APPENDIX 5C-4

Air Quality Emission Inventory

APPENDIX 5C-4

AIR EMISSION INVENTORY

PART I: MINE SITE

MARY RIVER SITE OPERATIONS: BASE DATA

Power Generation	
Emission factors	• All emission parameters were supplied by the manufacturer • All particulate matter was assumed to be in the $PM_{2.5}$ size fraction • Sulphur dioxide (SO_2) emission rates are based on 0.0015% fuel sulphur content
Base quantities	• Mary River has 6 generators (4 operating, 1 standby and 1 backup), each with a power rating of 5.8MW • Arctic Diesel with fuel sulphur content of 0.0015% or 15 ppm will be used
Source parameters	• Stack heights of 30 m provided by manufacturer. • It was identified that 30m stack is not suitable at its current location due to the threshold violation at the accommodation building. Therefore, RWDI recommended a stack height of 40m at its current location. Alternately, power plant can be relocated approximately 300m northwest of the accommodation building. • Stack diameters of 1.0 m were provided by manufacturer based on an assumed exit velocity of 30.7 m/s and for a flow rate of 86760 Am^3/hr. • Exhaust exit temperature is maximum 340 ºC for the generators based on the information provided by manufacturer if no heat recovery system is considered. The exhaust temperature will go down to 150 ºC if heat recovery system is in place.
Emission controls	• No emission controls were assumed. For CALPUFF modelling, all four generators were assumed to be running at full load. Emergency and backup generators were not considered for modelling purpose due to the fact that the total number of generators would not exceed four at any time.
Schedule of Operations	• Four (4) generators will operate 24 hours a day, 7 days a week exhausting through 2 equivalent stacks.
Thermal Heat Generation – Back-up Emergency Boilers	
Emission factors	• All emission parameters were supplied by the manufacturer • All particulate matter was assumed to be in the $PM_{2.5}$ size fraction • Sulphur dioxide (SO_2) emission rates are based on 0.0015% fuel sulphur content
Base quantities	• Mary River has two 5MW thermal emergency boilers
Source parameters	• A stack heights of 30 m was provided by the vendor • Stack diameter of 1.22 m was provided by the vendor along with an exit velocity of 18.2 m/s and a flow rate of 22503 Am^3/hr • Exhaust temperature is 175 ºC as per the vendor
Emission controls	• No emission controls were assumed
Schedule of Operations	• Boilers used for back up heat generation only and were therefore not included in the air quality impact assessment as the operation of the generators results in higher emissions compared to the boilers.

Dust Collectors

Emission factors	• All emission parameters were supplied by the manufacturer • Only PM was assumed to be emitted
Base quantities	• There are seven (7) baghouses at various locations of Mine Site
Source parameters	• Source Parameters were included below:

Equip. No.	Stack No. (#)	Co-ordinates		Stack	Building Height (m)	Stack Height above roof (m)	Flow Rate (Am^3/h)	Exit Velocity (m/s)	Ave. Temp. (deg. C)
		North (m)	East (m)	I. D. (m)					
1210-DC-008	1	7,913,418	563,476	1.60	**20.0**	**5.0**	133,500	18.4	20.0
1230-DC-017	2	7,913,266	563,360	1.00	**39.0**	**5.0**	60,000	21.2	20.0
5130-DC-008	3	7,912,317	562,604	0.50	**20.0**	**5.0**	41,000	59.0	20.0
5130-DC-029	4	7,912,259	562,552	0.60	**20.0**	**5.0**	20,000	19.6	20.0
5130-DC-019	5	7,912,990	561,740	0.63	**15.0**	**5.0**	12,500	11.0	20.0
5130-DC-014	6	7,913,043	561,794	1.32	**15.0**	**5.0**	12,500	2.5	20.0
5180-DC-006	7	7,912,081	562,401	0.60	**37.0**	**5.0**	20,500	20.1	20.0

Railway

Emission factors	• US EPA Tier III standards for locomotives were used to generate NO_x, CO and PM emissions • SO_2 emissions will be based on fuel sulphur content of 0.0015% and a fuel density of 0.81 g/cm^3
Base quantities	• The trains will have 4400 bhp engines depending on the manufacturer selected they could be 4400 bhp (GE) or 4300 bhp (EMD), 2 locomotives and 110 wagons per train. The higher of the two values was assumed for emission calculation. • The recommended maximum operating speed for the early years of operation is 60km/h. However the passing track pattern is such that on average the trains will be operating at lower speeds than 60 km/hr. and the loaded train will be operating at a much lower speed on the long climb between the Ravn River crossing and the crest between the Ravn and Cockburn watersheds. • Transfer rate to load wagons: 6,000 tonnes per hour • Unloading rate: 1 minute per wagon (63 rails cars per hour)
Source parameters	• Stack heights of 4.7 m above ground level were based on EMD4300 • Stack diameters of 0.5 m, exit velocity of 21.4 m/s, flow rate of 4.2m³/s and exhaust exit temperature of 149 ºC were based on previous studies conducted by RWDI
Emission controls	• No emission controls were assumed. Locomotives currently coming out of GE and EMD are meeting the EPA Tier 2 emission requirements. Depending on when the Baffinland locomotives are ordered, they are likely to be meeting EPA Tier 3 emission requirements as a minimum and may be meeting Tier 4. However, Tier 3 standards were used for emission calculation.
Schedule of Operations	• Six trains per day will travel the railway corridor (145 km) between Mary River and Steensby. • 12 hours a day 7 days a week • Two days a week an additional freight train will also run

Aircraft	
Emission factors	• Based on the Federal Aviation Administration's (FAA) emission inventory for aircraft entitled Emissions and Dispersion Modeling System (EDMS) for inventory purposes only.
Base quantities	• During operations, Cessnas will be bringing in workers to Mary River. • 737 200C combination (freight + people) • Bell Ranger helicopters
Source parameters	• The aircraft sources were not quantified. Specific source parameters not required.
Emission controls	• No emission controls were assumed
Schedule of Operations	• 104 flights per year to Mary River (737s) • A few Cessna flights every two weeks to coincide with shift changes • Up to four helicopter flights per day. • Due to intermittent nature of flights, the air quality impacts were not quantified explicitly.
Incinerator	
Emission factors	• Emission estimates are based on two references provided to RWDI by HATCH from vendor • Sulphur dioxide (SO_2) emission rates are based on 0.0015% fuel sulphur content
Base quantities	• Burns 2,000 kg/day
Source parameters	• Average flow rate of 4 m³/s (240 m^3/min), exit velocity of 7.57 and exhaust temperature of 1200^oC, were based on the info provided by the selected vendor in the Technical Data Sheet (Doc. No. H337697-PM406-D118219) • Stack inside diameter is 0.82 m and stack height is 11 m
Emission controls	• No emission controls were assumed
Schedule of Operations	• Assumed batch operation 20 hours per day, 7 days a week

Blasting, Grading and Dozing	
Emission factors	• PM emissions from blasting, grading and dozing operations were estimated using AP-42 11.9
Base quantities	Blasting: • Total area blasted per blast hole averages 72m^2, with an average of 43 ea. blast hole per blast. Average area blasted per blast is 3,000$m^{2.}$ • The blasting will occur approximately 275 times per year. Total area per year is 850,000$m^{2.}$. Grading: • 2 graders (CAT-16H) will be operating simultaneously Dozing: • 3 track dozers (D10) and 2 wheel dozers (CAT834) will be operating simultaneously
Source parameters	Blasting: • Total area of a blast is 3,200$m^{2.}$ The blasts will occur approximately 275 times per year blasting (43 blast holes simultaneously per blast). Grading: • The mean vehicle speed used for graders is 30 km/hour. Dozing: • Material silt content of 1.2% based on bulk sampling conducted by RWDI • Moisture content of 0.1% based on bulk sampling • Material flow of 100,000 tonnes waste per day/300 days per year Average annual waste production is 31,000,000 tonnes per year
Emission controls	• No emission controls were assumed for blasting, grading and dozing. (heavy equipment is regulated to be tier 4)
Schedule of Operations	• One blast per day and 275days per year. • Grading and dozing operations were assumed to occur 20 hours per day, 7 days per week, approximately 300 days/year.
Processing Operations – Drilling	
Emission factors	• PM emissions from drilling were estimated using AP-42 11.19.2.1 • Wet drilling emission factors are used since there are no dry drilling emission factors.
Base quantities	• Processing 48,000,000 tonnes per year of ore and waste
Source parameters	• Material handled from drilling was calculated using the volume of a cylinder • Blasting hole diameter is 10 inches (0.254 m), assumed a drilling depth of 16.5m at an average density of 3.6. Estimated average volume of rock drill cuttings per day is 33m^3 or 120 tonnes.
Emission controls	• Drills are equipped with dust collectors
Schedule of Operations	• 20 hours a day, 7 days a week

Bulk Material Handling

Emission factors	• PM emissions from bulk material handling operations were estimated using AP-42 13.2.4
Base quantities	• The following sources and corresponding parameters are included in the modelling:

ID [2]	Process	Material Handled (Hourly) (Mg)	Material Handled (Daily) (Mg)	Material Handled (Annual) (Mg)	Site Specific Data? (y/n)	Hours of Operation	Moisture Content (%)
VOL1	Tripper Conveyor to Diverter Gate	2500	60,000	18,000,000	y	24	2.0%
VOL2	Diverter Gate Chute to conveyor drop operation	1250	30,000	9,000,000	y	24	2.0%
VOL3	Diverter Gate Chute to mobile stacker	1250	30,000	9,000,000	y	24	2.0%
VOL4	Mobile Stacker to stockpile drop operation	1250	30,000	9,000,000	y	24	2.0%
VOL5	Tripper Conveyor to Mobile Stacker/Reclaimer drop	2500	30,000	9,000,000	y	12	2.0%
VOL6	Mobile Stacker/Reclaimer to Stockpile	2500	30,000	9,000,000	y	12	2.0%
VOL7	Stockpile to Mobile Stacker/Reclaimer Operation	2500	30,000	9,000,000	y	12	2.0%
VOL8	Mobile Stacker/Reclaimer from Stockpile to Conveyor	2500	30,000	9,000,000	y	12	2.0%
VOL9	Stockpile to Mobile Reclaimer Operation	1250	30,000	9,000,000	y	24	2.0%
VOL10	Mobile Reclaimer to Conveyor drop	1250	30,000	9,000,000	y	24	2.0%

Emission controls	• No emission controls were assumed
Schedule of Operations	• See Table Above

Stockpiles (Mine Site for Rail Transport to Steensby Port)

Emission factors	• $PM_{2.5}$ emissions from stockpiles were estimated using AP-42 13.2.5
Base quantities	• One Off spec stockpile of 150,000 tonnes • Two Product stockpile of 400,000 tonnes each • One emergency Off spec stockpile of 150,000 tonnes • One emergency Product stockpile of 400,000 to 800,000 tonnes
Source parameters	• Surface roughness length of 0.003 m was applied in the calculations. • Threshold velocity for iron ore was estimated to be 6.94 m/s based on bulk sampling program conducted by RWDI. • Emission rates calculated on an hourly basis to vary according to wind speeds
Emission controls	• No emission controls were assumed
Schedule of Operations	• 24-hours per day, 7 days per week assumed for simplicity

<table>
<tr><th colspan="2">Mobile Engine Emissions</th></tr>
<tr><td>Emission factors</td><td>

The generation of NO_x, CO and $PM_{2.5}$ from the combustion of diesel fuel in diesel engines was considered
U.S. EPA Tier IV Non-Road CI standards were used to calculate emission rates for the off-road fleet
All engine PM emissions were assumed to be in the $PM_{2.5}$ size fraction

</td></tr>
<tr><td>Base quantities</td><td>

The equipment fleet in the table below was provided by Hatch

<table>
<tr><th>Equipment Fleet</th><th>Availability</th><th>Average Vehicle Weight (tonnes)</th><th>Power Rating (kW)</th></tr>
<tr><td>• Production Drills - P&H</td><td>3</td><td>113</td><td>746</td></tr>
<tr><td>• Drills - Atlas Copco D9</td><td>1</td><td>15*</td><td>168</td></tr>
<tr><td>• Hydraulic Shovel – Komatsu PC8000</td><td>3</td><td>700*</td><td>3000</td></tr>
<tr><td>• Loader - Letourneau L1850</td><td>1</td><td>190</td><td>1490</td></tr>
<tr><td>• Truck – Komatsu 930E 290t</td><td>15</td><td>210</td><td>2040</td></tr>
<tr><td>• Trackdozer - D10</td><td>3</td><td>66</td><td>433</td></tr>
<tr><td>• Wheeldozer - CAT834</td><td>2</td><td>47</td><td>372</td></tr>
<tr><td>• Grader - CAT16H</td><td>2</td><td>27</td><td>221</td></tr>
<tr><td>• Watertruck - 20,000 Gallon Trucks^</td><td>1</td><td>90</td><td>700</td></tr>
<tr><td>• Backhoe - CAT385</td><td>1</td><td>85</td><td>382</td></tr>
<tr><td>• Service Truck</td><td>2</td><td>12*</td><td>200*</td></tr>
<tr><td>• Tire Handler - CAT988</td><td>1</td><td>50</td><td>373</td></tr>
<tr><td>• Pickup Truck - 6.7L engine</td><td>8</td><td>3</td><td>230*</td></tr>
</table>
NOTES: * - values not provided therefore some assumptions were made
^ Summer season only (2 months per year)

Arctic Diesel with ultra-low sulphur fuel (i.e., 0.0015 % fuel sulphur) will be used

</td></tr>
<tr><td>Source parameters</td><td>

Power ratings and availability of vehicles

</td></tr>
<tr><td>Emission controls</td><td>

No emission controls were assumed

</td></tr>
<tr><td>Schedule of operations</td><td>

20 hours a day, 7 days a week

</td></tr>
</table>

Haul Road Emissions (Komatsu 930E)	
Emission factors	• Dust generation from vehicular activity on surface roads was considered • AP-42 13.2.2 was used to calculate PM emissions
Base quantities	• Fifteen (15) 290 tonnes trucks (average weight of 210 tons) were to be used (see Mobile Engine Emissions) • A silt content of 5.2% was applied based on bulk sampling.
Source parameters	• Unpaved industrial roads
Emission controls	• No emission controls were assumed
Schedule of Operations	• 20 hours a day, 7 days a week

MINE SITE OPERATIONS: EMISSION DATA TABLES

Table 1: Mary River Stationary Point Sources

Source Name	PWST1	PWST2	INCIN1	BGHOUS1	SCBAG1	TTRST1	TTRST2	TTRST3	TTRST4	TTRST5
Source Description	Power Plant Stack 1	Power Plant Stack 2	Incinerator Stack	Primary Crusher Plant Baghouse	Secondary Crusher Baghouse	Transfer Tower Building 5130.101 Baghouse	Transfer Tower 5130.102 Building Baghouse	Transfer Tower 5130.103 Baghouse	Transfer Tower 5130.104 Baghouse	Train Loading Building Baghouse
UTMX (km)	561.50826	561.533	561.075	563.476	563.36	562.604	562.552	561.74	561.794	562.401
UTMY (km)	7913.1285	7913.111	7913.450	7913.418	7913.266	7912.317	7912.259	7912.99	7913.043	7912.081
Stack Height (m)	30	30	11	25	44	25	25	20	20	42
Stack Diameter (m)	1	1	0.82	1.6	1	0.9	0.6	0.5	0.5	0.6
Exit Velocity (m/s)	30.7	30.7	7.5743	18.4	21.2	18	19.6	18	18	20.1
Exit Temp. (K)	613	613	1473	291	293	293	293	293	293	293
Emission Rate (g/s)										
SO2	7.44E-02	7.44E-02	6E-11	0	0	0	0	0	0	0
SO4	0	0	0	0	0	0	0	0	0	0
Nox	3.88E+01	3.88E+01	2.31E-01	0	0	0	0	0	0	0
HNO3	0	0	0	0	0	0	0	0	0	0
NO3	0	0	0	0	0	0	0	0	0	0
CO	2.40E+00	2.40E+00	1.86E-02	0	0	0	0	0	0	0
PM0.5	8.19E-01	8.19E-01	7.68E-02	0.104296875	4.69E-02	3.20E-02	1.56E-02	9.77E-03	9.77E-03	1.60E-02
PM1.5	8.19E-01	8.19E-01	7.68E-02	0.062578125	2.81E-02	1.92E-02	9.38E-03	5.86E-03	5.86E-03	9.61E-03
PM3.0	0	0	0	0.056082819	2.52E-02	1.72E-02	8.40E-03	5.25E-03	5.25E-03	8.61E-03
PM5.0	0	0	0	0.044866255	2.02E-02	1.38E-02	6.72E-03	4.20E-03	4.20E-03	6.89E-03
PM8.0	0	0	0	0.103009259	4.63E-02	3.16E-02	1.54E-02	9.65E-03	9.65E-03	1.58E-02
PM12.5	0	0	0	0	0	0	0	0	0	0
PM17.5	0	0	0	0	0	0	0	0	0	0
PM25.0	0	0	0	0	0	0	0	0	0	0

Table 2: Mary River Area Sources

Source Name	AREA01	AREA02	AREA03	AREA04 - AREA47	OFFSP1	OFFSP2	PRODT1	PRODT2	STOCK1
Source Description	**Blasting**	**Dozing, Grading, Drilling**	**Combustion from OffRoad**	**Haul Truck**	**OFFSpec Stockpile**	**OFFSpec Stockpile**	**Product Stockpile**	**Product Stockpile**	**Emergency Stockpile**
Area (m2)	4000	4000	4000	900	3330	3183	10288	11427	30900
Source Ht (m)	0	1	4	4	12	12	12	12	12
Sigma z (m)	10	1	2	2	2	2	2	2	2
Emission Rate (g/s)									
SO2	0.00E+00	0.00E+00	3.91E-04	1.33E-05	Variable	Variable	Variable	Variable	Variable
Nox	0.00E+00	0.00E+00	1.37E+01	6.33E-01	Variable	Variable	Variable	Variable	Variable
CO	0.00E+00	0.00E+00	1.85E+01	6.33E-01	Variable	Variable	Variable	Variable	Variable
PM0.5	1.97E-01	1.67E+01	9.03E-02	5.45E-02	Variable	Variable	Variable	Variable	Variable
PM1.5	1.18E-01	1.00E+01	9.03E-02	5.45E-02	Variable	Variable	Variable	Variable	Variable
PM3.0	1.61E+00	1.17E+02	0.00E+00	2.91E-01	Variable	Variable	Variable	Variable	Variable
PM5.0	1.29E+00	9.39E+01	0.00E+00	2.18E-01	Variable	Variable	Variable	Variable	Variable
PM8.0	2.26E+00	1.64E+02	0.00E+00	4.36E-01	Variable	Variable	Variable	Variable	Variable
PM12.5	1.49E+00	7.23E+01	0.00E+00	1.01E+00	Variable	Variable	Variable	Variable	Variable
PM17.5	1.49E+00	7.23E+01	0.00E+00	8.04E-01	Variable	Variable	Variable	Variable	Variable
PM25.0	2.08E+00	1.01E+02	0.00E+00	1.01E+00	Variable	Variable	Variable	Variable	Variable

Notes:
1. Emission from stockpiles vary based on wind speed

Table 3: Mary River Volume Sources

Source Description	Tripper Conveyor to Diverter Gate Drop Operation	Diverter Gate to Conveyor Drop Operation	Diverter Gate to Mobile Stacker Drop Operation	Mobile Stacker to Stockpile Drop	Tripper Conveyor to Stacker Reclaimer	Stacker/ Reclaimer to Stockpile Drop	Stockpile to Mobile Stacker /Reclaimer	Mobile Stacker/Re-claimer to Conveyor Drop	Stockpile to MObile Reclaimer	Mobile Reclaimer to conveyor drop
Source Name	**VOL01**	**VOL02**	**VOL03**	**VOL04**	**VOL05**	**VOL06**	**VOL07**	**VOL08**	**VOL09**	**VOL10**
Location [X-coord] (km)	562.522	562.504	562.466	562.439	562.086	562.093	562.081	562.099	561.817	561.844
Location [Y-coord] (km)	7912.412	7912.429	7912.455	7912.437	7912.694	7912.699	7912.691	7912.683	7912.930	7912.906
Elevation (m ASL)	220	220	217	215	209	210	209	209	207	207
Sigma y (m)	0	0	0	0	0.31	0.25	0.25	0.25	0.25	0.25
Sigma z (m)	0.93	1.86	0.93	0.70	1.40	1.40	1.40	1.40	1.40	1.40
Release Height (m)	9.25	2	9.5	13.5	9	15	15	2	15	2
Emission Rates (g/s)										
NOx	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SO2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SO3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SO4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PM2.5 (Combustion)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSP (Fugitive)	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File	Hourly Emission File
PM10 (Fugitive)										
PM2.5 (Fugitive)										

AIR EMISSION INVENTORY

PART II: STEENSBY PORT

STEENSBY SITE OPERATIONS: BASE DATA

Power Generation – Unknown	
Emission factors	• All emission parameters were supplied by the manufacturer • All particulate matter was assumed to be in the $PM_{2.5}$ size fraction
Base quantities	• Steensby has 7generators (5 operating and 2 standby), each with a power rating of 5.8MW • Arctic Diesel with ultra-low sulphur fuel (i.e., 0.0015 % fuel sulphur) will be used
Source parameters	• Stack heights of 30 m provided by manufacturer, which was confirmed by RWDI through preliminary stack height modelling. • Stack diameters of 1.2 m were provided by the vendor along with an exit velocity of 26.4 m/s and a flow rate of 107640 Am^3/hr • Exhaust exit temperature is 336 ºC for the generators based on the manufacturer specification sheet, if no heat recovery system is in place. If heat recovery system is in place, the exit temperature will be 150 ºC
Emission controls	• No emission controls were assumed. For CALPUFF modelling, all five generators were assumed to be running at full load. Emergency and backup generators were not considered for modelling purposes because the total number of generators would not exceed five at any time.
Schedule of Operations	• Five (5) generators will operate 24 hours a day, 7 days a week.
Thermal Heat Generation – Back-up Emergency Boilers	
Emission factors	• All emission parameters were supplied by the manufacturer • All particulate matter was assumed to be in the $PM_{2.5}$ size fraction • Sulphur dioxide (SO_2) emission rates are based on 0.0015% fuel sulphur content
Base quantities	• Mary River has two 5MW thermal emergency boilers
Source parameters	• A stack heights of 30 m was provided by the vendor • Stack diameter of 1.22 m was provided by the vendor along with an exit velocity of 18.2 m/s and a flow rate of 22503 Am^3/hr • Exhaust temperature is 175 ºC as per the vendor
Emission controls	• No emission controls were assumed
Schedule of Operations	• Boilers used for back up heat generation only and were therefore not included in the air quality impact assessment as the operation of the generators results in higher emissions compared to the boilers.

Dust Collectors

Emission factors	• All emission parameters were supplied by the manufacturer
Base quantities	• There are eleven (11) baghouses at various locations in the port
Source parameters	• Source Parameters were included below:

Equipment No. (#)	Stack No. (#)	Co-ordinates		Stack I. D. (m)	Building Height (m)	Stack Height from the roof (m)	Flow Rate (Am^3/h)	Exit Velocity (m/s)	Ave. Temp. (deg. C)
		North (m)	East (m)						
5210-DC-010	1	7,800,924	594,647	1.30	14.0	5.0	89,000	18.6	20.0
5210-DC-014	2	7,800,401	594,580	0.55	17.0	5.0	12,500	14.5	20.0
1260-DC-059	3	7,800,282	594,172	1.50	47.0	5.0	121,000	19.0	20.0
1260-DC-062	4	7,800,270	594,152	0.70	47.0	5.0	22,500	16.2	20.0
1260-DC-064	5	7,800,277	594,140	0.70	47.0	5.0	22,500	16.2	20.0
1260-DC-066	6	7,800,284	594,128	2.40	47.0	5.0	280,500	17.2	20.0
1270-DC-017	7	7,800,430	593,901	1.10	39.0	5.0	57,000	16.7	20.0
5350-DC-016	8	7,800,385	594,000	0.45	22.0	5.0	10,000	17.5	20.0
5350-DC-003	9	7,800,423	593,939	0.57	39.0	5.0	15,500	16.9	20.0
5370-DC-008	10	7,799,154	593,160	1.80	29.0	5.0	174,000	19.0	20.0
5370-DC-015	11	7,798,643	592,864	0.60	32.0	5.0	16,500	16.2	20.0

Incinerator

Emission factors	• Emission estimates are based on two references provided to RWDI by HATCH from vendor • Sulphur dioxide (SO_2) emission rates are based on 0.0015% fuel sulphur content
Base quantities	• Burns 1000 kg/day
Source parameters	• Average flow rate of 2.1m³/s (127 m^3/min), exit velocity of 6.14 m/s and exhaust temperature of 1200^oC were based on the info provided by the selected vendor in the Technical Data Sheet, Doc. No. H337697-PM406-D118219 • Stack Inside diameter is 0.66m was calculated
Emission controls	• No emission controls were assumed
Schedule of Operations	• 20 hours a day, 7 days a week (the 20-hour cycle consists of 8 hours of heating and 12 hours of cooling)

Ships	
Emission factors	• Ore Carrier ships meet IMO Tier II requirements • Sulphur dioxide (SO_2) emission rates are based on 0.0005% fuel sulphur content in the auxiliary generator when carriers are in port and 1.5% fuel sulphur in the main engines when the ship is in transit.
Base quantities	• Average of 12 ore carriers per month on a year round basis with up to 17 vessels per month in summer open-water season • Ten (10) Polar Class 4 cape-size vessels with a capacity of 135,000 dry weight tonne will transport 90-95% of annual ore production to market • Ships will be about 330m long and about 52m wide and will have a 20m draft • Ships will be equipped with three 2MW "hotel power" generator
Source parameters	<u>Three 2MW Generator (Two operating at the port)</u> • About 30 m stack height • Stack diameters of 0.5 m were based on vendor supplied data with an exit velocity of 35.9 m/s and a flow-rate of 7.05 m³/s • Exhaust exit temperature is assumed to be 328 ºC <u>Two 27 MW Generators when Carriers in Transit</u> • 30 m stack height • Stack diameters of 1.9 m • 34 m/s exit velocity based on a flow rate of 96.3 m³/s • Exhaust exit temperature is assumed to be 250 ºC
Emission controls	• No emission controls were assumed
Schedule of Operations	• The vessels will each require about 16-17MW propulsion in open water at 13 knots with 15% sea margin and about two (2) MW auxiliary power for 300 days per year at sea baseline. The maximum power will only need to be utilized occasionally. In port, the aux load is about 2 MW. As a guess, an average representative power value of about 25MW per main engine and two (2) MW per generator would be closer to being typical. • It is expected that ore carrier will be docked at the port one day in every three days. However, for the simplicity and uncertainty on the specific days, it is assumed that ship hotel power generators will operate throughout the year to determine the worst case hourly concentrations as the dominant pollutants from generator exhaust will be NO_x and SO_2

Ice Management Vessels (IMVs) and Tug Boats	
Emission factors	• All the vessels are IMO Tier II compliant • Sulphur dioxide (SO_2) emission rates are based on 0.1% fuel sulphur content
Base quantities	• Two IMVs will operate throughout the year at variable load depending on season and load requirements. • During 47 days in summer, the IMVs will operate at a load of 4MW and 6 hours per day. • During 153 days in winter, IMVs will operate at 16 MW for 10 hrs per day for docking and undocking operation. In every three days, one day IMVs will perform docking operation and another day it will perform undocking operation. The ore carrier will be docked at the port for loading and unloading operation for the remaining day of each three days. • During hard winter days, IMV's will also perform some ice breaking operation at 16 MW for 95 days, 16 hours per day. • IMV on-board generators will operate throughout the year to produce electricity, comfort heating, cooking and other utility purposes. • Two tugboats will operate at 3 MW during summer for 120 days, 6 hrs per day. • On days when the hours of operation are expected to be less than 24 hours, 24-hour operations was assumed any way, to ensure a worst-case prediction of maximum hourly pollutant levels.
Source parameters	• Due to the nature of the operation, emissions from the vessels will be modelled as a vast area source covering the harbour. • Emissions were based on IMO Tier II standards. The emission of SO_2 will be based on a fuel sulphur content of 0.1%. • IMVs and tugboats parameters are approximate values provided by the vendor based on best judgement. At this point, no decision was made in terms of the use of IMVs and tugboats. However, they are included in the modelling based on best available information
Emission controls	• No emission controls were assumed
Schedule of Operations	• Variable schedule of operation

Stockpiles	
Emission factors	• PM emissions from stockpiles were estimated using AP-42 13.2.5
Base quantities	• One (1) Fine stockpile having a capacity of 1,300,000 tonnes • One (1) Lump stockpile having a capacity of 2,300,000 tonnes • One (1) Lump stockpile having a capacity of 900,000 tonnes •
Source parameters	• Surface roughness length of 0.003 m was assumed
Emission controls	• No emission controls were assumed
Schedule of Operations	• Erosion can potentially occur 24 hours a day 7 days a week.
Bulk Material Handling	
Emission factors	• PM emissions from bulk material handling operations were estimated using AP-42 13.2.4
Base quantities	• The following sources and corresponding source parameters are included in the assessment:
Emission controls	• No emission controls were assumed
Schedule of Operations	• Twelve (12) to fifteen (15) hours a day, 7 days a week, except for reclaimers to ship loading operation. • The reclaimer to ship loader operation occurs 24 hours a day, once every 3 days (the remaining two out of the three days are for bringing the ship into the dock and leaving the dock). • For simplicity, these operations were assumed to occur 24-hours per day.

ID [1]	Process	Material Handled (Hourly) (Mg)	Material Handled (Daily) (Mg)	Material Handled (Annual) (Mg)	Site Specific Data? (y/n)	Moisture Content (%)
VOL1	Tripper chute to Stacker drop	1409	21,139	6,341,741	y	2.0%
VOL2	Stacker to Stcokpile drop	1409	21,139	6,341,741	y	2.0%
VOL3	Tripper chute to Stacker/Reclaimer drop	3886	58,291	11,658,259	y	2.0%
VOL4	Stacker/Reclaimer to Stockpile drop	3886	58,291	11,658,259	y	2.0%
VOL5	Stockpile to Stacker/Reclaimer	3750	90,000	9,000,000	y	2.0%
VOL6	Stacker/Reclaimer to Conveyor drop	3750	90,000	9,000,000	y	2.0%
VOL7	Stockpile to Reclaimer	3750	90,000	9,000,000	y	2.0%
VOL8	Reclaimer to Conveyor drop	3750	90,000	9,000,000	y	2.0%
VOL9	Ship Loader1 to Ship drop	3750	90,000	9,000,000	y	2.0%
VOL10	Tripper Chute to Ship Loader2	3750	90,000	9,000,000	y	2.0%
VOL11	Ship Loader2 to Ship drop	3750	90,000	9,000,000	y	2.0%

STEENSBY PORT OPERATIONS: EMISSION DATA TABLES

Table 1: Steensby Port Stationary Point Sources

Source Name	STCK01	STCK02	STCK03	STCK04	STCK05	STCK06	STCK08	STCK09
Source Description	Rail Car Unloading Baghouse	Transfer House Baghouse	Screening Plant Baghouse 1	Screening Plant Baghouse 2	**Screening Plant Baghouse 3**	**Screening Plant Baghouse 4**	**Yard Conveyor/Stacker Reclaimer Transfer Tower BLD-5350.101 Baghouse**	**Yard Conveyor /Stacker Reclaimer Lump Transfer Point**
UTMX (km)	594.647	594.580	594.172	594.152	594.140	594.128	594.000	593.939
UTMY (km)	7800.924	7800.401	7800.282	7800.270	7800.277	7800.284	7800.385	7800.423
Stack Height (m)	19	22	52	52	52	52	27	44
Stack Diameter (m)	1.3	0.5	1.5	0.7	0.7	2.4	0.45	0.55
Exit Velocity (m/s)	18.6	18	19	16.2	16.2	17.2	17.5	18
Exit Temp. (K)	293	293	293	293	293	293	293	293
Emission Rate (g/s)								
NOx	0	0	0	0	0	0	0	0
CO	0	0	0	0	0	0	0	0
SO2	0	0	0	0	0	0	0	0
PM0.5	6.95E-02	9.77E-03	9.45E-02	1.76E-02	1.76E-02	2.19E-01	7.81E-03	1.21E-02
PM1.5	4.17E-02	5.86E-03	5.67E-02	1.05E-02	1.05E-02	1.31E-01	4.69E-03	7.27E-03
PM3.0	3.74E-02	5.25E-03	5.08E-02	9.45E-03	9.45E-03	1.18E-01	4.20E-03	6.51E-03
PM5.0	2.99E-02	4.20E-03	4.07E-02	7.56E-03	7.56E-03	9.43E-02	3.36E-03	5.21E-03
PM8.0	6.87E-02	9.65E-03	9.34E-02	1.74E-02	1.74E-02	2.16E-01	7.72E-03	1.20E-02
PM12.5	0	0	0	0	0	0	0	0
PM17.5	0	0	0	0	0	0	0	0
PM25.0	0	0	0	0	0	0	0	0

Table 1 (cont'd): Steensby Port Stationary Point Sources

Source Name	STCK07	STCK10	STCK11	STCK13	STCK12	STCK14	MW2ST1	MW2ST2
Source Description	Tertiary Crushing Plant Baghouse	Ship Loading Transfer Tower BLD-5370.100 Baghouse	Ship Loading Transfer Tower BLD-5370.101 Baghouse	Power Plant Stack 1	Power Plant Stack 2	Incinerator	Ship 2MW Generator1 at port	Ship 2MW Generator2 at port
UTMX (km)	593.901	593.153	592.892	596.236	596.252	596.032	592.790	592.795
UTMY (km)	7800.430	7799.153	7798.643	7803.123	7803.098	7803.010	7798.445	7798.445
Stack Height (m)	44	34	37	30	30	30	30	30
Stack Diameter (m)	1.1	1.8	0.6	1.2	1.2	0.66	0.5	0.5
Exit Velocity (m/s)	16.7	19	16.2	26.4	26.4	6.1	35.9	35.9
Exit Temp. (K)	293	293	293	609	609	1473	601	601
Emission Rate (g/s)								
NOx	0	0	0	5.83E+01	5.83E+01	9.39E-05	8.16E+00	8.16E+00
CO	0	0	0	3.00E+00	3.00E+00	7.56E-06	6.23E-01	6.23E-01
SO2	0	0	0	9.28E-02	9.28E-02	3.15E-11	1.09E-03	1.09E-03
PM0.5	4.45E-02	1.36E-01	1.29E-02	1.03E+00	1.03E+00	4.03E-02	2.83E-01	2.83E-01
PM1.5	2.67E-02	8.16E-02	7.73E-03	1.03E+00	1.03E+00	4.03E-02	2.83E-01	2.83E-01
PM3.0	2.39E-02	7.31E-02	6.93E-03	0	0	0	1.94E-01	1.94E-01
PM5.0	1.92E-02	5.85E-02	5.55E-03	0	0	0	1.45E-01	1.45E-01
PM8.0	4.40E-02	1.34E-01	1.27E-02	0	0	0	2.90E-01	2.90E-01
PM12.5	0	0	0	0	0	0	0	0
PM17.5	0	0	0	0	0	0	0	0
PM25.0	0	0	0	0	0	0	0	0

Table 2: Steensby Port Volume Sources

Source Description	Tripper Conveyor to Diverter Gate	Diverter Gate to Conveyor Drop	Diverter Gate to Mobile Stacker	Mobile Stacker to Stockpile Drop	Tripper Conveyor to Stacker Reclaimer	Stacker/Re-claimer to Stockpile Drop	Stockpile to Mobile Stacker/Re-claimer	Mobile Stacker/Re-claimer to Conveyor Drop	Stockpile to Mobile Reclaimer	Mobile Reclaimer to conveyor drop	Mobile Reclaimer to conveyor drop
Source Name	**VOL01**	**VOL02**	**VOL03**	**VOL04**	**VOL05**	**VOL06**	**VOL07**	**VOL08**	**VOL09**	**VOL10**	**VOL11**
Location [X-coord] (km)	593.568	593.573	593.797	593.800	593.796	593.803	593.352	593.347	592.790	592.858	592.790
Location [Y-coord] (km)	7799.677	7799.682	7800.217	7800.215	7800.212	7800.219	7799.474	7799.476	7798.469	7798.230	7798.228
Sigma y (m)	0.31	0.25	0.31	0.25	0.25	0.25	0.25	0.25	0.25	0.31	0.25
Sigma z (m)	0.93	0.70	0.93	1.40	1.40	1.86	1.40	1.86	4.42	1.40	4.42
Release Height (m)	9.5	13.5	9.5	15	15	2	15	2	19	9	19
Emission Rates (g/s)											
NOx	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SO2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SO3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SO4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PM2.5 (Combustion)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSP (Fugitive)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PM10 (Fugitive)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PM2.5 (Fugitive)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3: Steensby Port Area Sources

Source Name	FINE11	LUMP11	LUMP12	LUMP21	TUG01	ICE01	DOC01	SUM01
Source Description	**Fine Stockpile Area Source 1**	**Lump Stockpile Area Large Source1**	**Lump Stockpile Large Area Source 2**	**Lump Area Source Small**	**Tug Emission**	**IMV Ice Mangement**	**IMV Docking Undocking**	**IMV Summer**
Area (m2)	52019	35890	35905	26778	4500000	4500000	4500000	4500000
Source Ht (m)	12	12	12	12	10	16	16	16
Sigma z (m)	2	2	2	2	10	16	16	16
Emission Rate (g/s)								
SO2	Variable	Variable	Variable	Variable	1.67E-01	8.89E-01	8.89E-01	2.22E-01
Nox	Variable	Variable	Variable	Variable	2.40E+01	1.28E+02	1.28E+02	3.20E+01
CO	Variable	Variable	Variable	Variable	1.83E+00	9.78E+00	9.78E+00	2.44E+00
PM0.5	Variable	Variable	Variable	Variable	8.33E-01	4.44E+00	4.44E+00	1.11E+00
PM1.5	Variable	Variable	Variable	Variable	8.33E-01	4.44E+00	4.44E+00	1.11E+00
PM3.0	Variable	Variable	Variable	Variable	5.69E-01	3.04E+00	3.04E+00	7.59E-01
PM5.0	Variable	Variable	Variable	Variable	4.27E-01	2.28E+00	2.28E+00	5.69E-01
PM8.0	Variable	Variable	Variable	Variable	8.54E-01	4.55E+00	4.55E+00	1.14E+00
PM12.5	Variable	Variable	Variable	Variable	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM17.5	Variable	Variable	Variable	Variable	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM25.0	Variable	Variable	Variable	Variable	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Notes:
1. Emission from stockpiles vary based on wind speed
2. See variable emission file for details about the emission from tugboats and ice management vessels