CUMBERLAND
RESOURCES LTD.

MEADOWBANK GOLD PROJECT

AIR QUALITY IMPACT ASSESSMENT

JANUARY 2005

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DESCRIPTION OF SUPPORTING DOCUMENTATION

Cumberland Resources Ltd. (Cumberland) is proposing to develop a mine on the Meadowbank property. The property is located in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake on Inuit-owned surface lands. Cumberland has been actively exploring the Meadowbank area since 1995. Engineering, environmental baseline studies, and community consultations have paralleled these exploration programs and have been integrated to form the basis of current project design.

The Meadowbank project is subject to the environmental review and related licensing and permitting processes established by Part 5 of the Nunavut Land Claims Agreement. To complete an environmental impact assessment (EIA) for the Meadowbank Gold project, Cumberland followed the steps listed below:

1. Determined the VECs (air quality, noise, water quality, surface water quantity and distribution, permafrost, fish populations, fish habitat, ungulates, predatory mammals, small mammals, raptors, waterbirds, and other breeding birds) and VSECs (employment, training and business opportunities; traditional ways of life; individual and community wellness; infrastructure and social services; and sites of heritage significance) based on discussions with stakeholders, public meetings, traditional knowledge, and the experience of other mines in the north.

2. Conducted baseline studies for each VEC and compared / contrasted the results with the information gained through traditional knowledge studies (see Column 1 on the following page for a list of baseline reports).

3. Used the baseline and traditional knowledge studies to determine the key potential project interactions and impacts for each VEC (see Column 2 for a list of EIA reports).

4. Developed preliminary mitigation strategies for key potential interactions and proposed contingency plans to mitigate unforeseen impacts by applying the precautionary principle (see Column 3 for a list of management plans).

5. Developed long-term monitoring programs to identify residual effects and areas in which mitigation measures are non-compliant and require further refinement. These mitigation and monitoring procedures will be integrated into all stages of project development and will assist in identifying how natural changes in the environment can be distinguished from project-related impacts (monitoring plans are also included in Column 3).

6. Produce and submit an EIS report to NIRB.

As shown on the following page, this report is part of the documentation series that has been produced during this six-stage EIA process.

EIA DOCUMENTATION ORGANIZATION CHART

Project Description Report
Main Contributor: Cumberland Resources
Reviewer: All Consultants

ENVIRONMENTAL IMPACT STATEMENT

Project Alternatives
Main Contributor: Lynton Gormley, AMEC Americas
Reviewer: Brad Thiele, Cumberland Resources; Golder Associates Ltd.

Baseline Reports

Aquatic Ecosystem
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Fish Habitat
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Terrestrial Ecosystem
Main Contributor: Martin Gebauer, Gebauer & Associates
Reviewer: Ben Hubert , Hubert & Associates

Physical Ecosystem
Main Contributor: BGC Engineering
Reviewer: Golder Associates Ltd.

Socioeconomic
Main Contributor: Robert Hornal
Reviewer: Susan Ross, Golder Associates Ltd.

Archaeology
Main Contributor: Deborah Webster
Reviewer: Gloria Fedirchuk, FMA Heritage Resource Consultants

Traditional Knowledge (TK)
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Tom & Hattie Mannik

Impact Assessments

Aquatic Ecosystem/Fish Habitat
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Cumulative Effects (CEA)
Main Contributor: Ly-Shu Ramos, AMEC Americas
Reviewer: Robert Hornal, Hornal & Associates

Terrestrial Ecosystem
Main Contributor: Martin Gebauer, Gebauer & Associates
Reviewer: Ben Hubert, Hubert & Associates

Physical Ecosystem
Main Contributor: BGC Engineering Ltd.
Reviewer: Golder, Azimuth, AMEC

Socioeconomic & Archaeology
Main Contributor: Susan Ross, Golder Associates Ltd.
Reviewer: George Hegmann, AXYS Environmental Consulting

Noise
Main Contributor: Richard Palczynski, AMEC Americas
Reviewer: Bob Humphries, Levelton Engineering

Air Quality
Main Contributor: Richard Palczynski, AMEC Americas
Reviewer: Levelton Engineering

Management & Monitoring Plans

Aquatic Effects Management Program (AEMP)
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Metal Mining Effluent Regulations (MMER)
Main Contributor: Randy Baker, Azimuth Consulting
Reviewer: Mike Lawrence, North-South Consulting

Terrestrial Ecosystem
Main Contributor: Martin Gebauer, Gebauer & Associates
Reviewer: Ben Hubert , Hubert & Associates

No-Net-Loss of Habitat (NNL)
Main Contributor: Randy Baker, Azimuth
Reviewer: Mike Lawrence, North-South Consulting

Socioeconomic & Archaeology
Main Contributor: Susan Ross, Golder Associates Ltd.
Reviewer: Robert Hornal, Hornal & Associates

Mine Waste & Water
Main Contributor: Golder Associates Ltd..
Reviewer: BGC Engineering Ltd.

Air Quality & Noise
Main Contributor: Richard Palczynski, AMEC Americas
Reviewer: Bob Humphries, Levelton

Access & Air Traffic
Main Contributor: Raj Anand, Cumberland Resources
Reviewer: Alistair Kent, Gartner Lee

Reclamation & Closure
Main Contributor: Golder Associates Ltd..
Reviewer: BGC Engineering Ltd.

Emergency Response
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Cumberland Resources

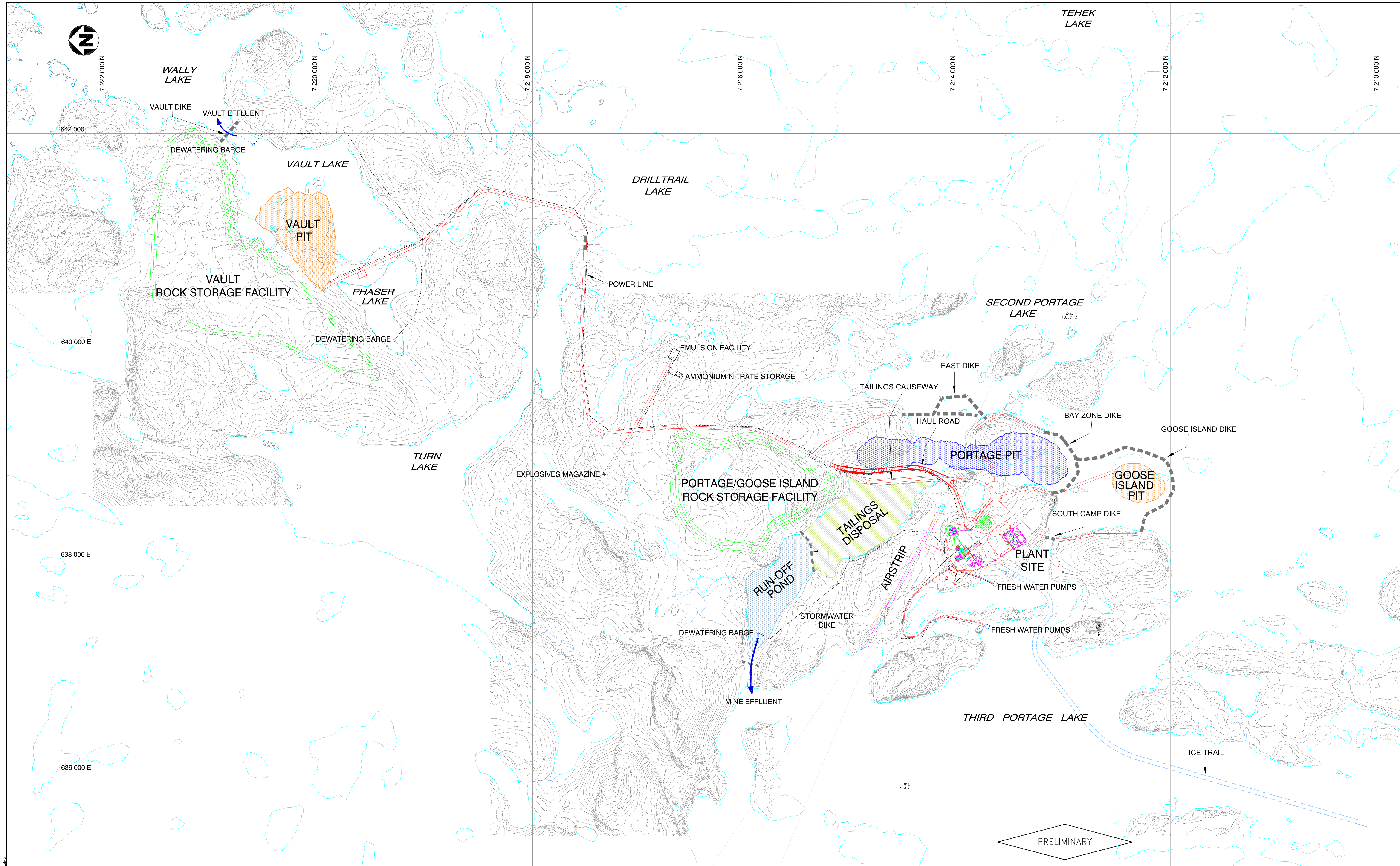
Hazardous Materials
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Cumberland Resources

Spill Contingency
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Cumberland Resources

Occupational Health & Safety
Main Contributor: Darlene Hughes, IBIS Group, Inc.
Reviewer: Ted Rutherglen, Cumberland Resources

Human Resources
Main Contributor: Ted Rutherglen, Cumberland Resources
Reviewer: Cumberland Resources

PROJECT LOCATION MAP



Proposed Mine Site Layout

CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

SOURCE: AMEC drawing 100-c000c.dwg

SECTION 1 • INTRODUCTION

This report addresses the environmental concerns and regulatory interests regarding the potential for air emissions from the Meadowbank Gold project. The assessment presented herein analyzes potential emissions to the atmosphere, estimates ambient concentrations, and compares these estimates to relevant guidelines or objectives. A discussion of project emissions impact on ambient air quality is included.

A limited number of point emission sources will be present at the plant. The most significant ones will be the exhaust stacks of the diesel power plant. Combustion of diesel fuel involves emissions of nitrogen oxides (NO_x), with most of nitrogen oxide (NO) converting to nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), water vapour (H_2O), and some small quantities of unburned hydrocarbons (HC), particulate matter (PM), and other compounds.

Mining activities and ore processing facilities will generate dust. The dust arises predominantly from inert soil, ore materials, and tailings. The main potential sources of dust will include processing plant, stockpiles, ore hauling trucks, tailings and waste rock disposal, stripping, and overburden storage. They are generally dispersed sources rather than specific point sources. Plant-located dust emission sources will include primary crusher, ball mill, and furnace vent. Windy and dry weather conditions greatly enhance fugitive dust emission.

Various mining equipment and hauling trucks powered by diesel engines will exhaust air pollutants such as nitrogen oxides, volatile organic compounds, particulate matter (mainly small sizes, less than 10 µm [PM_{10}] and 2.5 µm [$PM_{2.5}$] of aerodynamic diameter), carbon monoxide, and carbon dioxide.

The following air quality issues are of primary concern and, therefore, selected for the air quality assessment:

- emissions resulting from combustion of diesel fuel in the power plant and vehicles, including nitrogen oxides, carbon monoxide, sulphur dioxide, and particulate matter (PM_{10} and $PM_{2.5}$)
- fugitive dust emissions from tailings, overburden, and waste disposal and process operations including ore hauling.

SECTION 2 • BOUNDARIES OF THE STUDY AREA

2.1 SPATIAL BOUNDARIES

The air quality assessment has been conducted for regional study area (RSA) and local study area (LSA). The RSA for the cumulative air quality assessment was defined in preliminary dispersion modelling with the AERMOD model and resulted in the selection of a 5 km zone around the emission sources. The RSA is extended to the south and north by 7 km resulting from the distance between the processing plant and the Vault mine. The RSA can be viewed in a series of concentration isopleths presented in Section 6.

The LSA is based on a 3 km distance from project sites, within which the maximum ground level concentrations will occur due to mining equipment, mobile sources, and plant activities. The extent of the LSA was also determined by preliminary dispersion modelling. The LSA is shown in Section 6, Figures 6.8 to 6.10, 6.12 to 6.14; and in Figures 6.16 to 6.24 (except Figure 6.22, which is within RSA boundaries).

2.2 TEMPORAL BOUNDARIES

The establishment of temporal boundaries is based on the worst-case scenario when air quality impacts would be worst throughout the life of the project. This will happen when the Vault pit is in operation and the ore is hauled to the processing plant by a fleet of 90-tonne trucks over a distance of approximately 7 km. Mining at the Vault site is scheduled for three-year period for an ore mining total of 1,715,000 t/a.

SECTION 3 • AIR QUALITY GUIDELINES & OBJECTIVES

The primary aim of establishing ambient air quality guidelines and objectives is to protect public health and the environment from the effects of air pollution. Table 3.1 lists maximum, time-based pollutant concentration levels (guidelines and objectives) for the protection and preservation of ambient air quality. For each of these air contaminants, the concentration in the ambient air will not be greater than the concentration indicated.

For National Ambient Air Quality Objectives (NAAQO), three levels have been defined:

Maximum desirable level (Level A) – defines the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of control technology.

Maximum acceptable level (Level B) – is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.

Maximum tolerable level (Level C) – denotes the concentration of an air contaminant that requires abatement without delay to avoid further deterioration to air quality that would endanger the prevailing Canadian life-style or ultimately, to air quality that would pose a substantial risk to public health.

The appropriate level will be selected based on the degree of protection to be afforded to receptors. Maximum tolerable levels are only for evaluation purposes to identify the severity of an anthropogenic or natural phenomenon in order to protect human health and institute appropriate corrective action. In general, maximum acceptable levels are not to be exceeded in any urban centre, including areas that are in the vicinity of industries with atmospheric emissions. Within rural areas, the goal is to maintain pollutant concentrations at or below maximum desirable levels.

In addition to NAAQOs, references are made to NWT guidelines and interim Canada-wide standards (CWS) for O_3 and $PM_{2.5}$ developed by the Canadian Council of Ministers of the Environment (CCME) under the Canadian Environmental Protection Act (CEPA).

The CWS are intended to be achievable standards based on sound science, which take into consideration social implications and technical feasibility. They do not, however, have any legal standing. Each jurisdiction that is a participant in the Harmonization Accord will implement the standards under existing provincial legislation or draft new legislation. In keeping with the concepts of Continual Improvement and Keeping Clean Areas Clean (CI/KCAC) by the Canadian Council of Ministers of the Environment, the project will make every effort to minimize emissions by implementing strategies described in other documents of this EIA series. Given the sensitivity of the northern environment, the facility will strive to surpass the goal of simply meeting the ambient air quality standards and achieve as minimal an impact as possible on ambient air quality. This air quality assessment report, submitted in support of the proposed development, reflects the CI/KCAC approach.

Table 3.1: Ambient Air Quality Objectives

Jurisdiction	Substance	Level	Concentration[a] µg/m³	Averaging Time
Northwest Territories	SO_2	Acceptable	450 150 30	1 h 24 h Annual
	$PM_{2.5}$	Acceptable	30	24 h
	TSP	Acceptable	120 60	24 h Annual[(b)]
ON, NF, BC	PM_{10}	Acceptable	50	24 h
Canada	O_3	Desirable	100 30	1 h 24 h
		Acceptable	160 50 30	1 h 24 h Annual
		Tolerable	300	1 h
	$PM_{2.5}$	Acceptable	30	24 h
	TSP	Desirable	60	24 h
		Acceptable	120 70	24 h Annual[b]
		Tolerable	400	24 h
	NO_2	Desirable	60	Annual
		Acceptable	400 200 100	1 h 24 h Annual
		Tolerable	1,000 300	1 h 24 h
	CO	Desirable	15,000 6,000	1 h 8 h
		Acceptable	35,000 15,000	1 h 8 h
		Tolerable	20,000	8 h

Note: a. At a temperature of 25°C and pressure of 101.3 kPa. **b**. As a geometric mean.

SECTION 4 • EXISTING CONDITIONS IN THE PROJECT AREA

4.1 CLIMATE & TERRAIN

The Meadowbank project region is within a low Arctic ecoclimate described as one of the coldest and driest regions of Canada. Arctic winter conditions occur from October through May, with temperatures ranging from +5° to -40°C. Summer temperatures range from -5° to +25°C, with isolated rainfall increasing through September. The long-term mean annual air temperature for Meadowbank is estimated to be approximately -12°C and can drop below 0°C in any month of the year. Air temperatures at the Meadowbank area are, on average, about 0.6°C cooler than Baker Lake air temperatures, with extreme temperatures at Meadowbank tending to be larger in magnitude (i.e., more extreme) than the extremes at Baker Lake; this is thought to reflect the effect at Baker Lake of a moderating maritime influence.

Skies tend to be more overcast in the winter than the summer. The average annual wind speed is 10 km/h and winds tend to be most frequently from the west and east-southeast quadrants. Light-to-moderate snowfall is accompanied by variable winds up to 70 km/h, creating large, deep drifts and occasional whiteout conditions. Monthly rainfall, snowfall, and total precipitation values were adjusted for undercatch using the values reported by Environment Canada for Baker Lake to develop estimates of adjusted monthly and annual values for Meadowbank, for the period 1949 to 2003. The resulting adjusted mean annual rainfall, snowfall, and precipitation totals for Meadowbank are 144.0 mm, 148.8 mm, and 292.8 mm, respectively.

Land exposure consists of gently rolling hills less than 25 m high and muskeg bound by numerous lakes and streams. Glacial derived overburden is rare in the vicinity, and vegetation is limited to small shrubs, lichen, and grasses. Areas of the property, such as the Third Portage peninsula, have relatively thin layers of overburden ranging from 0 to 5 m and are underlain by bedrock.

Shallow lakes surround all the gold deposits at Meadowbank. Seasonal freezing of these lakes occurs in October and lasts until early June with average maximum ice thickness of 2 m.

Permafrost is known to exist beneath all major landforms in the area; however, a level of thermal insulation is associated with the lakes, preventing permafrost development beneath or proximal to water bodies over 100 m in diameter and 2 m in depth. Over landforms, an active layer of up to 3.5 m is present, depending on soil conditions. Below the active layer, thermistors have been installed on-site to record permafrost temperatures. Values of -7 to -8^{o}C have been measured at depths below 10 m. The depth of permafrost can also vary depending on proximity to lakes.

4.2 BACKGROUND AIR QUALITY

The Environment Protection Service of the Government of NWT reported PM_{10} concentrations of less than 10 μg/m^3 for undisturbed areas of Northwest Territories (NWTWRED, 2004). Concentration of other pollutants considered in this project, such as SO_2, NO_x, and CO, are expected to be very low, in keeping with the area's pristine quality of air.

SECTION 5 • EMISSION SOURCES

5.1 POINT SOURCES

Emission point sources include the power plant and primary crusher (see Appendix B for locations). These sources are described below.

5.1.1 Power Plant

The facility maximum electrical demand is currently estimated to be 15.5 MW. To supply this power, three diesel generators will be in operation, with a fourth on stand-by duty. A total of 15.5 MW operating capacity is sufficient to handle the peak demand during the winter season. These engines will provide mechanical power to operate electricity generators. There will be two emergency generator units, each capable of supplying 0.5 MW. These will be used initially to supply construction power. They will be housed in separate modules located away from the main powerhouse to ensure operability of the system in case of powerhouse fire.

Most of the pollutants from internal combustion (IC) engines are emitted through the exhaust. Evaporative losses are insignificant in diesel engines due to the low volatility of diesel fuels.

The primary pollutants from internal combustion engines are nitrogen oxides (NO_x); hydrocarbons (HC) and other organic compounds; and carbon monoxide (CO) and particulate matter (PM), which include both visible (smoke) and non-visible emissions. Nitrogen oxide formation is directly related to high pressures and temperatures during the combustion process and to the nitrogen content, if any, of the fuel. The other pollutants, HC, CO, and PM, are primarily the result of incomplete combustion. Ash and metallic additives in the fuel also contribute to the particulate content of the exhaust. Sulphur oxides also appear in the exhaust from IC engines. The sulphur compounds, mainly sulphur dioxide, are directly related to the sulphur content of the fuel. Short descriptions of each primary pollutant, as provided in the EPA publication "Compilation of Air Pollutant Emission Factors" (2000), are as follows:

Nitrogen Oxides – Nitrogen oxide formation occurs by two fundamentally different mechanisms. The predominant mechanism with internal combustion engines is thermal NO_x, which arises from the thermal dissociation and subsequent reaction of nitrogen (N_2) and oxygen (O_2) molecules in the combustion air. Most thermal NO_x is formed in the high-temperature region of the flame from dissociated molecular nitrogen in the combustion air. Some NO_x, called prompt NO_x, is formed in the early part of the flame from reaction of nitrogen intermediary species, and HC radicals in the flame. The second mechanism, fuel NO_x, stems from the evolution and reaction of fuel-bound nitrogen compounds with oxygen. Gasoline, and most distillate oils, have no chemically bound fuel nitrogen and essentially all NO_x formed is thermal NO_x.

Total Organic Compounds – The pollutants commonly classified as hydrocarbons are composed of a wide variety of organic compounds and are discharged into the atmosphere when some of the fuel remains unburned or is only partially burned during the combustion process. Most unburned hydrocarbon emissions result from fuel droplets that were transported or injected into the quench layer during combustion. Partially burned hydrocarbons can occur because of the following:

- poor air and fuel homogeneity due to incomplete mixing, before or during combustion
- incorrect air/fuel ratios in the cylinder during combustion due to maladjustment of the engine fuel system
- excessively large fuel droplets in diesel engines
- low cylinder temperature due to excessive cooling (quenching) through the walls or early cooling of the gases by expansion of the combustion volume caused by piston motion before combustion is completed.

Carbon Monoxide – Carbon monoxide is formed as an intermediate combustion product that appears in the exhaust when the reaction of CO to CO_2 cannot proceed to completion. This situation occurs if there is a lack of available oxygen near the hydrocarbon (fuel) molecule during combustion, if the gas temperature is too low, or if the residence time in the cylinder is too short. The oxidation rate of CO is limited by reaction kinetics and, as a consequence, can be accelerated only to a certain extent by improvements in air and fuel mixing during the combustion process.

Particulate Matter – White, blue, and black smoke may be emitted from IC engines. Liquid particulates appear as white smoke in the exhaust during an engine cold start, idling, or low load operation. These are formed in the quench layer adjacent to the cylinder walls, where the temperature is not high enough to ignite the fuel. Blue smoke is emitted when lubricating oil leaks, often past worn piston rings, into the combustion chamber and is partially burned. Proper maintenance is the most effective method of preventing blue smoke emissions from all types of IC engines. The primary constituent of black smoke is agglomerated carbon particles (soot). Inhalable particulate matter PM_{10} and $PM_{2.5}$ are also present in IC exhaust. Particulates are important because they can permanently lodge in the deepest and most sensitive areas of the lung, and can aggravate many respiratory illnesses including asthma, bronchitis, and emphysema.

Sulphur Oxides – Sulphur oxide emissions are a function of the sulphur content in the fuel rather than any combustion variables. During the combustion process, essentially all the sulphur in the fuel is oxidized to SO_2. The oxidation of SO_2 gives sulphur trioxide (SO_3) which reacts with water to give sulphuric acid (H_2SO_4), a contributor to acid precipitation. Sulphuric acid reacts with basic substances to give sulphates, which are fine particulates that contribute to PM_{10} and visibility reduction.

Power Plant Emission Parameters – Emission rates of the pollutants discussed above have been calculated with AP-42 emission factors that are shown in Table 5.1. Factors are based on averages across all manufacturers and duty cycles. To convert from lb/hp-h to g/kWh, multiply by 608.

Emission source geometrical and operating parameters were established based on project design specifications. Their values and emission rates of substances included in dispersion modelling are given in Table 5.2.

Table 5.1: Emission Factors for Large Stationary Diesel Engines

Pollutant	Emission Factor	
	lb / hp-h[1]	**Rating**
NO_x		B
CO	0.024[2]	C
SO_x[3]	0.0055	B
CO_2	0.0081 x S	B
PM	1.160.0007	B
TOC (as CH_4)	7.05 x 10^{-4}	C

Notes: 1. Power output. **2.** Uncontrolled. **3.** Assumes that all sulphur in the fuel is converted to SO_2: S = % sulphur in diesel fuel. Rating: B = Emission tests are based on a generally sound methodology, but lacking enough detail for adequate validation; C = Emission tests are based on an unproven or new methodology, or are lacking a significant amount of background information.

Table 5.2: Emission Parameters of Diesel Plant

Parameter	Units	Stack No.		
		1	**2**	**3**
Power	MW	5.17	5.17	5.17
Height	m	30.5	30.5	30.5
Diameter	m	1.2	1.2	1.2
Gas exit velocity	m/s	17.3	17.3	17.3
Exit temperature	K	600	600	600
UTM-E location	m	638,101	638,106	638,111
UTM-N location	m	7,214,014	7,214,007	7,214,000
Emission rate				
SO_2	g/s	0.18	0.18	0.18
NO_2	g/s	21.0	21.0	21.0
CO	g/s	4.8	4.8	4.8
CO_2	kg/s	1.014	1.014	1.014
TOC	g/s	0.62	0.62	0.62
PM_{10}	g/s	0.304	0.304	0.304
$PM_{2.5}$	g/s	0.293	0.293	0.293

Certain polycyclic aromatic hydrocarbons (PAH) are present in the diesel exhaust. Forecasted emissions of PAH from the plant powered by large uncontrolled stationary diesel engines are shown in Table 5.3. Emissions were calculated with the AP-42 emission factors, annual fuel consumption of 25.8 M L and diesel higher heating value (HHV) of 137,000 Btu/gal. Considering that calculated emissions of PAH are very low, no meaningful ground level concentrations could be expected and therefore dispersion modelling is not warranted.

Table 5.3: Diesel Plant Exhaust Summary – Polycyclic Aromatic Hydrocarbons

Compound	Emission Factor for Large Diesel Engines (lb/MM Btu)	Emission (kg/a)
Naphthalene	1.30 x 10-4	55.115
Acenaphthene	4.68 x 10-6	1.984
Acenaphthylene	9.23 x 10-6	3.913
Anthracene	1.23 x 10-6	0.521
Benz(a)anthracene	6.22 x 10-7	0.264
Benzo(b)fluoranthene	1.11 x 10-6	0.471
Phenanthrene	4.08 x 10-5	17.298
Chrysene	1.53 x 10-6	0.649
Fluoranthene	4.03 x 10-6	1.709
Fluorene	1.28 x 10-5	5.427
Pyrene	3.71 x 10-6	1.573
Total PAH		**88.924**

5.1.2 Primary Crusher & Mills

Run-of-mine (ROM) ore will be hauled from the open pits and stockpiled or dumped directly into an ore hopper. From the hopper, an apron feeder will reclaim the ore and feed it directly into a primary jaw crusher to reduce it to 100% passing 230 µm. The primary crushing rate is expected to average 52 t/h to provide the mill feed requirements of 213 t/h. A conveyor will then convey the crushed material to a live uncovered coarse ore stockpile. Two belt feeders will reclaim the ore from the stockpile and discharge it onto a wide primary mill feed conveyor. The ore will be fed to a semi-autogenous (SAG) mill, from where the pulp product will be pumped over a closed-circuit scalping screen. Screen oversize (8-mesh aperture) will be returned to the SAG mill, while screen underflow will drop into the cyclone feed pumpbox from where the slurry will be pumped to a bank of 250 mm diameter hydrocyclones. For treating potential critical size SAG mill product, a pebble crushing circuit may be required. Hydrocyclone underflow product will report to a 3,358 kW ball mill. The closed ball mill circuit incorporates gravity concentration for the recovery of coarse free gold. The gravity concentrate from a single gravity concentrator unit will be upgraded on a shaking table. The gravity concentrator tailings will be combined with the ball mill discharge and pumped to the hydrocyclones. The cyclone overflow (80% passing 44 µm) will flow by gravity to a bank of primary rougher flotation cells.

Most of the milling and materials handling will take place in wet conditions. For this reason, no particulate matter (PM) emissions to the atmosphere are anticipated from wet streams. Potential dry PM emission sources include the truck dump bin vent, primary crushing, ore stockpile, pebble crushing plant, and furnace; however, for all these sources, plant design specifies the installation of dust control equipment, which will reduce emissions of PM to the ambient air. Primary crushing and pebble crushing plants will be equipped with SISW BI type filters, each handling 10,000 ft^3/min airflow. The remaining sources will be provided with smaller SISW filters, approximately 3,000 ft^3/min each. Considering a filter efficiency of over 98%, insignificant PM emissions from crushing/grinding operations are anticipated.

5.2 MOBILE SOURCES

In terms of emission associated with material transportation, the worst-case scenario will involve ore hauling on the longest route at the mine area, namely from the Vault pit to the processing plant. The route will be approximately 7 km long. To transport the mined ore, a total of 14 trucks, with a 90 tonne load each will be available. The estimated number of trips per truck during a nine-hour shift is four, a rate that is consistent with mining 1,715,000 tonnes annually during the first three years of operation. To fulfill these requirements, the trucks will be operational 317 d/a, resulting in 5,400 t/d of material hauled.

To calculate exhaust emissions, it was estimated that the project would use 11,200 m^3/a of diesel, mainly for trucks. It was also assumed that 10 trucks would be on the road from the Vault pit to the plant at any given point in time. The remaining trucks would be in the process of loading, unloading, or temporarily out of service for maintenance. The diesel fuel considered for this project contains approximately 250 ppm sulphur. The emission factors compiled from the EPA AP-42 documents (1997) were used for emission estimates that are shown in Table 5.4. Suspended particulates (SP) and particulate matter ($PM_{2.5}$) are sums of the haul trucks exhaust emissions, detailed in Table C.3 (Appendix C), and the wheel entrainment emissions, given in Section 5.3.4, Table 5.11.

Table 5.4: Mobile Sources Total Emissions

Compound	Annual Emissions	Units	Max. Daily Emissions	Units	Instantaneous Emissions	Units
Suspended particulates (SP) ≤30 µm	1,414	t/a	5,437	kg/d	62.93	g/s
Particulate matter ≤2.5 µm ($PM_{2.5}$)	71.2	t/a	265.9	kg/d	3.08	g/s
Methane (CH_4)	2.39	t/a	6.5	kg/d	0.076	g/s
Nitrogen oxides (NO_x)	92.3	t/a	252.9	kg/d	2.93	g/s
Sulphur dioxide (SO_2)	5.5	t/a	15.0	kg/d	0.17	g/s
Volatile organic carbon (VOC)	0.96	t/a	2.62	kg/d	0.03	g/s
Carbon dioxide (CO_2)	33,600	t/a	92.055	t/d	1.065	kg/s
Carbon monoxide (CO)	84.9	t/a	232.7	kg/d	2.69	g/s
Nitrous oxide (N_2O)	148	kg/a	405.48	g/d	4.69	mg/s

5.3 FUGITIVE SOURCES

Fugitive dust refers to small particles of geological origin that are moved into the atmosphere from non-ducted, open sources. Open fields, paved and unpaved roads, construction sites, unenclosed aggregates storage piles, open mines, and mineral material transfer systems are the major sources of fugitive dust. Large dust plumes are often noticed over these sources when wind speeds are high or when vehicles are moving.

For the above sources of fugitive dust, the dust-generation process is caused by two basic physical phenomena:

1. Pulverization and abrasion of surface materials by application of mechanical force through implements such as wheels and blades (e.g., primary crusher and mills at the Cumberland ore processing plant, hauling trucks on the Vault pit to the plant unpaved road).

2. Entrainment of dust particles by the action of turbulent air currents, such as wind erosion of an exposed surface by wind speeds over 19 km/h (e.g., for example, tailings wind erosion, waste rock disposal area, stockpile fugitive emissions).

The potential drift distance of particles is governed by the initial injection height of the particle, the terminal settling velocity of the particle, and the degree of atmospheric turbulence. Dispersion models have computed theoretical drift distance as a function of particle diameter and mean wind speed for fugitive dust emissions. Results indicate that, for a wind speed of 16 km/h, particles larger than about 100 µm are likely to settle out within 6 to 9 m from the point of emission. Particles that are 30 to 100 µm in diameter are likely to undergo impeded settling. These particles, depending on the extent of atmospheric turbulence, are likely to settle within tens to hundreds of metres from the point of release. Smaller particles have much slower gravitational settling velocities and are much more likely to have their settling rate retarded by atmospheric turbulence.

For air quality impact assessments, therefore, the most important particles are the suspended particulates (SP) consisting of fractions ≤30 µm in aerodynamic diameter. The following definitions apply to particulate classes in the ≤30 µm range:

SP = Suspended particulate: particulate matter (PM) with an aerodynamic diameter ≤30 µm; often used as a surrogate for TSP. SP may also be denoted as PM_{30}. An effective cut point of 30 µm aerodynamic diameter is frequently assigned to the standard high volume sampler.

PM_{10} = Particulate matter ≤10 µm in aerodynamic diameter; because PM_{10} is the size basis for the current primary Ambient Air Quality Standards (AAQS) for particulate matter, it represents the particle size range of the regulatory interest in some Canadian jurisdictions, such as BC, ON, and NF, as well as in the U.S.

$PM_{2.5}$ = Particulate matter ≤2.5 µm in aerodynamic diameter. Some provinces and NWT have introduced AAQS for this group of particles. There are also Canada-wide standards for $PM_{2.5}$.

Quantity of fugitive dust emission rate depends on several factors, the most important being wind speed, moisture content, and dust density. Maximum fugitive emissions will take place during windy weather with small and light particles present in dry active surface material.

The following sections describe the main fugitive emission sources. Discussion of the marginal sources applicable to Meadowbank Gold project is included in Appendix C.

5.3.1 Stockpile Wind Erosion

The project is designed to include a large coarse-ore stockpile to be located near the plant building and the primary crusher. The pile will consist of 100% passing 20 cm (8") material. The size of the pile will be 17 m high and 44.3 m diameter.

Dust emission from an open surface of a particular conical storage pile depends on the following factors:

- age of the pile
- moisture content
- proportion of aggregate fines
- wind speed
- time of the year.

The following section contains discussion of the main factors affecting wind erosion from stockpiles; however, other fugitive dust area sources such as open yards, tailings, and waste aggregate disposal facilities are also affected by these factors.

Age of Storage Pile – When freshly processed aggregate is loaded onto a storage pile, the potential for dust emissions is at a maximum. Fines are easily disaggregated and released to the atmosphere on exposure to air currents, either from aggregate transfer itself (including conveyor transfer) or from high winds. As the aggregate pile weathers, the potential for dust emissions is greatly reduced; however, the coarse ore storage pile at the Meadowbank plant will be continuously active and turnover time will be short; consequently, the pile-aging factor has not been considered in this project.

Precipitation – Any significant rainfall soaks the interior of the pile, which slows the drying process significantly. Based on measurements taken for the period of 1997 to 2003 at the Meadowbank camp, the annual average of days with measurable precipitation in the Meadowbank area is 106, with a mean annual precipitation of 246.8 mm (149.4 mm of rainfall and 97.4 mm of snowfall or water equivalent). A summary of the Meadowbank camp climate station monthly and annual rainfalls observations and their means for the 1997 to 2003 period are summarized in Table 5.5.

The mitigating effect of precipitation has been incorporated in the estimation of annual fugitive dust emission rates by a precipitation factor of 0.71, based on the ratio of 106 days with precipitation higher than 0.254 mm over 365 days of the year (0.71 = 1 – 106/365).

Wind Speed – Field testing of coal piles and other exposed materials using a portable wind tunnel has shown that threshold wind speeds exceed 5 m/s (18 km/h) at 15 cm above the surface or 10 m/s (36 km/h) at 7 m above the surface. As wind speed increases, more aggregate material will become airborne; however, wind gusts may quickly deplete a substantial portion of the fugitive potential. In addition, increased wind speed will provide better ventilation with consequent dilution of suspended particulates and lower concentration. Higher wind speeds (more than 52 km/h) have been recorded at the Baker Lake meteorological station. Most frequent annual directions are northeast. For fugitive emissions, the weighted average wind speed of 7.8 m/s was applied for winds above the threshold value of 5 m/s (see Section 6.2.1). For area dust sources associated with materials handling (loading and unloading trucks, conveyor dumping, bulldozing, and wheel entrainment) the overall average wind speed of 5.0 m/s for the Meadowbank area was used because dust is introduced to the ambient air by mechanical means regardless of wind occurrence.

Table 5.5: Meadowbank Camp Observed Monthly & Annual Total Rainfall – 1997 to 2003

	Precipitation (mm)													
Year	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**	**Total/Avg.**
97-98	7.6	0.0	0.0	0.0	0.0	0.0	1.3	10.9	23.4	69.5	49.6	34.6	196.9	1.32
98-99	6.5	0.1	0.0	0.0	0.0	0.0	6.6	17.8	8.7	67.9	80.0	33.6	221.2	1.48
99-00	3.9	0.0	0.0	0.0	0.0	0.9	5.8	15.9	0.4	11.9	44.7	43.5	127.0	0.85
00-01	1.1	0.0	0.0	0.0	0.0	0.0	0.9	16.9	18.5	15.5	44.9	5.2	103.0	0.69
01-02	4.4	0.0	0.0	0.0	0.0	0.0	1.6	4.3	35.2	40.7	51.3	20.1	157.6	1.06
02-03	0.6	0.0	0.0	0.0	0.0	0.0	0.0	3.0[e]	9.5[e]	45.6[a]	23.1[a]	23.2e	105.0	0.70
Average	4.0	0.0	0.0	0.0	0.0	0.2	2.7	11.5	16.0	41.9	48.9	24.2[i]	149.4	
Fraction of Annual	0.03	0.0	0.0	0.0	0.0	0.0	0.02	0.08	0.11	0.28	0.33	0.16	1.00	

Notes: a. Manual rain gauge data. **e.** Estimated from Baker Lake data. **i.** Includes 9.3 mm for the 96-97 year.

Time of the Year – According to available meteorological data, the most favourable conditions for fugitive dust generation exist in June, July, and August. This is based on observed highest temperatures of the year (above freezing), low rainfall, and occurrence of wind speeds higher than the threshold value of 5 m/s.

The long-term monthly air temperature statistics for Baker Lake, based on the available period of record (1946 to 2003), are listed in Table 5.6.

Table 5.6: Monthly Air Temperature Statistics for Baker Lake – 1946 to 2003

Month	Extreme Daily Temp. (ºC)		Average Daily Temp. (ºC)		Mean
	Maximum	**Minimum**	**Maximum**	**Minimum**	
January	0.0	-50.6	-28.1	-34.2	-30.4
February	-4.1	-50.0	-28.7	-35.0	-31.5
March	1.5	-50.0	-22.9	-30.7	-26.6
April	19.2	-41.1	-12.6	-21.7	-17.3
May	13.9	-27.8	-2.6	-9.5	-6.1
June	28.1	-13.9	8.0	0.2	4.0
July	33.6	-1.7	16.0	5.8	10.9
August	30.9	-3.4	13.6	5.1	9.4
September	22.6	-20.0	5.8	-0.5	2.6
October	9.7	-30.6	-4.1	-10.4	-7.2
November	2.2	-42.7	-16.1	-23.6	-19.6
December	-1.1	-45.6	-24.2	-30.2	-27.3
Year	33.6	-50.6	16.0	-35.0	-11.4

Stockpile Fugitive Dust Estimation – Fugitive dust emission from the coarse-ore stockpile will comprise emissions from conveyor ore drop at the top of the pile and wind erosion. Conveyor daily emission of suspended particulates (≤50 µm dia.) is calculated in Appendix C, Section B.6, and it is 9.84 kg (0.1139 g/s, included in dispersion modelling). The particle size composition was obtained with aerodynamic particle size multiplier as per AP-42 emission factors (EPA, 1995), given in Table 5.7.

Table 5.7: Particle Size Multiplier (Dimensionless)

Particle Size, µm	<50	<30	<15	<10	<5	<2.5
Multiplier	1.00	0.74	0.48	0.35	0.20	0.11

Source: EPA, 1995, Part 13.2.4.

Stockpile fugitive dust emission resulting from wind erosion was predicted by computer simulation with the STOCKPIL Version 1.01 commercial computer model (Beer, 1989). This model was developed by F.W. Parrett Limited (London, UK), a company specializing in dust measurement and control. The STOCKPIL was written based on field observations and the wind tunnel measurements carried out by the Warren Springs Laboratory at Cambridge University, UK. The EPA has adopted the Warren Springs Laboratory findings in developing AP-42 fugitive dust emission factors (Parrett, 1992).

STOCKPIL model input parameters were as follows:

- stockpile diameter: 44.3 m; height: 17 m
- average wind speed: 7.76 m s^{-1}
- roughness surface coefficient: 0.03 for open flat terrain with few obstacles
- maximum particle diameter: 30 µm, which can be airborne and dispersed beyond the plant fence line
- dust particle density: 3.0 g cm^{-3}
- threshold friction velocity of stockpile surface from references for similar material: 0.35 m/s
- K_{sa} constant, which depends on the surface and moisture content: typical value of 0.0002 was used.

For the above input data, the model computed dust loss from the stockpile at the rate of 0.1116 kg/h (0.031 g/s) for particulates ≤30 µm; therefore, combined (conveyor and wind erosion) particulate emissions of ≤30 µm will be at the rate of 0.1449 g/s. The conveyor emission is 0.1139 g/s.

5.3.2 Tailings Wind Erosion

Exposed surface layers of tailings containing fine grain particles of wastes discarded from gold ore processing are subject to regular erosion by wind and water. Prediction of fugitive dust emission caused by wind erosion has been conducted for estimated areas of tailings beach that may be exposed at specific times during the operations of the proposed Second Portage Lake tailings facility at the Meadowbank project. The specific time periods considered are at the end of Years 3, 5, and 7.

The tailings area estimates are based on the following assumptions:

- detailed deposition plan has not been prepared
- basin storage volume curve was used to estimate the elevation of the tailings surface for each of the specific times, assuming a horizontal tailings surface for each of Years 3, 5, and 7; a 1%

grade was then applied, centred on the mid-point of the tailings surface, to estimate the elevation of the tailings surface along the dike face, and to estimate the maximum length of exposed beach

- tailings will be spigotted evenly from the dike face along the entire length of the dike; there is currently no information on the number of spigot points that will be utilized during operations, and this will be likely determined during the detailed engineering design phase
- minimum pond volume of 900,000 m^3 for reclaim, and including ice
- progressive reclamation of the exposed tailings beach during operations was not considered.

A deposition plan will be developed during the detailed engineering design phase for the project. Consequently, the estimates of exposed tailings beach may change as a result of the development of the deposition plan. The actual exposed beach areas will be determined during mine operations, and will likely be managed by progressive reclamation to decrease the area of exposed beach.

Based on the current understanding of the mine plan and tailings volumes, between Years 6 and 7 the surface of the main tailings basin will be approximately 1 m above the current lake level elevation of 133 m, and will be fully exposed unless progressively reclaimed. After the main tailings basin has been filled, tailings will be deposited into the northwest basin, behind the stormwater dike. Table 5.8 summarizes the estimates of exposed beach area for the specific times.

Table 5.8: Tailings Beach Data

Year	Average Elevation (masl)	Elevation Along Dike Face (masl)	Length of Exposed Beach (m)	Estimate of Exposed Beach Area (m^2)
3	122	126	160	92,000
5	129	134	260	144,000
7	134	135	960	537,000

Tailings grain sizing revealed that 90th percentile will be around 0.07 mm diameter for both Vault and Third Portage Tailings as shown in Appendix D.

Rates of fugitive dust emission caused by wind erosion were predicted with STOCKPIL fugitive dust model. All three cases were modeled separately, with the following common input parameters:

- average wind speed: 7.76 m/s measured at height of 10 m
- roughness surface coefficient: 0.03 (dimensionless)
- separate runs for 30 µm, 10 µm, and 2.5 µm diameter particulate
- material density of 3.1 g/cm^3 (Portage and Vault average as determined by Golder)
- threshold friction velocity of tailings surface equal to 0.5 m/s
- K_{sa} constant for the smooth surface and higher moisture content equal to 2 x 10^{-5}.

Table 5.9 summarizes fugitive dust emissions computed by STOCKPIL model. The results indicate that emissions increase with the area exposed, but emission rates decrease for the same fractions. This can be contributed to re-deposition of airborne particulates as they drift over larger tailings area.

Table 5.9: Fugitive Dust Emissions for Three Stages of Tailings Development

Year	Exposed Beach Area (m^2)	SP Diameter (µg)	Hourly Emission (kg/h)	Emission Factor (µg/m^2/s)
3	92,000	30.0	5.585	16.86
		10.0	3.328	10.05
		2.5	1.670	5.04
5	144,000	30.0	6.495	12.30
		10.0	3.863	7.45
		2.5	1.939	3.74
7	537,000	30.0	9.318	4.82
		10.0	5.513	2.85
		2.5	2.764	1.43

5.3.3 Waste Rock Disposal Fugitive Emissions

Total dust emissions from disposal site operations result from three distinct source activities within the disposal cycle:

- equipment traffic in storage area
- waste aggregate unloading (handling)
- wind erosion of pile surfaces and ground areas around open rubbles.

Dust emissions from an open flat surface depend on the following parameters:

- proportion of aggregate fines
- particle size distribution
- material moisture content
- wind speed
- quantity of material processed and equipment traffic (trucks, front-end loaders, dozers, etc.).

Because not all of the above information is available at this time for the Meadowbank project, estimates of fugitive emission of suspended particulate were taken from relevant technical literature. According to Parrett (1992), emission factor for open-cut mining operations for particulates ≤30 µm overburden truck dumping is 0.02 kg/t of material. Estimated total overburden and waste rock disposal rate for this project will be 5,400 t/d, which gives an SP emission rate of 108 kg/d. The disposal facility area will be 707 m by 1,263 m (area = 892,941 m^2).

An emission factor for aggregate waste dumping was calculated by the equation given in Section C.7 (Appendix C), using ≤30 µm particulate size multiplier k = 0.74, mean wind speed of 5.0 m/s, and material moisture content of 5%. The calculated emission factor is 0.000954 kg/t, which gives SP emissions of 5.15 kg/d.

Traffic fugitive dust emission estimates were calculated with EPA empirical equation (EPA, 2001) for 90-tonne, four-wheel trucks on unpaved road with 9.2 % silt, making 60 trips a day with an average speed of 30 km/h. A total of 106 days per year with precipitation was included in the equation. The calculation result is 1,347 kg of SP per day, the highest value of the three main fugitive dust sources considered for the waste rock disposal facility. In summary, SP emissions will be 1,347 kg/d. Emission rates of each of the three main fractions are shown in Table 5.10.

Table 5.10: Fugitive Dust Emission Rates for Waste Disposal Facility

Particle Diameter (µm)	30.0	10.0	2.5
Particle Size Multiplier (k)	1.0	0.5	0.2
Emission Rate (µg m^2/s)	18.0	9.0	3.6
Mass fraction	0.59	0.29	0.12

5.3.4 Wheel Entrainment Emissions

Dust emissions from road travel result from dust entrainment by vehicle wheels and the wake created by moving vehicles. Table 5.11 summarizes emissions on the haul road from Vault mine to the plant. It was conservatively assumed that there are no dust control measures applied to this road. The only mitigation is a 29% lower annual emission due to days with measurable precipitation.

Table 5.11: Emission Summary – Road Emissions

Description	VKT (km/d)	Emission Factor (kg SP/VKT)	SP (t/a)	SP (kg/d)	SP (g/s)	Emission Factor (kg PM2.5/VKT)	PM 2.5 (t/a)	PM 2.5 (kg/d)	PM 2.5 (g/s)
Unpaved Road Truck Emissions	903	5.96	1395	5382	62.3	0.27	63.2	244	2.82

Note: VKT = Vehicle kilometres traveled.

5.4 DRILLING & BLASTING

Dust emissions from blasting and drilling are summarized in Table 5.12. The average depth of the blasted layer will be about 15 m and there will be one hole drilled per 10 m^2.

Table 5.12: Emission Summary – Blasting & Drilling

Description	Area (m^2)	Emission Factor (kg SP/event)	SP (kg/a)	Emission Factor (kg $PM_{2.5}$/event)	$PM_{2.5}$ (kg/a)
Vault Mine ore blasting	1601	14.1	479	0.42	14.3
Vault Mine ore drilling	160	0.59	3210	0.018	97.9

SECTION 6 • DISPERSION MODELLING

Note: To facilitate reading, all figures referenced in this section are included at the end of Section 6.

6.1 POWER PLANT & MOBILE SOURCES

6.1.1 Modelling Approach & Limitations

A dispersion model is composed of a series of equations that describe the relationship between the concentration of a pollutant in the atmosphere at a chosen location and the pollutant release rate, and various factors affecting dispersion and dilution in the atmosphere. The model requires information on the emission characteristics and the local and regional meteorology. Modelling is used to predict air quality associated with future development scenarios.

Dispersion modelling of power plant and vehicle emissions was performed with the AERMOD model. The EPA's Regulatory Model Improvement Committee (AERMIC) developed AERMOD specifically as a replacement for a previous generation dispersion model ISCST3, although the latter is still used for certain tasks such as particulate deposition modelling. AERMOD is intended to use hourly averaged meteorological data sequentially through at least one year, although five-year meteorological data is desired. AERMOD includes improved treatment of the atmospheric boundary layer and a more complete understanding of diffusion processes. EPA refers to AERMOD as being state-of-the-practice (Hoffnagle, 2003).

AERMOD can use measured values of horizontal and vertical turbulence directly in calculating diffusion. This capability is a significant improvement over ISCST3 because it replaces the empirically derived Pasquill-Gifford-Turner stability categories (A through F) with direct measurements. This provides a much more accurate approach to diffusion estimation. The other features of AERMOD include:

- ability to model dispersion of primary pollutants and toxic and hazardous waste pollutants
- ability to handle multiple sources including point, volume, and area source types; line sources, such as moving trucks, may also be modeled as a string of volume sources or as elongated area source (polygon area)
- optional treatment of source emission rates as constant or varied by month, season, hour-of-day, or other periods, for a single source or for a group of sources
- ability to account for the effects of aerodynamic downwash on point source emissions due to nearby buildings
- specification of receptors' locations as gridded and/or discrete receptors in Cartesian or polar coordinates
- use of real-time meteorological data to account for the atmospheric conditions that affect the dispersion of air pollutants.

Although the model is designed to consider area, volume, and line sources in addition to point sources, the major advantage of using this model is for evaluating impacts of point sources affected by building downwash.

The AERMOD model has the following limitations:

- model predictions are not valid at distances beyond 50 km from the source
- model cannot be used for non-steady-state conditions
- no particulate deposition can be modeled with AERMOD.

The first two limitations do not apply to this project. The last one was resolved by using the ISCST33 model for predicting particulate deposition.

6.1.2 Model Input Parameters

6.1.2.1 Emission Sources

Two types of emission sources were considered for modelling: point sources and elongated area source. The point sources model input parameters are listed in Table 5.2 (Section 5.1.1). The vehicle sources were modelled as an area source shaped as a polygon of four sites sitting on the Vault-to-plant route (Appendix E). Area emission rates in g/s/m^2 were calculated by dividing instantaneous emission rates in g/s, given in Table 5.4 (Section 5.2), by the polygon area. The area source approach provides a more realistic release scenario of moving trucks than the volume-source approach, which considers a number of stationary trucks positioned at fixed locations.

6.1.2.2 Buildings

The presence of large buildings near point emission sources may influence ground level concentrations of air pollutants because of the building downwash effect. Building downwash occurs when the aerodynamic turbulence induced by nearby buildings cause a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground level concentrations. The main structure of the plant accommodating leaching tanks, mills, furnace, offices and warehouse, primary crusher and pebble plant were included in dispersion modelling with the Building Profile Input Program (BPIP). The BPIP output is required by AERMOD as an input file.

6.1.2.3 Meteorology

Regional screening meteorological data for the Baker Lake region was purchased from Environment Canada (EC). This electronic data comprises five years (1998-2002) of meteorological records, which assures that the data is representative of recent meteorological conditions in the region. The EPA recommends five-year meteorology for dispersion modelling. To make the data project-specific, Meadowbank site wind and temperature data recorded over six months of 2002 were used to replace the values provided by EC. This data is adequate to make 1-, 8-, and 24-hour and annual screening predictions. The meteorological data was pre-processed with the RAMMET computer program prior to running AERMOD. RAMMET generates a surface meteorological file in CD-144 format and a profile meteorological file in SCRAM format.

6.1.3 Model Running Parameters

The AERMOD dispersion modelling options selected for this project included:

- regulatory default
- concentration output
- rural area
- simple terrain calculation algorithms
- single pollutant
- no exponential decay
- the 1-h, 8-h, 24-h, and annual averaging time, depending on AAQG for a particular contaminant
- building downwash effect
- all wind speed and stability classes
- first and fifth highest concentration values for all averaging periods except annual.

6.1.4 Receptors

The model requires user-specified receptor locations. The Cartesian grid receptor network with uniform grid spacing was used in the model. After defining the plant boundaries the model was run first time with the coarse grid of 500 m. After determining the areas of maximum impact it was run the second time with the finer grids defined as fenceline receptors in the vicinity of the affected area to obtain the maximums. Distances of 25 m, 50 m, and 100 m between three fenceline nodes were selected. The near plant grid is shown in Appendix F. Maximum distance to receptors was approximately 7,000 m from emission sources, justified by low concentrations observed at these locations as compared to maximum values close to the sources.

6.1.5 Modelling Results

Modelling results consist of graphical and tabular maximum concentrations in micrograms per cubic meter for each of the modeled substances that included criteria pollutants, such as SO_2, NO_x, CO, PM_{10}, and $PM_{2.5}$.The model was run for normal operating conditions. The concentration isopleths are shown in Figures 6.1 to 6.14 at the end of Section 6.

The summary of dispersion modelling results for each of the selected substances is given in Table 6.1. Location of the maximum concentration points and relevant AAQS are also given.

Graphical results show isopleths at indicated level of concentrations (µg/m^3), location of emission sources, the plant boundary, and a topographical map of the area. It should be realized that ambient air quality standards are applicable to the area beyond the plant boundary. The concentrations within the plant boundary fall under the occupational health and safety (OH&S) regulations and not under ambient air quality standards/objectives. Regardless, the model predicts that ground level substance concentrations for SO_2, NO_2, and CO will meet the AAQS, both at the plant area and beyond.

Analysis of emissions from the diesel plant and mobile sources indicates that most of the NO_x is released from the plant with a comparably little contribution from the mobile sources.

Table 6.1: Summary of Dispersion Modelling Results

Substance	Sources	Average Time	Max GLC µg/m³	AAQS µg/m³	Receptor Location m		Reference
					UTM E	UTM N	
Sulphur dioxide (SO_2)	Plant & Vehicles	1 h	134	450	641000	7217500	Figure 6.1
		24 h	24	150	639000	7215500	Figure 6.2
		Annual	1.7	30	639000	7215500	---
Nitrogen oxides (as NO_2)	Plant & Vehicles	1 h	362	400	641000	7217500	Figure 6.3
		24 h	114	200	638000	7214000	Figure 6.4
		Annual	9.5	60	638000	7214000	---
Carbon monoxide (CO)	Plant & Vehicles	1 h	2123	35,000	641000	7217500	Figure 6.5
		8 h	624	15,000	641500	7218000	Figure 6.6
Particulate matter <10 µm dia. (PM_{10})	Plant & Vehicles	24 h	127	50	639000	7215500	Figure 6.7
		Annual	8.7	---	639000	7215500	Figure 6.8
	Plant	24 h	11	50	638000	7214000	Figure 6.9
		Annual	0.9	---	638000	7214000	Figure 6.10
Particulate matter <2.5 µm dia. ($PM_{2.5}$)	Plant & Vehicles	24 h	59	30	639000	7215500	Figure 6.11
		Annual	4.0	---	639000	7215500	Figure 6.12
	Plant	24 h	11	50	638000	7214000	Figure 6.13
		Annual	0.9	---	638000	7214000	Figure 6.14

Note: GLC = Ground Level Concentration. AAQG = Ambient Air Quality Guideline.

Cumulative (the plant and mobile sources) emissions of PM_{10} and $PM_{2.5}$ will result in exceedances of AAQS for 24-hour averaging time. To find the source of excessive emissions, additional runs only for the diesel plant alone were completed (Figures 6.9, 6.10, 6.13, and 6.14). The results clearly identify mobile sources as being responsible for high particulate concentrations. Watering of the hauling route during dry weather would decrease PM fugitive emissions to the levels of compliance.

Analysis of emissions from the diesel plant and mobile sources indicates that most of the NO_x is released from the diesel plant (no mitigation at the source is considered) while the mobile sources significantly contribute to particulate matter emissions. Dispersion modelling has confirmed that the least favourable wind direction will be south to north (S-N) because the mobile sources and the plant will configure sources along the S-N line over the length of approximately 7 km. This will result in accumulation of emissions with the S-N winds.

No dispersion modelling has been completed for mine pits. During stable atmospheric conditions and a low-level inversion, equipment and fugitive emissions can be trapped in the pit and pollutant concentrations increased to high values. There will be a need for in-pit monitoring of air quality so the intensity of operation would be reduced by switching off high emission sources or even temporarily suspending operation until it is safe to continue with pit work. Pollutants entrapment is very likely, considering pits depth that ultimately will be 126 m at Goose, 144 m at Portage, and 196 m at Vault.

6.2 FUGITIVE DUST SOURCES

6.2.1 Model Approach

The EPA Industrial Source Complex Short Term Version 3 model (ISCST3) was used in this project for near-surface particulate dispersion estimation. The ISCST3 is a steady-state Gaussian plume model, which assesses pollutant concentrations and/or deposition and fluxes from a wide variety of sources associated with an industrial source complex. It uses real time meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impacts on the modelling area. The model was designed to support the EPA's regulatory modelling options, as specified in the EPA Guidelines on Air Quality Models (Revised). Alberta Environment, Environmental Protection Service of Government of NWT, and Environment Canada consider this model a supporting tool for the ambient air quality regulations.

The following dispersion modeling options and assumptions were selected for the assessment of particle dispersion in air:

- no regulatory default
- concentration and deposition output
- rural area
- flat simple terrain calculation algorithms
- single pollutant (particulate matter)
- no exponential decay
- 24-h, 30-day, and annual averaging times
- wind speeds higher than 5 m/s and atmospheric stability classes (A to F)
- first highest values for combined five-year meteorological data from 1998 to 2002, inclusive, for the Baker Lake area.

As already discussed in Section 5.3.1, wind speed strongly influences the fugitive dust generation rate. Wind speed frequency classes for the project area are illustrated in Figure 6.15.

Dispersion modelling was performed for three stages of tailings development for Years 3, 5, and 7 of operation. All three fugitive dust sources (i.e., tailings, waste disposal facility, and the coarse ore stockpile) were modelled. Separate runs were executed for each 30 μm, 10 μm, and 2.5 μm fraction, which totals to 9 runs. Concentration isopleths have been presented in the graphical form for 30 μm fraction only. Results for other fractions were produced by the model in a tabular form.

The following outputs were obtained from the model:

- contour plots of concentrations for predetermined average times within selected geographical boundary at specified receptor locations
- maximum ground level concentrations and the deposition rate for the modelled time
- multiple plots with site maps as backdrops.

Two categories of model output were acquired: (1) the maximum ground level concentration (expressed in μg/m^3) of suspended particulates in the atmosphere at the ground level, and (2) particulate deposition rate (expressed in mg/m^2 per 30 days). The results presented are the highest values in the five years of modelling.

Furthermore, the model was set to select for modelling only those periods with wind speeds greater than 5 m/s, which is the lower wind speed threshold necessary to lift dust particles from the surface.

6.2.2 Modeling Results

Modelling results for total suspended particulates (≤30 μm diameter) for three stages of tailings development are shown in Figures 6.16 to 6.24 at the end of this section.

A summary of maximum ground level concentration (GLC) of fugitive dust originating at three sources (tailings, waste disposal, and the ore stockpile) is presented in Table 6.2. The relevant ambient air quality standards (AAQS) are also provided. For PM_{10}, the concentration value is the fourth highest, in line with National AAQS.

Table 6.2: Fugitive Dust Dispersion Modelling Maximum Concentration Values

Tailings Area (m^2)	Particle Diameter (μm)	Maximum GLC (μg/m^3)	Average Time	Maximum GLC (μg/m^3)	AAQS, (μg/m^3)	Reference
92,000	30	24.3	24 h	24.3	120[1]	Figure 6.16
		7.3	Annual	7.3	60[1]	Figure 6.17
	10	20.4	24 h	20.4	50[2]	ISCST3
		4.7	Annual	4.7	40[3]	ISCST3
	2.5	4.8	24 h	4.8	30[1]	ISCST3
144,000	30	60.1	24 h	60.1	120	Figure 6.19
		32.3	Annual	32.3	60	Figure 6.20
	10	47.8	24 h	47.8	50	ISCST3
		21.2	Annual	21.2	40	ISCST3
	2.5	13.2	24 h	13.2	30	ISCST3
537,000	30	99.2	24 h	99.2	120	Figure 6.22
		51.5	Annual	51.5	60	Figure 6.23
	10	33.3	24 h	33.3	50	ISCST3
		17.0	Annual	17.0	40	ISCST3
	2.5	19.3	24 h	19.3	30	ISCST3

Notes: 1. NWT & CWS. **2.** ON, NF, BC. **3.** EPA Act 1992 (proposed).

As shown in the above table, the maximum GLC will meet ambient air quality objectives in all modeled cases.

The highest concentrations of fugitive dust will be around ore stockpile and south of waste rock storage facility. This can be explained by activities at these sources where dust is introduced to air continuously, regardless of wind speed, during conveyor discharge at stockpile and truck movement and waste discharge at the dumping site. Tailings will be discharged by pipeline in a form of slurry. Fugitive dust will be generated only when the tailing material dries up with winds above the threshold value (>5 m/s).

The airborne dust will eventually be deposited on the ground at rates as shown in Figures 6.18, 6.21, and 6.24. The highest particle deposition rate of 26.4 g/m^2 per 30 days will be for the largest tailing beach area. This can be compared with existing dustfall guidelines. For Alberta industrial areas, the deposition rate guideline for 30 days averaging time is 15.8 g/m^2 (Alberta Environment, 2000). The deposition modelling results indicate that particles deposition may exceed Alberta guidelines; however, no deposition objective exists for Nunavut or NWT.

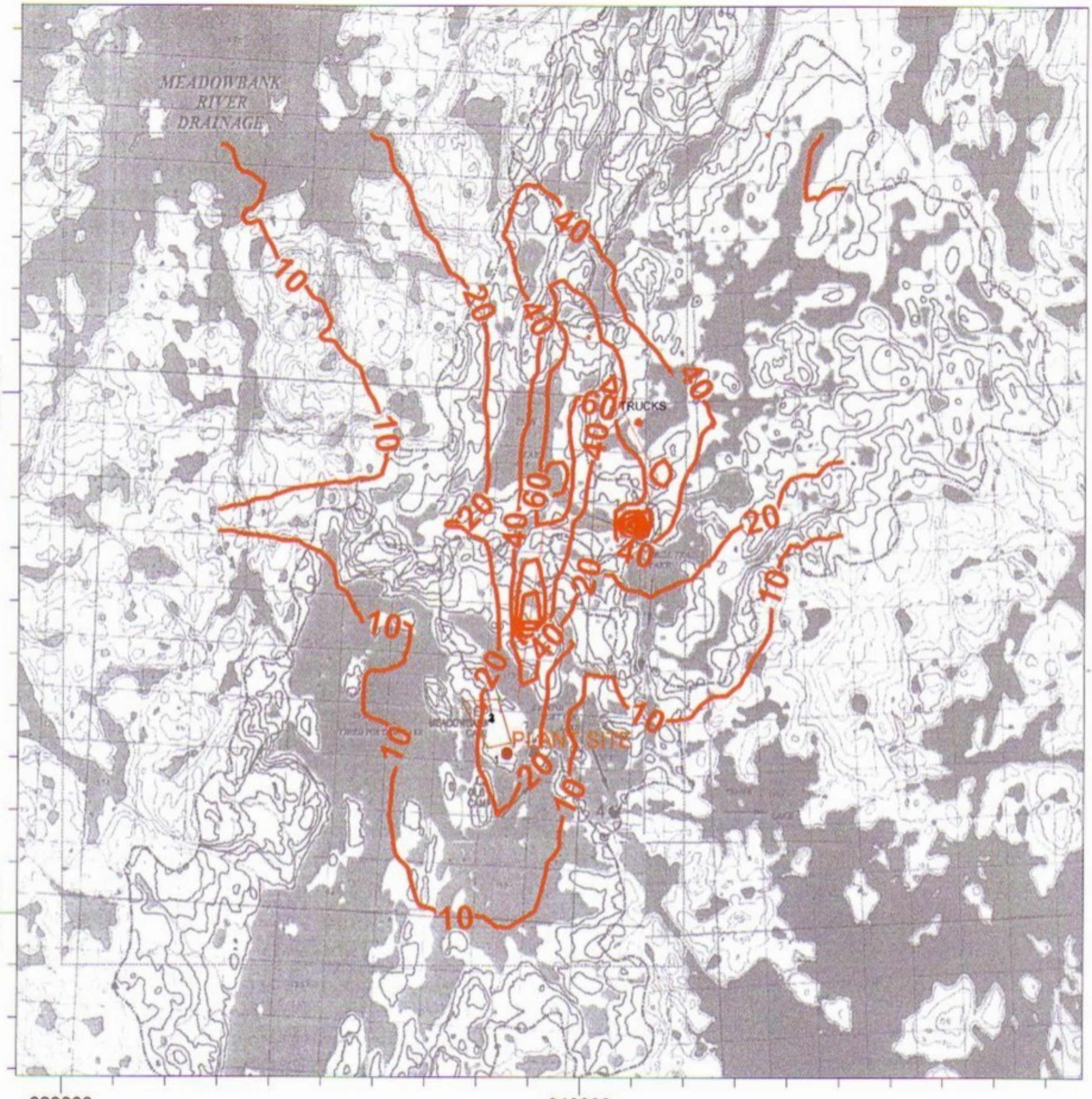
6.3 CUMULATIVE EFFECT

The cumulative effects of gaseous and fine particulate (PM_{10} and $PM_{2.5}$) emissions from the power plant, hauling truck exhaust, and wheel entrainment were predicted using the AERMOD model. The results are presented and discussed in Section 6.1.

The cumulative effect of fugitive dust sources, including the coarse ore stockpile, the tailings area, and the waste rock disposal facility, were modelled with the ISCST3 model, which, in contrast to AERMOD, is capable of predicting both particulate concentrations and particulate deposition rates. The results are presented and discussed in Section 6.2.

The cumulative effect of all dust sources cannot be adequately modelled. As explained earlier in this report, the fugitive dust from the tailings and waste disposal areas will be generated when the wind speed is at least 5 m/s. The meteorological data for the ISCST3 model was therefore limited to winds above this threshold value of 5 m/s; however, the modelling of power plant emissions, truck exhaust, and wheel entrainment dust were performed for the whole range of wind data with the AERMOD model.

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling

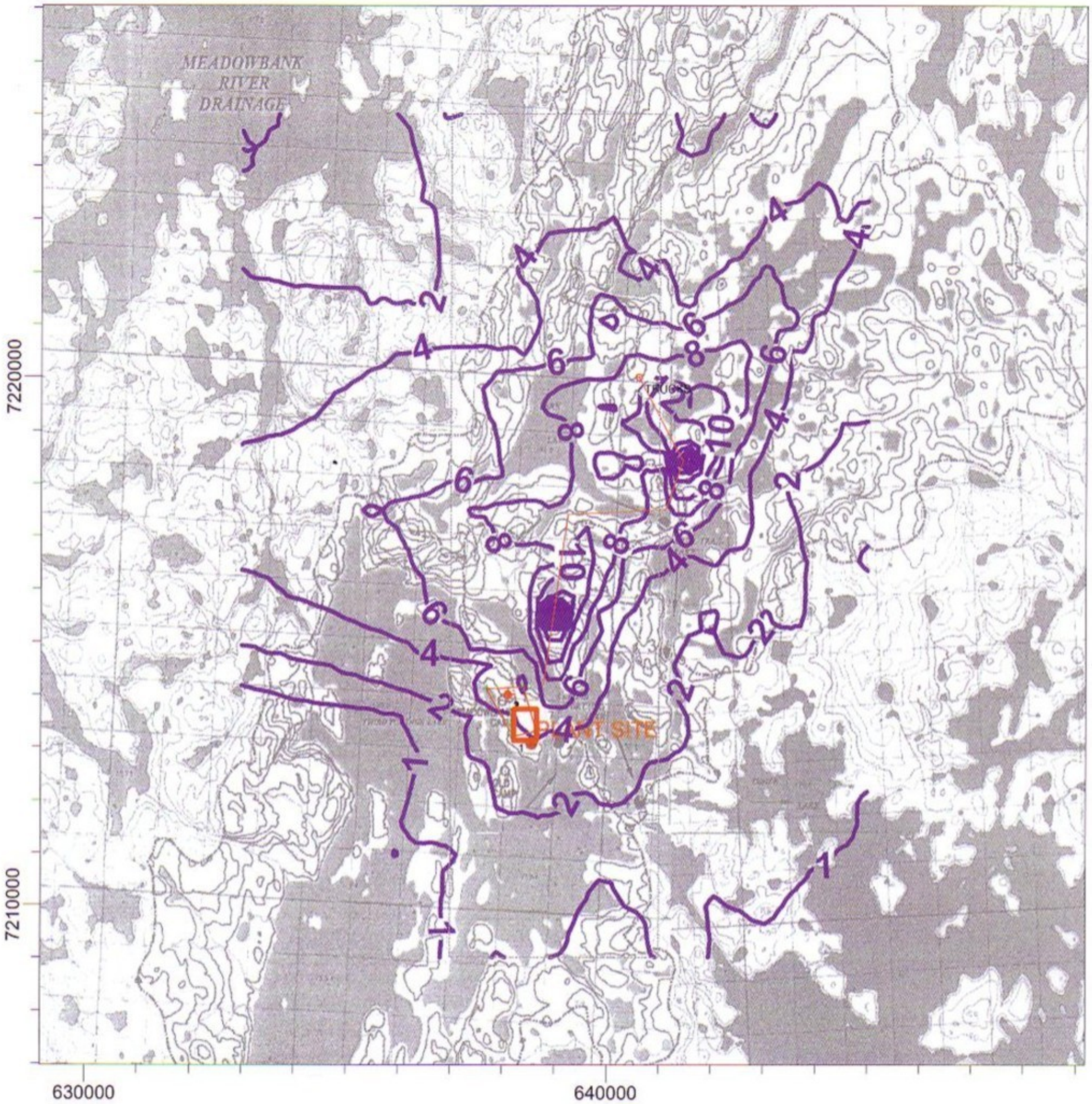


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of sulphur dioxide, 1-hour averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 4 km	
	MAX: 134.65071	UNITS: µg/m³	DATE: 04/02/2004	Figure 6.1

POST View - Lakes Environmental Software

C:\Disp Gold Mine\SO2\01H1GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling

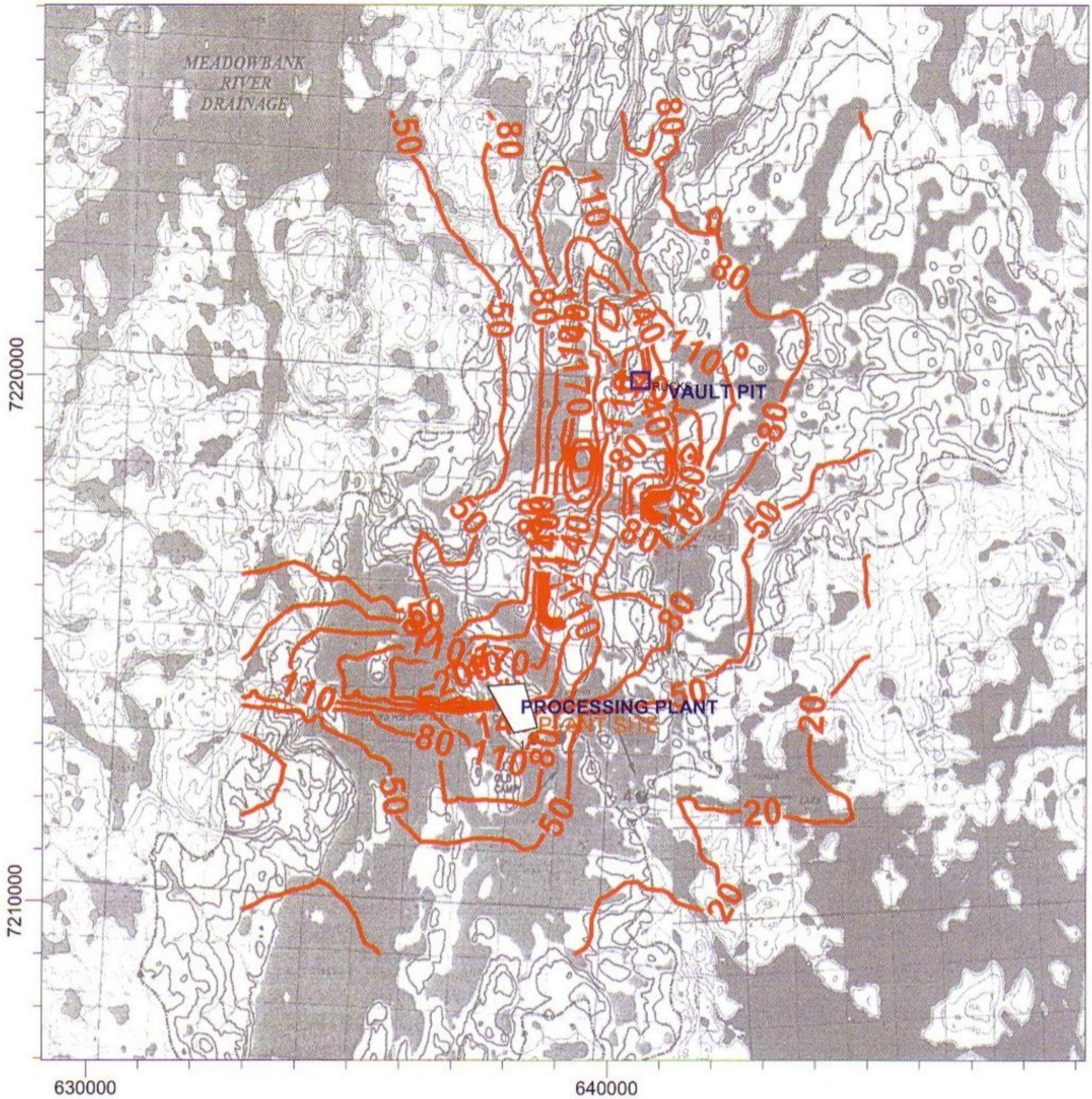


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of sulphur dioxide, 24-hour averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 3 km	
	MAX: 24.6571	UNITS: μg/m³	DATE: 04/03/2004	Figure 6.2

POST View - Lakes Environmental Software

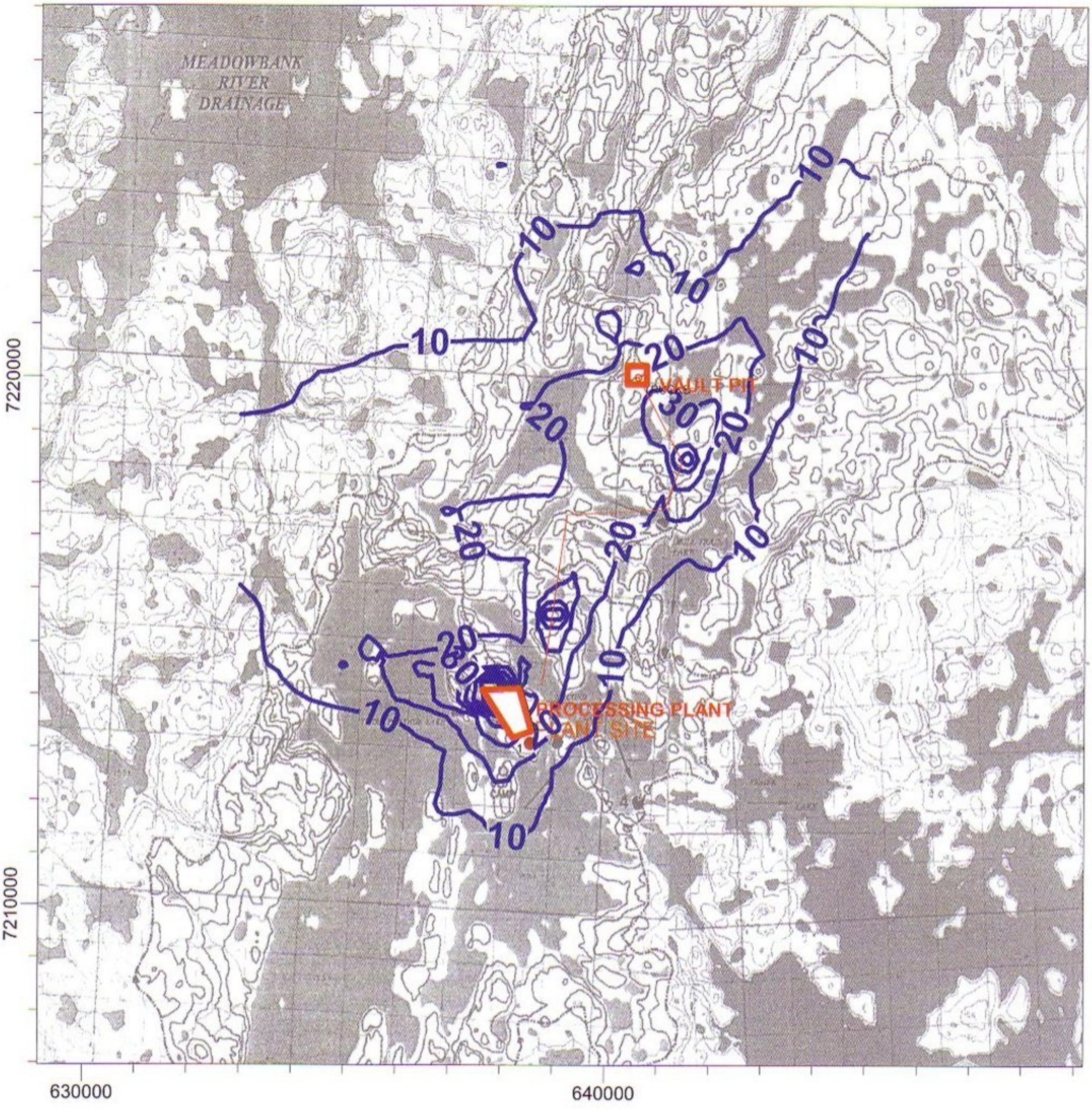
C:\DISP GOLD MINE\SO2\24H1GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of nitrogen oxides, 1-hour averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 3 km	
	MAX: 362.52124	UNITS: μg/m³	DATE: 04/05/2004	Figure 6.3

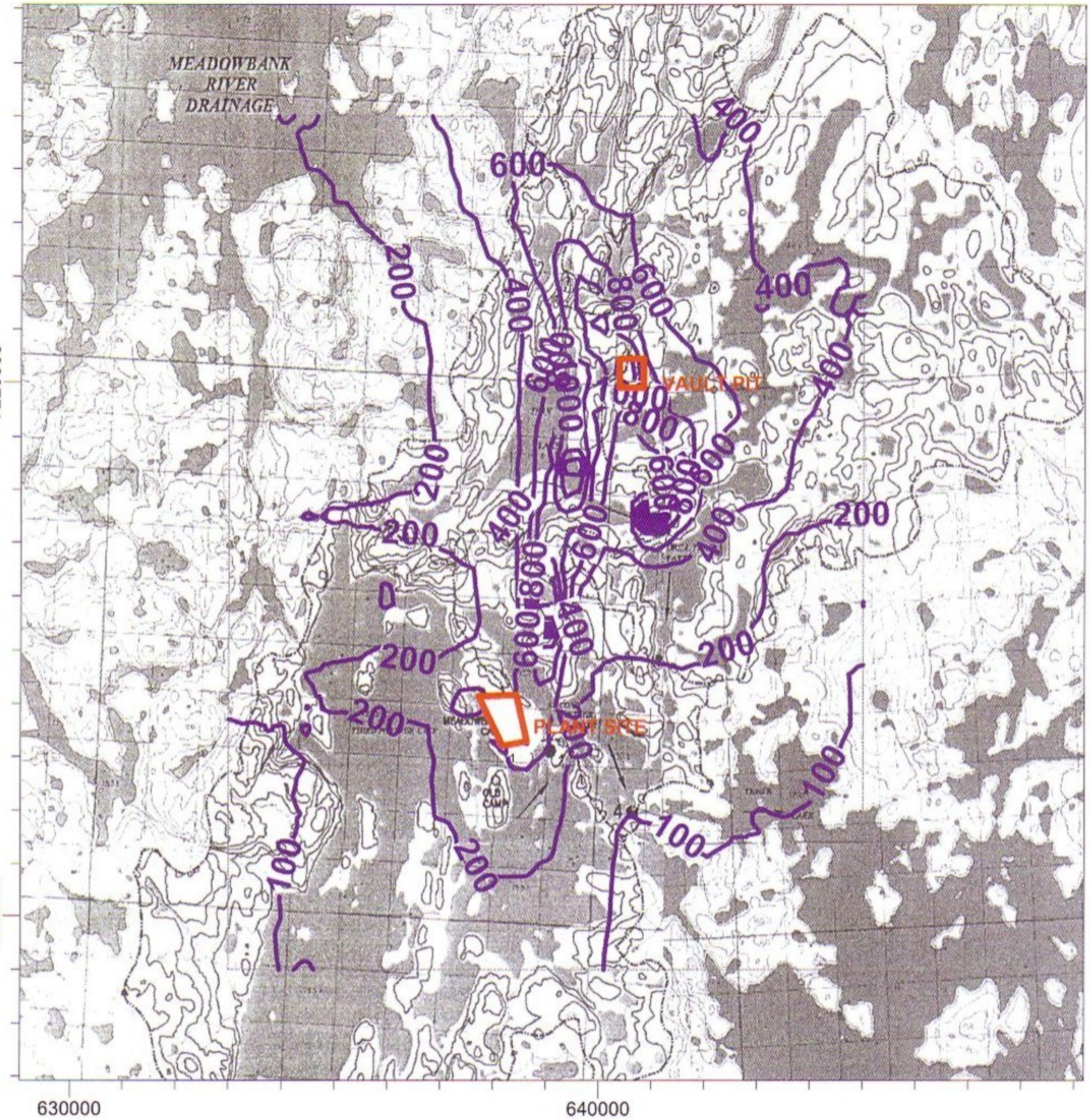
Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of nitrogen oxides, 24-hour averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 3 km	
	MAX: 114.42155	UNITS: μg/m³	DATE: 04/05/2004	Figure 6.4

POST View - Lakes Environmental Software C:\Disp Gold\NOx\24H1GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling

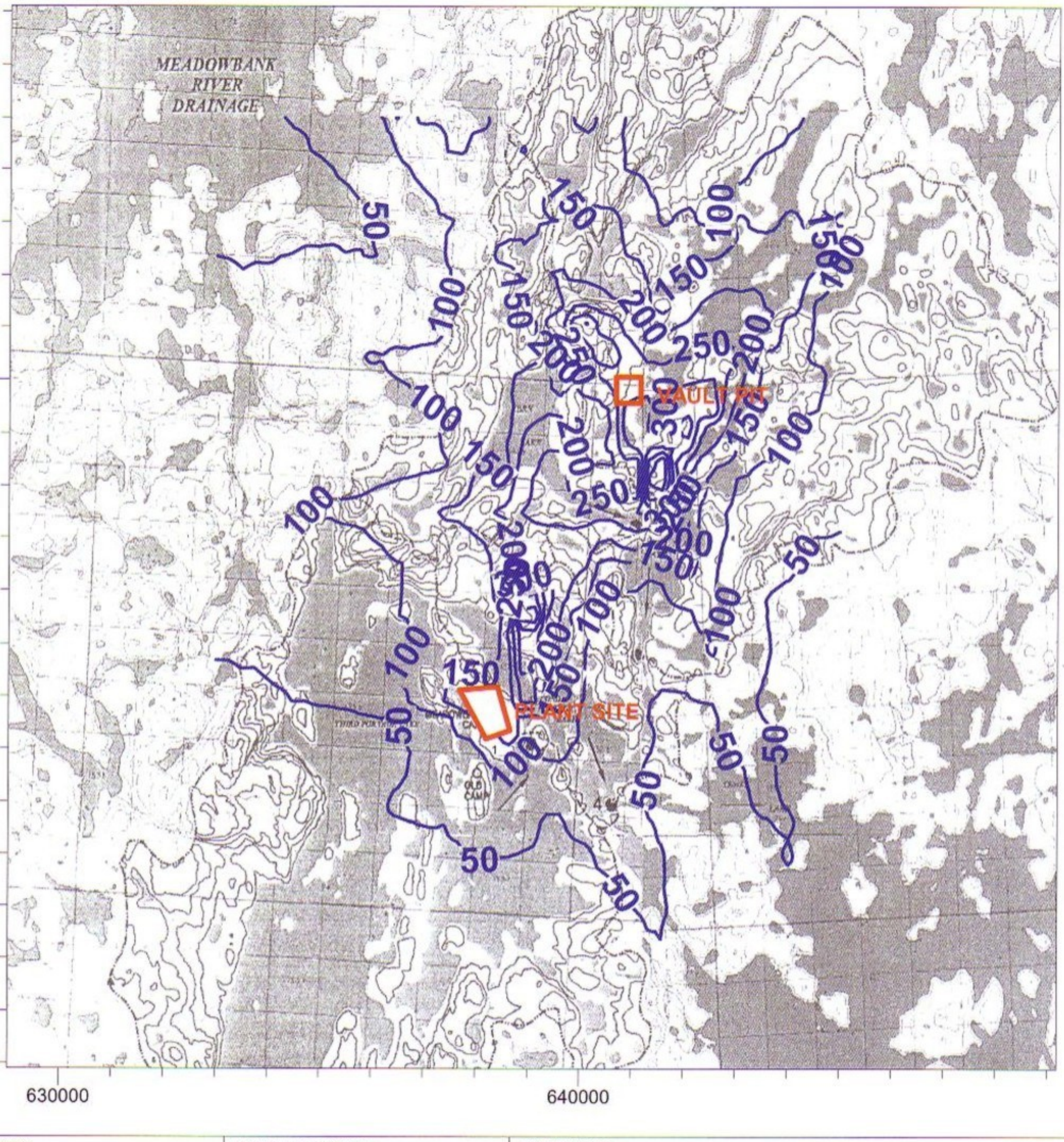


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of carbon monoxide, 1-hour averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 3 km	
	MAX: 2123.33813	UNITS: µg/m³	DATE: 04/05/2004	Figure 6.5

POST View - Lakes Environmental Software

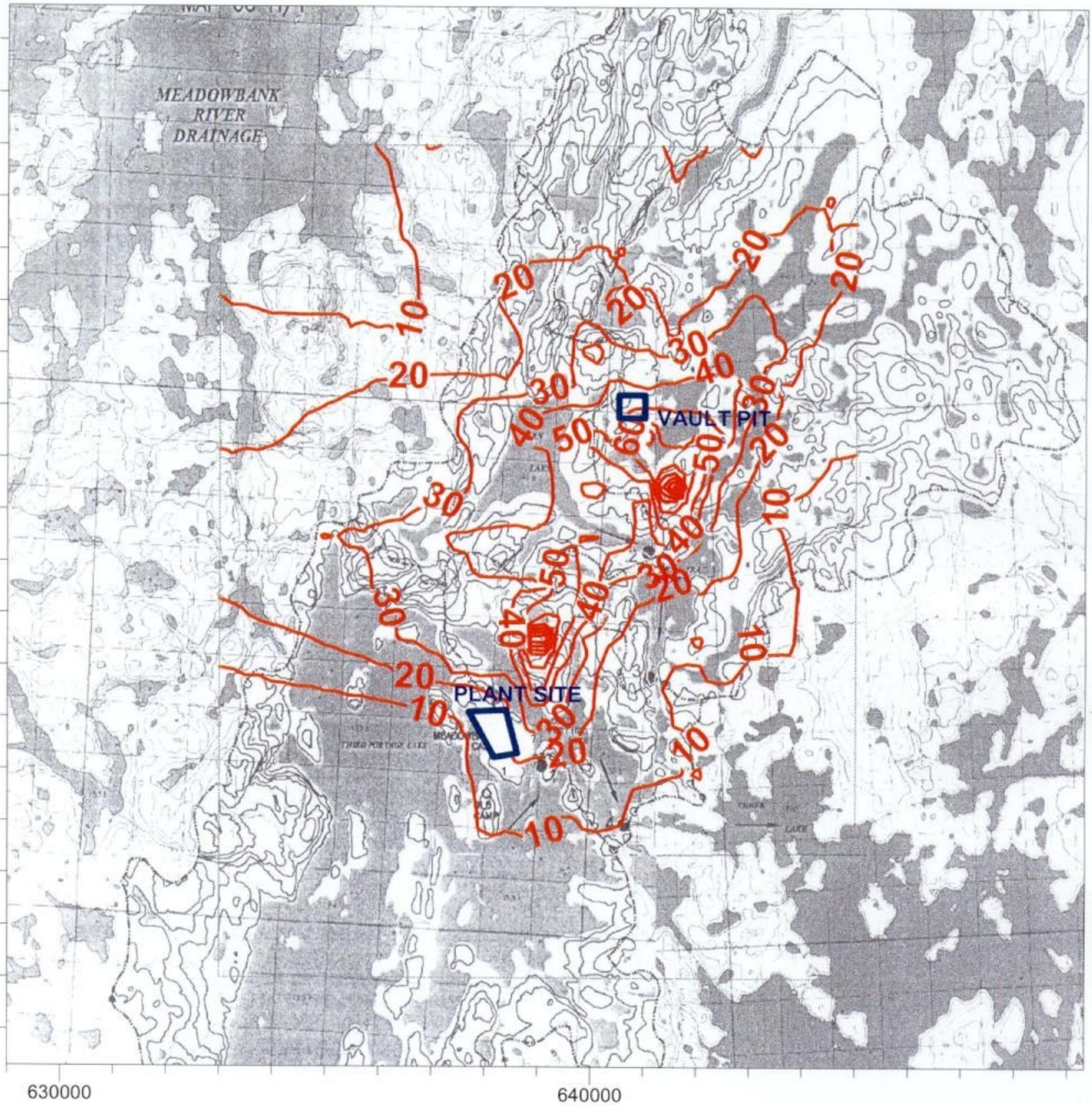
C:\Disp Gold\CO\01H1GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of carbon monoxide, 8-hour averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 3 km	
	MAX: 624.23529	UNITS: µg/m³	DATE: 04/05/2004	Figure 6.6

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling

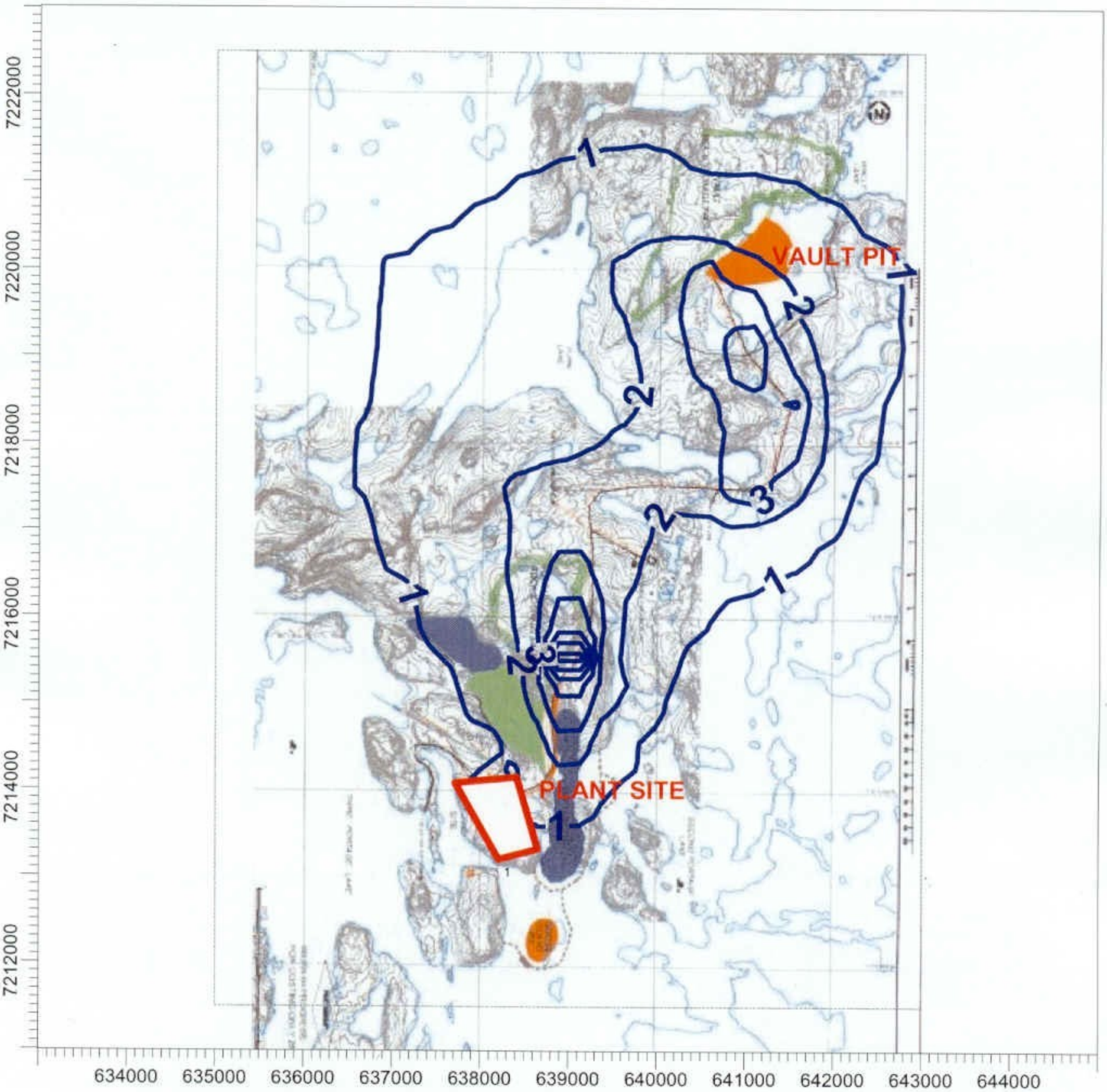


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of SP, 24-hour averaging time.	CONC, DFAULT, ELEV, MULTYR		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 3 km	
	MAX: 127.0789	UNITS: μg/m³	DATE: 04/05/2004	Figure 6.7

POST View - Lakes Environmental Software

C:\Disp Gold\PM10B\24H1GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:
The first highest concentrations of SP, annual averaging time.	CONC, DFAULT, ELEV, MULTYR		Cumberland Resources Ltd.
			PROJECT NO: EC80864
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 2 km
	MAX: 8.74504	UNITS: μg/m³	DATE: 04/05/2004

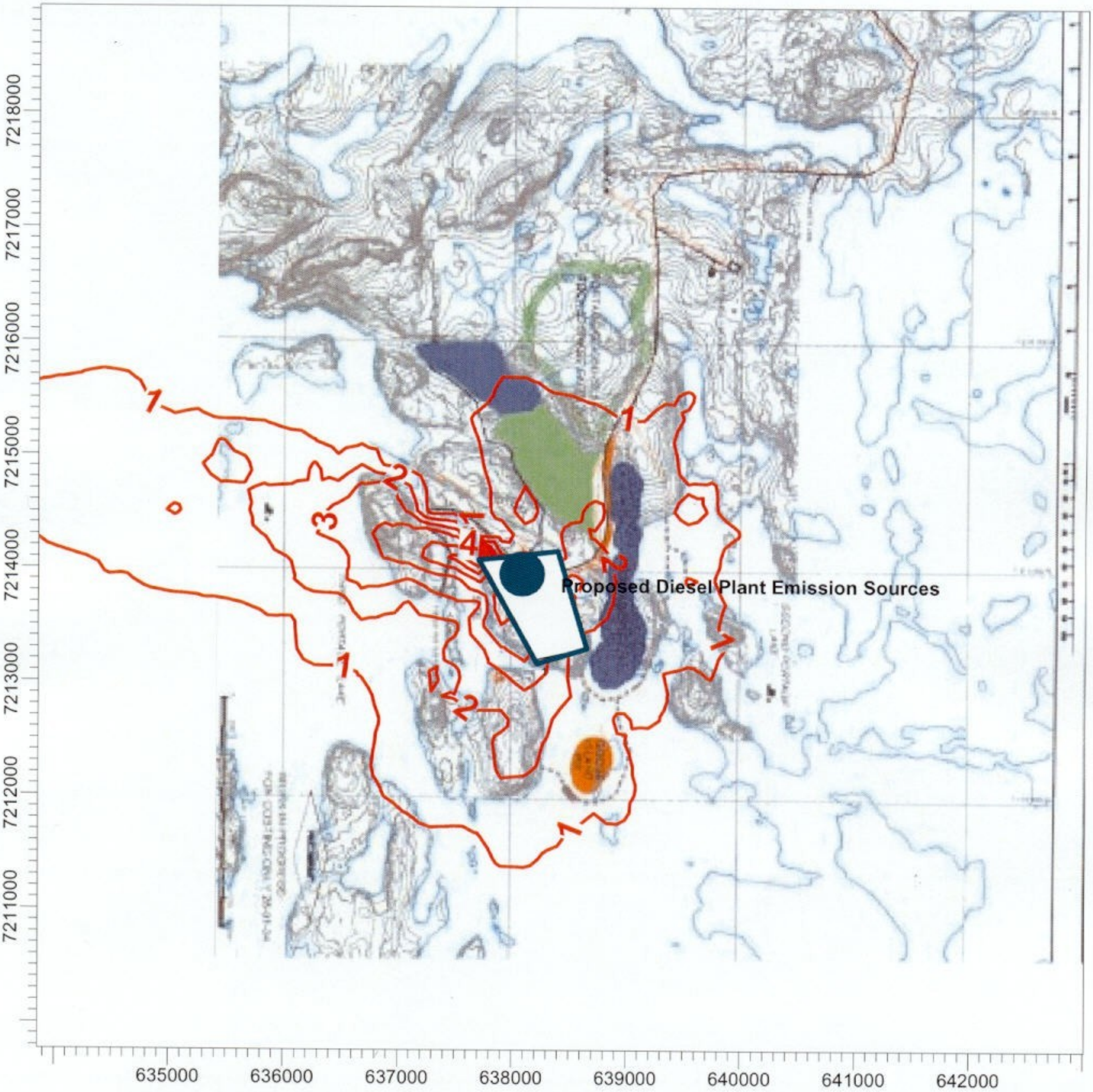
CUMBERLAND RESOURCES LTD

Figure 6.8

POST View - Lakes Environmental Software

C:\Disp Gold\PM10B\AN00GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:

The first highest concentrations of SP, 24-hour averaging time. Diesel plant emissions.

MODELING OPTIONS:

CONC, DFAULT, ELEV, MULTYR

CLIENT NAME:

Cumberland Resources Ltd.

PROJECT NO:

EC80864

OUTPUT TYPE:	RECEPTORS:
CONC	**1649**

0 ▬▬▬ 1 km

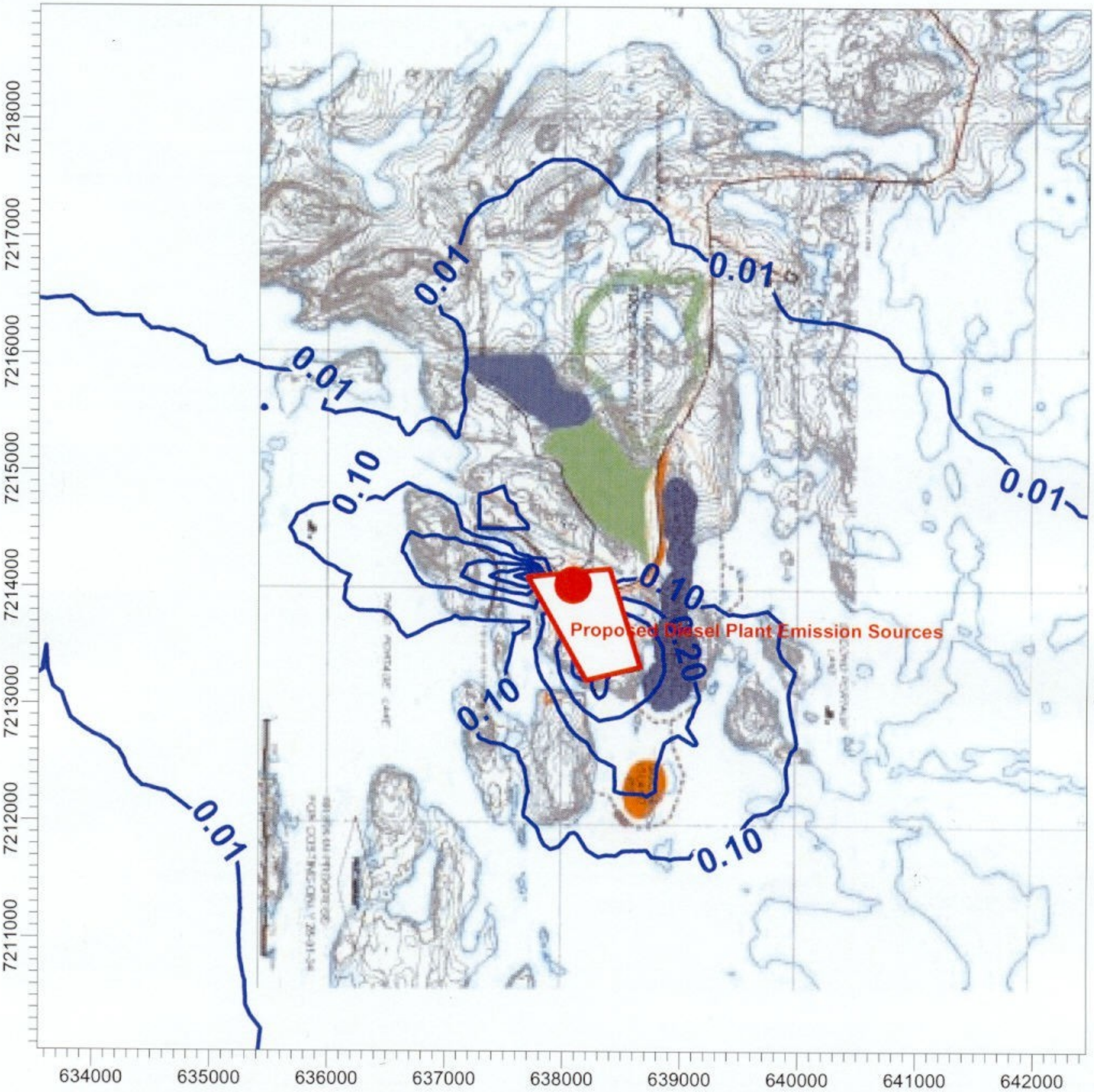
MAX:	UNITS:	DATE:
11.19553	**µg/m³**	**04/05/2004**

Figure 6.9

POST View - Lakes Environmental Software

C:\Disp Gold\PM10St\24H1GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



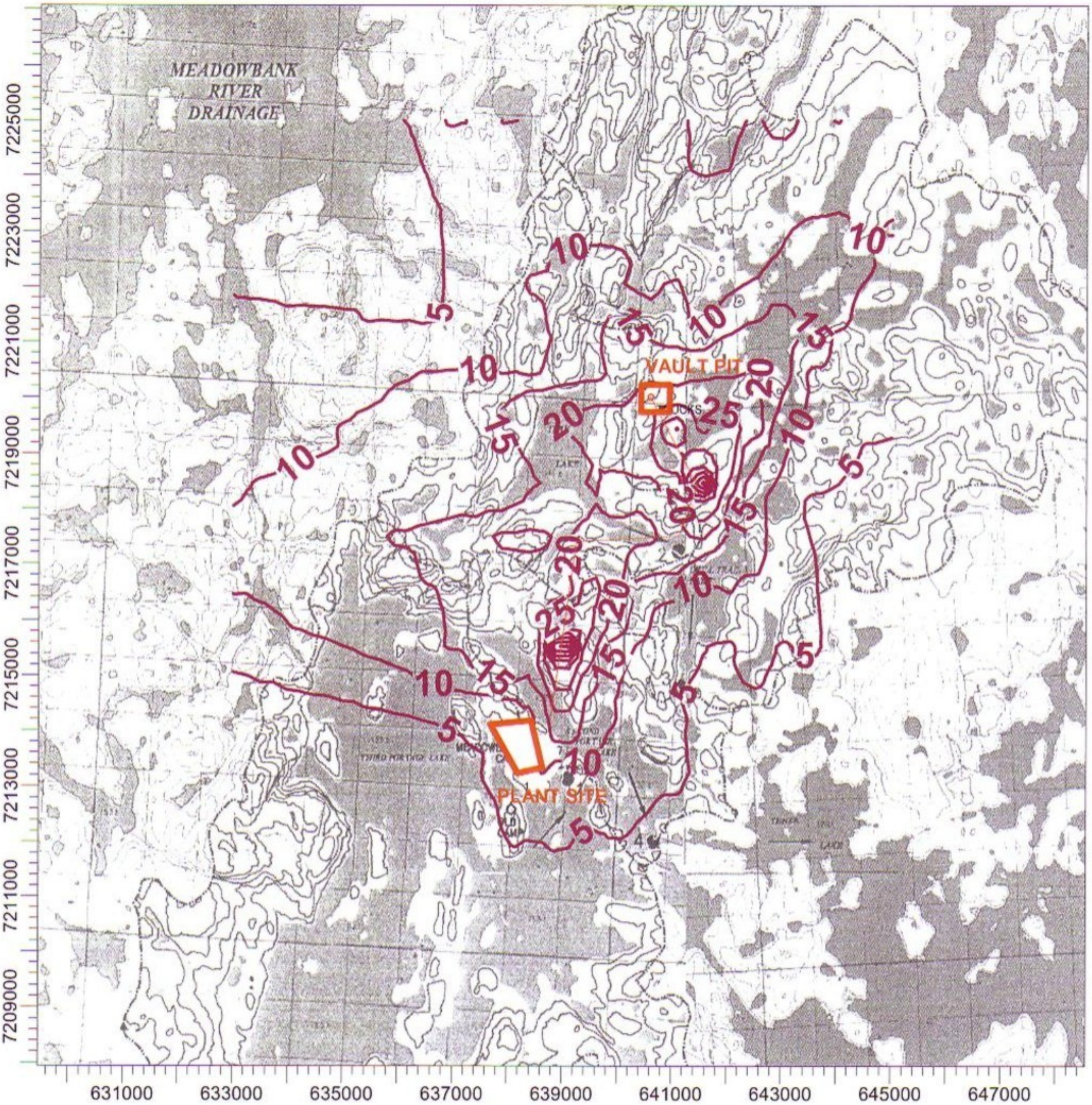
COMMENTS:	MODELING OPTIONS:		CLIENT NAME:
The first highest concentrations of SP, annual averaging time. Diesel plant emissions.	CONC, DFAULT, ELEV, MULTYR		Cumberland Resources Ltd.
			PROJECT NO: EC80864
	OUTPUT TYPE: CONC	RECEPTORS: 1649	0 — 1 km
	MAX: 0.91109	UNITS: µg/m³	DATE: 04/05/2004

Figure 6.10

POST View - Lakes Environmental Software

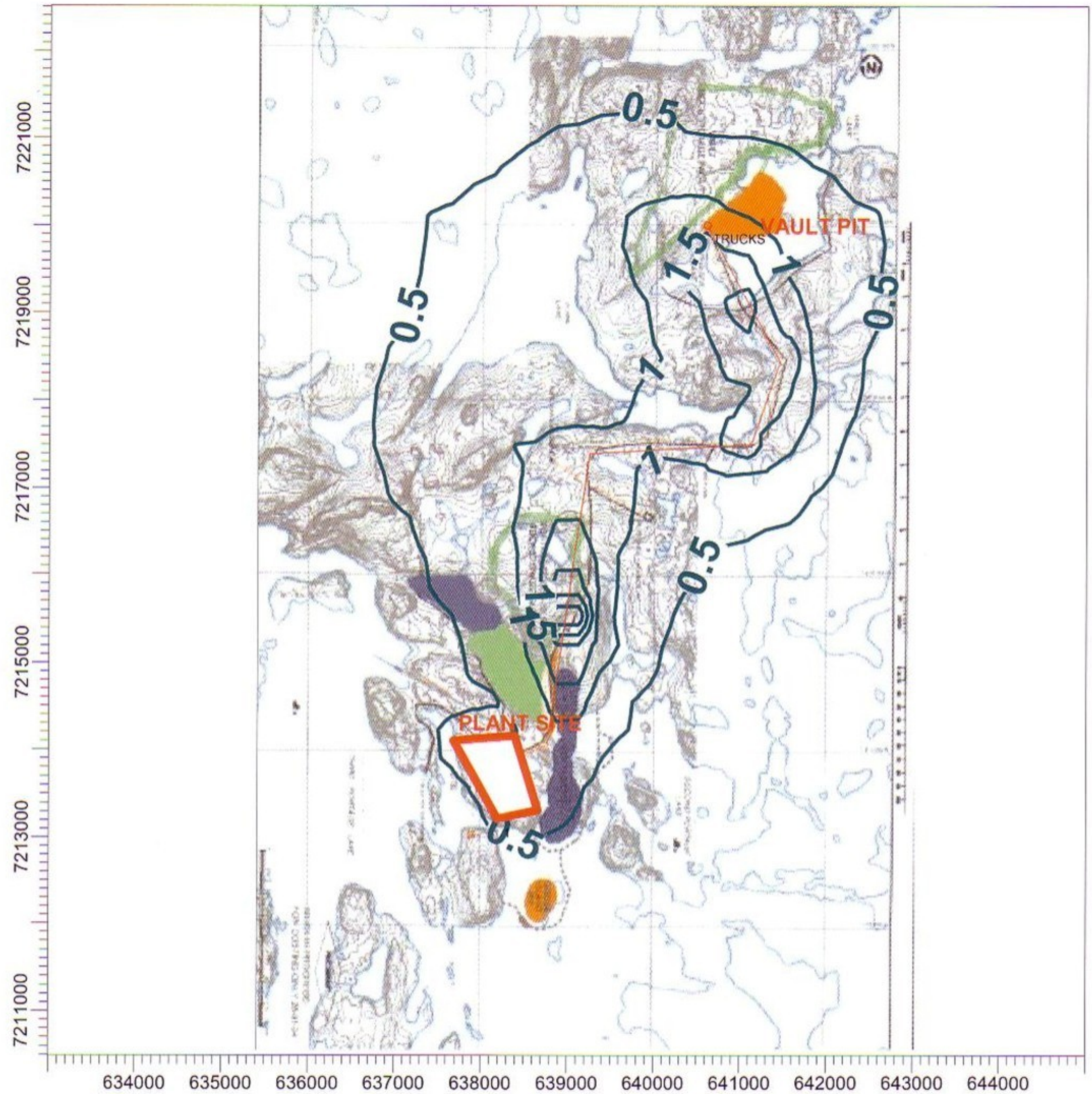
C:\Disp Gold\PM10St\AN00GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of PM2.5, 24-hour averaging time.	CONC, DFAULT, ELEV		**Cumberland Resources Ltd.**	
			PROJECT NO: **EC80864**	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: **CONC**	RECEPTORS: **829**	0 — 3 km	
	MAX: **58.7977**	UNITS: **μg/m³**	DATE: **04/05/2004**	Figure 6.11

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling

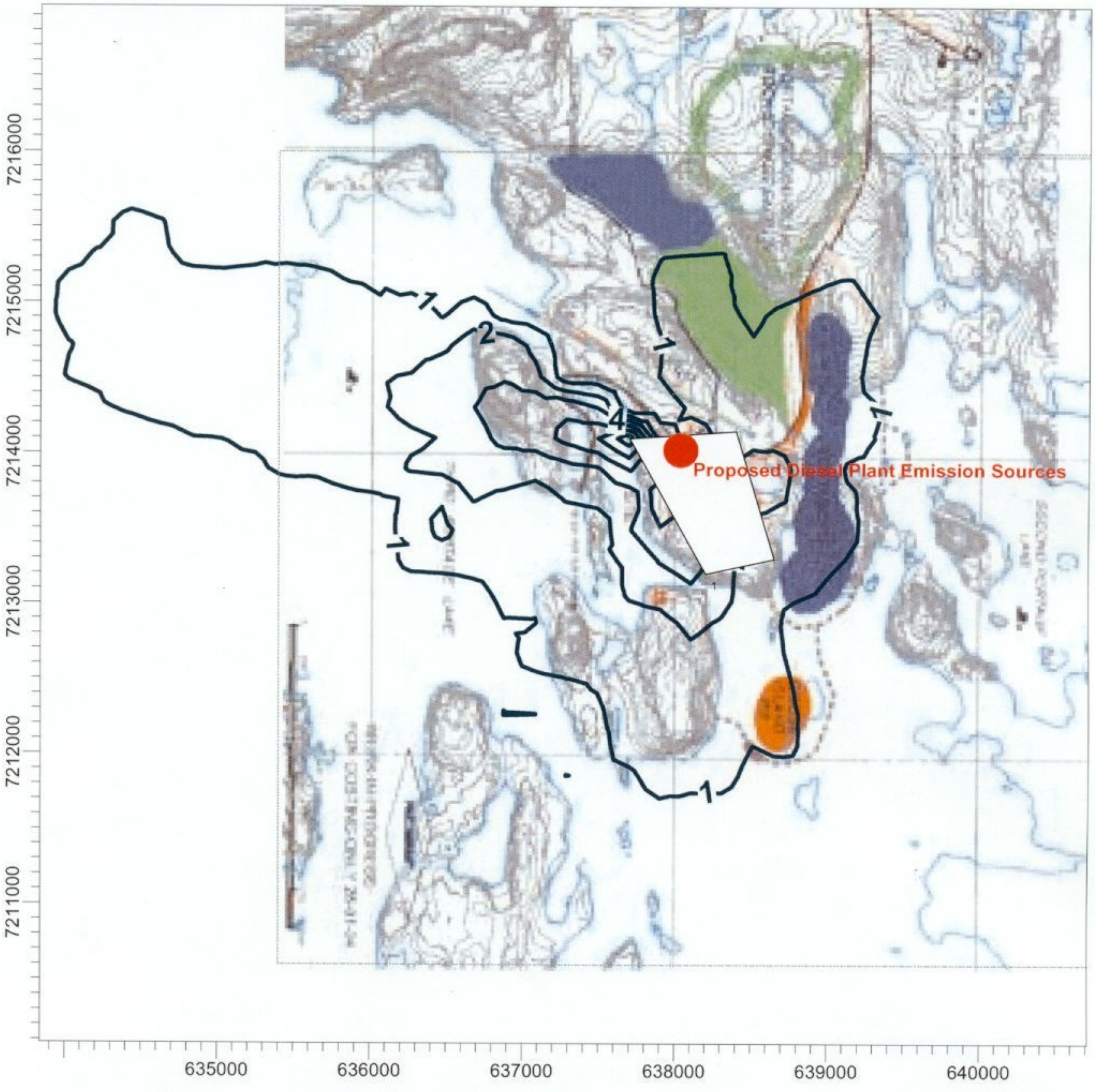


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of PM2.5, annual averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 829	0 — 2 km	
	MAX: 4.05725	UNITS: μg/m³	DATE: 04/05/2004	Figure 6.12

POST View - Lakes Environmental Software

C:\Disp Gold Mine\PM2_5\AN00GALL.PLT

Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of PM2.5, 24-hour averaging time. Diesel plant emissions.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 1649	0 — 1 km	
	MAX: 10.79043	UNITS: µg/m³	DATE: 04/05/2004	Figure 6.13

POST View - Lakes Environmental Software

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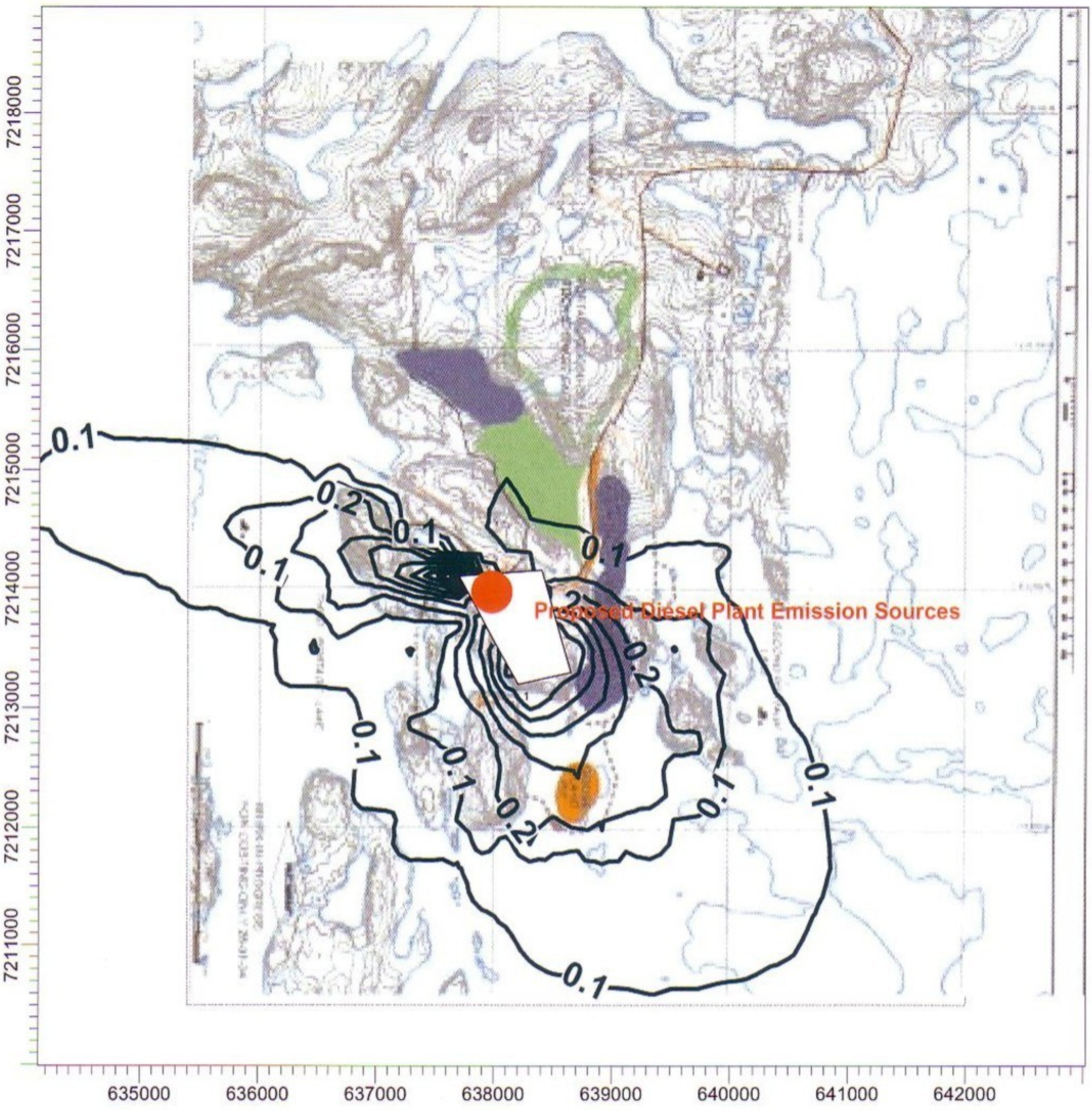
Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling

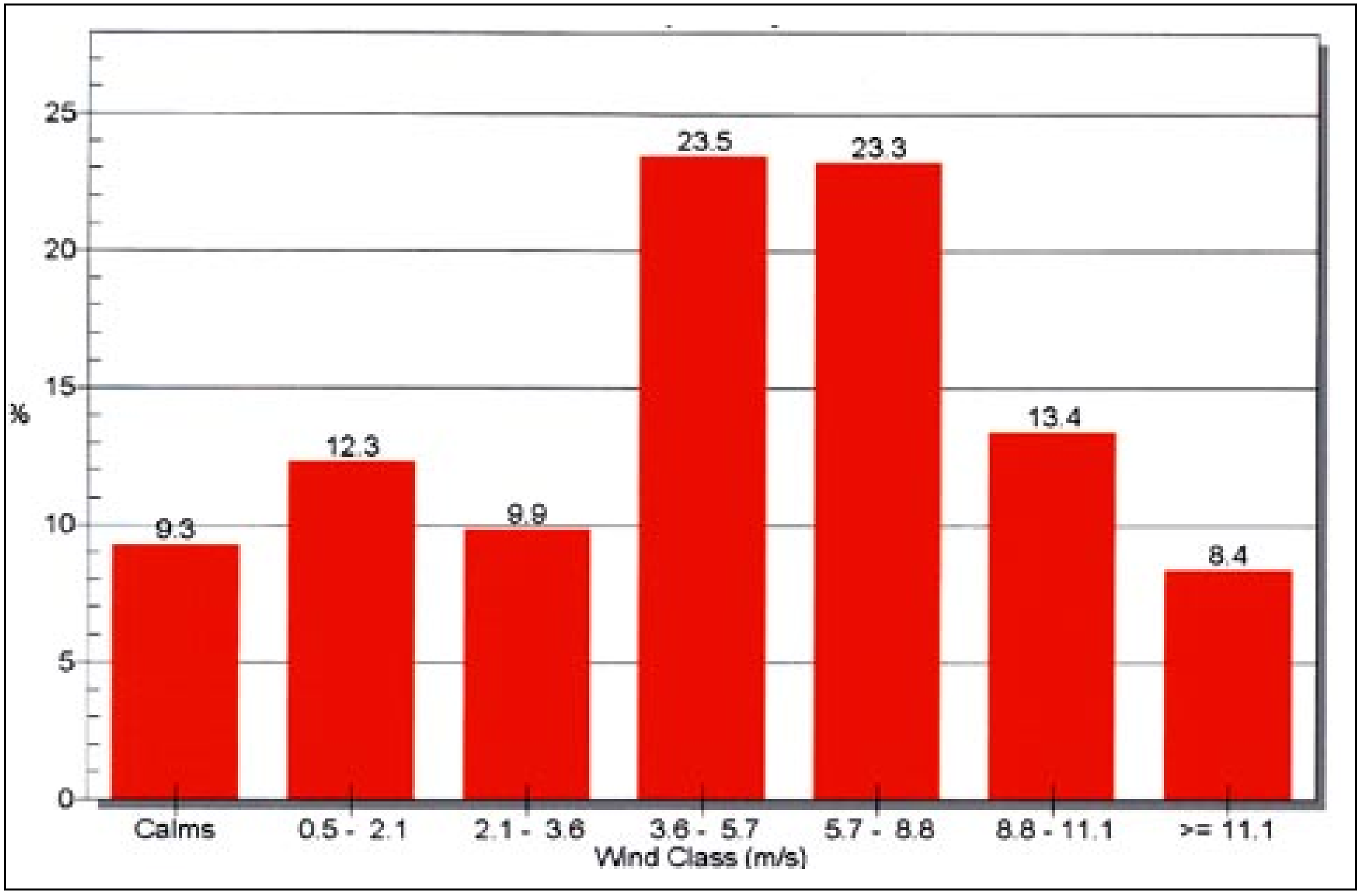


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentrations of PM2.5 diesel plant emission sources, annual averaging time.	CONC, DFAULT, ELEV		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 1649	0 ▬ 1 km	
	MAX: 0.87812	UNITS: μg/m³	DATE: 04/05/2004	Figure 6.14

POST View - Lakes Environmental Software

C:\DISP GOLD MINE\TEST\AN00GALL.PLT

Figure 6.15: Wind Speed Frequency Classes for the Meadowbank Area



Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling

COMMENTS	MODELING OPTIONS		CLIENT NAME
The first highest concentration of total suspended particulate, 24 hour average. Tailings area 160 m x 560 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.
			PROJECT NO: EC80864
	OUTPUT TYPE: CONC	RECEPTORS: 741	0 — 1 km
	MAX: 24.3068	UNITS: µg/m³	DATE: 05/06/2004

Figure 6.16

POST View - Lakes Environmental Software

C:\Disp Dust Gold\160m24H1GALL.PLT

Meadowbank Gold Project
Fugitive Dust Dispersion Modelling

COMMENTS: The first highest concentration of total suspended particulate, annual average. Tailings area 160 m x 560 m.	MODELING OPTIONS: CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		CLIENT NAME: **Cumberland Resources Ltd.**
			PROJECT NO: **EC80864**
	OUTPUT TYPE: **CONC**	RECEPTORS: **741**	0 — 1 km
	MAX: **7.30111**	UNITS: **µg/m³**	DATE: **05/06/2004**

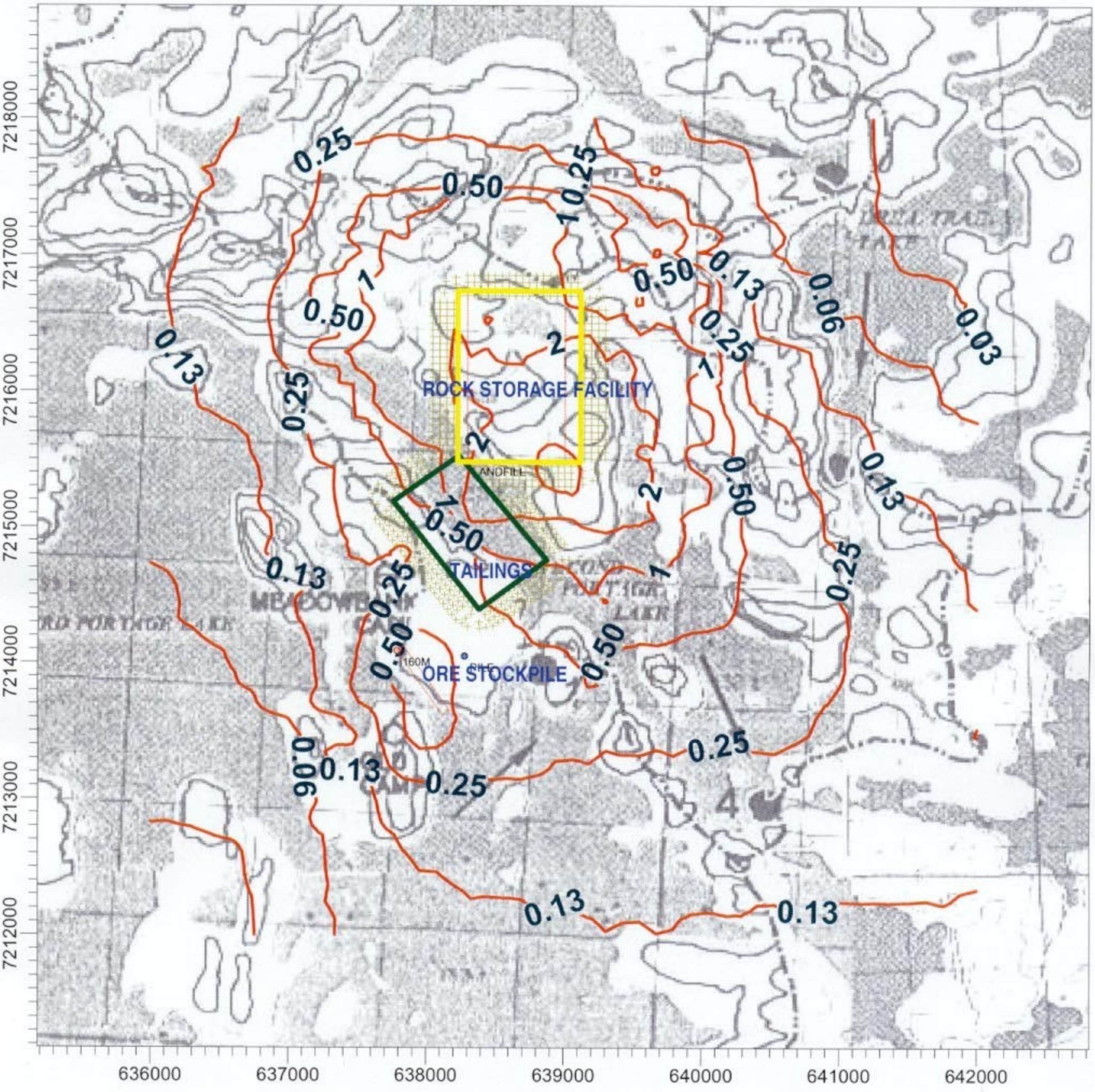
CUMBERLAND RESOURCES LTD

Figure 6.17

POST View - Lakes Environmental Software

C:\DISP DUST GOLD\160M\PE00GALL.PLT

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling

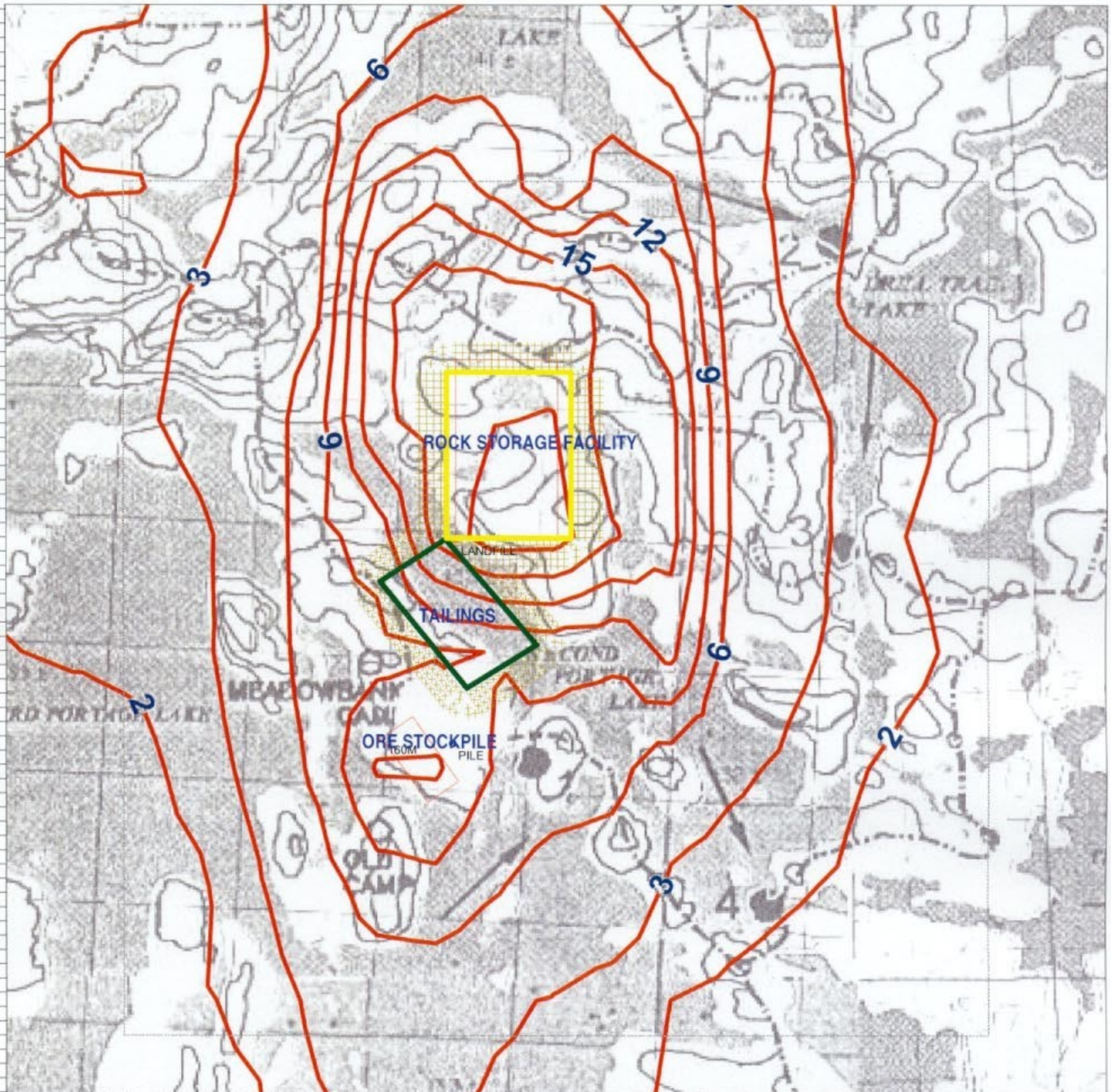


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
Particulate deposition rate, 30 days period. Tailings area 160 m by 560 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: DDEP	RECEPTORS: 741	0 — 1 km	
	MAX: 4.52368	UNITS: g/m²	DATE: 05/06/2004	Figure 6.18

POST View - Lakes Environmental Software

C:\DISP DUST GOLD\160M\MOH1GALL.PLT

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling

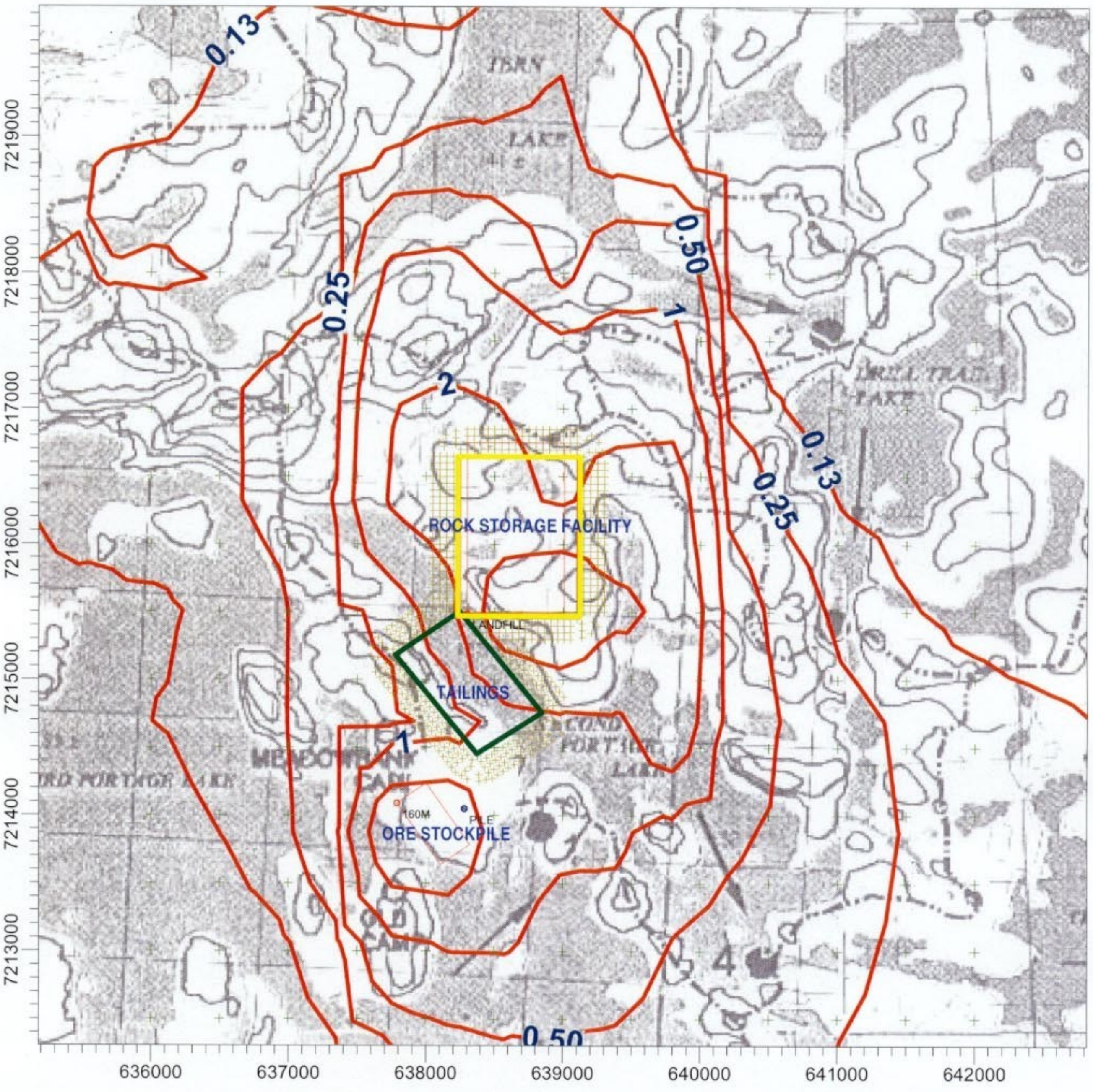


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:
The first highest concentration of total suspended particulate, 24 hour average. Tailings area 260 m x 554 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.
			PROJECT NO: EC80864
	OUTPUT TYPE: CONC	RECEPTORS: 862	0 — 1 km
	MAX: 60.08185	UNITS: μg/m³	DATE: 05/07/2004

CUMBERLAND RESOURCES LTD

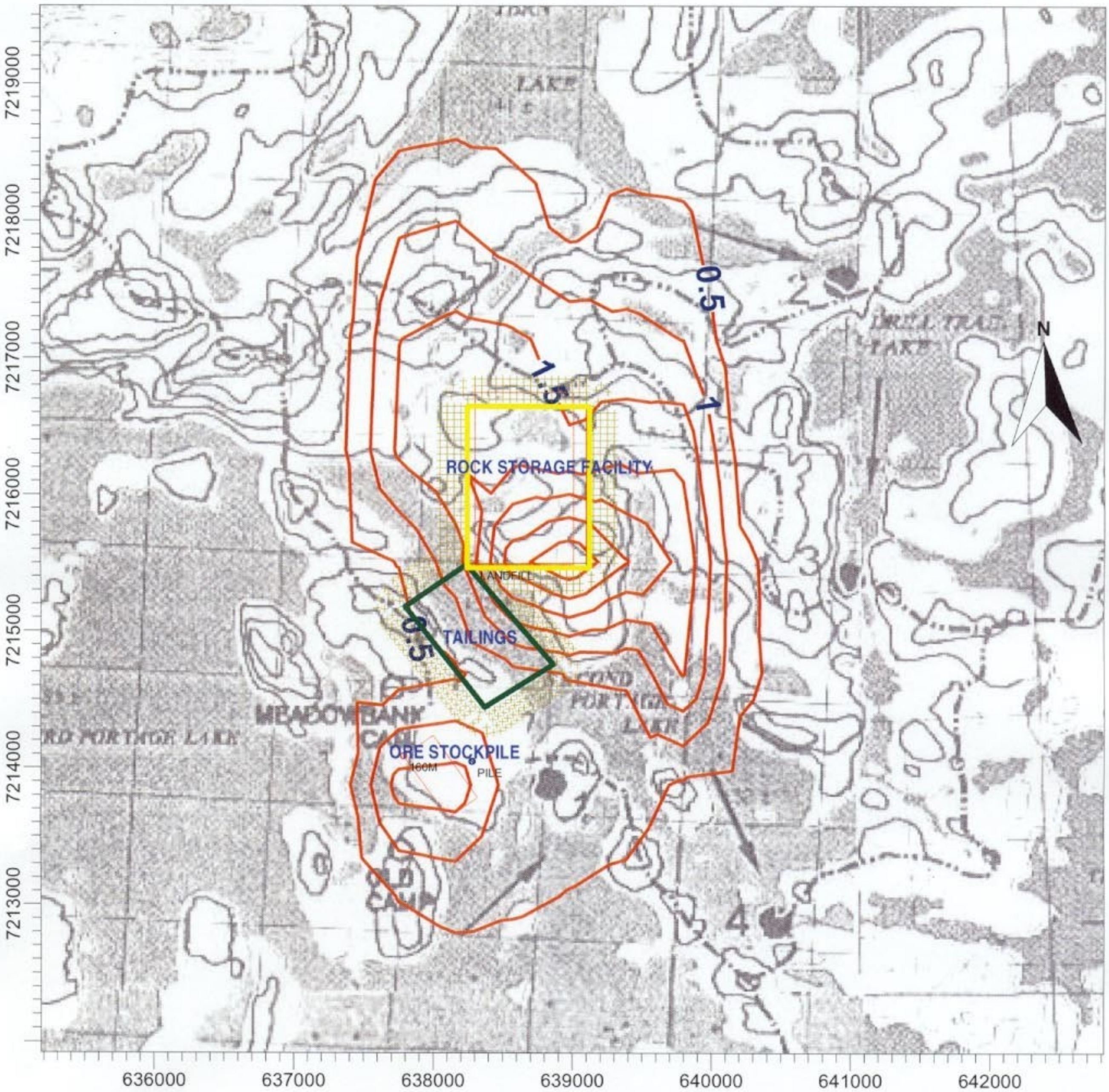
Figure 6.19

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentration of total suspended particulate, annual average. Tailings area 260 m x 554 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 862	0 — 1 km	
	MAX: 32.31496	UNITS: μg/m³	DATE: 05/07/2004	Figure 6.20

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling

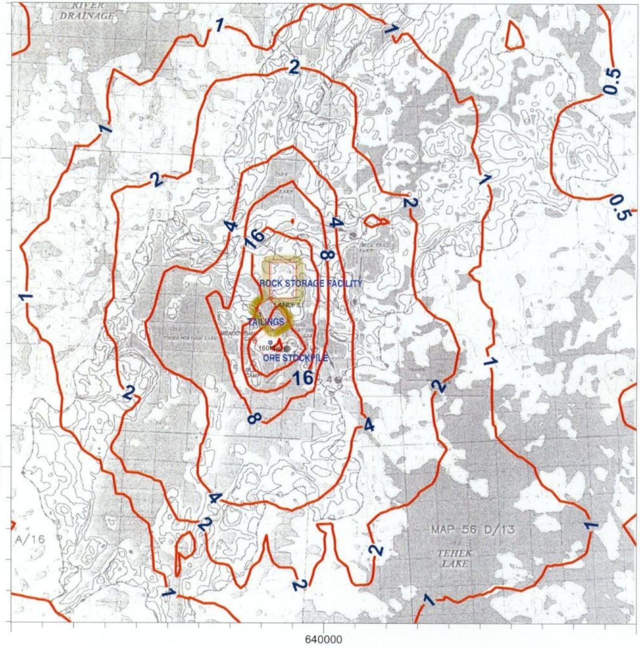


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
Particulate depositon rate, 30-day period. Tailings area 260 m x 554 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		**Cumberland Resources Ltd.**	
			PROJECT NO: **EC80864**	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: **DDEP**	RECEPTORS: **862**	0 — 1 km	
	MAX: **16.7651**	UNITS: **g/m²**	DATE: **05/07/2004**	Figure 6.21

POST View - Lakes Environmental Software

C:\DISP DUST GOLD\260\MOH1GALL.PLT

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling

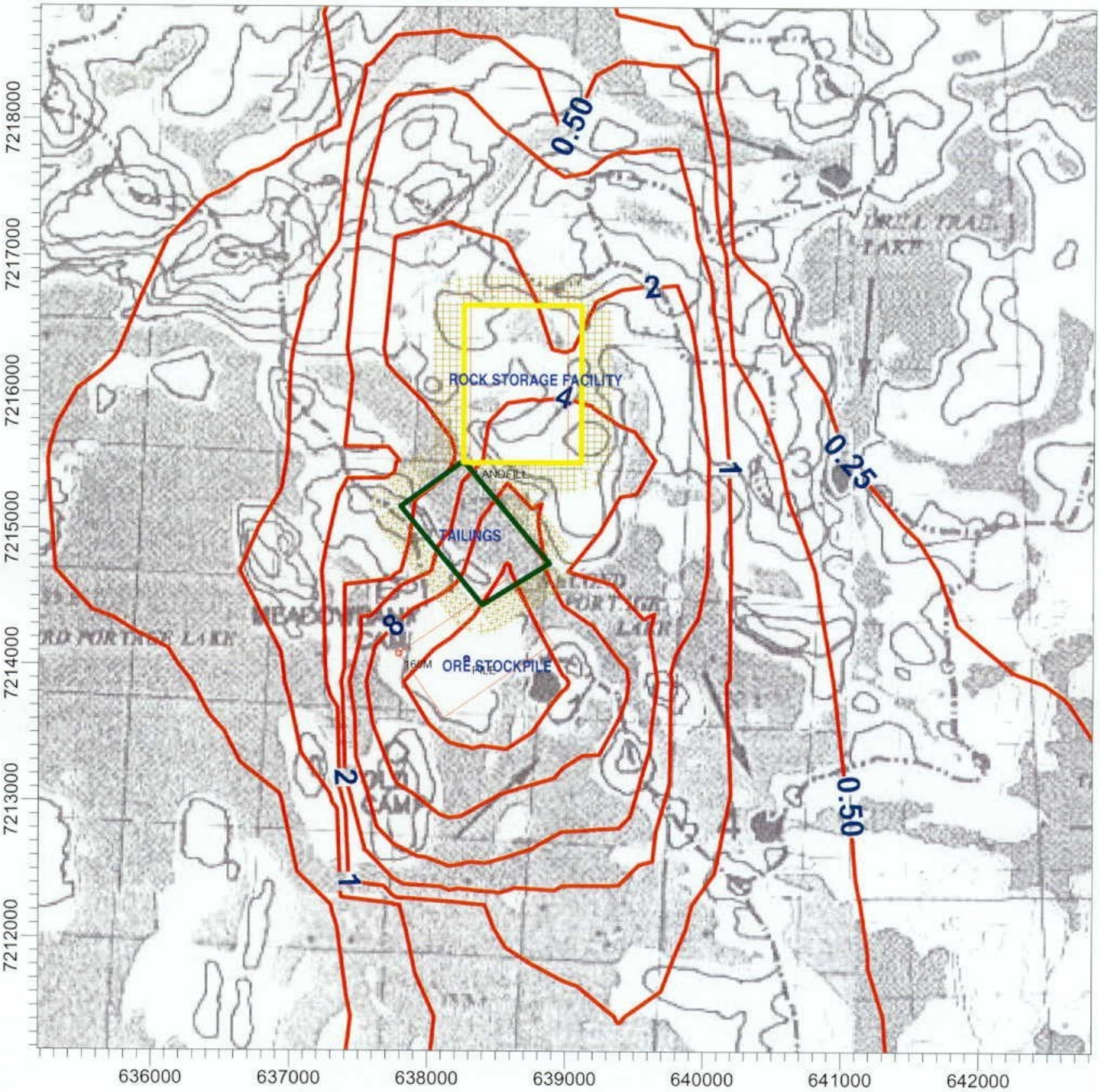


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentration of total suspended particulate, 24 hour average. Tailings area 960 m x 560 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 862	0 — 3 km	
	MAX: 99.21265	UNITS: µg/m³	DATE: 05/07/2004	Fig. 6.22

POST View - Lakes Environmental Software

C:\Disp Dust Gold\960\24H1GALL.PLT

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling

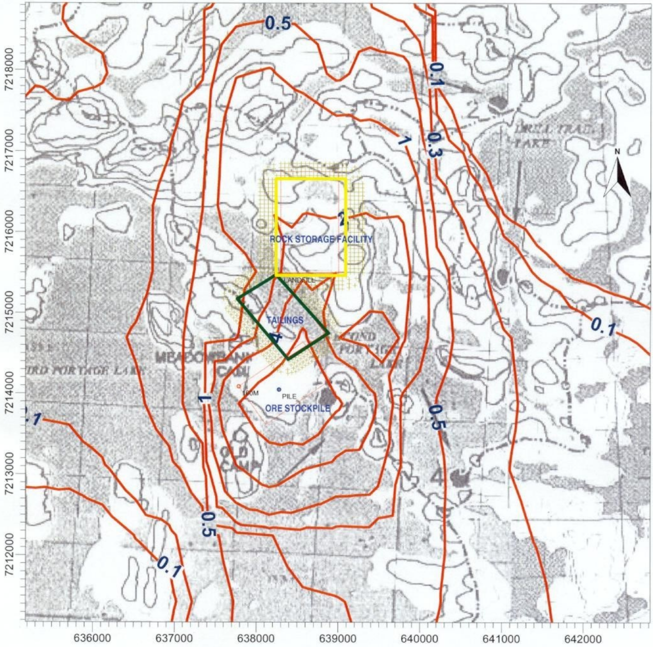


COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
The first highest concentration of total suspended particulate, annual average. Tailings area 960 m x 560 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: CONC	RECEPTORS: 862	0 — 1 km	
	MAX: 51.51228	UNITS: µg/m³	DATE: 05/07/2004	Figure 6.23

POST View - Lakes Environmental Software

C:\DISP DUST GOLD\960\PE00GALL.PLT

Meadowbank Gold Project EIA
Fugitive Dust Dispersion Modelling



COMMENTS:	MODELING OPTIONS:		CLIENT NAME:	
Particulate deposition rate, 30-day period. Tailings area 960 m x 560 m.	CONC, DDEP, RURAL, FLAT, TOXICS, DRYDPL		Cumberland Resources Ltd.	
			PROJECT NO: EC80864	CUMBERLAND RESOURCES LTD
	OUTPUT TYPE: DDEP	RECEPTORS: 862	0 — 1 km	
	MAX: 26.37203	UNITS: g/m²	DATE: 05/07/2004	Fig. 6.24

POST View - Lakes Environmental Software

C:\DISP DUST GOLD\960\MOH1GALL.PLT

SECTION 7 • SECONDARY POLLUTANTS

The three most important substances generating secondary pollutants are discussed briefly below.

7.1 NITROGEN OXIDES

When released to the atmosphere, NO_x enters into a series of chemical reactions with air components. The chemistry of atmospheric nitrogen in the troposphere is different from the chemistry in the stratosphere. Nitrogen chemistry at both levels is driven by the photochemical dissociation of nitrogen dioxide (NO_2), but the products formed depend on other substances able to react with the photochemically excited NO_2 molecules. At ground level the air is denser than in the troposphere, so the concentration of O_2 is much greater. Also at ground level are volatile organic carbon substances (from mobile sources and mining equipment) that react with nitrogen oxides to form peroxyacylnitrates, a product of photochemical smog.

Most NO_2 is emitted directly to the atmosphere, but some is formed from NO, which is also present in the diesel exhaust, in the reaction with atmospheric ozone. If the ozone concentration is greater than the maximum predicted NO_x concentration, then total conversion is assumed. The ozone concentration data is unavailable for the Meadowbank project area, but 100 $\mu g/m^3$ can be assumed based on accepted value for Alberta.

7.2 SULPHUR OXIDES

The atmospheric reactions of SO_2 are complex and proceed through three different pathways to the sulphate ion (SO_4^{2-}). Sulphur dioxide can react with the hydroxyl radical to form an HSO_3 radical, which can react with another hydroxyl radical to form water and SO_3 or H_2SO_4 (H_2SO_4 in water is $2H^+$ and SO_4^{2-}). Sulphur dioxide also dissolves in water droplets, where it reacts with oxygen gas to form SO_4^{2-}. The third pathway to sulphate is through an SO_2 reaction with hydrogen peroxide to produce sulphuric acid ($2H^+$ and SO_4^{2-}). The ultimate fate of all sulphur in the atmosphere is to be oxidized to the sulphate ion, usually as sulphuric acid (H_2SO_4). The most common base present in the atmosphere is ammonia (NH_3) which reacts with sulphuric acid to form ammonium bisulphate (NH_4HSO_4) and ammonium sulphate ($(NH_4)_2SO_4$). Sulphuric acid, ammonium bisulphate, and ammonium sulphate are all hydroscopic substances, readily dissolving in water. They wash out of the atmosphere during precipitation events.

7.3 OZONE

Anthropogenic ozone creation is engendered by photochemical reactions between oxides of nitrogen and volatile organic compounds in the presence of favourable meteorology. Appreciable ozone creation tends not to occur unless atmospheric temperatures are high (>30°C) and associated mixing depths are low (<500 m). Daily average wind speeds during ozone episodes tend to be only about 3 km/h. It should be realized that atmospheric conditions in Nunavut do not tend to be conducive to ozone creation because high atmospheric temperatures are relatively rare and extremely low temperatures of the atmosphere are common. In addition, absence of industrial facilities inhibits creation of anthropogenic ozone.

SECTION 8 • GREENHOUSE GASES

Greenhouse gases (GHG) such as carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) are produced during fuel combustion in diesel engines. Nearly all of the fuel carbon is converted to CO_2 during the combustion process. This conversion is relatively independent of firing configuration. Formation of another greenhouse gas, carbon monoxide (CO), will also take place, but its amount is insignificant compared to the amount of CO_2 produced. The majority of the fuel carbon not converted to CO_2 is due to incomplete combustion. In this assessment, calculated volatile organic carbon emissions are assumed as methane (CH_4) equivalent. Formation of N_2O during the combustion process is governed by a complex series of reactions and is dependent on many factors; however, the formation of N_2O is minimized when combustion temperatures are kept high (above 800ºC) and excess air is kept to a minimum. It was conservatively assumed that 10% of NO_x emissions are N_2O. With these assumptions, annual GHG emissions were calculated to be 190,768 t as CO_2 equivalent. The breakdown per gas is shown in Table 8.1.

Table 8.1: Meadowbank Gold Project Greenhouse Gas Emissions

Greenhouse Gas	Annual Greenhouse Emissions CO^2 Equivalent (t)
CO_2	129,518
N_2O	59,846
CH_4	1,404
Total	**190,768**

The 2000 estimates of greenhouse gas emissions in Canada are 726 x 10^6 t; therefore, the GHG emission estimates are 0.026% of the total for Canada. The Meadowbank Gold project will incorporate energy efficiency and emission minimization features in design and operation of facilities. The policy of purchasing energy-efficient equipment applies to this project.

SECTION 9 • ATMOSPHERIC IMPACT SUMMARY

The air quality impacts from the proposed project have been demonstrated to be negligible to the local study area and as having no impact to the regional study area. Potential ambient concentration of NO_2 is approximately 90% of the 1 hour averaging time objective. Particulate matter concentrations of PM_{10} and $PM_{2.5}$ are predicted to be higher than relevant ambient air quality objectives (AAQO). Such a situation can be expected during the dry weather when continuous ore hauling on the dirt road is taking place. A commonly used mitigation technique, such as road watering, would reduce PM concentrations to the acceptable levels. It is important to understand that the dispersion modelling results refer to the maximum possible concentration that would occur once over a five-year period if meteorological conditions are the same as those observed for the 1998 to 2002 period.

The environmental impact of fugitive dust sources, which include the ore stockpile, tailings, and waste rock disposal facility, will be insignificant. As expected, the highest concentration of particulates will be for the tailings area of 0.537 km^2, the largest of the three areas considered. Particulate concentrations predicted by the dispersion models will be lower than AAQO. The maximum particulate deposition rate will be approximately <30 g/m^2 per 30 days. No particulate deposition objective has been established for Nunavut or Northwest Territories.

SECTION 10 • REFERENCES

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APPENDIX A

Air Quality Impact Matrices

Table A.1: Air Quality Impact Matrix – Construction

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Timing	Assessment of Unmitigated Effects: Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Impacts	Assessment of Residual Effects: Probability	Management and Monitoring
MAIN FACILITIES												
Air Quality and Activity	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dykes												
East Dyke	Generation of dust during placement of dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower particulate concentration	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
West Dyke	Generation of dust during placement of dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower particulate concentration	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
Portage South Dyke	Generation of dust during placement of dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower particulate concentration	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
Goose Island and 3rd Portage Arm Dykes	Generation of dust during placement of dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower particulate concentration	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Dewatering												
2nd Portage Lake	Generation of dust from fine lake bottom sediments exposed during dewatering	High	Local	Continuous	Long	Summer	Yes	Apply water spray during summer; cover dry areas; see Air Quality and Noise Management Plan	Lower particulate concentration	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
Portage Pit (3rd Portage Lake)	Generation of dust from fine lake bottom sediments exposed during dewatering	High	Local	Continuous	Long	Summer	Yes	Apply water spray during summer; cover dry areas; see Air Quality and Noise Management Plan	Lower particulate concentration	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
Goose Island (3rd Portage Lake)	Generation of dust from fine lake bottom sediments exposed during dewatering	High	Local	Continuous	Long	Summer	Yes	Apply water spray during summer; cover dry areas; see Air Quality and Noise Management Plan	Lower particulate concentration	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
Pits												
Portage Pit	Generation of dust and gases from blasting, overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize pit footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; use specialized blasting techniques; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan , Aquatic Environmental Management Plan, and Wildlife Management Plan.

Table A.1 Continued

		Assessment of Unmitigated Effects							Assessment of Residual Effects			
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts		
Project Components	**Potential Effects**	**Magnitude**	**Spatial Extent**	**Frequency**	**Duration**	**Timing**		**Proposed Mitigation**			**Probability**	**Management and Monitoring**
Goose Island Pit	Generation of dust and gases from blasting, overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize pit footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; use specialized blasting techniques; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan , Aquatic Environmental Management Plan, and Wildlife Management Plan.
Waste Dump (Portage/Goose)	Generation of dust from materials deposited on waste dump	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; cover stockpiles with material with low potential for dust generation; see Air Quality and Noise Management Plan	Lower particulate concentration	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan.
Borrow Pit/ Quarry (MAY NOT APPLY)	Generation of dust and gases from blasting, overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	Medium	Local	Continuous	Long	All Year	No	Minimize quarry footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; avoid prolonged idling of service equipment vehicle engines; use specialized blasting techniques; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan , Aquatic Environmental Management Plan, and Wildlife Management Plan.
Tailings Facilities (2nd Portage Lake)	Not until operations	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Impacts	Assessment of Residual Effects: Probability	Management and Monitoring
Roads and Traffic	Generation of dust and emissions from overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize road length and width; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate and gaseous pollutants; better visibility	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
	Generation of dust and emissions from frequent activity by service and mine vehicles, and ongoing maintenance	High	Local	Continuous	Long	All Year	Yes	Enforce speed limits; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate and gaseous pollutants; better visibility	No	Certain	Monitor scheduling to ensure number of trips are minimized; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan and Access and Air Traffic Management Plan

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Frequency	Temporal Boundaries: Duration	Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Management and Monitoring
Airstrip and Air Traffic	Generation of dust and gases from overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize airstrip length and width; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan
	Generation of dust and emissions from frequent activity by aircraft	High	Local	Continuous	Long	All Year	Yes	Minimize number of take-offs and landings; avoid excessive engine operation on high rotation; see Air Quality and Noise Management, and Access and Air Traffic Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Monitor scheduling to ensure number of trips are minimized; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
Mine Plant and Associated Facilities	Generation of dust and gases from overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize plant footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan
Freshwater Intake and Pipeline	Low levels of dust and emissions related to construction of pipeline and intake	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	High	Maintain equipment in good repair
Discharge Facilities and Pipeline(s)	Low levels of dust and emissions related to construction of facility	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	High	Maintain equipment in good repair

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Fuel Storage (at Plant site)	Low levels of dust and emissions related to construction of facility	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	High	Maintain equipment in good repair
Emulsion/AN Storage/ Explosives Magazines	Low levels of dust and emissions related to construction of facilities	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	High	Maintain equipment in good repair
Camps (North and South)	Small release of carbon monoxide, carbon dioxide and other contaminants from oil-fired tent heaters and diesel generators	Low	Local	Continuous	Medium	Summer	No	Maximize combustion efficiency of diesel generators; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain equipment in good repair
Sewage and Solid Waste Disposal	Low levels of dust and emissions related to construction of facility	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	High	Maintain equipment in good repair
	Release of pollutants such as carbon monoxide and nitrogen oxides from incineration	Low	Local	Continuous	Long	All Year	No	Use fuel efficient incinerator with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	Certain	Maintain construction equipment and air scrubbers in good repair; see Air Quality and Noise Management Plan
	Food and other wastes not disposed of by incineration my result in unpleasant odours and attraction of scavengers such as Grizzly Bear and Wolverine	Medium	Local	Continuous	Long	All Year	No	Incinerate all rubbish, such as food wastes when needed; see Air Quality and Noise Management Plan	Lower concentration of particulate and gaseous pollutants	No	High	Monitor adherence to daily burning policy; see Air Quality and Noise Management Plan

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
VAULT FACILITIES												
Air Quality and Activity												
Dyke(s)	Generation of dust during placement of dyke materials	Low	Local	Infrequent	Short	Summer	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower concentration of particulate matter	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan
Dewatering	Not until operations	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pit	Not until operations	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Waste Dump	Generation of dust from materials deposited on waste dump	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; cover stockpiles with material with low potential for dust generation; see Air Quality and Noise Management Plan	Lower concentration of particulate matter	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Roads and Traffic	Generation of dust and emissions from frequent activity by service and mine vehicles, and ongoing maintenance	High	Local	Continuous	Long	All Year	Yes	Minimize vehicle traffic and speeds; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Monitor scheduling to ensure number of trips are minimized; enforce speed limits; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
Non-contact Diversion Facilities												
Mine Shop/ Office	Low levels of dust and emissions related to construction of facility	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	High	Maintain equipment in good repair

Table A.1 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Extent	Temporal Boundaries: Frequency	Duration	Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Management and Monitoring
OTHER FACILITIES												
Winter Road and Traffic	Low levels of emissions related to maintenance	Low	Regional	Continuous	Long	Winter	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Maintain equipment in good repair
	Low levels of emissions related to road use	Medium	Local	Continuous	Long	Winter	No	Use fuel efficient machinery with emissions controls; minimize vehicle traffic and speeds; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Enforcement of traffic speeds; maintain equipment in good repair in order to reduce emissions; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
Baker Lake Access Road and Traffic	Generation of dust and emissions from overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	Medium	Local	Continuous	Permanent	All Year	No	Minimize road length and width; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
	Generation of dust and emissions from frequent activity by service and vehicles accessing staging facility, and ongoing maintenance	Medium	Local	Continuous	Permanent	All Year	No	Minimize vehicle traffic and speeds; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Monitor scheduling to ensure number of trips are minimized; enforce speed limits; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan

Table A.1 Continued

		Assessment of Unmitigated Effects							Assessment of Residual Effects			
		Spatial Boundaries		Temporal Boundaries								
Project Components	**Potential Effects**	**Magnitude**	**Spatial Extent**	**Frequency**	**Duration**	**Timing**	**Significance of Unmitigated Effects**	**Proposed Mitigation**	**Residual Effects/ Influence of Mitigation**	**Significance of Residual Impacts**	**Probability**	**Management and Monitoring**
Barge Landing Facility	No measurable effects on air quality anticipated	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA
Barge Traffic	Minor levels of emissions associated with barge engines	Low	Regional	Continuous	Long	Summer	No	Minimize number of barges required per year; minimize amount of engine idling	Lower frequency of pollutant occurrences	No	Certain	None recommended
In-town Staging Facility	Generation of dust and gases from overburden stripping, excavation and other construction related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize staging facility footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan
Explosives Magazine	Low levels of dust and emissions related to construction of facilities	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	High	Maintain equipment in good repair
Tank Farm	Low levels of dust and emissions related to construction of facilities	Low	Local	Infrequent	Medium	Summer	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	High	Maintain equipment in good repair
	Potential explosion or fire may release contaminants into the air	Low	Local	Infrequent	Short	All Year	No	Follow Hazardous Materials Management Plan; follow Spill Contingency Guidelines	Unpredictable	No	Improbable	Regular maintenance checks; monitor fuel handling procedures in Hazardous Materials Management Plan

Table A.2: Air Quality Impact Matrix – Operation

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Monitoring/ Management
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
MAIN FACILITIES												
Air Quality and Activity	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA
Dykes	Generation of dust during placement of Goose Island dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
East Dyke	Generation of dust during placement of Goose Island dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
West Dyke	Generation of dust during placement of Goose Island dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Portage South Dyke	Generation of dust during placement of Goose Island dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects – Spatial Boundaries – Magnitude	Spatial Extent	Temporal Boundaries – Frequency	Duration	Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects – Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Monitoring/ Management
Goose Island and 3rd Portage Arm Dykes	Generation of dust during placement of Goose Island dyke materials	Medium	Local	Continuous	Long	All Year	No	Apply water spray during summer or use other dust suppressants; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Dewatering												
2nd Portage Lake	Ongoing generation of dust from fine lake bottom sediments exposed during dewatering	Medium	Local	Continuous	Long	Summer	No	Apply water spray during summer; cup dry areas; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Portage Pit (3rd Portage Lake)	Ongoing generation of dust from fine lake bottom sediments exposed during dewatering	Medium	Local	Continuous	Long	Summer	No	Apply water spray during summer; cover dry areas with non-PAG waste rock; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Goose Island (3rd Portage Lake)	Ongoing generation of dust from fine lake bottom sediments exposed during dewatering	Medium	Local	Continuous	Long	Summer	No	Apply water spray during summer; cover dry areas with non-PAG waste rock; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Pits												

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Frequency	Temporal Boundaries: Duration	Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Monitoring/ Management
Portage Pit	Generation of dust and gases from blasting, excavation and other mine-development related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize pit footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; use specialized blasting techniques; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants; increased visibility	No	Certain	Maintain vehicles in good operating condition; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Goose Island Pit	Generation of dust and gases from blasting, excavation and other mine-development related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize pit footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; use specialized blasting techniques; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants; increased visibility	No	Certain	Maintain vehicles in good operating condition; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Waste Dump (Portage/Goose)	Generation of dust from materials deposited on waste dump	High	Local	Continuous	Long	All Year	Yes	Apply water spray during summer or use other dust suppressants; cover stockpiles with material with low potential for dust generation; see Air Quality and Noise Management Plan	Lower concentration of particulate matter; increased visibility	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Tailings Facilities (2nd Portage Lake)	Generation of dust from tailings	High	Local	Continuous	Permanent	All Year	Yes	Apply water spray during summer; cover dry areas with non-PAG waste rock; see Air Quality and Noise Management Plan	Reduce dispersion of airborne dust	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Spatial Boundaries: Spatial Extent	Temporal Boundaries: Frequency	Temporal Boundaries: Duration	Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	Monitoring/ Management
Roads and Traffic	Generation of dust and emissions from further road development and maintenance activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	Medium	Local	Continuous	Long	All Year	No	Minimize road length and width; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants; increased visibility	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
	Generation of dust and emissions from frequent activity by service and mine vehicles, and ongoing maintenance	Medium	Local	Continuous	Long	All Year	No	Enforce speed limits; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants; increased visibility	No	Certain	Monitor scheduling to ensure number of trips are minimized; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan

Table A.2 Continued

		Assessment of Unmitigated Effects							Assessment of Residual Effects			
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects					
Project Components	**Potential Effects**	**Magnitude**	**Spatial Extent**	**Frequency**	**Duration**	**Timing**		**Proposed Mitigation**	**Residual Effects/ Influence of Mitigation**	**Significance of Residual Impacts**	**Probability**	**Monitoring/ Management**
Airstrip and Air Traffic	Generation of dust and gases from airstrip expansion and maintenance activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	Medium	Local	Continuous	Long	All Year	No	Minimize airstrip length and width; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan
	Generation of dust and emissions from frequent activity by aircraft	Medium	Local	Continuous	Long	All Year	No	Minimize number of take-offs and landings; avoid excessive engine operation on high rotation; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Monitor scheduling to ensure number of trips are minimized; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan and Access and Air Traffic Management Plan
Mine Plant and Associated Facilities	Power plant emissions result in ground level concentration of pollutants; crushing and grinding releases dust containing heavy metals with potential impacts on aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Use low sulphur oil; purchase low NOx emission burners; provide adequate stack height; operate efficient dust filters for operation dust emissions; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Installation of continuous emissions monitoring system (CEMS) on the power plant stack for nitrogen oxides and particulate matter; confirmation of CEMS accuracy by relative accuracy test audit (RATA); see Air Quality and Noise Management Plan
Freshwater Intake and Pipeline	No further impacts to air quality once pipeline is constructed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Discharge Facilities and Pipeline(s)	No further impacts to air quality once pipeline is constructed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Monitoring/ Management
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Non-contact Diversion Facilities												
Fuel Storage (at Plant site)	Potential explosion or fire may release contaminants into the air	Low	Local	Infrequent	Short	All Year	No	Follow Hazardous Materials Management Plan; follow Spill Contingency Guidelines	NA	No	Moderate	Regular maintenance checks; monitor fuel handling procedures in Hazardous Materials Management Plan
Emulsion/AN Storage/ Explosives Magazines	Potential explosion or fire may release contaminants into the air	Low	Local	Infrequent	Short	All Year	No	Follow Hazardous Materials Management Plan; follow Spill Contingency Guidelines	NA	No	Moderate	Regular maintenance checks; monitor fuel handling procedures in Hazardous Materials Management Plan
Camps (North and South)	No further impacts to air quality since camp will be decommissioned	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sewage and Solid Waste Disposal	Release of pollutants such as carbon monoxide, particulate and nitrogen oxides from incineration	Low	Local	Continuous	Long	All Year	No	Follow code of waste disposal practices	Lower concentration of particulate matter and odorous substances	No	Certain	Maintain air scrubbers in good condition; see Air Quality and Noise Management Plan
	Food and other wastes not disposed of by incineration my result in unpleasant odours and attraction of scavengers such as Grizzly Bear and Wolverine	Medium	Local	Continuous	Long	All Year	No	Incinerate all rubbish, such as food wastes when necessary ; see Air Quality and Noise Management Plan	No attraction	No	High	Monitor adherence to daily burning policy; see Air Quality and Noise Management Plan
VAULT FACILITIES												
Dyke(s)	No further measurable impacts to air quality	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects: Spatial Boundaries: Magnitude	Assessment of Unmitigated Effects: Spatial Boundaries: Spatial Extent	Assessment of Unmitigated Effects: Temporal Boundaries: Frequency	Assessment of Unmitigated Effects: Temporal Boundaries: Duration	Assessment of Unmitigated Effects: Temporal Boundaries: Timing	Significance of Unmitigated Effects	Proposed Mitigation	Assessment of Residual Effects: Residual Effects/ Influence of Mitigation	Assessment of Residual Effects: Significance of Residual Impacts	Assessment of Residual Effects: Probability	Monitoring/ Management
Dewatering	Generation of dust from fine lake bottom sediments exposed during dewatering	Medium	Local	Continuous	Long	Summer	No	Apply water spray during summer; cover dry areas; cupping of exposed dry areas; see Air Quality and Noise Management Plan	Lower concentration of dust	No	High	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Pit	Generation of dust and gases from blasting, excavation and other construction and mine-development related activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	High	Local	Continuous	Long	All Year	Yes	Minimize pit footprint; apply water spray during summer or use other dust suppressants; use fuel efficient machinery with emissions controls; use specialized blasting techniques; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants; decrease area affected by pollutants	No	Certain	Maintain vehicles in good operating condition; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan
Waste Dump	Generation of dust from materials deposited on waste dump	High	Local	Continuous	Long	All Year	Yes	Apply water spray during summer or use other dust suppressants; cover stockpiles with material with low potential for dust generation; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, Aquatic Environmental Management Plan, and Wildlife Management Plan

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Monitoring/ Management
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Roads and Traffic	Generation of dust and emissions from further road development and maintenance activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	Medium	Local	Continuous	Long	All Year	No	Minimize road length and width; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
	Generation of dust and emissions from frequent activity by service and mine vehicles, and ongoing maintenance	Medium	Local	Continuous	Long	All Year	No	Enforce speed limits; apply water spray during summer or use other dust suppressants when necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan		No	Certain	Monitor scheduling to ensure number of trips are minimized; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
Mine Shop/ Office	No further measurable impacts to air quality	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Monitoring/ Management
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
OTHER FACILITIES												
Winter Road and Traffic	Low levels of emissions related to ongoing maintenance	Low	Regional	Continuous	Long	Winter	No	Use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants		Certain	Maintain equipment in good repair
	Low levels of emissions related to road use	Medium	Local	Continuous	Long	Winter	No	Use fuel efficient machinery with emissions controls; minimize vehicle traffic and speeds; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan		no	Certain	Enforcement of traffic speeds; maintain equipment in good repair in order to reduce emissions; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
Baker Lake Access Road and Traffic	Generation of dust and emissions from maintenance activities resulting in poor air quality and contamination of aquatic and terrestrial habitats	Low	Local	Continuous	Long	All Year	No	Use dust suppressants as necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Maintain vehicles in good operating condition; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
	Generation of dust and emissions from frequent activity by service and vehicles accessing staging facility	Medium	Local	Continuous	Long	All Year	No	Minimize vehicle traffic and speeds; use dust suppressants as necessary; use fuel efficient machinery with emissions controls; see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan		no	Certain	Monitor scheduling to ensure number of trips are minimized; enforce speed limits; monitor dust fallout by static collectors (method ASTM D1739); see Air Quality and Noise Management Plan, and Access and Air Traffic Management Plan
Barge Landing Facility	No measurable effects on air quality anticipated	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.2 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Monitoring/ Management
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Barge Traffic	Minor levels of emissions associated with barge engines	Low	Regional	Continuous	Long	Summer	No	Minimize number of barges required per year; minimize amount of engine idling	Lower frequency of air pollution events	No	Certain	None recommended
In-town Staging Facility	Power plant emissions result in ground level concentration of pollutants	Medium	Local	Continuous	Permanent	All Year	No	Use low sulphur oil; purchase low NOx emission burners; provide adequate stack height; see Air Quality and Noise Management Plan	Lower concentration of particulate matter and gaseous pollutants	No	Certain	Installation of continuous emissions monitoring system (CEMS) on the power plant stack for nitrogen oxides and particulate matter; confirmation of CEMS accuracy by relative accuracy test audit (RATA); see Air Quality and Noise Management Plan
Explosives Magazine	Potential explosion or fire may release contaminants into the air	Low	Local	Infrequent	Short	All Year	No	Follow Hazardous Materials Management Plan; follow Spill Contingency Guidelines	NA	NA	Improbable	Regular maintenance checks; monitor fuel handling procedures in Hazardous Materials Management Plan
Tank Farm	Potential explosion or fire may release contaminants into the air	Low	Local	Infrequent	Short	All Year	No	Follow Hazardous Materials Management Plan; follow Spill Contingency Guidelines	NA	NA	Improbable	Regular maintenance checks; monitor fuel handling procedures in Hazardous Materials Management Plan

Table A.3: Air Quality Impact Matrix – Closure & Post-Closure

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
MAIN FACILITIES												
Dykes	No effect – flooding operation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
East Dyke	No effect – will remain intact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
West Dyke	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Portage South Dyke	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Goose Island and 3rd Portage Arm Dykes		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Flooring	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Portage Lake	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Portage Pit (3rd Portage Lake)	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Goose Island (3rd Portage Lake)		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pits	No effect – flooding operation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Portage Pit	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Goose Island Pit	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Waste Dump (Portage/Goose)	Generation of dust and gases linked with surface re-grading by heavy vehicles	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Borrow Pit/ Quarry	**No effect**											
Tailings Facilities (2nd Portage Lake)	Generation of dust and emissions from equipment during cover with non-PAG waste rock	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Roads and Airstrip	Generation of dust during re-grading and recontour embankment	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Mine Plant and Associated Facilities	Medium – dust generation during demolition of structures	Medium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Freshwater Intake and Pipeline	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A.3 Continued

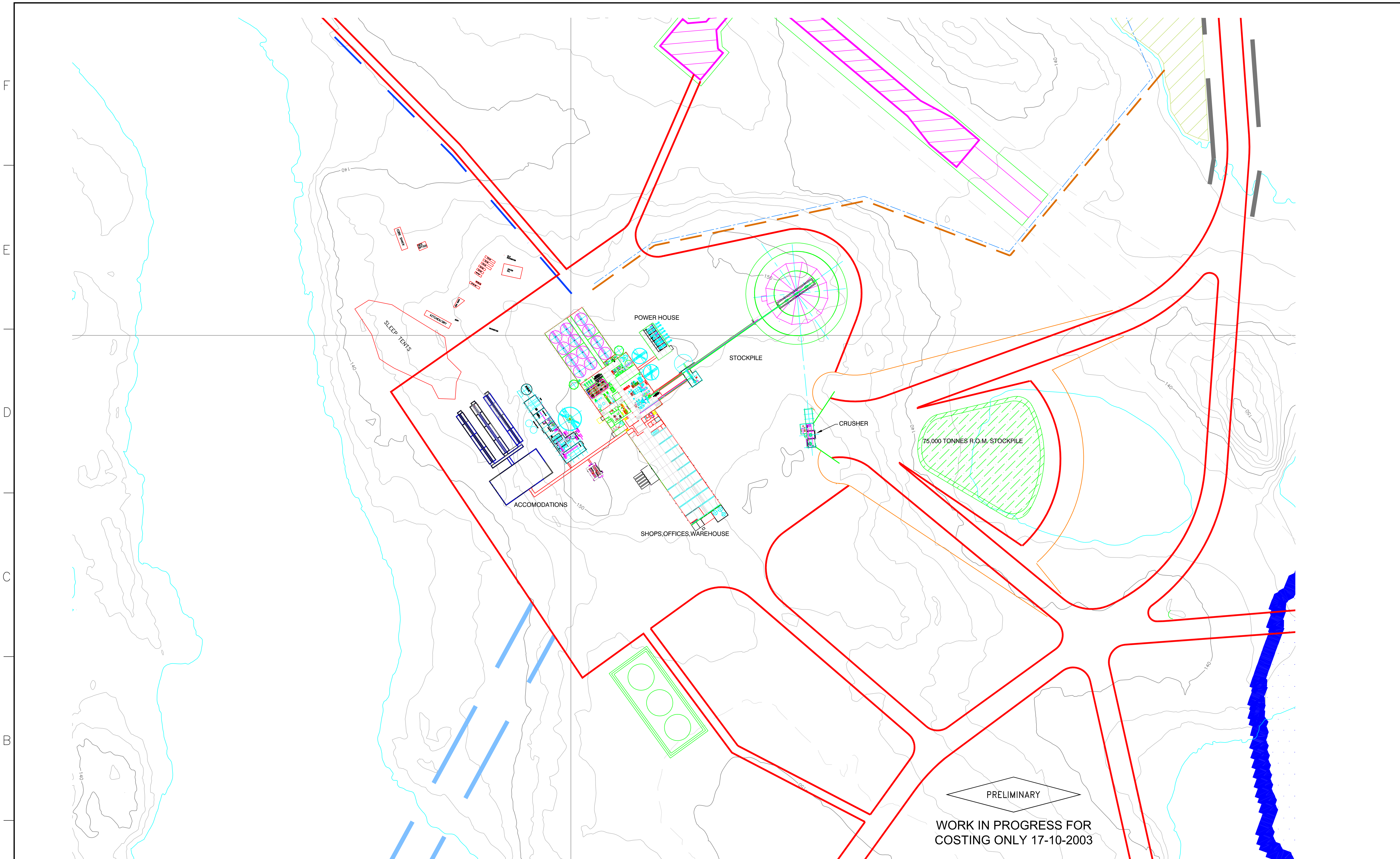
Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Discharge Facilities and Pipeline(s)	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Non-contact Diversion Facilities	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fuel Storage (at Plant site)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Emulsion/AN Storage/ Explosives Magazines	Dust generated during structure demolition	Low	Local	Discontin after closuring	Medium	Summer	No	Use equipment that meets noise emission specification standards.	Lower noise level	No	Certain	Conduct work according to code of practice for minimizing noise. Schedule work to avoid simultaneous noisy operations.
Camps (North and South)	Low - dust generated during structure demolition	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Sewage and Solid Waste Disposal	Low - dust generated during cover with waste rock	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
VAULT FACILITIES												
Dyke(s)	Controlled flooding – no effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pit	No effect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Waste Dump	Dust generated during cover with waste rock	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Roads	Generation of dust during re-grading and recontour embankment	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Non-contact Diversion Facilities	No effects	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mine Shop/ Office	Dust generated during demolition of buildings	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
OTHER FACILITIES												
Winter Road	Low - generation of dust during re-grading and recontour embankment	Low	Local	Discontinue after abandonment	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation

Table A.3 Continued

Project Components	Potential Effects	Assessment of Unmitigated Effects						Proposed Mitigation	Assessment of Residual Effects			Management and Monitoring
		Spatial Boundaries		Temporal Boundaries			Significance of Unmitigated Effects		Residual Effects/ Influence of Mitigation	Significance of Residual Impacts	Probability	
		Magnitude	Spatial Extent	Frequency	Duration	Timing						
Baker Lake Access Road	Generation of dust during re-grading and recontour embankment	Low	Local	Discontinue after abandonme nt	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Barge Landing Facility	No Effects	Low	Regional	Continuous	Long	Summer	No	Apply dust suppressants; control vehicles movement	Lower noise level	No	Certain	Conduct work according to code of practice for minimizing noise. Schedule work to avoid simultaneous noisy operations.
Barge Traffic	No effects	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
In-town Staging Facility	No effects	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives Magazine	Low – dust generated during structure demolition	Low	Local	Discontinue after abandonme nt	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation
Tank Farm	Low – dust generated during tanks dismantling	Low	Local	Discontinue after abandonme nt	Short	Summer	No	Apply dust suppressants; control vehicles movement	Lower dust concentration; improved visibility	No	Moderate	Supervise the operation

APPENDIX B

Location of Point Emission Sources



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TITLE: PLANT SITE PLAN

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CLIENT DWG. NO.

DRAWING NO. A1-131395-100-C-0002

REV. A

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Table F.3 Continued

APPENDIX C

Fugitive Dust Estimation Methods

SUPPORTING DATA USED IN SUSPENDED PARTICULATE MATTER EMISSION CALCULATIONS

C.1 Production Numbers

Production numbers were given in project Description Report. According to this report mining production will be constant for 8 years of production at 1,715,000 t/year. It was assumed that on the base of 365 working days it would be 4,700 t/d of ore. Based on a more reasonable assumption of 318 days a year (taking into consideration downtime for repairs, scheduled maintenance breaks, etc.) the actual daily production should be 5,400 t/d. It was also assumed that the mine will operate 9 h/d, 7 d/wk.

C.2 Ore Moisture Content

According to information from the AMEC mill water balance, ore moisture content is 5%. Waste rock used for road material has moisture content about 10%.

C.3 Conveyor Drop Height

Table C.1 summarizes drop heights from conveyor used in emission estimation.

Table C.1: Conveyor Drop Height

Receiver	Conveyor Drop Height (m)
Ore Pile	1.5

C.4 Other Parameters Used in Emission Estimation

The sources of silt content were as follows:

- roads = 9.2%
- ore = 8.6%.

An average wind speed of 5.0 m/s is used for emission calculations where appropriate. The average is based on observations at the Meadowbank station ambient monitoring site. A similar value was obtained for winds from Baker Lake station.

The excavated rock density is calculated from the specific gravity of ore and waste materials and the bulking factor equal to 1.4. The specific gravities of the ore are: Goose Mine, 3.15 t/m^3; Vault, 2.75 t/m^3; and Portage, from 2.8 to 3.05 t/m^3. The average value is about 2.94 t/m^3, similar to average of the specific gravity of waste materials (2.93 t/m^3). These values, divided by the bulking factor (1.4), gives an ore density about 2,100 kg/m^3.

C.5 Vehicle Data

The following vehicle weights were assumed in emission estimation:

- payload of ore 90 tonnes
- empty truck 60 tonnes
- average truck weight for its travel back and forth 105 tonnes.

The road from Vault Mine to the processing plant is about 7 km long. The mine itself is 500 m long. The maximum estimated haul distance is approximately 7.5 km one way.

Table C.2 provides a detailed listing of haul truck parameters related to SP and $PM_{2.5}$ emissions.

Table C.2: Parameters of Haul Truck Operation

Return Trips	VKT (vehicle km traveled)	Average Number of trips/truck/day	Number of Trucks	Average Weight (tonnes)
Vault Mine	903	4.3	14	105

A preliminary project data anticipates diesel use by mobile equipment, mainly hauling trucks, in the amount of 11,200 m^2/a. This quantity was used to calculate SP and $PM_{2.5}$ exhaust emissions, conservatively assuming 365 days of operation. The particulate emissions are shown in Table C.3.

Table C.3: Exhaust Particulate Emission

Source	Fuel Use (L/a)	Emission Factor (g SP/L)	SP (t/a)	SP (kg/d)	Emission Factor (g $PM_{2.5}$/L)	PM2.5 (t/a)	PM2.5 (kg/d)
Hauling trucks and other diesel powered equipment	11,200,000	1.79	20.05	54.93	0.715	8.01	21.94

C.6 Emissions from Conveyors

The following summarizes the approach taken to estimate SP emissions from dumping by conveyor. The equation to predict particulate emissions from a dragline was used to estimate this dumping process. In this case, the scraping action of the dragline in the horizontal plane simulates the collision between material pieces as they fall in the vertical, or the collisions between material pieces rolling down a hill of previously deposited material. The use of a dragline to reflect this dumping process is conservative when compared with the aggregate-handling equation method.

For example, constants used in the calculations of the ore drop from conveyor include:

- moisture content (M) = 5.0%
- drop distance (0.5 to 4 m, depending on the amount of material on the stockpile) - average (d) = 1.5 m

- density of the ore = 2,100 kg/m^3
- rate of the material transported = 4,698 t/d.

Conveyor dumping SP emissions:

- dumping SP emission factor:

$$SP\ (kg/m^3) = \frac{0.0046\,(d)^{1.1}}{(M)^{0.3}}$$

$$SP\ (kg/m^3) = \frac{0.0046(1.5)^{1.1}}{(5.0)^{0.3}} = 0.0044$$

(Note: equation taken from AP-42, Table 11.9-1. [EPA, 1995]).

- conveyor dumping daily SP emission:

$$SP = 0.0044\ \frac{kg}{m^3} \times (\text{Density})^{-1} \times (\text{Daily Removal}) \times 1000\,\frac{kg}{t}$$

$$SP = 0.0044\ \frac{kg}{m^3} \times \frac{1}{2100}\ \frac{m^3}{kg} \times 4698\ \frac{t}{day} \times 1000\,\frac{kg}{t} = 9.84\ \frac{kg}{day}$$

According to the EPA emission factors AP-42 (EPA, 1995), the $PM_{2.5}$ emissions are 1.7% of the SP emissions.

C.7 Ore Handling Particulate Emissions

Ore dust particulate emissions are created when mine haul trucks are loaded at the mine, when dumping ore into a hopper for conveying into the stockpile at the processing plant, and during material bulldozing.

Calculating the total dust emission caused by dumping and ore transferring requires multiplying the emission factor by the ore quantity. The constant coefficients used in calculating the loading of the ore at the mine include:

- average wind speed (u) = 5.0 m/s
- ore moisture content (M) = 5.0%
- daily ore load = 5,400 t/d.

Ore dumping and handling SP emissions:

- ore dumping and handling emission factor:

$$SP = 0.74(0.0016)\frac{\left(\frac{u}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

$$SP = 0.74(0.0016)\frac{\left(\frac{5.0}{2.2}\right)^{1.3}}{\left(\frac{5.0}{2}\right)^{1.4}} = 0.000954\,\frac{kg}{day}$$

(Note: equation taken from AP-42, Section 13.2.4. [EPA, 1995]).

- ore dumping and handling daily emission:

$$SP = 0.000954\,\frac{kg}{t} = x5400\,\frac{t}{day} = 5.15\,\frac{kg}{day}$$

The same emissions will be during loading at the mining site. In the case of $PM_{2.5}$, the 0.74 factor in the above equations is replaced by the 0.11 factor the $PM_{2.5}$ emissions are about 14.9% of the SP emissions.

The AP-42 provides separate SP equations for bulldozing of ore. It is assumed that bulldozing activities take place 9 h/d.

- average material silt content (s) = 8.6%
- average material moisture content (M) = 5%
- bulldozing SP hourly emissions:

$$SP = \frac{2.6\,(s)^{1..2}}{(M)^{1..3}} = \frac{2.6\,(8.6)^{1..2}}{(5)^{1..3}} = 4.24\,\frac{kg}{hour}$$

Bulldozing daily emissions:

$$SP = 4.24\,\frac{kg}{hour} \times 9\,\frac{hour}{day} = 38.16\,\frac{kg}{day}$$

In the case of $PM_{2.5}$ the emission factor is 10.5% of the SP emission factor.

C.8 Emissions as a Result of Haul Truck Wheel Entrainment

The following summarizes the approach taken to estimate SP emissions as a result of truck hauling. Haul trucks transport ore from Vault mine to preparation plant stockpiles. Road SP emissions result from dust entrainment by vehicle wheels and the wake created by moving vehicles.

The following calculations provide an example for hauling fly ash on the haul road segment between Vault Mine and processing plant. The applicable constants used in the calculations include:

- average road surface silt loading (S) = 9.2%
- average weight of vehicles (W) = 105 t

SP emissions:

- unpaved road, hauling emission factor:

$$SP\,(kg/VKT) = 4.9 \times 0.2819 \times \left(\frac{S}{12}\right)^{0.7} \left(\frac{W}{2.7}\right)^{0.45}$$

$$SP = 4.9 \times 0.2819 \times \left(\frac{9.2}{12}\right)^{0.7} \left(\frac{105}{2.7}\right)^{0.45} = 5.96\ \frac{kg}{VKT}$$

In the case of $PM_{2.5}$ emissions the emission factor is:

$$PM_{2.5}\,(kg/VKT) = 0.29 \times 0.2819 \times \left(\frac{S}{12}\right)^{0.9} \left(\frac{W}{2.7}\right)^{0.45}$$

$$PM_{2.5} = 0.29 \times 0.2819 \times \left(\frac{9.2}{12}\right)^{0.9} \left(\frac{105}{2.7}\right)^{0.45} = 0.34\ \frac{kg}{VKT}$$

Equations taken from AP-42, Chapter 13.2.2 (EPA, 1995).

- hauling daily emissions:

$$SP = 5.96\,\frac{kg}{VKT}\ \text{x Distance}\,\frac{VKT}{day} = 5.96\,\frac{kg}{VKT}\ \text{x}\ 903\,\frac{VKT}{day} = 5382\,\frac{kg}{VKT}$$

$$PM_{2.5} = 0.27\,\frac{kg}{VKT}\ \text{x Distance}\,\frac{VKT}{day} = 0.27\,\frac{kg}{VKT}\ \text{x}\ 903\,\frac{VKT}{day} = 244\,\frac{kg}{VKT}$$

C.9 Drilling & Blasting

The following summarizes the approach taken to determining emissions from drilling holes and ore blasting.

It was assumed that there would be 34 blasts per year. Each blast is going to move material 15 m deep. With material density of 2,100 kg/m3, and 1,715,000 t/year of ore, it can be calculated that every blast is moving 24,020 m^3 of ore. Then the blast area is about 1601 m^2. It can be assumed that one hole will be drilled per 10 m^2. It means 160 holes drilled per blast.

Emissions for drilling were estimated from AP-42 – Chapter 11.9, Table 11.9-4, Version 7/98. This chapter discusses emissions from the Western coal mines; however, emission for drilling is given for overburden (0.59 kg/hole) and for coal (0.10 kg/hole). It can be assumed that the drilling of the gold ore resembles more the drilling of the overburden. It was conservatively assumed that emission factor is 0.59 kg/hole.

Emission for blasting is estimated using the AP-42 Table 11.9-1 from the same chapter. The emission factor is the same for coal and overburden and can be used for gold ore as well. It is dependent on the area of the blast in m^2:

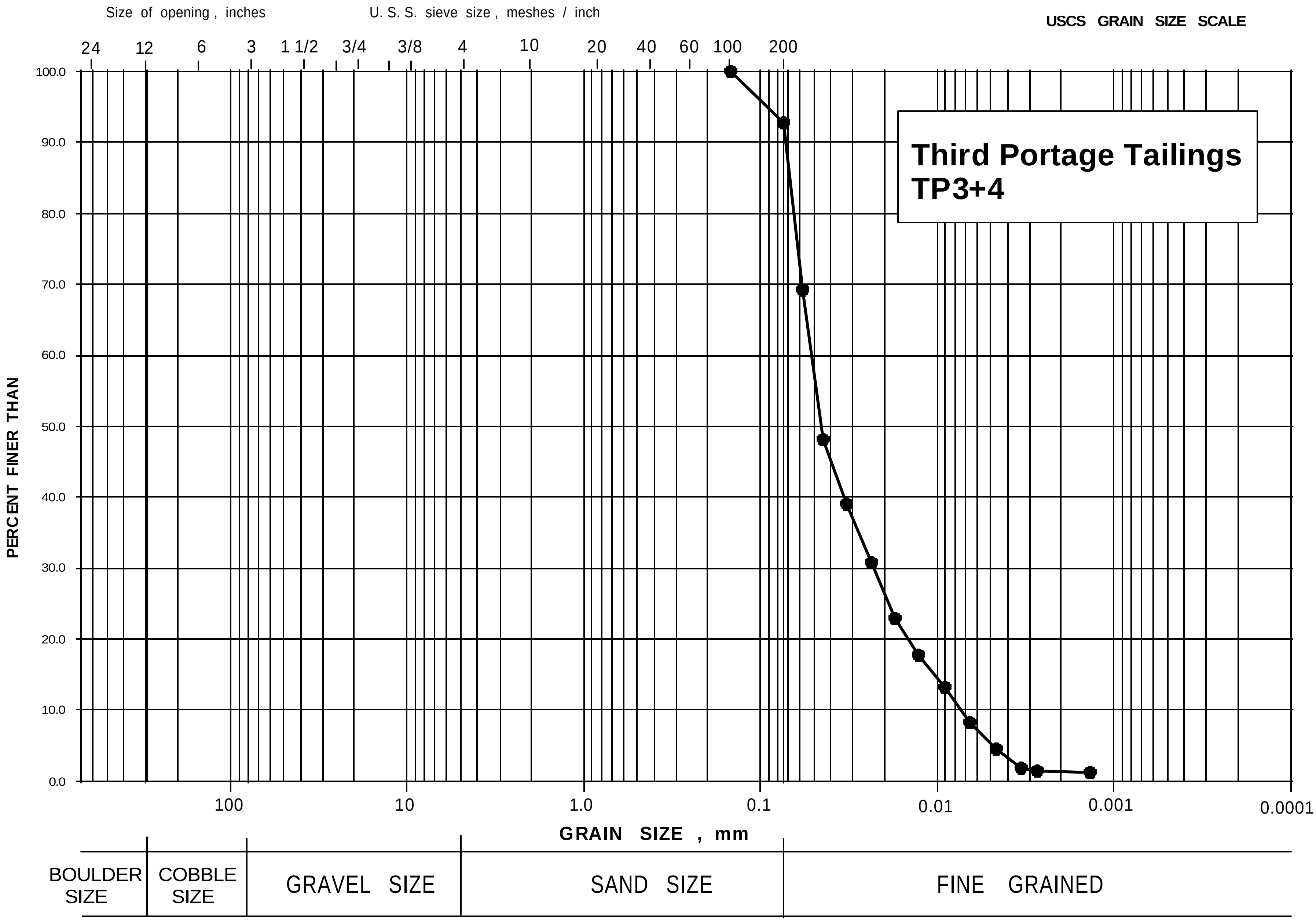
$$SP = 0.00022\ A^{1.5} = 0.00022\ (1601)^{1.5} = 14.1 \text{ kg/blast}$$

The emissions for $PM_{2.5}$ are assumed to be 3% of the SP emissions.

APPENDIX D

Grain Size Analysis Data

Hydrometer Analysis – Third Portage (Graph)
Hydrometer Analysis – Third Portage (Data)
Hydrometer Analysis – Vault (Graph)
Hydrometer Analysis – Vault (Data)
Specific Gravity – Third Portage Tailings
Specific Gravity – Vault Tailings



Project No. 03-1413-078
Drawn TM
Reviewed LL
Date 02/11/04

Golder Associates

GRAIN SIZE DISTRIBUTION

Figure

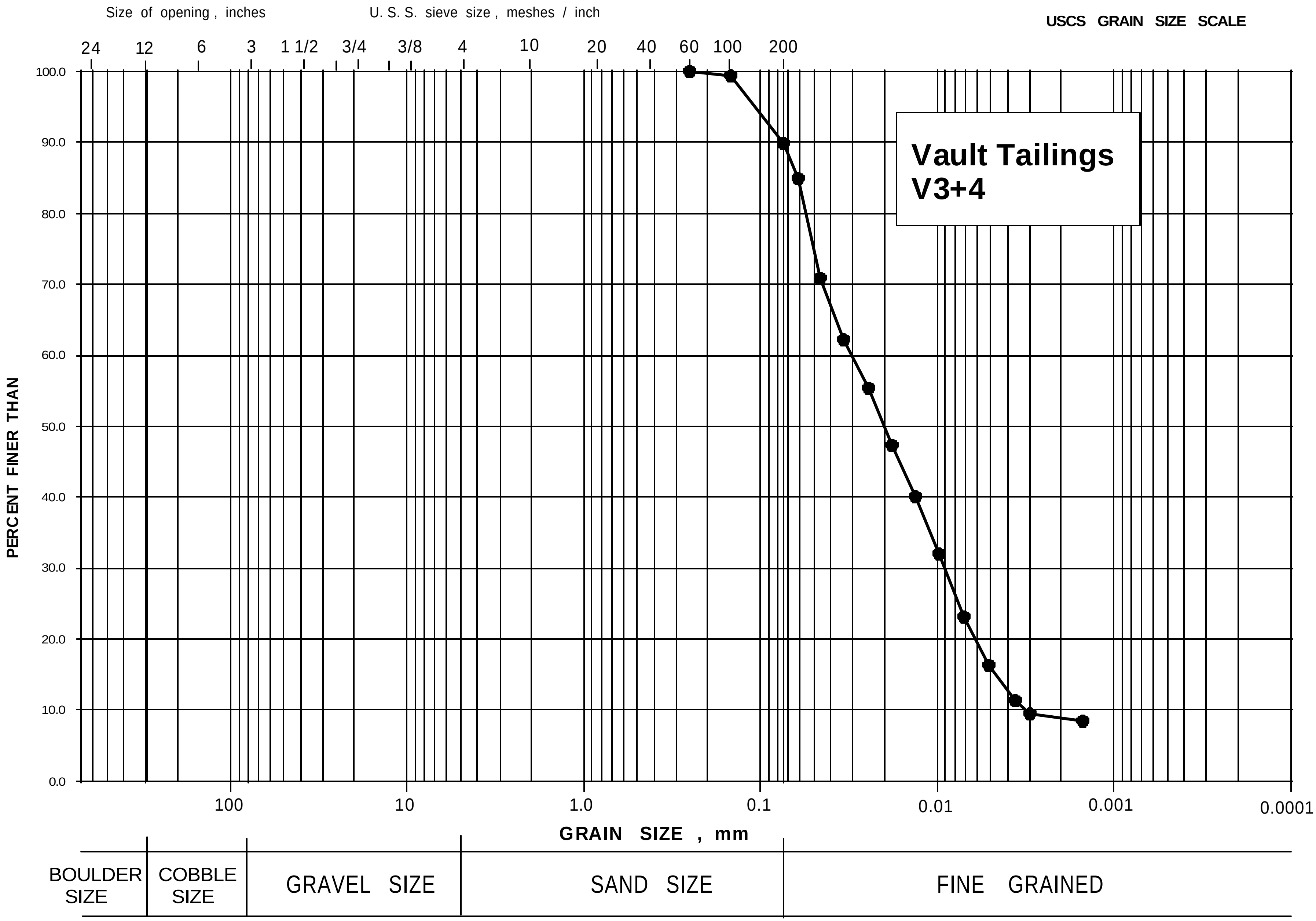
PARTICLE SIZE ANALYSIS OF SOILS   ASTM D 422-63

Project No. :	03-1413-078	**Client :**	Cumberland		Third Portage Tailings		
Sch#	25	**Project :**	Baseline Reports		TP3+4		
Lab Work:	TM	**Location:**	Nunavut				
	1ST SIEVING		**Hydrometer: (Minus #10)**		Residual #200	1.9	
	Total Weight	46.2	Before Wash	46.2	Total -200	42.9	
			After Wash	5.2	Gs	3.34	

Size (USS)	Weight Retained	Retained (%)	Weight Retained	Retained (%)	% Retained Total	Diameter (mm)	% Passing
							100.0
6"	0.0					**152.4**	**100.0**
3"	0.0					**76.2**	**100.0**
1 1/2"	0.0					**38.1**	**100.0**
1"	0.0					**25.4**	**100.0**
3/4"	0.0					**19.1**	**100.0**
1/2"	0.0					**12.7**	**100.0**
3/8"	0.0					**9.52**	**100.0**
#4	0.0					**4.76**	**100.0**
#10	0.0					**2.00**	**100.0**
#20			0.0			**0.840**	**100.0**
#40			0.0			**0.420**	**100.0**
#60			0.0			**0.250**	**100.0**
#100			0.0			**0.149**	**100.0**
#200			3.3	7.1	7.1	**0.074**	**92.9**
Pan			42.9	92.9	92.9		

HYDROMETER ANALYSIS

Time (min)	Hydrometer Reading	Temperature (°C)		Composite Correction	Hydrometer Corrected	Diameter (mm)	% Passing
0.5	40.0	18.0		-4.04	36.0	**0.0580**	**69.2**
1	29.0	18.0		-4.04	25.0	**0.0447**	**48.0**
2	24.3	18.0		-4.04	20.3	**0.0327**	**39.0**
4	20.0	18.0		-4.04	16.0	**0.0238**	**30.7**
8	15.9	18.0		-4.04	11.9	**0.0172**	**22.8**
15	13.1	19.5		-3.84	9.3	**0.0128**	**17.8**
30	10.7	19.5		-3.84	6.9	**0.0092**	**13.2**
60	8.1	20.0		-3.77	4.3	**0.0066**	**8.3**
120	6.0	20.5		-3.70	2.3	**0.0047**	**4.4**
240	4.4	22.0		-3.48	0.9	**0.0033**	**1.8**
360	4.2	22.0		-3.48	0.7	**0.0027**	**1.4**
1440	4.1	19.0		-3.48	0.6	**0.0014**	**1.2**



Project No. 03-1413-078 **Drawn** TM **Reviewed** LL **Date** 02/11/04	Golder Associates	**GRAIN SIZE DISTRIBUTION**	**Figure**

PARTICLE SIZE ANALYSIS OF SOILS ASTM D 422-63

Project No. :	03-1413-078	**Client :**	Cumberland		Vault Tailings		
Sch#	25	**Project :**	Baseline Reports		V3+4		
Lab Work:	TM	**Location:**	Nunavut				
	1ST SIEVING		**Hydrometer: (Minus #10)**		Residual #200	2.4	
	Total Weight	48.5	Before Wash	48.5	Total -200	43.5	
			After Wash	7.4	Gs	2.85	

Size (USS)	Weight Retained	Retained (%)	Weight Retained	Retained (%)	% Retained Total	Diameter (mm)	% Passing
							100.0
6"	0.0					152.4	100.0
3"	0.0					76.2	100.0
1 1/2"	0.0					38.1	100.0
1"	0.0					25.4	100.0
3/4"	0.0					19.1	100.0
1/2"	0.0					12.7	100.0
3/8"	0.0					9.52	100.0
#4	0.0					4.76	100.0
#10	0.0					2.00	100.0
#20			0.0			0.840	100.0
#40			0.0			0.420	100.0
#60			0.0			0.250	100.0
#100			0.3	0.6	0.6	0.149	99.4
#200			4.6	9.5	9.5	0.074	89.9
Pan			43.5	89.7	89.7		

HYDROMETER ANALYSIS

Time (min)	Hydrometer Reading	Temperature (^oC)		Composite Correction	Hydrometer Corrected	Diameter (mm)	% Passing
0.5	47.0	18.0		-4.04	43.0	0.0612	85.0
1	39.9	18.0		-4.04	35.9	0.0461	70.9
2	35.5	18.0		-4.04	31.5	0.0338	62.2
4	32.0	18.0		-4.04	28.0	0.0246	55.3
8	28.0	18.0		-4.04	24.0	0.0179	47.4
15	24.1	19.5		-3.84	20.3	0.0134	40.1
30	20.0	19.5		-3.84	16.2	0.0097	32.0
60	15.5	20.0		-3.77	11.7	0.0071	23.2
120	11.9	20.5		-3.70	8.2	0.0051	16.2
240	9.2	22.0		-3.48	5.7	0.0037	11.3
360	8.3	22.0		-3.48	4.8	0.0030	9.5
1440	7.8	19.0		-3.48	4.3	0.0015	8.5

SPECIFIC GRAVITY OF SOILS

ASTM D 854-92

Project # 03-1413-078
Third Portage Tailings
TP3+4

Sch# : 25
Tested By : TM/RLD
Calculated By : TM/RLD
Checked By : LL

TEST NUMBER			1	2		
BOTTLE NUMBER			2	3		
AIR REMOVAL METHOD			Vacuum	Vacuum		
WEIGHT OF BOTTLE , g.			172.69	173.97		
INITIAL WEIGHT OF BOTTLE + SOIL, g.			248.48	249.51		
INITIAL WEIGHT OF SOIL, g			75.79	75.54		
WEIGHT OF BOTTLE + SOIL + WATER, g.		**W_1**	723.73	724.89		
TEMPERATURE, ^{0}C		**T**	20.0	20.0		
WEIGHT OF BOTTLE + WATER, g.		**W_2**	671.24	672.39		
EVAPORATING DISH NUMBER			34	L3		
WEIGHT OF DISH + DRY SOIL, g.			430.42	421.31		
WEIGHT OF DISH, g.			355.41	346.48		
WEIGHT OF SOIL, g.		**W_S**	75.01	74.83		
Correction Factor @ Temperature T		**G_k**	1.0000	1.0000		
$G_K W_S$			75.01	74.83		
$W_1 - W_2$			52.49	52.50		
$W_S-(W_1-W_2)$			22.52	22.33		
SPECIFIC GRAVITY OF SOIL		**G_S**	**3.33**	**3.35**		

$G_S = (G_K * W_S)/((W_S-(W_1-W_2))$ = **3.34** (average value)

REMARKS :
(1) Method A - Oven Dried Procedure
(2) Passing the #10 sieve (2.00 mm)

Golder Associates Ltd.

SPECIFIC GRAVITY OF SOILS
ASTM D 854-92

Project #	**03-1413-078**	**Sch# :**	**25**
	Vault Tailings	**Tested By :**	**TM/RLD**
	V3+4	**Calculated By :**	**TM/RLD**
		Checked By :	**LL**

		1	2		
TEST NUMBER		1	2		
BOTTLE NUMBER		1	4		
AIR REMOVAL METHOD		Vacuum	Vacuum		
WEIGHT OF BOTTLE , g.		179.52	172.72		
INITIAL WEIGHT OF BOTTLE + SOIL, g.		253.28	254.29		
INITIAL WEIGHT OF SOIL, g		73.76	81.57		
WEIGHT OF BOTTLE + SOIL + WATER, g.	**W_1**	725.84	724.14		
TEMPERATURE, ^{0}C	**T**	20.0	20.0		
WEIGHT OF BOTTLE + WATER, g.	**W_2**	678.05	671.37		
EVAPORATING DISH NUMBER		27	20		
WEIGHT OF DISH + DRY SOIL, g.		425.56	441.73		
WEIGHT OF DISH, g.		351.94	360.46		
WEIGHT OF SOIL, g.	**W_S**	73.62	81.27		
Correction Factor @ Temperature T	**G_k**	1.0000	1.0000		
$G_K W_S$		73.62	81.27		
$W_1 - W_2$		47.79	52.77		
$W_S-(W_1-W_2)$		25.83	28.50		
SPECIFIC GRAVITY OF SOIL	**G_S**	**2.85**	**2.85**		

$G_S = (G_K * W_S)/((W_S-(W_1-W_2))$ = **2.85** (average value)

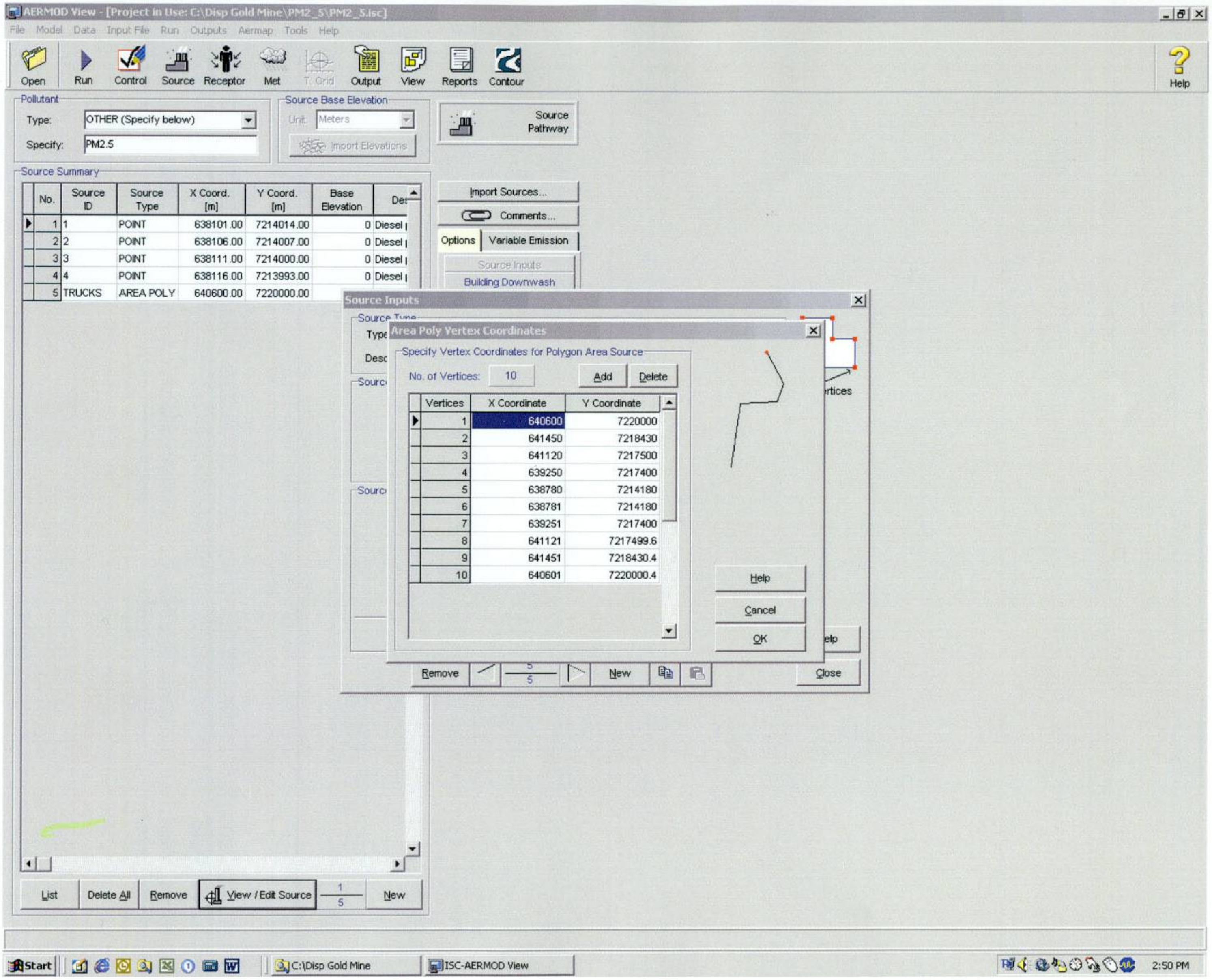
REMARKS :

(1) Method A - Oven Dried Procedure
(2) Passing the #10 sieve (2.00 mm)

Golder Associates Ltd.

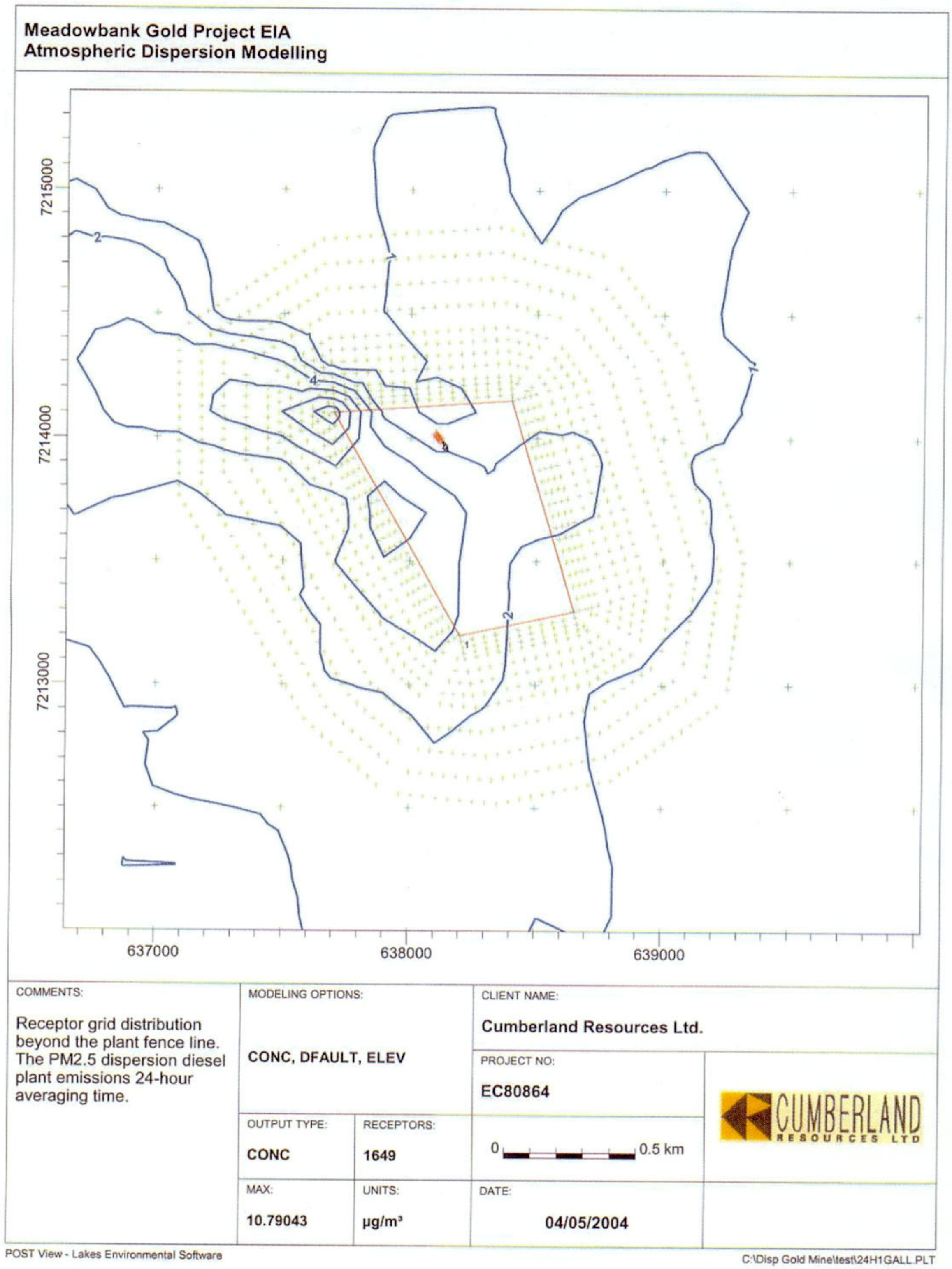
APPENDIX E

Mobile Source Area


AERMOD View - [Project in Use: C:\Disp Gold Mine\PM2_5\PM2_5.isc]
File Model Data Input File Run Outputs Aermap Tools Help
Open Run Control Source Receptor Met T. Grid Output View Reports Contour Help
Pollutant
Type: OTHER (Specify below)
Specify: PM2.5
Source Base Elevation
Unit: Meters
Import Elevations
Source Pathway
Source Summary
No. Source ID Source Type X Coord. [m] Y Coord. [m] Base Elevation
1 1 POINT 638101.00 7214014.00 0 Diesel
2 2 POINT 638106.00 7214007.00 0 Diesel
3 3 POINT 638111.00 7214000.00 0 Diesel
4 4 POINT 638116.00 7213993.00 0 Diesel
5 TRUCKS AREA POLY 640600.00 7220000.00
Import Sources...
Comments...
Options Variable Emission
Source Inputs
Building Downwash
Source Inputs
Area Poly Vertex Coordinates
Specify Vertex Coordinates for Polygon Area Source
No. of Vertices: 10
Add Delete
Vertices X Coordinate Y Coordinate
1 640600 7220000
2 641450 7218430
3 641120 7217500
4 639250 7217400
5 638780 7214180
6 638781 7214180
7 639251 7217400
8 641121 7217499.6
9 641451 7218430.4
10 640601 7220000.4
Help
Cancel
OK
Remove New Close
List Delete All Remove View / Edit Source New
Start C:\Disp Gold Mine ISC-AERMOD View 2:50 PM

APPENDIX F

Grid Receptor Network


Meadowbank Gold Project EIA
Atmospheric Dispersion Modelling
7215000
7214000
7213000
637000
638000
639000
COMMENTS:
Receptor grid distribution beyond the plant fence line. The PM2.5 dispersion diesel plant emissions 24-hour averaging time.
MODELING OPTIONS:
CONC, DFAULT, ELEV
CLIENT NAME:
Cumberland Resources Ltd.
PROJECT NO:
EC80864
OUTPUT TYPE:
CONC
RECEPTORS:
1649
0
0.5 km
MAX:
10.79043
UNITS:
µg/m³
DATE:
04/05/2004
POST View - Lakes Environmental Software
C:\Disp Gold Mine\test\24H1GALL.PLT