 1	102	87	2.2
		200	160	156	149	145	136	126	102	85	22
)		160	162	158	151	145	136	126	101	98	7.5
		125	161	157	152	146	136	125	100	82	99
		0 100	158	154	150	144	1 133	120	26 0	62 73	6 53
		e3 80	152 157	154	144 149	135 14	55 13	118	18 90	44 6	12 36
		9 09		45 150	139 14	131 13	18 125	05 110	2 69	28 4	Ĺ
		40	138 1	137 14	133 1	125 1	113 11	99 10	99	8	H
		32	145	142	137	129	117	102	51	H	\vdash
		25	147	144	139	131	119	103	45		l
		20	148	144	139	131	119	102	40		
	(HZ)	3 16	3 148	5 143	138	129	117	102	31		
	quency	10 13	138	135	129	9 123	114	94 99	24 25		L
	ad Frequ		171 135	166 130	160 125	154 119	145 109	136 9.	114 2	101	92
	broad	band									
	Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000
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	00 16000 20000	128 127 127	121 120 119	114 112 110	105 102 97	87 77 64	19				
	10000 1250	130	123	116	108	94	64				
	0008 0009	133 133	130 129	125 124	120 120	114 112	106 105	98 95	94 91	92 86	88 80
	4000 5000	135 134	131 131	127 126	122 122	115 114	107 107	86 86	95 26	94 94	68 06
	2500 3150	138 137	135 134	130 128	125 124	117 116	111 109	102 100	86 66	26 26	92 91
	1600 2000 2	140 139	136 134	131 131	126 127	118 117	111 110	102 102	86 66	26 86	92 92
	000 1250 1	143 141	139 138	133 134	129 127	121 119	113 112	104 103	101 100	101 100	96 94
	630 800 10	145 143 1	140 140 1	137 134 1	129 130 1	121 122 1	115 114 1	104 104 1	101 102 1	100 101 1	96 98
	400 500 (147 147	141 142	135 136 ′	132 131	122 123	115 115	104 105	101 102	100 101	96 96
	250 315	149 148	144 143	140 137	135 133	124 125	116 115	103 104	100 100	66 66	94 94
	160 200	151 149	147 145	141 139	135 133	125 124	115 115	102 102	66 66	66 86	91 94
	100 125	153 152	150 146	145 141	139 137	127 126	115 113	102 99	38 35	94 94	92 90
	63 80	159 157	155 154	,	,	128 129	115 116	101 99	94 97	880	87 91
	2 40 50	3 153 158	148 153	146 147	2 136 139	3 122 125	1 108 112	86 93	79 87	3 72 82	5 71 78
	0 25 32	4 145 148	9 142 145	3 135 140	5 129 132	9 113 118	2 96 101	22 29 6	99 99	5 46 58	1 43 55
y (Hz)	13 16 20	133 141 144	128 135 139	2 130 133	6 121 126	108 109	86 89 92	45 52 59	29 37 46	15 25 35	10 21 31
ad Frequenc	10	165 131 13	161 127 12	155 121 122	148 115 116	135 104 105	125 84 8	114 40 4	111 22 2	109 8 1	103 2 1
Range broad	(m) band	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000 1

Table 4b. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during open water conditions - Low-frequency cetaceans M-weighting applied

	0	7	4	ιΩ	7	29					\Box
	2000	122	114	105	92						
	16000	124	116	108	98	74	15				
	12500	126	118	111	103	84	44				
	10000	128	121	114	107	92	62				
	8000	131	127	123	119	111	104	94	06	85	29
	6300	133	130	125	120	113	105	46	93	91	87
	2000	134	130	125	121	113	106	26	96	93	88
	4000	135	131	126	122	115	107	86	26	94	88
	3150	137	134	128	123	116	109	100	86	26	91
	2500	138	135	130	125	117	111	102	66	26	92
	2000	139	134	130	126	117	110	102	86	46	92
	1600	140	136	131	126	118	111	102	66	86	92
	1250	141	138	134	127	119	112	103	100	100	94
	1000	143	139	133	129	121	113	104	101	101	96
	800	143	140	134	130	122	114	104	102	101	95
	630	145	140	137	129	121	115	104	101	100	95
	200	147	142	136	131	123	115	105	102	101	96
	400	147	141	135	132	122	114	104	101	100	96
	315	148	143	137	133	125	115	104	100	66	용
	250	149	144	140	135	124	116	103	100	66	94
	200	149	145	139	133	124	115	102	66	66	94
	160	151	147	141	135	125	115	102	66	86	91
	125	152	146	141	137	126	113	66	98	94	90
	100	153	150	145	139	127	115	102	86	94	92
	80	157	154	150	142	129	116	101	46	94	90
	63	159	155	150	141	2.0	115	66	94	88	87
	90	157	153	147	139	125	111	93	87	82	78
	40	152	148	146	135	121	107	98	62	72	70
	32	148	144	140	132	117	101	9/	29	28	22
	25	144	142	134	128	113	96	99	22	46	43
	20	143	138	132	125	108	91	28	45	34	30
(Hz)	16	139	134	128	119	107	88	51	35	24	19
uency (13	130	125	120	114	103	84	43	26	13	8
Fredu	10	128	123	118	112	100	80	37	18	4	П
broad	pand	165	160	155	147	135	125	114	111	109	103
Range	Ē	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 4c. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during open water conditions - Mid-frequency cetaceans M-weighting applied

ā	road Fr	Frequency	cy (Hz)																														
Ď	pand	10	13 1	16 20	0 25	32	40	09	63	. 08	1001	125 10	160 200	0 250	315	400	009	089	800	1000	1250	1600	2000	2500	3150 4	\$ 000t	9 0000	08 0069	000 10	000 13	12500 16	0009	20000
	156	84 (90 1C	102 108	114	121	129	138	143	144	143 1	144 14	146 146	147	146	146	146	145	143	143	141	140	139	138	137	135	134	133	133	130	128	127	127
300	151	80	3 82 6	96 104	111	117	125	133	139	141	139 1	139 17	142 147	1 141	141	140	141	139	139	139	138	136	134	135	134	131	131	130	129	123	121	120	119
000'	146	74	ŝ 6/	91 98	8 103	113	122	121	133	137	135 1	133 13	136 135	5 137	136	134	135	136	134	133	134	130	131	130	128	127	126	125	124	116	114	112	110
000	140	. 89	3 P/	82 90	26 0	105	112	119	125	129	128 1	130 13	129 129	9 133	131	131	130	129	129	128	127	126	127	125	124	122	122	120	120	108	105	102	97
10,000	130	9 / 29	62 E	12 69	74 82	16	86	105	112	116	117 1	118 12	120 120	121	123	121	122	121	121	120	119	118	117	117	116	115	114	114	112	94	28	2.2	64
30,000	122	37 4	44	50 57	29 /	74	84	85	66	103	104 1	105 10	111 601	1 113	114	113	115	114	114	112	112	111	110	111	109	107	107	106	105	64	46	18	
000'	112	H	3 1	13 24	4 36	49	63	23	83	88	91	91	6 /6	98 100	102	103	105	103	104	104	103	102	102	102	100	86	86	86	98				
000	109	H	Н	11	1 24	40	99	29	28	84	88	87	93 9	96 98	66 8	66	101	101	102	101	100	66	86	66	86	26	98	94	91				
000	108	H	Н		15	31	49	62	71	81	83	98	92 9	96 96	26 9	66	100	100	101	101	100	86	26	26	26	94	94	92	98				
000	102				12	58	47	89	11	2.2	82	82 8	6 98	90 92	5 92	66	96	94	96	96	94	92	92	92	91	06	68	88	80				

Table 4d. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during open water conditions - High-frequency cetaceans M-weighting applied

1		_		_	_		_					_
		0007	121	119	110	46	64					
		16000	127	120	112	102	77	18				
		12500	128	121	114	105	87	46				
		0000	130	123	116	108	94	64				
50		8000 1	133	129	124	120	112	105	96	91	98	80
5		0009	133	130	125	120	114	106	86	94	92	88
		2000	134	131	126	122	114	107	86	95	94	88
		4000	135	131	127	122	115	107	86	97	94	90
2		3150	137	134	128	124	116	109	100	86	46	91
	400	2500	138	135	130	125	117	111	102	66	26	92
		2000	139	134	130	126	117	110	102	86	26	92
		1600	140	136	130	126	118	111	102	66	86	92
0		1250	141	137	134	127	119	112	103	100	100	94
		1000	143	139	133	128	120	112	104	101	100	96
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		630	144	139	136	128	121	114	103	101	100	94
		200	146	141	135	129	121	114	104	100	66	96
6		5 400	145	139	133	130	120	113	102	66 8	86 9	1 93
	2.00	315	145 145	9 140	5 135	130	122	1 112	101	86 96	94 96	90 91
1		200 250	143 14	139 139	133 135	127 131	118 120	111	6 96	93 9	6 86	6 88
		160 20	143 14	139 13	133 13	127 12	117 1	107 10	94	3 06	06	83
6		125 1	141 1	135 1	130 1	126 1	115 1	102 1	88	84	83	42
		1001	139	136	131	125	113	101	88	84	80	8.4
		80	140	137	133	125	112	86	84	80	2.2	73
		63	138	134	1	121	107	94	28	73	29	99
)		09	133	129	123	115	100	87	69	29	29	54
		40	124	120	118	107	93	92 6	99 9	51	44	3 42
5		5 32	116	112	8 108	2 100	98 /	69 09	1 45	19 35	10 26	7 23
		20 25	103 109	90 106	86 86	86 92	22 69	52 60	19 31	1 18	11	Ĺ
	1	16 2	97 10	91 8	6 98	8 22	64 6	45 5	8 1			
	icy (Hz)	13 1	3 98	s 08	74 8	1 69	9 /9	39 4	L		L	L
	Frequency	10	62	12	69	63	52	32				
	broad Fr	pand	155	150	144	138	129	121	112	109	108	102
	-	Ď	100	300	1,000	3,000	000	000	000	000	000	000
	Range	Ξ	1	6	1,0	3,0	10,000	30,000	100,000	150,000	200,000	250,000

Table 4e. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during open water conditions - Pinnipeds M-weighting applied

	20			,	, ,	7 5	, .		2 8	
	16000	127	120	112	101	22	18			
	12500	128	121	114	105	87	46			
	10000	130	123	116	108	94	64			
	8000	132	128	124	120	112	105	98	91	98
	6300	133	130	125	120	114	106	86	94	92
	2000	134	131	126	122	114	107	86	92	94
	4000	135	131	127	122	115	107	86	26	94
	3150	137	134	128	124	116	109	100	86	26
	2500	138	135	130	125	117	111	102	66	26
	2000	139	134	131	121	117	110	102	86	16
	1600	140	136	131	126	118	111	102	66	86
	1250	141	138	134	127	119	112	103	100	100
	1000	143	139	133	129	120	112	104	101	101
	800	143	140	134	130	122	114	104	102	101
	0 630	145	139	136	1 129	121	5 115	5 104	1 101	100
	00 200	146 147	142	135 136	132 131	122 122	114 115	104 105	100 101	100
	315 400	148 14	143 14	137 13	132 13	124 12	115 11	104 10	100 10	99 10
	250 3	149 1	143 1	139 1	135 1	123 1	115 1	102 1	1001	86
	200	148	144	138	132	123	114	101	86	86
	160	149	145	140	133	123	113	101	26	96
	125	150	144	138	135	123	110	96	82	16
	100	149	146	141	135	123	111	86 9	94	90
	3 80	1 151	149	145	136	1 123	110	1 96	7 92	88 0
	50 63	12 12	43 147	142	134	15 127	107	83 91	17 87	72 80
	40	139 14	135 14	133 13	123 13	109 1	95 10	73	. 99	. 69
	32	132 1	128 1	124 1	116 1	102 1	85	09	51	42
	25	125	122	115	109	. 66	92	47	36	56
	20	120	115	110	102	98	69	98	22	12
(Hz)	16	114	108	102	93	18	62	25	6	
hency	0 13	102	1 97	16 91	98 0	9 74	9 22	5 15		L
d Frequ	10	96 09	16 91	98 09	08 81	12 69	124 49		0	109
broad	band	160	155	150	143	132		113	110	Ĺ
Range	Ē	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000

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5a. Estimated sound levels at set radii from the	
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Table 5a. Estimated sound levels at set radii from the	

	9	ıΩ	<u></u>	9	0	52					
	2000	135	127	116	100	00.1					
	16000	136	128	119	107	72					
	12500	137	129	121	111	98	26				
	10000	138	131	124	115	96	53				
	8000	139	134	130	125	113	96	53	25		
	9300	142	137	134	128	117	19	69	47	56	သ
	2000	142	138	133	128	117	106	78	09	42	25
	4000	141	136	132	127	117	106	81	99	20	36
	3150	143	139	135	129	120	109	87	73	09	47
	2500	145	141	136	131	122	112	90	78	29	22
	2000	146	142	137	135	122	113	91	80	69	69
	1600	147	143	138	133	123	113	94	83	72	63
	1250	148	145	141	134	124	115	96	82	9/	29
	1000	149	145	139	136	126	116	26	88	78	20
	800	152	146	141	137	127	117	66	88	81	72
	630	151	145	142	136	126	116	86	88	80	73
	900	152	147	142	136	127	116	66	06	81	73
	400	154	148	142	138	128	117	99	91	83	75
	315	155	148	144	138	129	117	66	91	82	74
	250	155	149	145	140	128	117	66 (91	92	7 75
	0 200	8 155	2 15′	8 144	1 138	129	118 118	0 100	93 92	28 2	79 77
	125 160	158 158	33 152	147 148	143 14	30 130	117 11	100	94 9	89 87	84 7
	100 12	157 15	154 153	149 14	142 14	130 130	117 11	101 100	5 96	3 06	87 8
	1 08	160	157 13	153 1	144 1	130	117 1	101	96	91	98
	63	160	156 1	150 1	142	128 1	115 1	98	92	82	83
	20	157	154	147	139	125	111	91	84	29	75
	40	154	149	146	136	122	107	82	77	20	89
	32	154	151	146	138	124	107	81	71	61	29
	25	156	153	146	140	123	107	9/	64	22	52
	20	158	153	147	140	124	106	72	58	47	43
(20)	16	158	152	147	137	125	106	89 8	5 52	3 41	36
rieduelicy	0 13	1 152	6 147	1 141	5 135	3 124	3 105	9 63	0 46	6 33	0 28
LIE	10	151	146	14,	135	123	7 103	0 59	13 40	97 26	92 20
DIOGO	band	169	164	159	15.	139	127	11	103	6	
Rallige	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 5b. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thin ice conditions - Low-frequency cetaceans M-weighting applied

_	_	_	<u>α</u>	_	ıo	<u></u>					_
	3000	130	122	111	96	47					
	16000	132	124	115	103	89					
	12500	135	127	119	109	84	24				
	0000	137	129	122	114	용	51				
	8000	138	133	129	124	112	92	25	24		
	0009	141	137	133	127	116	103	69	46	25	4
	2000	142	137	133	127	117	106	28	09	41	25
	4000	141	136	132	121	117	106	08	64	09	36
	3150	143	139	135	129	120	109	28	23	09	47
	2500	145	141	136	131	122	112	06	8/	19	22
	0007	146	3 142	137	134	3 122	113	16 1	3 80	69 2	3 59
	1600	147	5 143	138	133	123	5 113	5 94	2 83	76 72	2 63
	0 1250	9 148	5 145	9 141	136 134	126 124	116 115	96 26	88 85	4 84	70 67
	1000	152 149	146 145	139	137 13	127 12	117 11	6 66	8 68	81 7	72 7
	008 069	151 15	_	142 141	136 13	126 12	116 11	5 86	3 88	3 08	73 7
	9 009	152 1	147 1	142 1	136 1	127 1	116 1	66	06	81	73
	400	154	148	142	138	128	117	66	91	83	75
	315	155	148	144	138	129	117	66	16	82	74
	250	155	149	145	140	128	117	66	91	82	. 75
	0 200	8 155	2 151	8 144	1 138	0 129	8 118	001 0	93 92	82 85	79 77
	125 160	158 158	153 152	147 148	143 147	130 130	117 118	100 100	94 9	8 68	84 7
	100 13	157 1	Ĺ	0	142 14	130 1	117 1	101 11	96	1 06	87
	80 1	160	157	152 1	144	130 1	117	101	96	91	98
	63	160	156	150	141	Ι-	114	26	92		
	90	157	153	147	139	124	110	91	84	82	75
	2 40	4 153	149	6 146	8 136	3 122	7 107	84	17 77	1 70	89 8
	25 32	155 154	152 150	145 146	139 138	123 123	106 107	26 80	64 71	54 61	51 58
	20 2	157 15	152 15	146 14	139 13	123 12	105 10	71 7	9 /9	46 5	42 5
Hz)	16	156 1	150 1	146 1	136 1:	124 1:	105 1	. 29	51	39	35
uency (H	13	149	144	139	133	122	102	61	44	30	56
Freq	10	148	143	137	132	120	100	99	28	22	17
broad	pand	169	164	159	151	139	127	110	103	26	92
Range	Ξ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
		_				-	_				_

Table 5c. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thin ice conditions - Mid-frequency cetaceans M-weighting applied

Table 5d. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thin ice conditions - High-frequency cetaceans M-weighting applied

1						_						
		2000	135	121	116	100	25					
		16000	136	128	119	107	72					
		12500	137	129	121	111	98	26				
		0000	138	131	124	115	96	23				
		8000 1	139	134	130	125	113	96	23	25		
a ciginal g applica		0089	142	137	134	128	117	104	69	47	26	2
9		2000	142	138	133	128	117	106	28	09	42	25
9		4000	141	136	132	127	117	106	18	99	09	98
		3150	143	139	135	129	120	109	48	73	09	47
ingli independ companie		1 2500	145	141	136	131	122	112	06	18	19	99
6		2000	146	142	137	134	122	113	16 1	80	69 7	69 8
2		1600	3 146	142	138	133	123	113	5 94	5 83	76 72	9 9
9		0 1250	9 148	145	141	134	6 124	114	6 26	87 85)/ 8/	99 69
		1000	149	146 144	141 139	136 136	126 126	117 116	66	8 68	2 08	72 6
daming arming arming and		030 800	150 151	144 14	141 14	135 13	125 12	115 11	6 /6	8 /8	8 62	72 7
2		9 009	151 1	146 1	141	135 1	126 1	115 1	86	68	80	72
		400	152	146	140	136	126	116	26	68	81	73
		315	152	145	141	135	126	114	96	88	62	72
carrier transfering in 1 are pagin,		250	151	145	141	135	124	113	96	98	82	11
200		0 200	149	145	138	3 132	123	112	2 94	98 9	62 62	1 71
9		125 160	147 149	142 144	136 140	132 133	119 122	106 109	89 92	83 85	2 82	73 71
		100 12	143 14	140 14	135 13	128 13	116 17	103 10	8 / 28	82 8	. 22	73 7
		80 1	143 1	140 1	135 1	127 1	113 1	100	84	79	74	69
		63	139	135	129	121	107	94	22	71	64	62
		90	133	129	122	115	100	98	99	09	24	51
5		40	125	121	118	3 108	2 94	62 9	99 6	9 49	9 42	40
5		25 32	120 122	117 119	110 114	103 106	87 92	71 75	40 49	28 39	19 29	16 27
2		20 2	118 12	113 11	107	100 10	83	99	32 4	18		3
2	(zH)	16	114 1	108 1	103 1	93 1	81	62	24	6		
		13	104	66	94	88	92	29	16			H
,	Frequency	10	66	94	68	83	7.1	51	2			
	broad	band	161	156	150	144	134	124	106	96	88	82
rapio od: Estimated sound levels at set ladii illori illo ello	Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 5e. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thin ice conditions - Pinnipeds M-weighting applied

	20000	134	126	116	100	51					
	16000	136	128	119	106	71					
	12500	137	129	121	111	98	26				
	10000	138	131	123	115	96	52				
	8000	139	134	130	125	113	96	23	25		
	0069	142	137	134	128	117	104	69	47	26	IJ
	5000	142	138	133	128	117	106	28	09	42	30
	4000	141	136	132	127	117	106	81	9	90	30
	3150	143	139	135	129	120	109	87	73	09	44
	2500	145	141	136	131	122	112	90	78	29	22
	2000	146	142	137	135	122	113	91	80	69	02
	1600	147	143	138	133	123	113	94	83	72	CJ
	1250	148	145	141	134	124	115	98	85	9/	23
	1000	149	145	139	136	126	116	26	88	28	20
	008	152	146	141	136	127	111	66	68	18	44
	630	151	145	142	136	126	116	86	88	08	2.2
	200	152	147	142	136	127	116	66	90	81	7.2
	400	154	148	142	138	127	117	66	91	82	7.4
	315	155	148	143	137	128	117	86	90	81	72
	250	155	148	144	139	127	116	66	90	81	22
	200	154	150	143	137	128	117	86	91	84	24
	160	156	150	146	139	128	116	66	91	85	20
	125	156	150	144	140	127	114	26	91	98	ó
	100	154	150	145	138	126	113	86	92	87	00
	80	154	151	147	138	125	111	96	90	98	ó
	63	152	148	142	134	121	107	90	84	11	7.5
	90	147	143	137	129	114	100	81	74	89	20
	40	141	136	133	123	109	94	11	64	29	1
	32	138	135	130	122	107	91	99	22	45	40
	25	136	133	126	120	103	28	99	44	38	00
	20	134	130	123	116	100	82	48	35	54	UC
(Hz)	16	131	124	120	110	86	62	14	25	13	C
uency	13	121	116	110	105	66	74	32	15	7	
Frequ	10	116	111	106	100	88	89	74	9		
broad	band	165	160	154	148	137	126	108	100	94	00
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250 000

Table 6a. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thick ice conditions.

_											_
	20000	144	135	126	110	28					
	16000	145	137	129	116	29					
	12500	146	138	131	122	96	35				
	10000	147	140	133	125	104	19				
	8000	146	142	138	131	121	102	53	20		
	0069	150	147	142	137	126	112	17	99	35	13
	2000	150	146	143	136	127	115	85	89	20	34
	4000	147	144	139	133	123	113	88	71	99	42
	3150	150	146	142	137	128	111	66	80	99	55
	2500	152	150	144	140	130	119	86	98	92	63
	2000	153	149	146	141	130	120	100	88	9/ 1	9
	1600	154	150	146	141	131	121	103	9	08	70
	1250	156	152	148	142	133	123	105	94	83	74
	1000	157	153	148	143	134	123	105	96	85	77 6
	008 (158	155	149	145	135	125	108	98	88	3 79
	93(157	152	149	143	132	122	105	96	98	78
	900	160	155	149	144	134	125	106	26	88	79
	400	160	155	149	146	135	126	101	66	06	81
	315	160	155	149	145	136	125	106	86	88	79
	750	162	156	152	147	135	126	101	86	06	82
	200	162	121	121	145	136	125	101	66	16	83
	160	164	160	155	148	138	126	108	102	96	87
	125	165	159	154	150	138	125	108	101	96	90
	100	162	158	154	147	135	123	108	103	26	92
	08	162	160	156	147	134	121	106	101	96	91
	63	161	157	151	143	130	111	101	95	88	98
	09	158	154	148	140	126	113	94	88	83	28
	40	154	150	148	137	124	110	88	81	74	73
	32	161	158	153	145	131	115	90	81	72	69
	25	168	165	157	151	136	118	90	79	69	99
	20	173	168	162	155	138	121	88	75	65	61
(ZH)	16	175	169	164	155	143	123	98	71	09	99
uency (13	170	166	160	154	143	124	83	29	53	49
Frequ	10	111	166	161	155	143	123	80	62	47	42
broad	band	180	175	169	162	150	135	117	110	103	96
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 6b. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thick ice conditions - Low-frequency cetaceans M-weighting applied

	20000	138	130	121	105	53					
	16000	141	133	125	113	75					
	12500	143	136	129	119	92	33				
	10000	145	138	132	123	103	09				
	8000	145	141	137	130	120	101	29	19		
	6300	149	146	141	137	125	111	92	99	34	12
	0009	150	146	143	136	121	115	98	19	09	33
	4000	146	143	139	133	123	112	28	11	99	42
	3150	150	146	142	137	121	111	66	08	99	99
	7500	152	150	144	139	130	119	86	98	92	63
	2000	153	149	146	141	130	120	100	28	92	99
	1600	154	150	146	141	131	121	102	16	08	70
	1250	156	152	148	142	133	123	104	6	83	74
	1000	121	153	147	143	134	123	105	96	98	22
	800	158	155	149	145	135	125	108	86	88	79
	089 (157	152	149	143	132	122	105	96 /	98 8	8/ 6
-	009 0	0 160	5 155	9 149	144	134	125	106	26 6	88 0	1 79
	5 400	0 160	5 155	9 149	5 146	135	5 126	107	66 86	88 90	79 8′
	34	162 160	56 155	52 149	147 145	135 136	26 125	107 106	6 86	8 06	82 7
	200 250	162 16	57 15	151 15	145 14	136 13	125 12	107 10	66	91 6	83 8
	160 2	164 1	1 09	155 1	148	138	126 1	1 80	02	96	87
8	125 1	165	159 1	154 1	150 1	138 1	125 1	108	101	96	90
8	100	162	158	154	147	135	123	108	103	26	92
	80	162	160	156	147	134	121	106	101	96	91
	63	161	157	151	143	130	117	100	96	88	98
	09	158	154	148	140	126	112	94	88	82	78
	40	154	150	147	137	123	110	88 (81	74	73
	5 32	191	157	6 153	144	5 130	114	06 6	8 81	11	9 9
9	20 25	172 167	164	156	150	135	118	82 89	74 78	64 69	9 09
_	16 2	174 17	168 167	162 161	154 154	141 137	122 120	82 8	2 02	9 89	54 6
cy (Hz)	13	168 1	163 10	158 1	152 1	141 14	122 13	81	. 64	51	46
Frequence	10	167 1	163 1	157 1	152 1	140 1	120 1:	2.2	28	44	38
broad Fr	pand	179 1	174 1	168 1	161 1	149 1	135 1	117	110	103	96
Range bi	(E)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 6c. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thick ice conditions - Mid-frequency cetaceans M-weighting applied

	000 16000	146 145	138 137	131 129	121 116	94 79	35				
	000 12500	147 1	140 1	133 1:	125 13	104	61				
	8000 10	146	142	138	131	121	102	53	20		
	8 0069	150	147	142	137	126	112	2.2	99	35	13
	2000	150	146	143	136	127	115	98	89	9	34
	0 4000	150 147	146 144	142 139	137 133	128 123	117 113	93 88	80 71	99 99	55 42
	2500 3150	152 18	150 14	144 14	140 13	130 12	119 11	3 86	3 98	9 92	63
	2000 2	153	149	146	141	130	120	100	87	92	99
	1600	154	150	146	141	131	121	102	91	08	02
	1250	156 156	152	148	43 142	134 133	122	105 104	95 94	85 83	77 74
	800 1000	158 15	154 153	148 147	145 14	134 13	125 123	108 10	6 86	88	7 67
	8 089	121	151	148	143 1	131 1	121 1	104	96	98	2.2
	008 00	159	154	148 148	145 143	133	125 124	106 105	96 26	88 68	80 79
	315 400	159 159	154 154	148 14	143 14	134 134	123 12	104 10	6 96	8 /8	8 8/
	250	159	154	149	145	132	123	105	96	87	62
	160 200	158 158	155 153	149 147	142 141	132 132	21 122	103 104	96 98	91 88	82 79
	125 16	157 15	151 15	146 14	142 14	130 13	117 121	100 10	94 8	68	82 8
	100	152	148	143	137	125	113	86	66	48	82
	63 80	144 149	140 147	135 143	127 134	14 121	101 108	84 93	88 64	72 83	82 69
	90	138 14	134 14	128 13	120 12	106 17	93 10	74 8	89	63	989
	40	131	126	124	114	100	98 /	99 8	89 1	5 51	49
	25 32	136 134	133 130	126 126	120 118	104 104	87 87	28 63	47 54	38 45	35 42
	20	137 1	133 1	127 1	120 1	103 1	98	23	40	30	26
y (Hz)	13 16	136	131	7 125	112 116	104	1 84	.1 48	24 32	11 21	17
Frequency	10 1	124 128	119 123	114 117	108 11	96 100	76 81	33 41	15 2	1	
broad F	pand	169	164	158	153	143	132	114	105	26	68
Range	Œ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 6d. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thick ice conditions - High-frequency cetaceans M-weighting applied

broad		Frequency	ncy (Hz)																													
9	pand	10	13 1	16 2	20 25	32	40	20	63	80 10	100 12	125 160	0 200	250	315	400	200	8 089	800 10	000 1250	ı	600 2000	00 2500	3150	4000	2000	0089	8000	10000	12500	16000	20000
· -	168	119 1	123 13	131 132	131	129	126	134	0	145 14	148 15	54 156	3 156	157	158	158	158	157 1	158 1	156 1	56 1	54 15	153 152	150	147	150	150	146	147	146	145	143
Ĭ	163 1	114 1	118 12	126 128	8 128	125	122	129 1	136 1	143 14	144 14	148 152	151	152	153	154	154	151 1	154 1	153 1	52 1	50 14	149 150	146	144	146	147	142	140	138	137	135
•	157 1	109 1	112 12	120 122	121	121	119	124	130 1	138 14	140 14	143 146	5 145	148	147	147	148	148 1	148 1	147 1	48 14	46 14	146 144	142	139	143	142	138	133	131	129	126
Ĭ`	152 1	103 1	107 11	11 115	5 115	113	109	116 1	122 1	130 13	33 13	139 140	139	143	142	144	142	142 1	145 1	143 1	42 14	141 141	1 140	137	133	136	137	131	125	121	116	110
Ĭ`	142	91	3 26	66	98 100	66	96	101	109 1	117 12	127 127	129	130	130	133	133	133	131 1	134 1	134	133 13	131 130	0 130	128	123	127	126	121	104	94	62	28
Ĭ	131	7.1	1 91	19 81	1 82	83	81	88	96 1	104 10	11 601	14 118	3 119	121	122	124	123	121	125 1	123 1	22 1:	121 12	120 119	117	113	115	112	102	61	35		
Ĭ	113	28	36 4	43 4	48 54	- 58	09	20	80	68	94 9	97 100	101	103	103	105	104	104 1	107 1	105 1	104	02 10	100	93	88	98	22	53				
	104	10	19 2	27 3	35 43	49	53	63	22	84 8	6 68	90 93	3 93	93	92	97	96	95	86	95	94	91 8	87 86	90	71	89	99	20				
	96		9	16 2	25 33	40	46	28	89	3 62	83 8	82 88	3 85	85	98	88	87	85	88	85	83 (80 7	2 92	22 66	99	20	32					
	87	-	-	12 21	1 30	37	45	24	9	74	7 87	62 62	22 6	22	22	79	78	2.2	13	92	74 (9 69	65 63	3 55	42	34	13					

Table 6e. Estimated sound levels at set radii from the Ore Carrier transiting in Foxe Basin, during thick ice conditions - Pinnipeds M-weighting applied

		m	ıO	ıo	6	m					_
	20000	143	135	45 31	109	28					
	16000	144	137	129	116	28	5 1		3. 3.		
	12500	146	138	131	121	94	35				
	10000	147	139	133	125	104	61				
	0008	146	142	138	131	121	102	23	20		
	0089	150	147	142	137	126	112	2.2	99	35	٠,
	2000	150	146	143	136	127	115	85	89	90	, ,
	4000	147	144	139	133	123	113	88	11	99	•
	3150	150	146	142	137	128	117	93	80	99	
	2500	152	150	144	140	130	119	86	98	22	
	2000	153	149	146	141	130	120	100	88	92	
	1600	154	150	146	141	131	121	103	91	80	-
	1250	156	152	148	142	133	123	104	94	83	,
	1000	157	153	147	143	134	123	105	98	98	***
	800	158	155	148	145	135	125	108	86	88	-
	069 0	157	5 152	149	3 143	132	122	5 105	96 2	98 8	
	009 00	160	155 155	149 149	146 143	134	126 124	105	26 86	88 06	
	315 400	160 160	155 15	149 14	145 14	135 135	124 12	106 107	6 16	6 88	-
	250 3	161 1	155 1	151 14	146 14	134 1:	125 13	107 1	26	68	,
	200 2	161 1	156 1	150 1	144	135 1	124 1	106 1	86	06	
	160	162	158	153	146	136	125	107	100	94	
	125	162	156	151	147	135	122	105	66	94	-
	100	158	154	150	143	132	119	104	66	66	00
	80	157	154	150	142	129	116	100	96	16	
	50 63						2 109	84 93	88 22	72 81	00
			137 144	35 138	124 130	11 116	97 102		2 89	61 7	
	32 4	145 14	141 13	137 13		115 17	86	. 4/	9 9	99	
		148 1	145 1	137 1	131 1	116 1	86	20	69	49	•
		149	144	139		115	86	99	52	41	-
(HZ)	16	148	142	137	128	115	96	69	44	33	00
uency (13	140	135	129	124	112	93	23		23	,
Freq	10	H	131	125		108	88	3 45	3 26	1 12	
broad	band	8	166	160	155	144	133	116	108	101	
ange	(m)	100	300	1,000	3,000	10,000	30,000	000'00	50,000	000'00	000

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Range	broad	d Frequ	nency	(Hz)																															
(m)	band	16	13	3 16	20	25	32	40	90	63	08	100	125 1	160 2	200 2	250 3	315 4	400 5	9 009	08 08	800 1000	1250	0 1600	0 2000	0 2500	0 3150	0 4000	0009 0	0089 0	8000	10000	12500	16000	2000	0
100	163	133	134	138	141	146	150	153	155	157	155	152	151 1	150 1	149 1	147 1	147 1	146 1	145 14	143 14	143 14	142 141	139	9 139	138	137	7 135	5 134	134	132	132	128	127	121	7
300	158	119	124	130	131	138	140	145	150	151	152	149	146 1	144	143 1	143 1	142 1	140 1	139 13	139 13	139 13	137 136	6 134	4 134	133	3 132	130	128	127	127	124	119	118	118	8
1,000	152	113	3 117	123	126	128	134	139	143	146	145	143	139 1	137 1	136 1	137 1:	135 1	135 1	133 13	132 13	133 131	31 130	0 130	0 128	8 128	127	7 126	5 125	124	122	122	112	111	109	6
3,000	145	109	113	3 116	120	121	129	133	135	139	141	137	134 1	133 1	132 1	132 1:	131 1	131 1	129 13	129 13	129 12	126 125	5 124	4 125	5 123	3 122	120	119	119	119	111	108	105	100	О
10,000	138	100	102	106	111	114	120	124	129	132	132	132	129 1	127 1	127 1	127 1:	125 1	124 1	124 13	124 13	122 121	21 121	1 119	9 118	8 118	117	115	5 114	114	113	111	06	80	9	89
30,000	125	5 84	4 87	06 /	95	66	104	109	114	118	117	117	115 1	116 1	113 1	114 1	113 1	113 1	110 1	111 1	111 11	112 108	107	108	8 106	107	7 105	5 103	3 103	102	26	49	21		
100,000	120	74	6/ 1	83	88 8	1 92	86	103	108	111	112	111	110 1	110 1	109 1	109 1	109 1	108 1	107 10	106 10	106 10	105 105	5 104	4 103	3 102	100	66 0		26 86	96	83				
150,000	118	89 8	8 74	08 t	98 (06	96	101	107	109	110	111	108	110 1	110 1	110 1	109	108 1	108 10	107 10	107 10	107 106	6 103	3 102	2 103	3 101	1 99	6 97	26 2	96	92				
200,000	113	3 54	4 62	71	18	83	16	96	100	103	103	104	104 1	104 1	106 1	105 1	105 1	104 1	103 10	101 10	101 10	102 101		6 66	6 86	6 66	95 95	5 94	4 94	90	19				
250,000	112	2 40	0 51	1 63	71	79	28	92	- 26	100	100	101	101	101	103 1	102	102	100	101	100	99 10	100	6 86	6 /6	6 96	6 96	94 92	2 91	1 92	98	09				П

Table 7b. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during open water conditions - Low-frequency cetaceans M-weighting applied

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	2000	121	113	103	95	62					
	16000	124	115	107	101	11	17				
	12500	126	117	110	105	87	47				
	00001	130	123	120	115	109	96	82	75	99	28
	8000	131	126	121	118	112	101	94	94	68	85
	6300	133	127	123	118	113	102	26	96	94	91
	2000	134	128	125	119	113	102	86	46	94	91
	4000	135	129	126	120	115	104	66	66	98	92
	3150	137	132	121	122	116	101	100	101	96	94
	2500	138	133	128	122	111	106	102	102	66	95
	2000	139	134	128	125	118	108	103	102	86	96
	1600	139	134	130	124	119	107	104	103	66	97
	1250	141	136	130	125	121	108	105	106	101	98
	1000	142	137	131	126	121	112	105	107	102	100
	800	143	139	133	129	122	111	106	107	101	99
	630	143	139	132	129	124	111	106	107	101	100
	200	145	139	133	129	124	110	107	108	103	101
	400	146	140	135	131	124	113	108	108	103	100
	315	147	142	135	131	125	113	109	109	105	102
	250	147	143	137	132	127	114	109	110	105	102
	200	149	143	136	132	127	113	109	110	106	103
	160	149	144	137	133	127	116	110	110	104	101
	125	151	146	139	134	129	115	110	108	104	101
	100	152	149	143	137	132	111	111	111	104	101
	3 80	155	1 152	145	141	2 132	117	1 112	110	3 103	0 100
	63	15	151	14	13	13	۱ı	111	109	103	10
	90	155	150	143	135	128	114	108	107	100	96
	40	153	145	139	132	123	109	103	101	96 (92
	5 32	5 149	139	8 133	1 128	3 120	104	2 97	96 0	2 90	78 87
	20 25	140 145	130 138	125 128	119 121	110 113	94 99	87 92	85 90	77 82	70 78
	16 2	137 14	129 13	122 12	114 11	105 11	6 68	82 8	8 82	2 69	61 7
cy (Hz)	13 1	132 13	122 12	115 12	\Box	100 10	8 28	8 11	72 7	9 09	49 6
quency	10 1	129 13	116 12	110 11	106 111	96 10	8 08	2 02	64 7	9 09	37 4
Fred		52		5	9				200		
broad	band	163	158	152	145	138	125	120	118	113	112
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
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Table 7c. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during open water conditions - Mid-frequency cetaceans M-weighting applied

	20000	127	118	109	100	67					
	16000	127	118	111	105	80	21				П
	12500	128	119	112	108	06	49				
	10000	132	124	122	117	111	97	83	92	29	09
	8000	132	127	122	119	113	102	96	96	90	98
	6300	134	127	124	119	114	103	26	26	94	92
	2000	134	128	125	119	114	103	86	26	94	91
	4000	135	130	126	120	115	105	66	66	95	92
	3150	137	132	127	122	117	107	100	101	26	94
	2500	138	133	128	123	111	106	102	103	66	96
	2000	139	134	128	125	118	108	103	102	86	96
	1600	139	134	130	124	119	107	104	103	66	97
	1250	141	136	130	125	121	108	105	106	101	86
	1000	142	137	131	126	121	111	105	106	102	100
	008 (143	138	133	129	122	111	106	106	101	86 6
	0 630	4 143	8 139	3 131	8 129	3 123	0 110	901 9	701 7	100	66 0
	009 00	145 144	139 138	134 133	130 128	123 123	112 110	107 106	107 107	102 102	99 100
	315 400	146 14	140 1	133 13	129 13	124 13	112 1	107 10	107 10	103 10	100
	250 3	145 1	140 1	134 1	130 1	124 1	111	107 1	107 1	102	99
	200	145	139	132	128	123	109	105	106	102	66
	160	144	138	132	127	122	110	105	104	66	96
	125	143	138	131	126	121	107	103	100	97	94
	100	142	139	133	126	121	106	100	101	94	91
	63 80	140 142	35 139	0 132	22 128	6 119	02 104	86 98	93 97	87 90	4 87
	9 09	135 14	130 13	123 13	15 12	109 11	94 10	88	6 /8	8 08	77 84
	40	129 13	122 13	116 13	109 1	100 10	85	80	82	72	69
	32	122	112 1	107	101	93 1	2.2	7.1	69	63	09
	25	114	107	26	06	82	89	61	69	51	47
	20	106	96	91	85	92	69	53	90	42	36
(Hz)	16	66	91	98	22	29	51	44	41	32	24
lnency	13	5 91	2 82	5 74	2 70	09 ε	7 44	98 /	1 31	7 20	6
d Frequ	1	98 9	.9 72	99 8	8 62	2 53	37	5 27	5 21	2 0	0
broad	pand	155	149	143	138	132	120	115	115	110	110
Range	Ξ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 7d. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during open water conditions - High-frequency cetaceans M-weighting applied

Range	broad	Frequ	luency ((Z)																											4		
Œ	band	10	13	16	20	25	35	40	9 09	93 80	100	125	160	200	250	315	400	9 009	8 089	800 10	00 12	1250 1600	00 20	00 2500	31	50 4000	00 2000	089 00	0008 (10000	12500	16000	20000
100	154	18	98	94	101	109 1	117 1	125 13	131 136	138	3 138	140	141	143	143	144	144	143 1	142 1	142 1	142 1	141 1:	139 1:	139 13	138 137		135 13	134 134	132	132	128	127	127
300	148	19	22	98	91	102	108	117 12	125 130	135	135	135	136	136	138	139	138	137 1	138 1	138 1	136 1:	136 1:	134 1:	134 13	133 13	132 13	130 12	128 127	127	124	119	118	118
1,000	142	19	69	80	98	92 1	102	111 11	119 125	5 128	129	128	129	130	133	132	133	132 1	131 1	133 1:	131 1:	130 1:	130 1:	128 12	128 12	127 12	126 12	125 124	122	122	112	111	109
3,000	137	29 ,	99	72	80	85	1 96	104 11	11 11	8 124	123	123	125	126	128	128	129	128 1	128 1	129 1	126 1:	125 1:	124 1:	124 13	123 12	122 12	120 11	119 119	119	111	108	105	100
10,000	131	48	99	62	7.1	17	88	95 10	104 11	1 115	118	118	119	121	122	122	122	123 1	123 1	122 1	121 1:	121 1	119 1	118 1	117 11	117 11	115 11	113 114	113	111	06	80	67
30,000	119	32	68	46	22	63	7.5	81 8	6 68	97 100	103	104	107	107	110	111	111	109 1	110 1	111 1	111 1	108 1	107	108 10	106 10	107 10	105 10	03 103	3 102	26	49	21	
100,000	114	22	31	39	48	99	. 99	3 92	84 9	91 94	16 t	66 /	102	103	105	106	, 901	106 1	106 1	106 1	105 1	104 1	104	103 10	102 10	100	66	26 86	26 /	83			
150,000	114	16	56	36	45	54	. 64	73 8	83 8	88 93	3 97	7 97	102	104	105	106	, 901	107 1	106	106 1	106 1	106 1	103 1	102 10	103 10	101	66	26 26	26 /	9/			
200,000	109	2	15	27	38	47	- 69	2 29	8 9/	83 86	90	93	96	100	100	102	102	102 1	100	101	102 1	101	66	86	66	6 /6	95 6	94 94	06 t	29			
250,000	109		4	19	31	42	22	64 7	72 8	0 83	87	7 90	93	46	86	66	98	66	66	98 1	100	86	26	96	96	94 9	92 8	91 92	2 86	09			

Table 7e. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during open water conditions - Pinnipeds M-weighting applied

		_					_	_		_	
		20000	126	117	108	100	29				
		16000	127	118	110	104	80	21			
		12500	128	119	112	108	06	49			
		0000	131	124	122	117	111	26	83	92	29
		8000 1	132	127	122	119	113	102	98	98	06
		6300	134	127	124	119	114	103	26	26	94
		2000	134	128	125	119	113	103	86	26	94
		4000	135	130	126	120	115	105	66	66	98
0		3150	137	132	127	122	111	101	100	101	26
		2500	138	133	128	123	117	106	102	103	66
		2000	139	134	128	125	118	108	103	102	86
		0 1600	139	134	130	5 124	119	107	5 104	5 103	1 99
п		1250	141	136	1 130	3 125	121	108	5 105	106	101
		0 100	3 142	137	3 131	9 126	2 121	111	9 105	107	1 102
		08 089	143 143	139 139	131 133	129 129	123 122	111 111	106 106	107 107	101 101
		9 009	145 14	138 13	133 13	129 13	124 13	110 1	107 10	108 10	103 10
		400	145	140	135	130	124	113 1	108	108	103
		315	147	141	134	130	125	113	109	108	105
		250	147	142	136	132	126	113	109	109	104
		0 200	8 148	2 141	5 134	1 131	5 126	14 112	8 108	8 109	3 105
,		125 160	149 148	144 142	136 135	131 131	126 125	112 11	108 108	105 108	102 103
		1 001	149 1	145 1	139 1	133 1	128 1	113 1	107	107 1	1 00 1
		80	150	146	140	135	127	112	106	105	. 86
		63	149	144	139	131	125	110	104	102	96
		09 (145	140	133	125	118	104	86 (16	06
		32 40	3 140	3 132	8 126	119	110	96 88	82 90	88 08	74 82
		25 3	126 133	118 123	108 118	101 112	94 104	8 6/	72 8	8 02	63 7
		20	117 1	108 1	103 1	1 16	28	11	9	62	54
	(zh	16	111	103	96	68	62	63	99	23	44
		13	103	94	98	82	1.1	99	48	43	32
	Frequency	10	86	84	82 2	1 74	9 9	49	68 /	33	19
	broad	band	159	153	147	141	135	122	111	111	112
	Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000

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	da. Estimated sound levels at set radii from the	

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2000	135	124	11;	96	49					L			20000	130	118	106	06	44		
16000	136	126	114	102	69								16000	132	122	110	66	99		
12500	137	127	116	108	84	23		Г					12500	134	125	114	105	82	21	ľ
10000	138	129	119	112	94	48							10000	137	127	117	110	92	47	ŀ
8000	139	130	126	121	112	06	46	18		-	g		8000	138	129	125	120	111	88	45
8 0089	142	133	129	124	116	86	62	41	15	-	applie		6300 8	141	132	128	123	115	26	55
2000 6	142	133	129	124	118	100	72	53	31	12	hting		9 0009	142	132	129	124	118	100	42
4000 5	141	132	128	123	117	102	92	29	42	56	Carrier transiting in Hudson Strait during thin ice conditions - Low-frequency cetaceans M-weighting applied		4000	141	132	127	123	117	101	25
3150 4	143	135	131	126	119	104	82	89	20	36	ans M		3150 4	143	135	131	126	119	104	ć
2500	145	138	134	128	121	108	98	73	69	43	etace		2500	145	138	133	128	121	108	200
2000	146	139	134	127	122	108	88	77	19	20	ncy c		2000	146	139	134	127	122	108	90
1600	146	139	135	129	124	108	06	79	99	53	reque		1600	146	139	135	129	124	108	Š
1250	148	141	136	132	125	110	91	82	89	99	Low-f		1250	148	141	136	132	125	110	Š
1000	149	141	137	132	126	112	93	84	72	69	ons -		1000	149	141	137	132	126	112	ć
800	150	144	139	136	121	114	96	28	92	99	onditi		008	150	144	139	136	121	114	Š
630	150	144	138	134	127	113	96	98	9/	7 9	ice c		630	150	144	138	134	127	113	Š
200	151	144	138	134	128	114	100	1 90	22 6	29 C	g thin		200	151	144	138	134	128	114	400
5 400	3 153	8 146	1 142	981 9	0 130	6 115	1 100	93 91	80 79	71 70	durin		5 400	3 153	8 146	1 142	136	0 130	6 115	,00
0 315	4 153	.6 148	141	136	130	116	101	95	82 8	15 7	Strait		0 315	4 153	.6 148	141	136	130	116	101
200 250	155 154	147 146	141 142	137 137	132 132	117 117	105 103	6 96	8 /8	1 11	lson (200 250	155 154	147 146	141 142	137 137	132 132	117 117	405
160 20	156 1	150 14	144 14	141 13	133 13	118 17	107 10	101	3 06	. 83	n Huc		160 20	156 18	150 14	144 14	141 13	133 13	118 17	407
125 1	156 1	152 1	145 1	140 1	135 1	120 1	110 1	104	94	28	iting i		125 1	156 1	152 1	145 1	140 1	135 1	120 1	7
100	156	152	147	140	134	118	109	, 201	26	06	trans		100	156	152	146	140	134	118	,
80	158	153	147	143	134	118	110	107	66	93	arrier		80	158	153	147	143	134	118	7,70
63	157	152	144	140	131	115	108	104	26	91	Ore C		63	157	152	144	140	131	115	400
99	155	150	141	134	128	113	105	101	96	68	the (09	155	149	141	134	128	113	102
40	153	145	135	130	124	108	100	96	16	98	i from		40	153	145	135	130	123	108	,
32	155	145	139	134	124	109	100	96	06 9	83	t radi		32	155	145	139	133	124	108	00
0 25	157	147	139	132	123	108	100	4 96	3 86	08 9	at se		0 25	156	146	8 138	3 132	3 123	107	1
16 20	155	5 145	139	1 134	1 124	5 107	86 96	92 94	1 83	92 02	evels		16 20	1 154	4 144	138	0 133	123	4 106	20
13 1	153 152	141 145	139	131	121	103 105	94 9	87 9	74 81	2 09	und	y (Hz)	13 1	151 09	144	137	129 130	119	104	,
10 1	152 15	138 14	133 135	128 131	119 120	102 10	6 06	83 8	2 19	51 6	ed so	brnad Frequency (Hz)	10 1	149 150	134 139	129 133	124 12	116 117	101 86	22
L	168 1	161 1	154 1	149 1	141 1	127 1	115	111	102	96	stimat	ad Fr	<u> </u>	168 1	161 1	154 1	149 1	141 1	127	277
band	100									0(8b. E			1001				·		L
(E)	10	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000	Table 8b. Estimated sound levels at set radii from the Ore	Range	Ê	10	300	1,000	3,000	10,000	30,000	400,000

Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait during thin ice conditions - Mid-frequency cetaceans M-weighting applied Table 8c.

	0000	135	124	111	96	49					П
20	16000 2	136	126	114	102	69	H	H	H	H	H
5	,	Ĺ				84	23	L	L	L	Щ
	1250	137	127	116	108	8					
	10000	138	129	119	112	94	48				
	8000	139	130	126	121	112	90	46	18		
	6300	142	133	129	124	116	98	62	41	15	
	2000	142	133	129	124	118	100	72	53	30	12
	4000	141	132	128	123	117	102	75	29	42	26
	3150	143	135	131	126	119	\$	82	89	20	36
	2500	145	138	134	128	121	108	98	73	69	43
	2000	146	139	<u>\$</u>	127	122	108	88	77	61	49
	1600	146	139	135	129	124	108	90	79	99	53
300	1250	148	140	136	132	125	110	91	82	89	99
	1000	149	141	137	132	126	112	93	8	72	59
	008	150	144	139	135	127	114	96	87	22	99
	630	149	143	138	133	127	112	92	98	22	63
	200	151	144	137	133	128	114	66	88	9/	29
	400	151	145	141	134	129	114	66	8	8/	69
	315	151	146	139	134	128	114	66	91	5 79	69
6	0 250	152	3 144	139	135	3 129	3 114	100	2 92	3 82	3 73
6	0 200	15/	5 143	137	5 134	8 128	3 113	2 102	6 92	5 83	7 73
	160	9 15	145	138	136	7 128	113	2 102	96 96	86 85	77 67
300	125	146 149	2 144	136 137	132	127	112	98 102	95	8 /8	80 7
	80 100	145 14	140 142	134 13	130 130	124	105 108	6 26	94 8	82 8	8 08
310	63		135 14	Ľ		15 121	10	92	87	80	3 92
	90	135 14	130 13	121 13	114 1	108 1	93	85	81	15	69
	40	130 1	122	112 1	106 1	100	92	92	73	29	62
	32	128	118	112	107	. 26	81	73	69	62	99
	52	125	116	108	101	92	2.2	69	64	22	49
	20	120	110	104	66	68	7.1	63	69	48	40
(Hz)	16	113	106	100	92	82	99	25	53	42	31
luency (13	110	66	92	68	22	61	51	45	31	18
Frequ	10	105	91	98	81	72	22	43	36	20	4
broad	band	162	154	149	143	137	122	108	101	91	91
Range	Ξ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 8d. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait during thin ice conditions - High-frequency cetaceans M-weighting applied

	20000	135	124	111	96	49					
	16000	136	126	114	102	69					
	12500	137	127	116	108	84	23				
	10000	138	129	119	112	94	48				
	8000	139	130	126	121	112	90	46	18		
	6300	142	133	129	124	116	86	62	41	15	
	2000	142	133	129	124	118	100	72	53	30	12
	4000	141	132	128	123	117	102	75	69	42	26
	3150	143	135	131	126	119	104	82	89	20	36
	2500	145	138	134	128	121	108	98	73	69	43
	2000	146	139	134	127	122	108	88	2.2	61	49
	1600	146	139	135	129	124	108	06	62	99	53
	1250	148	140	136	132	125	110	91	81	89	99
	1000	149	141	137	132	126	112	93	84	72	69
	800	150	143	139	135	127	113	96	28	22	99
	630	149	143	137	133	126	112	96	98	75	63
	900	150	143	136	133	121	113	66	88	9/	99
	400	151	144	140	134	129	113	86	88	17	89
	315	150	145	138	133	127	113	86 8	06	22 (89
	0 250	150	142	137	133	127	113	86 6	16 (1 80	1/2
	200	149	141	135	131	126	111	66 6	30	2 81	11
	5 160	5 148	1 142	135	133	125	110	66 6	3 93	3 82	92 22
	125	2 145	141	3 134	6 129	124	4 109	66 96	1 93	3 83	26 76
	80 100	142	136 138	133	125 126	117 120	104	93 99	89 91	81 83	12 92
	8 8	136 14	131 13	124 130	119 12	111 11	94 101	87 9	83 8	8 92	7 07
	9 09	131 13	125 13	117 12	110 11	103 11	5 68	3 08	3 92	70 7	65 7
	40	125 13	117 13	107 1	102 1	95 10	80	72	. 89	. 62	22
	32	123 1	113 1	107	102	92	7.7	89	64	28	51
	25	120	111	103	96	87	72	64	69	20	44
	20	115	105	66	94	84	99	28	54	43	36
(Hz)	16	108	101	96	28	2.2	19	25	48	28	97
uency	13	105	94	87	84	72	99	46	40	26	13
Frequ	10	100	98	81	9/	29 9	20	38	31	15	
broad	band	161	153	147	142	135	121	105	66	88	91
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 8e. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait during thin ice conditions - Pinnipeds M-weighting applied

	00 1250 1600 2000	149 148 146 146	141 141 139 139	137 136 135 134	132 132 129 127	126 125 124 122	112 110 108 108	93 91 90	84 82 79	72 68 65	
	500 630 800 10	151 150 150 1	144 143 144 1	137 138 139 1	134 134 136 1	128 127 127 1	114 113 114 1	96 96 001	8 98 87	77 75 75	
	315 400	152 152	146 147 146 14	140 141	136 135	130 130	116 115 115 1	101 100	94 93 91 1	84 80 79	
	5 160 200 250	4 154 154 154	148 146	2 142 140 141	7 139 136 137	2 131 130 131	117 116	7 105 104 102	96 66	98 88	
	80 100 125	153 153 154	148 148 150	7 141 143 142	137 136 137	129 130 132	7 112 114 117	105 105 107	101 101 101	93 93 91	
	40 50 63	140 145 149	132 139 144	122 131 137	117 124 132	111 118 124	95 103 107	87 95 100	83 91 96	85 89	
	20 25 32	131 137 139	121 127 129	115 119 123	111 112 118	100 103 108	83 88 92	75 80 84	70 76 80	59 66 73	
Frequency (Hz)	10 13 16	117 122 125	103 111 118	98 104 111	93 101 104	84 89 93	67 73 78	55 63 69	48 57 64	32 43 53	
broad	pand	100 164 1	300 157 1	151	146	139	124	112	106	26 000	
Range	Œ	10	30	1,000	3,000	10,000	30,000	100,000	150,000	200,00	

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Range	broad	Frequ	nency	(Hz)																															
(m)	band	10	13	16	20	25	32	40	90	63	80 1	1 00 1	125 16	160 200	0 250	315	5 400	009 0	089 (008 (1000	1250	1600	2000	2500	3150	4000	0009	6300	0008	10000	12500	16000	20000	
100	179	173	172	172	170	168	162	155	156 1	158 1	161 1	161 1	164 16	162 167	160	159	9 159	157	155	158	156	155	154	153	152	150	147	150	150	146	148	146	145	143	
300	170	158	162	164	161	161	153	147	151 1	153 1	157 1	157 1	159 15	156 15	155 154	154	4 153	3 152	150	153	152	151	148	147	147	144	140	143	142	137	139	136	135	133	
1,000	164	153	155	158	155	152	147	141	145 1	148 1	151 1	152 1	152 15	150 14	148 149	148	8 148	147	145	148	8	145	144	142	142	139	136	139	139	134	137	130	128	125	
3,000	158	149	151	151	150	144	142	134	137 1	141 1	147 1	146 1	147 14	146 14	144 14	144 141	1 144	4 142	140	142	143	141	137	139	138	134	132	135	136	130	132	121	115	108	
10,000	150	140	140	141	140	136	133	127	130 1	134 1	139 1	141 1	143 14	140 139	138	137	7 138	136	134	137	135	135	134	132	132	129	125	128	126	121	121	46	82	61	
30,000	136	124	125	125	125	123	118	112	115 1	120 1	125 1	126 1	129 12	127 127		124 123	3 125	5 123	3 123	`	8 8			80	120	117	l	114	112	102	92	37			
100,000	127	114	117	118	117	116	111	105	111	115 1	118 1	119 1	119 11	18 11	115 11	113 111	1 112	110	108	110	107	107	104	102	101	95	88	87	80	59	31				_
150,000	124	108	113	115	114	113	110	104	109 1	113 1	116 1	115 1	116 11	113 11	110 10	108 105	5 105	5 102	100	102	100	97	94	91	88	83	74	20	28	29					
200,000	116	96	101	106	106	107	102	. 26	102 1	107	108 1	109 1	108 10	104 10	6 001	97 97	26 /	5 92	8 8	92	88	87	83	62	92	69	69	53	36						
250,000	111	82	91	66	102	103	66	92	98 1	104	105 1	105 1	103 9	97 9	92 9	91 88	8 87	28 2	5 82	83	92 2	18	73	69	65	29	44	35	17						_

Table 9b. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during thick ice conditions - Low-frequency cetaceans M-weighting applied

		1000	3.0			30 00			10-05	35 37	
	20000	138	128	119	103	22					
	16000	141	131	124	111	78					
	12500	143	134	128	118	96	34				
	10000	147	138	135	130	119	90	30			
	8000	145	136	133	129	120	101	28	28		
	6300	149	141	138	135	126	111	62	28	36	16
	5000	150	142	139	135	128	114	87	69	52	35
	4000	146	140	136	132	124	111	88	74	69	44
	3150	150	144	138	134	129	116	96	83	69	29
	2500	152	147	141	138	132	119	100	88	16	99
	2000	153	147	142	139	132	119	102	16	64	69
	1600	154	148	144	137	134	121	104	94	83	23
	1250	155	151	145	141	135	123	107	46	48	8/
	1000	156	152	145	143	135	123	101	100	88	6/
	800	158	153	148	142	137	125	110	102	92	83
	630	155	150	145	140	134	123	108	100	68	82
	200	157	152	147	142	136	123	110	102	92	98
	400	159	153	148	144	138	125	112	105	26	87
	315	159	154	148	141	137	123	111	3 105	26 /	1 88
	0 250	1 160	5 154	149	144	138	7 124	5 113	108	26 0	2 91
	0 20	2 16	6 155	0 148	144	0 139	7 127	115	3 110	4 100	97 92
	9 160	3 162	156	150	147 146	143 140	127	119 117	116 113	108 104	103
	125	163	157 159	152 152	146 14	_	126 129	119 11	115 11	109 10	105 10
	80 100	31 16	157 15	-	147 14	139 14	125 12	118 11	115 11	108 10	105 10
	83 8	58 16	153 18	48 15		500	20	15 1'	12 1		323
	90	156 18	151 1	1 44	137 141	130 1	15 1	111 1	109 1	101	1 86
	40	154 1	147 1	141 1	134 1	126 1	111 1	105 1	104	1 26	94
	32	162	152	147	142	133	118	111	109	102	66
	25	167	160	151	143	136	122	115	113	107	103
	20	169	160	154	149	139	123	116	113	105	101
(HZ)	16	170	162	157	149	140	124	117	114	105	26
uency (13	169	160	153	149	138	123	115	110	66	68
Frequ	10	169	155	150	146	137	120	111	105	16	82
proad	pand	177	170	163	157	149	136	126	123	115	111
Range	Œ	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000
		_	_	_	_	_		-	_		_

Table 9c. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during thick ice conditions - Mid-frequency cetaceans M-weighting applied

	630 800 1000 1250 1600 2000 2500 3150 4000 5000 6300 8000 10000	155 158 156 155 154 153 152 150 147 150 150 156 146 148	150 153 152 151 148 147 147 144 140 143 142 137 139	144 148 145 145 144 144 142 142 139 136 139 139 134 137	139 141 143 141 137 139 138 134 132 135 136 130 132	134 136 135 134 134 132 132 129 125 128 126 121 120	122 124 123 123 121 119 119 117 111 114 112 102 92	107 110 107 107 104 102 100 95 89 87 80 59 31	99 101 100 97 94 91 89 83 74 70 58 29	89 92 88 86 83 79 76 69 59 53 36	82 82 78 77 73 69 65 57 44 35 17
	160 200 250 315 400 500	157 157 157 157 158 157	151 151 152 152 151 151	941 146 146 147 146	141 140 141 140 143 141	135 135 135 135 137 136	121 123 121 121 124 122	112 111 111 109 111 109	107 106 105 103 104 101	99 96 95 95 94 91	92 88 88 86 84
	40 50 63 80 100 125	131 136 141 148 151 156	123 131 136 144 147 151	118 125 131 138 142 144	111 117 124 134 135 139	103 110 118 126 130 135	88 95 104 111 116 121	111 91 99 105 109 111	80 89 96 102 105 109	74 82 91 95 99 100	71 78 88 92 95 95
Frequency (Hz)	10 13 16 20 25 32	126 129 133 134 137 135	111 120 125 125 129 126	106 112 119 120 120 120	102 108 112 115 113 115 1	93 97 102 105 105 106	16 16 68 98 81 21	67 75 79 82 84 84	82 82 82 82	48 59 67 71 76 75	35 49 60 66 72 72
Range broad	(m) pand	100 168	300 162	1,000 156	3,000 151	10,000 145	30,000 132	100,000	150,000 113	200,000 105	250 000 100

Table 9d. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait, during thick ice conditions - High-frequency cetaceans M-weighting applied

									00 000		
	20000	143	133	124	108	09					
	16000	144	135	128	115	82					
	12500	146	136	130	121	26	37				
	0000	148	139	137	132	121	92	31			
	8000 1	146	137	134	130	121	102	69	29	2 0	
	6300	150	142	139	136	126	112	80	28	36	17
	2000	150	143	139	135	128	114	87	70	23	35
	4000	147	140	136	132	125	111	88	74	69	44
	3150	150	144	139	134	129	117	96	83	69	29
	2500	152	147	142	138	132	119	100	88	92	99
	2000	153	147	142	139	132	119	102	91	64	69
	1600	154	148	144	137	133	121	104	93	83	72
	1250	155	151	145	140	134	123	107	46	98	11
	1000	156	152	145	143	135	123	107	100	88	8/
	008 0	158	153	147	141	3 136	124	109	101	92	1 82
	630	155	149	144	139	133	122	107	99	88	81
	200	156	151	145	141	135	122	108	101	91	84
	400	157	151	146	142	136	123	110	103	93	85
	315	156	151	145	139	134	120	108	102	94	98
	250	155	150	144	139	134	119	109	103	93	98
	200	155	149	142	138	133	121	109	104	94	98
	160	154	148	141	138	132	118	109	105	96	88
	125	152	148	141	136	132	118	108	105	26	92
	100	147	143	138	132	127	112	105	101	92	91
	80	144	140	134	130	122	107	101	98	91	88
	63	137	132	127	120	114	66	94	92	98	83
	09	131	126	120	112	106	16	28	84	LL	74
	40	126	119	113	106	86	83	11	92	69	99
	32	130	121	115	110	101	98	19	78	02	29
	25	132	124	115	108	100	28 1	6/ /	17	1.1	29 7
	70	129	120	115	110	100	84	11	74	99	62
(HZ)	16	128	120	114	107	97	81	74	71	62	99
uency	13	124	115	107	103	93	28	70	65	54	44
Frequ	10	121	106	101	26	88	72	62	99	43	30
broad	pand	167	161	155	150	144	131	117	111	102	26
Range	(m)	100	300	1,000	3,000	10,000	30,000	100,000	150,000	200,000	250,000

Table 9e. Estimated sound levels at set radii from the Ore Carrier transiting in Hudson Strait. during thick ice conditions - Pinnipeds M-weighting applied

Range	broad	Frec	uency	(Hz)																														
Ξ	pand	10	13	16	20	25	32	40	9 09	03 E9	0 100	125	160	200	250	315	400	9 009	8 089	800 1000	00 1250	50 1600	00 200	0 2500	0 3150	0 400	0 200	0089 0	0008	10000	12500	16000	2000	0
100	170	138	141	145	146	148	146 1	141 12	146 150	30 155	157	191 2	161	160	159	159	159	157	155 1	158 1	156 1	155 18	154 153	152	2 150	147	150	150	146	148	145	144	143	က
300	164	123	132	137	137	141	137 1	134 14	140 145	9.	154	156	155	154	154	154	153	152	150 1	153 1	152 1	151 14	148 14	147 147	7 144	140	143	3 142	137	139	136	135		ტ
1,000	158	3 118	124	131	132	132	131 1	128 13	134 140		148	149	148	147	148	148	148	146 1	144 1	148 1	145 1	145 14	144 14	142 142	2 139	136	139	139	134	137	130	127	124	4
3,000	153	3 114	120	123	127	124	126 1		127 133		1 142	144	145	143	143	141	144	142	140 1	142 1	143 1	141 13	137 13	139 138	134	132	135	5 136	130	131	120	115	108	œ
10,000	146	3 105	109	114	117	116	117 1	114 13	120 127	133	3 137	140	139	138	137	137	138	136 1	134 1	137 1	135 1	135 13	134 13	132 132	2 129	125	5 128	3 126	121	120	46	81	9	9
30,000	133	88	94	86	101	103	102	99 10	105 113		9 122	126	125	126	123	122	125	123	123 1	124 1	123 1	123 1:	121 11	119 119	117	111	114	112	102	92	37			
100,000	122	2 79	98	16	94	96	98	92 10	101 107	9	3 115	116	116	114	113	110	112	109	108	110 1	107	107 10	104 10	102 100	96 0	68 9	87	08 /	69 (31				
150,000	118	3 73	82	88	91	93	93	91	99 105	110	112	114	111	109	107	104	105	102	100	101	100	3 26	94 6	91 8	89 83	3 74	4 70	89 C	3 29					
200,000	110	09 C	14	64	83	87	98	84	91 9	99 102	106	105	102	66	96	26	36	92	88	92	88	87	83 7	19 7	69 92	69 6	63	36						
000	100			~	-	~~	~~	,	00	00	, , ,	, ,				~~					-		-						L				L	Г

Table1a. Estimated sound levels at set radii from Dredging (basket) operations at the Ore Loading Dock, during open water conditions.

	0	œ	o	Ξ	28	43	П	П
	2000	108	10(6		4		\bigsqcup
	16000	109	101	93	82	29		
	12500	110	102	96	98	29	29	
	10000	111	104	96	88	74	46	
	8000	117	111	104	86	92	98	84
	6300	115	110	104	66	90	98	84
	5000	115	108	102	26	90	85	84
	4000	116	108	103	26	91	85	84
	3150	118	114	105	101	94	87	98
	2500	121	115	108	104	98	91	88
	2000	121	119	110	106	66	66	90
	1600	126	120	115	109	102	96	90
	1250	130	125	117	115	106	66	98
	1000	132	127	121	115	108	100	98
	800	136	130	124	121	112	106	66
	089	137	131	124	119	111	105	26
	200	140	132	126	121	111	105	66
	400	143	134	129	124	114	107	102
	315	144	137	132	126	117	107	97
	250	139	132	123	119	109	100	83
	200	142	138	128	122	113	102	87
	160	145	138	130	124	115	106	94
	125	136	131	124	118	107	86	82
	100	139	135	127	122	112	102	92
	80	136	130	121	115	105	92	62
	63	146	140	132	125	112	2000	09
	90	144	138	129	123	110	93	51
	40	131	125	117	112	101	83	36
	32	131	125	117	111	100	80	28
	25	129	123	114	108	96	92	19
	20	129	124	114	109	46	22	15
(Hz)	16	135	131	121	115	104	80	16
uency	13	117	110	102	96	84	62	
Frequ	10	106	103	96	91	28	99	П
broad	pand	153	146	139	132	123	114	106
Range	(m)	100	300	1,000	3,000	10,000	30,000	80,000

Table 1b. Estimated sound levels at set radii from Dredging (basket) operations at the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied

band Frequency (Hz) band Frequency (Hz) 13 4 6 7 1		00	103	95	85	72	38		П	ľ
band Frequency (Hz) band Frequency (Hz) 13 14 15		0 200	8	5						
band Frequency (Hz) band Frequency (Hz) 10 12 16 10 12		1600	10		886	2	85			
band Frequency (Hz) band 10 13 14		12500	107	100	92	84	65	26		
band Frequency (Hz) band Frequency (Hz) band 13 16 20 25 40 13 146 136 136 140 140 140 140 150 120 120 120 120 150		0000	109	102	94	87	72	44	50	
band Frequency (Hz) band Frequency (Hz) 13 14		8000	116	110	103	26	91	85	83	
band Frequency (Hz) band 13 16 20 25 40 15 40 50 40 40 40 60 10 12 10 13 16 13 144 146 136 136 142 143 140 137 136 130 120 120 121 111 118 136 136 143 143 140 137 136 136 136 136 144 145 145 143 143 140 137 136 130 136 136 136 136 136 144 143		9300	114	109	103	86	68	85	83	
band Frequency (Hz) Annual Frequency (Hz)		2000	114	108	101	26	90	84	83	
band Frequency (Hz) band 10 3 6 3 4 4 4 1		4000	116	•	102	26	91	84	83	
band Frequency (Hz) band Frequency (Hz) 1 1 1 1 2 4 1		3150	118	113	105	100	94	87	98	
band Frequency (Hz) band 10 13 16 20 25 40 10 15 16 20 25 40 10 12		2500	121		108	104	86	91	88	
band Frequency (Hz) band 10 13 16 20 125 18 18 18 18 18 18 18 18 18 18 130 135 145 142 139 144 143 140 18 130 136 145 142 139 144 143 140 137 136 130 136 145 142 139 144 143 140 137 136 130 136 145 142 139 144 143 140 137 136 130 136 145 142 139 144 143 140 137 136 130 136 145 142 139 144 143 140 137 136 137 137 137 137 137 137 137 137 137 137 137 137 137 137 137 137 137 137 137		2000	120	119	20	106	1225.0 0 80	70.50	06	
band Frequency (Hz) band Tolorad Frequency (Hz) 13 44 14		Į,	126							
band Frequency (Hz) 12 26 45 63 10 126 16 20 25 315 400 500 800 17 18 </th <th></th> <th>1250</th> <th></th> <th>Ш</th> <th>117</th> <th></th> <th></th> <th></th> <th></th> <th></th>		1250		Ш	117					
band Frequency (Hz) band Trequency (Hz) band 10 13 14 50 63 80 126 160 20 250 250 400 630 630 146 99 107 128 128 128 136 136 136 145 145 146 146 136 139 136 145 147 148 146 136 139 148 148 146 146 146 146 136 139 136 148 148 148 148 149 148 148 139 148		1000	27	8 (`			
band Frequency (Hz) 15 16 20 25 40 50 63 10 126 160 315 40 500 10 150 150 315 40 500 100 150				Ŀ			112	`		
band Frequency (Hz) band 10 13 16 20 25 32 40 63 63 10 10 13 14 14 14 14 14 136 136 136 142 142 139 14 142 143 144 144 144 146 136 136 146 142 143 143 144 144 144 146 136 136 136 142 142 143 144 144 144 146 136 136 136 146 146 144 144 144 144 146 136 136 136 136 137 144						1	11 11/			
band Frequency (Hz) band 10 13 16 20 25 32 40 63 80 100 125 126 31 134 144 146 136 136 145 145 145 136 136 145 143 144 146 136 136 145 142 139 144 144 146 136 136 145 145 143 144 146 136 136 145 142 139 144 144 146 <th></th> <th>200</th> <th></th> <th></th> <th></th> <th></th> <th>11,</th> <th></th> <th></th> <th></th>		200					11,			
band Frequency (Hz) band 10 13 16 20 25 32 40 50 63 80 100 115 160 20 250 10 13 14 134 136 136 136 136 142 139 10 146 39 107 129 122 124 126 138 130 136 131 138						10				
band Frequency (Hz) band 10 13 16 20 25 40 50 63 80 100 125 160 200 100 125 160 100 125 160 100 125 160 100 100 145 145 145 144 146 136 139 135 145 </th <th></th> <th>315</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>46</th> <th></th>		315							46	
band Frequency (Hz) band Frequency (Hz) band 10 13 16 20 25 32 40 60 63 100 105 160 105 160 105 160 105 160 105 160 105 160 105 160 105		250	Œ.	6	22	8	`		Ц	
band Frequency (Hz) band 10 13 16 20 25 40 50 63 80 105 128 130 131 144 146 136 139 136 139 136 139 136 139 136 139 136 139 131 131 131 144 146 146 136 139 136 139 139 139 139 139 136 131 139 136 131 136 131 136 139 136 131 136 131 136 131 136 131 136 131 136 131 136 131 136 131 136 131 136 131 136 136 136 131 136 136 136 136 136 136 136 136 136 136 136 136 136 148 136 136 136 136 136 </th <th></th> <th>200</th> <th>142</th> <th></th> <th>128</th> <th>88</th> <th></th> <th>102</th> <th>28</th> <th></th>		200	142		128	88		102	28	
band band Frequency HZ Frequency HZ 1 6 20 25 32 40 50 63 80 100 10 10 11 11 12 128 130 131 144 146 136 130		Ď.	145	138	130	200	115	106		
band band Frequency (Hz) Frequency (Hz) 20 25 40 50 63 80 11 0 165 10 146 10 13 16 128 130 131 144 146 136 139 130 140 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130		125	62	131	123	,				
band band Frequency (Hz) Frequency (Hz) 20 25 32 40 60 63 0 146 19 107 129 122 122 131 144 146 130 131 144 146 100 122 122 122 122 122 131 144 146 132 </th <th></th> <th>100</th> <th>139</th> <th>135</th> <th>127</th> <th>122</th> <th>112</th> <th>102</th> <th>9/</th> <th></th>		100	139	135	127	122	112	102	9/	
band band band (10 12) Frequency (Hz) 13 16 20 25 32 40 50 10 146 19 17 13 128 128 128 131 144 138 93 100 120 113 114 113 116 117 129 132 87 94 114 108 107 111 112 123 123 74 81 102 96 96 99 100 101 144 52 60 73 74 75 80 82 93 103 114 102 74 75 80 82 93			80	130	121	115	105	6	62	
band Frequency (Hz) band 10 13 16 20 25 32 40 10 13 16 18 18 18 18 10 11 146 99 107 129 123 124 125 138 93 100 120 113 116 117 10 132 87 94 114 108 107 111 112 11 12 81 102 96 96 99 100 114 52 60 79 74 75 80 82 114 52 60 79 74 75 80 82 10 106 74 75 80 82 82										
brad band band Frequency H2 Frequency H2 20 25 32 band 10 13 16 20 25 32 10 14 13 12 122 13 10 146 99 107 129 122 124 1 10 138 93 100 120 113 113 116 1 1 132 87 94 114 108 107 111 1 1 123 74 81 102 96 96 99 1 0 114 52 60 79 74 75 80 0 106 16 15 14 19 27 80		90	144					66		
brad band band band band band band band ba			131			112	100	82		
broad Frequency (Hz) Hz 20 band 10 13 16 20 163 103 114 129 13 10 136 93 107 129 13 132 87 94 114 108 123 74 81 102 96 114 52 60 79 74 10 114 52 60 79 74 10 10 16 96 79 74		200	8		90	111		8		
band Frequency (Hz) band (10 13 16 17 129 17 12 17 12 17 12 17 12 17 12				\perp						
broad Frequency IT band 10 133 146 138 93 132 87 133 74 144 60 145 100 132 87 143 74 144 62 145 60			52		_	8	86			
broad Freq band 116 10 153 103 10 138 99 10 123 74 10 114 52	(HZ)						102		15	
broad Freq band 116 10 153 103 10 138 99 10 123 74 10 114 52	nency	13			ш	Ш				
broad band 153 00 146 00 138 00 114 00 1106	Fred	10		8	2010					
(m) (m) 100 300 1,000 10,000 30,000 80,000	proad	pand	153	146	138	132	123	114	106	
	Range	(m)	100	300	1,000	3,000	10,000	30,000	80,000	

Table 1c. Estimated sound levels at set radii from Dredging (basket) operations at the Ore Loading Dock, during open water conditions - Mid-frequency cetaceans M-weighting applied

Frequency (R2) 10 31 6 20 3 4 5 6 3 8 1		00	108	100	91	77	43		
Proad Frequency (Hz) Annal Lange (Hz) Frequency (Hz) Annal Lange (200	0	l					
band Frequency (Hz) band 10 10 21 62 24 25 24 25 24 25 24 25 24 25 24 25		16000	109	8	66	82	19		
brand Frequency (Hz) band 10 all 10 all<		12500	110	102	94	86	67	29	
brand Float Float <th< td=""><td></td><td>10000</td><td>111</td><td>103</td><td>96</td><td>88</td><td>74</td><td>46</td><td>. *</td></th<>		10000	111	103	96	88	74	46	. *
band Frequency (Hz) band 10 - 3 </td <td></td> <td>8000</td> <td>117</td> <td>111</td> <td>104</td> <td>98</td> <td>92</td> <td>98</td> <td>84</td>		8000	117	111	104	98	92	98	84
broad Frequency (Hz) broad Frequency (Hz) 13 16 20 25 40 15 16 15 16 15 16 15 16 15 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 16 17 17 17 17 17		.77		l					
band Frequency (Hz) band Frequency (Hz) 13 16 20 125 120 125 120 125 120		5000	115	108	102	97	90	85	8
broad Frequency (Hz) All and broad and		4000	116	108	103	97	91	85	84
band Frequency (Hz) band 10 13 16 23 24 16 13 16 13 16 13 16 13 16 10 13 16 13 16 10 13 16 13 16 13 16 13 16 13 16 13 16 13		3150	118	114	105	,	94	28	98
band Frequency (Hz) band Frequency (Hz) 10 13 16 20 25 40 10 126 129 129 129 129 129 139 139 136 142 142 140 136		2500							
band Frequency (Hz) band 10 13 16 26 25 126 127 126 127 1		2000	120	119	•	106	66	93	90
band Frequency (Hz) band 10 13 16 20 126 129 129 129 129 129 139 136 142 140 186 187 104 108 124 186 187 104 108 124 186 129 129 129 139 136 142 140 186 187 104 186 124 186 187 141 186 187 142 189 136 136 143 136 142 140 186 136 137 126 129 139 136 142 130 136 136 136 136 136 136 136 136 136 137 136 139 136 137 136 137 141 141 141 141 141 141 141 141 141 141 141 141 141 141 141 141 141		1600	126	,	,				
broad Legistration (Hz) Frequency (Hz) A 6 6 10 12 16 13 16 20 25 4 10 13 16 14 16 12 15 12		1250	130	125	117	115		66	96
band Frequency (Hz) band 10 13 16 20 23 24 67 10 10 10 12 10 12 10 12 10 12 10 12 10 12 12 12 12 12 12 14 10 12 10 12		1000	132	127	121	115	20	100	98
band Frequency (Hz) 141 56 74 50 63 17 126 129 129 139 16 142			136	130			112	`	66
band Frequency (Hz) band 10 13 16 25 34 40 10 13 15 10 25 35 40 60 10 13 139 139 139 139 139 142 140 10 124 130 123 129 129 139		630	136	130	124	119	111	,	96
broad Frequency (Hz) broad 100 100 100 100 125 100 125 160 200 25 31 100 130 150		500		132			`	104	86
band band control (Hz) Frequency (Hz) App. 4 50 63 80 100 125 160 250 <t< td=""><td></td><td></td><td>142</td><td></td><td>Ċ</td><td></td><td></td><td>106</td><td>100</td></t<>			142		Ċ			106	100
Dirac Frequency (Hz) Line Lin		315	142	135	130		116	105	96
brand band control (Hz) Frequency (Hz) 1 3 6 3 8 10 12 16 12 16 12 16 13 16 12 16 13 16 15 160 15 160 15 160 12 160 12 160 15 160 15 160 15 160 15 160 15 160 15 160 13 160 13 15 15 15 15 13 15 15 15 13 13 16 13 16 13 17 15 15 13 14 14 15 16 17 16 13 14<		250	136	130	•	े	101	86	
Dirac Frequency (Hz) Line Lin		200		8	887	- 50	Ø.	86	83
brand band Frequency (Hz) 4 5 63 63 8 10 10 10 10 13 16 20 25 34 40 50 63 8 100 10 <td></td> <td>160</td> <td>139</td> <td>,</td> <td>2.5</td> <td>l</td> <td>109</td> <td>100</td> <td>88</td>		160	139	,	2.5	l	109	100	88
Draud Frequency (Hz) Frequency (Hz)		125	ű.	8	68		30	06	14
broad Label Frequency (Hz) 1 10 20 25 32 40 50 63 141 56 67 92 88 91 98 102 118 123 10 134 49 56 67 92 88 91 98 102 118 123 11 10 134 49 56 82 79 88 94 109 115 115 11 10 128 44 53 76 74 77 84 89 103 118 1 120 31 41 65 62 65 72 77 90 96 120 12 91 41 65 62 65 72 77 81 10 12 91 44 53 64 53 73 43		100			111	112	102		
brad band band (10 12) Frequency (Hz) 20 25 32 4 50 50 10 141 56 67 92 88 91 98 102 118 10 134 49 59 88 91 98 102 118 10 134 49 59 82 79 89 94 109 10 128 44 53 76 74 77 84 89 103 10 120 31 41 65 62 65 77 77 90 10 120 31 41 65 62 65 77 77 90 10 15 91 94 53 94 63 73 73 91		80	123	111	108	102	92	62	49
brand band band band of log		63					96		43
brad band band (10 12) Frequency (Hz) 20 25 32 0 143 56 67 92 89 91 98 0 134 49 59 88 91 98 91 98 0 134 49 59 82 79 88 91 98 0 128 44 53 76 74 77 84 0 120 31 41 65 62 65 72 0 120 31 43 44 53 65 65 72 0 120 31 43 44 53 65 65 72 0 100 105 96 97 94 53 94 65		72.60			52.	8	06		
brad band band band of legenency (Hz) Legenency (Hz) band to legenency (Hz) 13 141 56 67 92 88 91 17 10 134 49 59 82 79 82 10 134 49 59 82 79 82 10 128 44 53 76 74 77 10 120 31 41 65 65 65 10 112 31 41 33 44 10 165 165 165 65			108		94	68			
brad band band (10 12) Frequency (Hz) 0 149 59 74 99 94 0 134 56 67 92 88 0 134 49 59 75 10 0 134 49 59 82 79 0 128 44 53 76 74 0 120 31 41 65 62 0 120 31 41 65 62 0 105 105 105 105 105		200	104	86	89		72	53	0
brand band band band band on 10 13 16 16 16 16 16 16 16 16 17 16 16 16 17 16 16 17 16 16 17 16 16 16 17 16 16 17 16 16 16 16 17 16 17 18				16		700	65	44	
broad band Frequency (H) band 10 141 56 134 49 134 49 134 49 138 44 120 31 121 31 120 31 120 31 139 41 100 120			64		62		62	68	
broad Frequent band 10 149 59 10 141 56 10 124 49 10 128 44 10 12 31 10 12 9 10 105 9	(Z		100	92	82	76	65	41	
broad band 10 141 10 134 10 12 14 10 10	5		74	29			41	8	
broad band 10 141 10 134 10 12 14 10 16	Frequ	10		99			31		
Range (m) 100 100 1,000 1,000 3,000 1,000 30,000 80,000 80,000	broad	band	`	141	134	128	120	112	105
	Range	(m)	100	300	1,000	3,000	10,000	30,000	80,000

Table 10. Estimated sound levels at set radii from Dredging (basket) operations at the Ore Loading Dock, during open water conditions - High-frequency cetaceans M-weighting applied

broad Frequency (Hz) band 10 13 16 20 25 32 125 125 135 136																												١								ļ
10 13 16 20 25 32 40 60 80 100 125 15 15 15 15 15 15 13 15 13 15 13 10 12 12 13 14 12 12 12 13 14 12 12 12 13 14 13 14 13 14 13 14 13 14 13 12 12 13 14 14 13 14 14 13 14 14 13 14 1	٥	road	9	>	Hz)																															
64 69 91 89 92 99 103 119 125 136		pand		13	16	20	25	32	40	9		L	,		_	_	-	5 40	0 20	_	_	μ	-	ч	_	2500	3150	4000	9000	0089	0008	1000	0 1250	0 1600	0 200	00
140 51 62 87 83 86 93 97 113 119 113 121 120 130 132 134 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 130 140	100	147		69	91	68	95		52		•	`	,	8		`		1	-	Ĺ		,		1		Ĺ	118	116	115	114	117	11	1 110	55.	109	801
133 44 54 77 74 78 85 89 104 111 104 113 112 122 112 112 112 112 112 112 112 113 113 114	300	140		62	87	83	98				6	ı	Ш	_	,	l		,	,	<u>,</u>	l	126		l	1		1	108	108	110	111	103	3 102	10.	L	100
127 39 48 71 69 72 79 84 98 104 98 108 107 116 116 114 123 122 120 118 120 115 115 116 109 104 101 101 101 101 101 101 101 101 101	000'	133		54	11	74	82	85			1	4	,	,	ı	l		,	`	i .	,	,	117	114	8	_		103	102	104	104	96 1	94	200	93	91
119 26 36 60 57 60 68 72 86 92 87 98 96 107 105 115 113 110 111 112 107 105 102 99 98 94 111 4 14 36 35 39 48 54 68 77 75 88 87 98 96 104 105 103 104 105 100 99 95 93 91 87 105 105 107 105 1	0	127		48	7.1	69	72	62	84		04	1	87	1	l	٦,	Ĺ	Ĺ	l	_	,	2	,	l				26	46	66 ,	86 (88	98 8	887.0	82	78
4 14 36 35 39 48 54 68 77 75 88 87 98 96 96 104 105 103 104 105 100 99 95 93 91 87 87 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 86 88 88	0	119	50000	36	09	22	09	89			- 7	Ш			8	1		l I	,	11.	112			,	_			91	06	06	92		74 67		25	43
105 1 1 1 1 2 39 45 62 71 85 81 79 94 100 97 96 99 94 95 90 90 88 86	О	111	4	14	36	35	39	48	54		Ц		Ш		Ш						`	l					87	85	85	98	98	94 9		29	Ц	П
	0	105			H	H	Н	Н	8				Ш	Ш		Ц		_				200						84	84	84	84					П

Table 1e. Estimated sound levels at set radii from Dredging (basket) operations at the Ore Loading Dock, during open water conditions - Pinnipeds M-weighting applied

				_			_	_
	20000	107	66	96	11	43		
	16000	109	101	92	82	22		
	12500	110	102	94	98	29	29	
	0000	111	103	96	88	74	46	
	8000	117	111	104	86	92	98	84
	0069	114	110	104	66	90	98	84
	2000	115	108	102	26	90	85	84
	4000	116	108	103	26	91	85	84
	3150	118	114	105	101	94	28	98
	2500	121	115	108	104	86	91	88
	2000	120	119	110	106	66	93	90
	1600	126	120	115	109	102	96	90
	1250	130	125	111	115	106	66	96
	1000	132	127	121	115	108	100	96
	008 (136	130	124	120	112	106	99
	0 630	137	2 131	6 124	1 119	1 111	104 105	96 66
	400 50	143 140	133 132	129 126	124 127	114 111	106 10	101
	315 4	143 14	136 13	131 13	126 13	117 1	106 10	96 10
	250 3	138 1	132 1	123 1	118 1	109	100	83
	200	141	137	127	121	112	100	82
	160	143	137	128	122	113	104	92
	125	134	128	121	115	105	96	62
	100	135	131	123	118	108	86	72
	3 80	130	125	116	109	66 9	0 87	52 56
	50 63	4 138	128 132	119 12	112 117	10	83 90	40 52
	40 5	118 134	112 12	104 11	11 66	88 100	8 0/	23 4
	32 7	115 17	109 1	100 10	36	83	64	11
	25	109 1	103 1	94 1	88	92	99	Н
	20	106	100	91	92	73	51	H
(HZ)	16	108	103	94	88	92	53	П
uency (13	98	62	1.2	99	53	31	
Frequ	10	71	19 1	19	22	43	3 21	
broad	pand	150	144	136	130	121	113	106
Range	(m)	100	300	1,000	3,000	10,000	30,000	80,000

Estimated sound levels at set radii from Dredging (cutter) operations at the Ore Loading Dock, during open water conditions.

									20	100				
	20000	112	106	95	83	49						20000	106	100
	16000	115	109	66	68	64	8					80 100 125 160 200 250 315 400 500 630 630 1000 1250 1600 2600 2500 3150 4000 5000 6300 8000 10000 12500 16000 2000	111	105
	12500	118	112	103	96	92	38			cutter) operations at the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied		12500	115	100
	0000	125	118	115	107	26	82	29		nting a		0000	123	117
	1250 1600 2000 2500 3150 4000 5000 6300 8000 10000	123	118	112	107	66	92	68		-weigh		1 0008	121	
	3 0089	126	121	115	108	102	92	92		ıns M⊦		3 0089	125	120
	2000	126	121	113	107	100	94	91		staces		2000	126	1711 1001 171
	4000	124	121	113	108	101	94	91		ncy ce		4000	123	101
	3150	126	120	113	108	101	94	90		reque		3150	126	120 120 120 120 120 120 120 120 120 120
	2500	127	121	114	109	100	93	90		Low-f		2500	132 129 127	120
	2000	129	124	118	113	106	96	66		ons -		2000	129	101
	1600	133	127	120	115	106	100	94		onditi		1600	132	107
	1250	135	129	120	116	108	102	86		ater c		1250	142 143 141 137 135	100
	800 1000	137	131	122	119	110	103	16		oen w		1000	137	151
	008 (141	134	127	122	114	108	100		ing of		008 (141	121
	0 630	143	137	130	5 125	111	011	4 105		k, dur		0 630	2 143	137
	400 500	146 142	138	129	125	120 116	111 109	104 1		g Doc		00 20	14	11 13
	315 4	147 14	141 141	134 131	128 127	119 13	112 1	104 103		oading		15 4	47 12	11
		146 1	142 1	133 1	129	120 1	112 1	104		Ore Lo		250 3	146 147 146	110
	160 200 250	149	144	136	131	122	111	102		t the		200	149	111
		150	145	136	132	121	109	96		ons a		160	150	115
	125	150	144	135	130	121	109	68		perati		125	150	111
	100	148	142	135	129	118	106	85		ter) o		100	148 148	113
	3 80	1 149	141	134	1 127	116	7 103	2 74						_
	50 63	149 161	144 154	136 146	31 141	120 130	106 11	63 82		edgin		50 63	160	121
	40	142 14	136 14	128 13	123 131	112 12	94 10	47 6		om Dr		40	142 149	17 36
	32	148 1	142 1	133 1	128 1	117 1	26	45		adii fr		32	147 1	1111
	25	149	143	134	128	11	96	40		set n		25	149	1450 1731 1331 145 145 145 1431 1441 1351 1441
	20	152	146	137	131	119	26	37		rels at		20	160 151	115
(HZ)	16	161	157	147	141	130	106	42		nd lev	(HZ)	13 16 20		155
Range broad Frequency (Hz)	0 13	140	134	0 126	120	1 108	98 6	2 9		nos p	broad Frequency (Hz)	13	138	122
Fre	10	5 129	126	1 120	5 114	101	1 79			mate	4 Fre	10	5 126	13
broad	band	100 165	160	151	145	135	121	112		able 2b. Estimated sound levels at set radii from Dredging	_	band	165	L
_		0	300	,000	3,000	10,000	30,000	80,000	1	7	Range		100	200

		20000	111	105	95	83	48		
		16000	115	109	66	89	64	7	
plied		12500	117	112	103	94	22	38	
(cutter) operations at the Ore Loading Dock, during open water conditions - Mid-frequency cetaceans M-weighting applied		0000	125	118	115	106	26	82	22
weigh		8000 1	123	118	112	107	66	92	89
ns M		0069	126	121	115	108	102	96	66
tacea		2000	126	121	113	107	100	93	9.1
cy ce		4000	124	121	113	108	101	94	91
ednen		3150	126	120	113	108	101	94	Ub
∕lid-fr		2500	127	121	114	109	100	93	Ub
l-su		2000	129	124	117	113	106	96	65
nditic		1600	132	127	120	115	106	100	Рδ
ter co		1250	135	129	120	116	108	102	86
en wa		1000	137	130	122	119	110	102	96
g op		800	140	134	127	122	114	107	100
durir		630	143	136	130	125	116	110	100 100 103 104 100
Jock,		500	142	137	129	124	115	109	103
ing [400	144	139	130	126	119	110	102
Load		315	145	139	132	126	117	110	100
Ore		250	143	139	130	127	117	109	98 102
t the		200	145	140	132	127	118	108	86
ons 8		160	145	139	131	126	116	104	Ub
erati		125	142	136	127	123	113	101	81
er) op		100	138	132	124	118	108	96	42
(cutte		80	135	128	121	114	103	90	٤1
ging		63	144	138	130	124	114	100	55
Dred		90	129	124	116	111	100	98	£ P
from		40	119	113	104	100	88	20	56
adii 1		32	121	115	106	101	90	20	17
t set		25	118	112	103	97	98	99	α
els a		20	116	111	102	96	84	62	6
d lev	(zH)	16	122	118	108	102	91	29	3
soun	ency	13	86	91	84	78	99	44	
ated	Frequency (Hz)	10	82	62	73	29	54	32	
Estim	broad	band	154	148	139	134	125	117	110
Table 2c. Estimated sound levels at set radii from Dredging	Range	(m)	100	300	1,000	3,000	10,000	30,000	80 000
-									L

able 2d. Estimated sound levels at set radii from Dredging (cutter) operations at the Ore Loading Dock, during open water conditions - High-frequency cetaceans M-weighting applied

road	-reque	?	4z)																														
and	10	13	16	20	25						8	•	0 200	H		400	_	630	800	1000	1250	1600	2000	2500	3150	4000	2000	0089	0008	10000	12500	16000	2000
152	2.2	93	117	112 1	100		-33		,	È	,	35	,	ļ		1	141	143	140	137	135	132	129	127	126	124	126	126	123		117	115	11
146	74	98	`	106 1					,	,	,	Ĺ	8	,	,	,		136	,	130	129	121		121	120	121	121	121	118	`	11	109	105
137	89	62	104	26	98 10	Н	11	11 12	١,	Ĺ	H	,	`	`	131	129	,	`		122	120	120	117	114	113	113	113	115	112	115		66	96
132	62	73	26	91	92 6	CO-RI	8		l		l	`	8	,	, s	ä	32	125	,	119	115	,		109	108	108	107	108	107			68	83
124	49	09	98	62	81 8				560	,	ŀ	ı		1	,	1	114	ı	7	110	108	106		100	101	101	100		66	26		64	48
116	27	39	62	29	9 09	200	Ц		8	725.	8	101	_	2 107	_	6	,	,	107	102	102	100	96	66	94	76		96	92	85	200		
109	Н	H	Н	Н	4				-	83		0000	2000	3 100	101	101	102	22		96	86	94	66	06	06	91	91	6	68	29			
		Freq 10 77 77 76 65 65 65 74 8	Frequency	Frequency (Hz) 10 13 16 17 8 8 113 16 18 74 86 73 97 19 62 73 97 19 49 60 86 10 27 39 62	Frequency (Hz) 10 13 16 20 77 98 117 112 68 74 86 113 106 68 79 104 97 62 73 97 91 49 60 86 79 49 60 86 79 8 27 97 91 8 27 96 86 79 9 27 97 91 92 9 27 97 97 97	Frequency (Hz) 10 13 16 20 25 7 74 86 117 113 113 68 79 104 97 98 62 73 97 91 92 62 73 97 91 92 62 73 97 91 92 62 73 96 86 79 81 62 73 96 86 79 81 62 73 96 86 79 81 62 73 96 86 79 81 63 73 86 76 80 64 73 86 76 80 65 73 86 76 80 66 87 87 80 80 81 87 80 80 80 81 87 88 78 80	Frequency (Hz) 10 13 16 20 25 32 77 96 177 112 116 116 116 116 116 116 116 117 116 117 116 117 116 117 116 117 116 116 117 116 117 116 117 116 117 116 117 116 117 116 117 116 117 116 117 116 117	Frequency (Hz) 10 13 16 20 25 32 40 17 93 17 113 116 104 114 114 114 116 114 68 74 86 113 106 107 101 108 68 73 104 97 98 101 100 62 73 97 91 92 96 95 64 60 86 73 81 85 84 8 27 85 56 86 66 86 56 86 8 27 85 56 86 66 86 66 86 66 86 66 86 66 86 66 86 66 86 66 86 66 86 66 86 76 86 76 86 76 86 76 86 76 86	Frequency (Hz) 10 13 16 20 25 32 40 50 6 74 86 113 106 103 110 111 125 14 68 79 104 97 98 101 100 111 12 62 73 97 91 92 96 95 106 12 49 60 86 79 81 85 84 96 11 2 7 8 79 81 85 84 96 11 4 9 60 86 79 86 81 98 11 5 7 8 7 8 13 98 14 98 17	Frequency (Hz) 10 13 16 20 25 32 40 50 63 7 7 93 17 11 116 114 126 140 13 16 13 16 13 16 13 10 11 125 140 13 1 16 13 13 11 125 140 13 1 12 140 13 13 1 13 1 12 14 125 14 13 1 </th <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 74 86 171 112 113 116 114 125 140 131 124 68 79 104 97 98 101 100 111 125 117 62 73 97 91 92 96 95 106 120 10 49 60 86 79 81 86 84 96 110 99 2 7 96 86 84 96 110 99 8 7 96 86 84 96 110 99 8 2 7 80 65 66 81 96 86 8 2 7 80 65 66 81 96 86 9 8 8 13 13</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 7 7 93 17 112 116 14 125 140 131 134 68 79 104 97 101 108 113 124 128 68 73 97 91 92 96 106 111 126 117 121 49 60 86 79 81 86 96 96 106 106 107 101 43 60 86 79 81 86 96 96 104 99 104 43 60 86 79 81 86 9</th> <th>Frequency (Hz) 10 13 16 25 34 65 63 80 100 125 13 140 135 140 131 134 135 143 135 143 135 143 135 143 135 143 134 139 135 134 139 135 143 134 134 134 134 134 134 135 143 143 143 143 144 135 144 134 134 134 134 134 134 134 134 134 134 134 144</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 77 95 117 112 116 114 125 140 131 134 139 142 68 74 86 173 104 97 96 101 101 111 125 117 124 128 133 137 68 73 91 92 96 106 110 110 115 112 124 128 49 60 86 79 81 86 96 106 110 19 113 13 49 60 86 75 81 86 76 86 10 10 11 13 49 60 66 66 66 86 92 98 10 11 40 67 76</th> <th>Frequency (Hz) 10 13 16 20 25 40 50 63 80 100 125 160 17 160 17 112 13 13 134 13 13 13 142 143 13 142 143 13 142 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 133 143 143 133 143 143 133 144 143<</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 250 250 77 95 117 112 113 116 114 125 141 134 142 143 142 142 143 142 142 143 142 143 142</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 63 63 80 100 135 160 250 250 315 44 140 131 139 142 143 142 144 140 140 131 134 139 142 143 142 144 140 140 131 134 139 142 143 142 144 144 140 131 144 139 142 143 142 144 144 144 140 <</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 250 315 400</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 63 63 100 100 125 160 250 315 400 150 160 170 114 125 140 131 139 142 143 142 144</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 100 500 630 80 100 100 114 125 140 134 142 143 142 144 144 144 141 143 142 143 142 143 142 144 144 144 143 143 142 143 142 144 144 144 144 141 143 143 142 143 142 144 144 144 144 143 <</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 65 63 100 101 143 142 144 145 140 131 134 139 142 143 142 144 144 141 141 143 142 143 142 144</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 250 350 315 400 170 100 11 125 140 131 134 139 142 143 144 144 141 143 140 137 136 142 144 144 144 141 143 140 137 136 143 144 144 144 141 143 140 137 140 137 148 144 144 144 144 144 144 144 144 141 143 140 137 143 148 144 <</th> <th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 630 800 100 125 160 100 630 80 100 100 125 100 100 135 120 13 142 143 142 144 144 144 143 143 135 142 143 142 144 144 144 143 143 136 <t< th=""><th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 50 630 630 630 1260</th><th>Frequency (Hz) 410 13 40 12 40 12 40 13 40 10 10 11 12 13 14 15 140 13 12 14<th>Frequency (Hz) 10 13 16 20 23 24 140 151 16 150</th><th>Frequency (Hz) 410 13 40 6.50 4.6 4.0 6.50 4.0 4.0 6.50 4.0 4.0 6.50 6.5 4.0 6.50 6.5 4.0 6.5 </th></th></t<></th>	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 74 86 171 112 113 116 114 125 140 131 124 68 79 104 97 98 101 100 111 125 117 62 73 97 91 92 96 95 106 120 10 49 60 86 79 81 86 84 96 110 99 2 7 96 86 84 96 110 99 8 7 96 86 84 96 110 99 8 2 7 80 65 66 81 96 86 8 2 7 80 65 66 81 96 86 9 8 8 13 13	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 7 7 93 17 112 116 14 125 140 131 134 68 79 104 97 101 108 113 124 128 68 73 97 91 92 96 106 111 126 117 121 49 60 86 79 81 86 96 96 106 106 107 101 43 60 86 79 81 86 96 96 104 99 104 43 60 86 79 81 86 9	Frequency (Hz) 10 13 16 25 34 65 63 80 100 125 13 140 135 140 131 134 135 143 135 143 135 143 135 143 135 143 134 139 135 134 139 135 143 134 134 134 134 134 134 135 143 143 143 143 144 135 144 134 134 134 134 134 134 134 134 134 134 134 144	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 77 95 117 112 116 114 125 140 131 134 139 142 68 74 86 173 104 97 96 101 101 111 125 117 124 128 133 137 68 73 91 92 96 106 110 110 115 112 124 128 49 60 86 79 81 86 96 106 110 19 113 13 49 60 86 75 81 86 76 86 10 10 11 13 49 60 66 66 66 86 92 98 10 11 40 67 76	Frequency (Hz) 10 13 16 20 25 40 50 63 80 100 125 160 17 160 17 112 13 13 134 13 13 13 142 143 13 142 143 13 142 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 143 133 143 143 133 143 143 133 144 143<	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 250 250 77 95 117 112 113 116 114 125 141 134 142 143 142 142 143 142 142 143 142 143 142	Frequency (Hz) 10 13 16 20 25 32 40 63 63 80 100 135 160 250 250 315 44 140 131 139 142 143 142 144 140 140 131 134 139 142 143 142 144 140 140 131 134 139 142 143 142 144 144 140 131 144 139 142 143 142 144 144 144 140 <	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 250 315 400	Frequency (Hz) 10 13 16 20 25 32 40 63 63 100 100 125 160 250 315 400 150 160 170 114 125 140 131 139 142 143 142 144	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 100 500 630 80 100 100 114 125 140 134 142 143 142 144 144 144 141 143 142 143 142 143 142 144 144 144 143 143 142 143 142 144 144 144 144 141 143 143 142 143 142 144 144 144 144 143 <	Frequency (Hz) 10 13 16 20 25 32 40 65 63 100 101 143 142 144 145 140 131 134 139 142 143 142 144 144 141 141 143 142 143 142 144	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 250 350 315 400 170 100 11 125 140 131 134 139 142 143 144 144 141 143 140 137 136 142 144 144 144 141 143 140 137 136 143 144 144 144 141 143 140 137 140 137 148 144 144 144 144 144 144 144 144 141 143 140 137 143 148 144 <	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 630 800 100 125 160 100 630 80 100 100 125 100 100 135 120 13 142 143 142 144 144 144 143 143 135 142 143 142 144 144 144 143 143 136 <t< th=""><th>Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 50 630 630 630 1260</th><th>Frequency (Hz) 410 13 40 12 40 12 40 13 40 10 10 11 12 13 14 15 140 13 12 14<th>Frequency (Hz) 10 13 16 20 23 24 140 151 16 150</th><th>Frequency (Hz) 410 13 40 6.50 4.6 4.0 6.50 4.0 4.0 6.50 4.0 4.0 6.50 6.5 4.0 6.50 6.5 4.0 6.5 </th></th></t<>	Frequency (Hz) 10 13 16 20 25 32 40 50 63 80 100 125 160 200 50 630 630 630 1260	Frequency (Hz) 410 13 40 12 40 12 40 13 40 10 10 11 12 13 14 15 140 13 12 14 <th>Frequency (Hz) 10 13 16 20 23 24 140 151 16 150</th> <th>Frequency (Hz) 410 13 40 6.50 4.6 4.0 6.50 4.0 4.0 6.50 4.0 4.0 6.50 6.5 4.0 6.50 6.5 4.0 6.5 </th>	Frequency (Hz) 10 13 16 20 23 24 140 151 16 150	Frequency (Hz) 410 13 40 6.50 4.6 4.0 6.50 4.0 4.0 6.50 4.0 4.0 6.50 6.5 4.0 6.50 6.5 4.0 6.5						

Table 2e. Estimated sound levels at set radii from Dredging (cutter) operations at the Ore Loading Dock, during open water conditions - Pinnipeds M-weighting applied

	_							_
	20000	111	105	94	82	48		
	16000	114	109	66	88	64	7	
	12500	117	112	103	94	22	38	
	10000	124	118	115	106	26	82	99
	8000	122	118	111	107	66	92	88
	6300	126	120	115	108	102	98	92
	5000	126	121	113	107	100	93	91
	4000	124	121	113	108	101	94	91
	3150	126	120	113	108	101	94	90
	2500	127	121	114	109	100	66	06
	2000	129	124	118	113	106	96	66
	1600	132	127	120	115	106	100	94
	1250	135	129	120	116	108	102	86
	1000	137	130	122	119	110	102	97
	008 0	3 140	7 134	127	5 122	5 114	108	5 100
)	142 143	137	129 130		116 116	110	3 105
	-		137	12	124		109	103
	5 400	7 145	140	3 131	126	119	1 111	3 103
	0 315	145 147	141	133	129 127	119 119	1 11	104 103
	250	8	14.	132	,	11	11	10
	200	148	143	135	130	121	110	101
	160	149	143	135	130	119	108	94
	125	147	142	133	128	118	106	87
	100	145	138	131	125	115	102	28
	80	143	136	128	122	111	86	69
		153	146	139	133	123	109	74
	90	139	134	126	120	110	98	53
		129	123	115	110	66	81	34
	32	132	126	117	112	100	81	28
	25	129	123	114	108	26	9/	20
	20	128	122	113	108	96	74	14
(Hz)	16	134	130	120	114	103	79	15
nency	13	110	103	96	90	77	22	
Frequen	10	94	91	98	19	99	44	
broad	band	158	151	143	138	128	119	111
ange	(m)	100	300	1,000	3,000	10,000	30,000	80,000

Table 1a. Estimated sound levels at set radii from drilling through ice operations at the Ore Loading Dock, during open water conditions.

102 104 105 107 106 98 93 92 89 87 84 83 80 77 75 73 70 67 66 64 59 56 62 89 94 97 99 101 98 90 88 84 82 79 77 75 72 69 66 64 59 56 56 86 56 56 60 64 59 56 56 60 64 69 66 64 69 66 64 69 66 67 60 66 64 69 66 67 69 66 67 69 66 67 69 66 67 69 66 67 67 68 66 64 67 67 67 68 66 67 67 67 67 67 67 67 67 67 67 67 <t< th=""><th>102 104 105 107 106 98 93 92 89 87 84 83 80 77 75 75 73 70 67 66 64 59 58 86 91 92 98 88 84 82 73 77 75 72 69 66 64 59 58 86 91 92 94 91 83 80 76 77 75 75 69 66 64 59 56 56 50 80 88 89 74 47 40 89 86 86 86 66 66 67 66 67 66 80</th><th></th><th>102 104 105 107 106 98 93 92 89 87 84 83 80 77 75 75 73 70 67 66 89 88 89 89 89 89 89 89 89 89 89 89 89</th></t<>	102 104 105 107 106 98 93 92 89 87 84 83 80 77 75 75 73 70 67 66 64 59 58 86 91 92 98 88 84 82 73 77 75 72 69 66 64 59 58 86 91 92 94 91 83 80 76 77 75 75 69 66 64 59 56 56 50 80 88 89 74 47 40 89 86 86 86 66 66 67 66 67 66 80		102 104 105 107 106 98 93 92 89 87 84 83 80 77 75 75 73 70 67 66 89 88 89 89 89 89 89 89 89 89 89 89 89
94 97 99 101 98 90 88 84 82 79 77 75 75 69 66 64 59 86 91 92 94 91 83 80 76 75 70 67 66 63 61 56 52 80 86 86 86 64 61 66 64 67 56 52 89 80 76 77 76 </th <th>94 97 99 101 98 90 88 84 62 79 77 75 75 69 66 64 59 86 91 92 94 91 83 80 76 76 77 76 67 66 64 59 66 64 59 80 98 91 83 80 76 76 76 66 64 61 66 64 65 65 65 65 65 67<!--</th--><th>94 97 99 101 98 90 88 84 82 79 77 75 72 69 66 64 59 5 5 5 6 65 66 63 61 66 63 61 65 52 5 6 6 6 6 6 7 4</th><th>94 97 99 101 98 90 88 84 82 79 77 75 76 66 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 6 64 59 6</th></th>	94 97 99 101 98 90 88 84 62 79 77 75 75 69 66 64 59 86 91 92 94 91 83 80 76 76 77 76 67 66 64 59 66 64 59 80 98 91 83 80 76 76 76 66 64 61 66 64 65 65 65 65 65 67 </th <th>94 97 99 101 98 90 88 84 82 79 77 75 72 69 66 64 59 5 5 5 6 65 66 63 61 66 63 61 65 52 5 6 6 6 6 6 7 4</th> <th>94 97 99 101 98 90 88 84 82 79 77 75 76 66 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 6 64 59 6</th>	94 97 99 101 98 90 88 84 82 79 77 75 72 69 66 64 59 5 5 5 6 65 66 63 61 66 63 61 65 52 5 6 6 6 6 6 7 4	94 97 99 101 98 90 88 84 82 79 77 75 76 66 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 64 59 6 6 64 59 6
86 91 92 94 91 83 80 80 76 75 73 70 67 66 63 61 56 52 80 86 86 86 64 61 56 57 54 47 40 70 70 76 77 76 60 56 55 55 47 47 40 58 63 65 67 62 60 56 55 52 43 41 38 33 22 7 44 44 51 55 56 56 57 48 43 41 35 31 25 16	86 91 92 94 91 83 80 80 76 75 73 70 67 66 63 61 56 52 80 86 86 86 84 61 56 57 54 47 40 70 70 76 77 76 60 56 55 55 54 47 40 58 63 66 67 62 46 46 45 81 33 22 15 44 51 56 57 56 48 43 41 38 33 22 15 44 51 56 57 48 43 41 35 16	86 91 92 94 91 83 80 80 76 75 73 70 67 66 63 61 56 52 50 80 80 86 88 88 87 78 76 76 76 66 64 61 58 57 54 47 40 36 80 88 88 87 78 76 76 76 66 67 60 56 56 50 50 50 50 50 50 50 50 50 50 50 50 50	86 91 92 94 91 83 80 76 75 73 70 67 66 63 61 56 52 50 80 86 86 87 78 76 72 68 66 64 61 58 57 54 47 40 36 70 76 76 78 76 76 76 66 67 66 67 66 67 68 67 64 48 43 43 44 46 44 44 48 43 44 46 44 46 48 43 44 46 43 41 37 35 31 25 16 7 7 7 7 7 44 48 43 44 43 43 41 37 35 31 25 16 7 7 7 7 7 7 7 7 <t< td=""></t<>
80 86 86 88 87 78 76 75 68 66 64 61 58 57 54 47 40 36 70 76 77 78 69 66 67 65 56 56 55 50 48 43 27 15 58 63 63 65 56 56 46 46 45 41 33 22 7 15 44 51 56 56 56 48 43 41 37 35 31 25 16 7	80 86 86 86 89 87 78 76 76 72 68 66 64 61 58 57 54 47 40 36 70 76 77 78 77 78 66 67 62 60 56 55 52 48 43 27 15 58 63 65 65 56 46 46 45 41 38 33 22 7 15 44 51 56 56 52 49 46 45 41 38 33 22 7 15		
70 76 77 78 77 69 66 67 62 60 56 55 55 55 48 43 27 27 58 63 65 65 65 46 46 45 41 38 33 22 2 44 51 55 56 48 48 48 43 41 37 35 31 25 16 1	70 76 77 78 77 69 66 67 62 60 56 55 55 55 48 43 27 58 63 65 65 65 46 46 45 41 38 33 22 2 44 51 55 58 57 48 49 48 43 41 37 35 31 25 16 3	70 76 78 77 69 66 67 62 60 56 55 52 50 48 43 27 15 15 58 63 65 65 56 52 49 46 45 41 38 33 22 8 8 44 51 58 67 48 48 41 37 35 31 25 16 8 the colspan="8">the colspan="	70 76 77 78 77 69 66 67 62 60 56 55 55 55 55 55 56 56 57 48 48 48 44 45 41 38 33 22 7
58 63 65 67 66 56 56 52 49 46 45 41 37 33 33 44 51 55 56 57 48 49 48 43 41 37 35 31 25 16	58 63 65 66 57 56 56 52 49 46 45 41 38 33 44 51 55 58 57 48 49 48 43 41 37 35 31 25 16	58 63 65 67 66 57 56 56 52 49 46 45 41 38 33 22 8 44 51 55 58 57 48 49 48 41 37 35 31 25 16 3 the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied	58 63 65 66 57 56 56 52 49 46 45 41 38 33 22 1 44 51 55 56 57 48 43 41 37 35 31 25 16 44 51 43 41 37 35 31 25 16 <t< td=""></t<>
44 51 55 58 57 48 49 48 43 41 37 35 31 25	44 51 55 58 57 48 49 48 43 41 37 35 31 25	44 51 56 58 57 48 49 48 43 41 37 35 31 25 16 1 1 1 1 1 1 1 1 1 1 1 2 3 4 3 3 4 3 4 4 3 4	44 51 55 58 57 48 49 48 43 41 37 35 31 25 16
		the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied	t the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied

		20000	99	48	38	20			
		00091	63	22	46	32			
IIG ap		12500	64	22	20	38	12		
55		000	69	63	22	45	25		200
W-IVI 6		1000	72	9	09	23	42	21	
laccalls		8 0069	74	89	63	22	47	33	16
ייש ליו		9 000	2.2	11	65	28	20	37	25
מ		0001	80	75	29	61	52	41	31
LOW-11 CL		3150 4	83	2.2	69	64	22	45	35
		2500	84	79	73	99	99	46	37
		2000	87	82	74	89	09	49	40
3		1600	88	84	92	72	62	52	43
כוו שמוכו		1250	62	88	08	92	29	99	48
g obe		1000	66	88	80	92	99	99	49
3		800	98	3 90	83	8/ /	69	29 9	48
5		0 63(107 106	11 98	94 91	88 87	77 87	99 /9	58 57
5		200	`	10,					
Sac		400	105	66	85	98	LL	99	99
5		315	104	26	16	98	9/	69	19
מווום		250	102	94	98	80	70	28	44
allolls a		0 200	5 102	96 6	28 (1 82	1/	89 8	5 42
שווים שלה		5 160	95 105	66 68	82 90	75 84	4 74	4 63	44 55
3		0 125				30.03	69 64	58 54	
		80 10	1 98	95 93	86 84	80 79	9 69	99	40 45
ill on ill		63 8	86 10	155-2		8 99		20100	
		20	98	13	7.1	9	52	34	11
5		40	83	22	69	22	52	8	7
_ ac		32	72	99	28	53	40	21	
מו אנו		25	69	63	54	48	37	16	
202		20	29	19	25	46	8	12	
	(Hz)	16	62	25	48	42	30	9	
20 20	hency	0 13	5 49	9 41	3 33	7 27	4 14		
ומו	l Frequ	10	35	7 29	9 23	3 17		72	3
D. ES	broad	band	113	107	66	93	84		63
Table 15. Estillated sould levels at set Lauli Iloni dilling	Range	Œ	100	300	1,000	3,000	10,000	30,000	75,000

Table 1c. Estimated sound levels at set radii from drilling through ice operations at the Ore Loading Dock, during open water conditions - Mid-frequency cetaceans M-weighting applied

Range	broad Fi	Freque	uency (I	Hz)																														
Ξ	pand	10	13	16	20	25	32 4	40 5	50 63	3 80	100	125	160	200	250	315	400	200	630	008	1000	1250	1600	2000	2500	3150	4000	2000	6300	8000	10000	12500	1600) 2000
100	112	H	8	24	33	39 4	45 5	9 69	99	88 0	87	28	100	86	66	102	104	106	106	86	93	92	88	87	84	83	80	11	22	73	70	29 (99 ,	5 61
300	105			20	27	32	39 5	54 6	60 63	3 82	82	85	8	94	16	96	86	100	86	90	88	88	84	82	42	2.2	22	72	69	99	64	69 1		
1,000	26	H		10	17	23	31 4	46 51	1 55	5 73	3 74	74	85	83	83	06	91	93	90	83	79	80	92	74	73	20	29	99	63	19	99	5 52	90	7 44
3,000	91			4	12	18	26 4	41 4	45 49	9 67	89 /	89	79		77	8	85	87	98	78	26	92	72	89	99	64	61	58	57	54	47	7 40	36	5 25
10,000	82				0	9	14 2	29 3	32 36	99 9	99	29	89	29	29	74	9/	28	22	69	99	29	62	09	99	22	52	20	48	43		14		
30,000	02	Н		Н	H	L	Ĺ	11 1	15 22	2 43	3 48	46	99	54	99	19	64	99	99	99	99	22	52	49	46	45	41	38	33	22				
75 000	19				-	_	_			3 27	7 34	38	67	39	17	US	24	89	22	48	49	48	43	40	37	35	3.1	96	16					

Table 1d. Estimated sound levels at set radii from drilling through ice operations at the Ore Loading Dock, during open water conditions - High-frequency cetaceans M-weighting applied

		_			-				
		20000	62	53	44	25			
		16000	99	28	20	36			
		12500	29	69	52	40	14		
,		0000	70	64	99	47	27		
		1 000	73	99	61	54	43	22	
		3 0069	22	69	63	25	48	33	16
		2000	77	72	99	28	20	37	25
		4000	80	22	29	19	25	41	31
,		3150	83	2.2	20	64	22	45	35
		2500	84	62	73	99	99	46	37
		2000	28	82	44	89	09	49	40
		1600	68	84	92	72	62	52	43
		1250	92	88	80	92	29	55	48
		1000	93	18	62	92	99	99	49
		008 0	86 98	06 2	83 C	27	69 /	99 9	7 48
		00 63(106 105	100	92 90	98 /8	11 11	99	25 57
,		400 50	103 10) 16	06	84	75	63 (53 6
		315 4	101	95	88	83	73	09	49
		250	86	90	81	92	99	53	40
		200	96	85	18	92	99	25	36
		160	16 t	91	1 82	9/	99 8	92	3 47
-		00 125	84 84	79 78	12 02	65 64	55 53	44 43	31 33
,		80 10	84 8	78 7	2 69	9 69	52 5	39 4	23 3
,		63	9	69	51	45	32	17	
The second second		90	61	22	47	40	27	10	
		40	99	49	41	96	24	9	
		32	1 40	34	3 26	3 21	6		
		20 25	28 34	22 27	12 18	7 13	_		
	(2	16 2	19 2	15 2	5 1	L			
	luency (Hz)	13	3						
	Freque	10							
	oroad F	pand	111	104	96	91	81	69	19
	Range b	(m)	100	300	1,000	3,000	10,000	30,000	75,000
				_	$\overline{}$		$\overline{}$		_

Table 1e. Estimated sound levels at set radii from drilling through ice operations at the Ore Loading Dock, during open water conditions - Pinnipeds M-weighting applied

	12500 16000 200	99 /9	89 89	52 50	40 35	14		
	000 10000	73 70	66 64	61 56	54 47	43 27	22	
	6300 80	22	69	63	25	48	33	16
	000 2000	80 77	75 72	99 /9	61 58	52 50	41 37	31 25
	3150 40	83	. 22	20	64	22	45	35
	0 2500	87 84	82 79	75 73	99 89	99 09	49 46	41 37
	1600 200	8 68	84 8	1 91	72 6	62 6	52 4	43 4
	1250	93 92	88 88	80 80	92 92	29 99	99 99	49 48
	800 100	6 86	8 06	83 8	7 87	9 69	22 2	48 4
	00 630	106	101	93 91	98 88	77 87	99 /9	29 82
	400 5	105	66	92	98	2.2	99	22
	250 315	101 104	98 86	85 91	79 85	92 69	57 63	43 51
	60 200	104 101	26 26	98 88	82 81	72 70	62 57	53 41
	125 16)1	ŝ	8 62	3 82	29	9 19	41 6
	80 100	96 94	68 06	81 81	75 75	64 65	51 54	35 41
	0 63	62 92	9 72	1 64	1	7	30	1 12
	40 50	32 02	64 69	56 61	51 55	39 42	22 24	
	25 32	99 09	44 50	34 42	29 37	18 25	2	
	20	44	38	53	74	11		
ncy (Hz)	13 16	20 36	12 32	4 22	16	4		
Frequen	10	3 4	9	3	2	3	1	2
e broad	band	113	106	30 98	30 92	30 83	71 00	30 62
Range	Ξ	11	300	1,000	3,000	10,000	30,000	75,000

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Table

20000	108	102	89	72					I
0009	108	102	90	77					١
2500 1	107	101	91	80	55		-		
000	118	112	104	94	75	37	H	H	I
10	109	. 901	. 16	91	62	61	29		l
00 80	109 1	103 10	86	89	08	99	49	0.0	
00 63	10	106 1	86	91	82		23		
000 20	113 1	108	100	96	98	5	62		
150 40	117	113	104	86	06	78	99		l
500 3	123	117	111	105	96	83	73		
000 2	123	117	109	104	94	82	73	-	۱
1600 2	128	122	116	109	100	06	80	_	
1250 1	132	126	117	113	104	93	84		١
10001	139	132	123	120	110	100	91	-	١
800	140	133	127	121	113	102	8		
630	142	135	129	122	113	102	93		
200	130	125	117	113	103	66 1	98 1		
5 400	134	129	3 120	7 114	3 105	6 94	8 84		
315	3 137	131	123	5 117	106	96 E	98		
250	143	138	130	126	3 114	103	36 E	L	ı
200	147	142	134	130	118	107	66		۱
160	143	138	128	125	114	100	92		I
125	136	130	122	118	101	94	83		
100	138	132	125	119	101	85	82	18	I
80	139	132	124	118	106	93	17	21	۱
63	133	127	118	113	102	88	02	23	١
50	128	122	114	109	66	84	19	41	۱
40	120	114	106	101	90	72	45		ı
32	110	104	96	16	64	09	30		١
25	114	108	66	94	82	19	22		١
20	111	105	96	90	84	99	19		ı
16	101	103	66	87	92	29	13		١
13	86	16	83	11	42	43			۱
10	88	83	11	71	28	36			ı
pand	152	146	137	132	122	111	102	25	
(m)	100	300	1,000	3,000	10,000	30,000	75,000	80,000	

Table 2b. Estimated sound levels at set radii from drilling through the seabed operations at the Ore Loading Dock, during open water conditions - Low-frequency cetaceans M-weighting applied

_	_	-			_	-	_	_	_
	20000	103	97	84	19	19			
	16000	104	98	98	73	38			
	12500	104	86	88	78	52			
	0000	116	110	103	93	74	35		Г
	8000	108	105	96	90	92	09	28	H
	6300	109	103	97	68	19	99	48	-
	2000	109	105	97	90	81	29	52	
	4000	113	108	66	96	98	73	62	
	3150	117	113	103	86	83	11	99	
	2500	123	117	111	105	96	83	73	
	2000	123	117	109	104	94	82	73	
	1600	128	122	116	109	100	06	80	
	1250	132	125	111	112	104	85	84	
	1000	139	132	123	120	110	100	91	
	800	140	133	127	121	113	102	8	
	630	142	135	129	122	113	102	93	
	500	130	125	117	113	103	93	85	
	400	134	129	120	114	105	94	84	
	315	137	131	123	117	106	96	88	
	250	143	138	130	126	114	103	95	
	200	147	142	134	130	118	107	66	Г
	160	143	138	128	125	114	100	92	Г
	125	136	130	122	118	107	94	83	
	100	138	132	125	119	107	92	28	16
	80	139	132	124	118	106	93	77	21
	63	133	126	118	113	102	88	70	22
	90	128	122	114	109	66	84	61	16
	40	120	114	106	101	88	72	45	Г
	32	110	104	98	91	78	29	53	Г
	25	114	107	98	93	81	61	26	Г
	20	110	\$	8	83	17	99	18	
(zH)	16	106	101	91	98	74	90	11	Г
ency (13	96	88	81	22	62	40		Г
Freque	10	82	8	73	29	22	33	П	Г
broad	pand	152	146	137	132	122	111	102	25
Range	(m)	100	300	1,000	3,000	10,000	30,000	75,000	80,000

	_	_	-		_	-	-	_	_	_
		20000	108	102	88	72	24			
		16000	107	101	90	77	42			
		12500	107	101	91	8	92		3.5	
200		0000	118	112	104	94	22	37		
applic		8000	109	106	97	91	79	61	29	-
mid-liednesses referents M-weighting applied		0069	109	103	98	88	80	99	49	
NI-W		2000	110	106	86	91	82	29	52	
accall		4000	113	108	100	96	98	73	62	
icy cer		3150	117	113	104	86	90	8/ 1/8	99 8	
anha		2500	3 123	117	111	105	96 †	2 83	3 73	L
- 1010-		0 2000	123	117	116 109	104	94	0 82	0 73	L
- SIIOIIIOIIO		1600	128	122	117 116	112 109	100	92 90	83 80	L
2000		1250	139 132	132 125	11 22	20 11	10	6 00	91 8	L
II water		100	140 13	133 13	126 12	121 12	11	102 10	94	L
nado Silino		930 80	141 14	135 13	128 12	122 12	12 11	10	93	L
y, dull		9 009	130 1	125 1	117 1	112 1	103 1	92 1	84	-
y Duck,		400	133	128	119	113	104	93	83	H
OLE LUAUING L		315	135	129	121	116	105	96	98	
5		250	140	136	127	123	111	100	93	
at me		60 200	8 144	3 138	3 130	9 126	115	95 103	2 95	L
me seaped operations		125 16	128 138	122 133	14 123	10 119	99 108	6 98	16 87	L
ado no		100	128 13	122 13	14 1	108	97	82	89	9
Sean		. 08	126	119	111	104	93	80	4	8
am lifenoi		63	117	110	102	97	98	72	53	9
io un 6		90	10	102	94		62		41	
		2 40	3 96	2 90	9 82	4 78	2 66	3 48	2 21	L
5		25 32	83 83	77 77	69 /9	62 64	51 52	30 33		L
פנומה		20 2	8 94	7 07	9 09	9 99	43 5	21 3	H	H
בוף מו	(zH)	16	89	64	54	48	36	13	H	H
A I I	5	13	99	48	40	34	22	H	H	H
nos na	Frequen	10	14	36	30	24	11			
Sullian	broad	band	149	142	134	129	119	108	100	11
lable 20. Estillated sound levels at set fault if officially un	Range	(m)	100	300	1,000	3,000	10,000	30,000	75,000	000'08

Table 2d. Estimated sound levels at set radii from drilling through the seabed operations at the Ore Loading Dock, during open water conditions - High-frequency cetaceans M-weighting applied

13 46 20 25 3	63 71 78	43 59 65 72 7	35 49 55 63 6	29 43 50 57 5	17 31 38 46 4	8 16 25 2		
32 40 50 63	92 103 1	72 86 98 106	64 77 90 97	59 73 85 92	47 61 74 81	28 44 59 68	17 37 49	2
80 100	122 124	114 118 1	107 111 11	100 105	89 93	82 92	60 64	3 2
125 160 200	135	19 130 136	11 120 128	107 116 124	96 105 112	83 92 101	72 84 93	
250 315	139	134	8 126 120	121	110	86	91	
400	132	28 127 1	118 1	114 112 1	103 103 1	93 92	85 82	
500 630	-	124 134	116 128	111 122	102 112	101 26	84 92	
800 40	140	133 1	126	121	112 1	102	25	
1250	138 132	131 125	122 116	120 112	110 103	99 92	90 83	
1600 20	128	122 1	115	109	100	06	08	
2500	122 123	117 117	1109 111	104 105	96 96	82 83	73 73	
3150 400	117 11	113 10	104 10	6 86	8 06	78	99	L
A LUCUS IO	113 110	901 80	86 00	16 95	86 82	73 67	62 52	
Band Roon	109 109	103 106	98 97	89 91	80 79	66 61	49 29	
1 100001 12	118	112	104	94	12	37		
2500 1500	107 107	101 10	91 90	80 77	55 4	34		
200	7 10E	102	89	7 72	42 24			

Table 2e. Estimated sound levels at set radii from drilling through the seabed operations at the Ore Loading Dock, during open water conditions - Pinnipeds M-weighting applied

1										
		20000	108	101	89	71	23			
		16000	107	101	90	92	41			
	2.60	12500 1	107	101	91	80	99			
		1 0000	118	112	104	94	75	37	H	
noud do Sunification on addition	1	000	109	106	97	91	79	61	29	Н
	2000	8 0069	109	103	98	88	8	99	49	H
	36	9 0005	110	106	86	90	82	29	52	H
	100	4000	113	108	100	95	98	73	62	П
٠	18	3150	117	113	104	86	90	78	99	
		2500	123	117	111	105	96	83	73	П
	98	2000	123	117	109	104	94	82	73	
	100	1600	128	122	116	109	100	06	08	
1000		1250	132	125	117	112	104	92	84	
-	36	1000	139	132	123	120	110	100	16	
	· ·	008 0	140	5 133	127	121	3 113	1 102	3 94	L
S. Inches of	1	089 00	130 142	125 135	117 129	112 122	103 113	93 101	85 93	L
	8	400 200	134 13	129 12	20 11	14 11	105 10	93 9	84 8	Н
		315 4	136 1	130 13	122 13	117 1	106 1	96	1 28	Н
	265	250 3	142	137	129 1	125	113	102	94	H
	0	200	146	141	133	129	117	106	26	Н
1		160	142	136	127	123	112	66	91	П
-	9	125	133	127	119	115	104	91	18	
		100	134	128	121	115	103	88	2 74	5 12
0		63 80	133	119 126	1119	112	95 101	81 88	62 72	15 15
me all a manage and a manage a manage and a	22	9 09	118 125	112 11	104 11	99 106	89 9	74 8	51 6	9
	3.5	40	107	101	93 10	88	3 92	29	32	H
	3	32	94 1	88 1	80	75	63	44	13	Н
	355	25	94	88	62	74	62	41	7	
		20	28	18	7.2	29	54	33		
	(Hz)	16	80	75	99 7	9	48	25		
	quency	10 13	3 67	9 8	42 52	36 46	34	1 12	L	L
	d Frequ		151 53	145 48	136 43	131 36	21 23	110	10	19
	broad	pand					121		101	698
The state of the s	Range	(m)	100	300	1,000	3,000	10,000	30,000	75,000	80,000

Table1a. Estimated sound levels at set radii from Blasting operations at the Ore Loading Dock, during thick ice conditions.

Range	broad	Frequ	uency (I	Hz)																															
Œ)	band	10	13	16	20	52	32	40	9 09	83 8	80	100 12	125 16	60 200	0 250	0 315	5 400	0 200	0 630	800	1000	1250	1600	2000	2500	3150	4000	2000	0 6300	0008 6	10000	0 1250	0 1600	0 2000	90
100	194	159	169	179	182	181 1	180 1.	179 1.	179 18	81 18	181	179 18	180 180	30 180	180	180	0 179	9 179	180	180	182	182	180	179	180	179	179	179	178	1177	178	8 175	5 175	9	175
300	188	154	162	175	176	175 1	174 1	173 1	173 17	74 17	174 1	173 174	Ļ	175 17	75 175	5 174	4 175	5 174	173	173	175	175	173	174	173	175	174	175	172	173	3 173	3 170	1	1 69	169
1,000	179	148	154	165	166	166 1	166 1	165 1	165 16	99	166 1	16 16	167 16	165 16	166 167	166	6 165	991 9	167	167	165	166	167	166	167	166	165	167	167	164	165	5 159	9 158	े	156
3,000	174	142	148	159	161	161 1	161 1	160 1	160 16	61 16	160 1	160 16	162 16	1	162 162	161	1 160	162	160	161	163	162	161	161	191	160	160	159	158	159	155	5 149		145	139
10,000	163	129	135	148	149	149 1	149 1	149 1	150 15	50 12	149 1	15	1	50 15	15	150	0 15′	1 152	151	153	153	153	151	151	152	152	151	151	149	146	136	124	4 110		91
30,000	151	107	113	124	127	128 1	130 1:	131 1:	135 13	36 13	135 13	133 13	138 13	137 13	139 139	9 140	139	9 142	140	142	143	142	142	139	139	140	138	136	135	5 128	.52	98 6	64 2:	22	
80.000	139	21	23	41	47	48	. 99	72	5 98	97 10	102 1	103 121		123 12	127 130	0 130	0 122	133	3 125	133	130	131	130	128	125	126	124	119	113	3 90	_				

Table 1b. Estimated sound levels at set radii from Blasting operations at the Ore Loading Dock, during thick ice conditions - with bubble curtain Range | broad |Frequency tHz)

5000 164 160 152 144 136 121
165 165 167 167 168 168 169 169 169 169 169 168
158 160 160 158 152 150 151 152 146 148 147 146 138 138 138 136 127 128 127 127
161 160 161 162 152 150 161 152 151 162 162 161 162
146 145 146 146 148 147 146
135 136 137 136 138 138 138 136 136 136 125 124 127 125 127 128 127 127 124
125 124 127 125 127 128 127 127 124 124