APPENDIX C

DUST ASSESSMENT REPORT
SENES CONSULTANTS LTD.

DUST ASSESSMENT
OF THE HUNSBERGER PIT

Prepared for:

Hunder Development Limited
RR#1, Breslau, Ontario
N0B 1M0

Prepared by:

SENES Consultants Limited
121 Granton Drive, Unit 12
Richmond Hill, Ontario
L4B 3N4

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EXECUTIVE SUMMARY

Atmospheric dispersion modelling was undertaken to determine the maximum impact of the proposed Hunsberger Sand & Gravel Pit on ambient particulate matter concentrations in the area. The Industrial Source Complex Short Term model Version 3 (ISCST3) was used to simulate the emissions of all significant sources of particulate matter at the facility, in combination with emissions from surrounding public roads. The three phases that could most significantly affect the sensitive receptors in the vicinity of the proposed pit were analyzed, which were based on high activity levels occurring near sensitive receptor locations. The estimated emissions from each phase will be quite similar, but due to the fact that the extraction pit location varies between phases, it was necessary to model three phases to properly assess the maximum impact on all of the sensitive receptors. The maximum 24-hour and annual average dust concentrations in three size ranges (TSP, PM_{10}, and $PM_{2.5}$) were evaluated specifically at the ten sensitive receptors located closest to the boundary of the proposed site.

The analysis illustrated that even using a conservative emission scenario (i.e., an overestimate), the applicable standards for TSP, PM_{10}, and $PM_{2.5}$ were not predicted to be exceeded during site operations at any of the ten nearby sensitive receptors. With the exception of the area immediately surrounding the site entrance road, there were no predicted off-site exceedances of any applicable standards. Very infrequent exceedances (i.e., up to 3 exceedances every 5 years) of applicable 24-hr TSP and 24-hr PM_{10} standards are predicted to occur in the area immediately surrounding the site entrance road during poor meteorological dispersion conditions. In addition, due to the conservative modelling approach used in this study, and the presence of vegetation and berms around the site, the maximum concentrations will be lower than predicted.

The three phases analysed, Phases 3, 5 and 7, each representing a different location for the active pit, were found to have similar emissions and maximum off-property concentrations.

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1.0 INTRODUCTION

SENES Consultants Limited (SENES) was retained by Hunder Development Limited to assess the potential dust impacts of a proposed sand and gravel extraction operation north of Waterloo, Ontario in the Township of Woolwich. The site is proposed to be located on the west side of Katherine Street, approximately 1.1 km north of the intersection of Sawmill Road. The site surrounding area gently slopes towards the Grand River, which travels from north of the site winding around to south of the site. The surrounding land use is primarily agricultural with two built-up residential areas immediately north and west of the site.

SENES developed an emissions inventory for particulate matter, based on a maximum annual extraction limit of 500,000 tonnes/year of gravel and related product. Particulate matter (PM) is a term used for both solid and liquid particles in the atmosphere. Particulate matter varies considerably in size. Total Suspended Particulate (TSP) describes all particles with aerodynamic diameters less than 30 µm[1]; PM_{10} describes all particles with aerodynamic diameters less than 10 µm; and $PM_{2.5}$ describes all particles with aerodynamic diameters less than 2.5 µm. The larger diameter fraction of PM is commonly made up of crustal material (for inland locations) and can be emitted to the atmosphere by erosion by the wind, or disturbance of soil due to anthropogenic activity. The smaller diameter fraction of PM is largely due to combustion sources. Whereas larger particulate matter tends to be deposited relatively close to the source of emission, fine particulate matter can stay airborne for days and can be transported significant distances from a source. Currently, there is a provincial ambient air quality criterion specified for TSP, but not for PM_{10} or $PM_{2.5}$. There is, however, a proposed (federal) Canada-Wide Standard for $PM_{2.5}$, and an Ontario Ministry of the Environment (MOE) interim guideline for PM_{10}.

The objective of the dust impact assessment was to conservatively predict the highest levels of airborne particulates (dust) that are likely to result from the added industrial activity at the proposed Hunsberger Pit. The predicted air quality impacts were compared to relevant criteria and guidelines. The potential impact of particulate matter emissions on air quality in the vicinity of the operation was evaluated using dispersion modelling to determine the maximum predicted ambient air concentrations of total suspended particulate matter (TSP), inhalable particulate matter (PM_{10}), and respirable particulate matter ($PM_{2.5}$). The modelling analysis focussed on potential impacts at nearby residential properties, since these will be most sensitive to any dust emissions originating from the proposed operation.

The Industrial Source Complex Short Term Version 3 (ISCST3) model was used with the projected emissions to predict ambient particulate matter concentrations, as well as dustfall, in the area surrounding the site. This model was developed for the U.S. Environmental Protection

[1] In Ontario, TSP is defined as all particles 44µm in diameter and less.

Agency (U.S. EPA) and was designed specifically to determine downwind air concentrations and deposition rates of various airborne pollutants from industrial sources. The ISCST3 simulates the dispersion of pollutants by advecting a plume of material with an assumed Gaussian profile. The dilution of the plume as it travels downstream is calculated based on wind speed and mixing caused by atmospheric conditions.

1.1 AIR QUALITY CRITERIA

1.1.1 Total Suspended Particulate (TSP)

Total Suspended Particulate (TSP) is often used to characterize air quality near a dust source. TSP is measured with a high-volume (Hi-Vol) sampler over 24-hours and consists, in Ontario, of particles less than 44 μm in diameter. An annual average is calculated as the geometric mean of these samples measured every six days.

The Ontario Ministry of the Environment (MOE) Standards Development Branch released new Ambient Air Quality Criteria (AAQC) in February 2008 (PIBS #6570e). The AAQC for TSP is 120 $\mu g/m^3$ averaged over 24-hours, and the annual geometric mean of the 24-hour samples is 60 $\mu g/m^3$.

The ambient TSP standards and criteria were originally set to prevent a reduction in visibility. Particles suspended in the atmosphere reduce visibility or the visual range by reducing the contrast between an object being viewed and its background. This reduction is a result of particles scattering or absorbing light coming from both the object and its background, and from particles scattering light into the line of sight [Robinson, 1977]. Particles with a radius of 0.1 to 1.0 μm are most effective at reducing visibility. In a rural area where TSP levels are on the order of 30 $\mu g/m^3$, the visibility would be about 40 km. At 150 $\mu g/m^3$, a common urban concentration, the range would be reduced to about 8 km [Robinson, 1977]. The MOE 24-hour criterion for TSP of 120 $\mu g/m^3$ is based on a visual range of about 10 km.

1.1.2 Fine Particulate Matter (PM_{10} and $PM_{2.5}$)

Many studies over the past few years have indicated that fine particulate matter (PM_{10} and $PM_{2.5}$) in the air is associated with various adverse health effects in people who already have compromised respiratory systems such as asthma, chronic pneumonia and cardiovascular problems. However, the available studies have not been able to link the adverse health effects in such people to any one component of the pollution mix. PM_{10} is a mixture of chemically and physically diverse dusts and droplets, and some of these components may be important in determining the effects of PM_{10} on health.

Particulate Matter less than 2.5 µm – $PM_{2.5}$ is the "finer fraction" of fine particulate, and is also known as respirable particulate. It is referred to as "respirable" since the particles are generally small enough to be drawn in and deposited into the deepest portions of the lungs. Anthropogenic sources, such as combustion of fossil fuels, tend to be the largest contributor to $PM_{2.5}$ levels in the environment.

A summary of the applicable air quality objectives for this study is provided in Table 1.1.

TABLE 1.1
PARTICULATE MATTER AIR QUALITY CRITERIA

Pollutant	Averaging Period	Objective	Air Quality Standard (µg/m³)
TSP	24-hour	AAQC	120
TSP	Annual	AAQC	60
PM_{10}	24-hour	Ontario Interim Guideline	50
$PM_{2.5}$	24-hour	Canada-Wide Standard	30*

*Compliance is measured as the 98th percentile of measured concentrations, averaged over 3 years.

1.2 DUSTFALL CRITERIA

Dustfall, or dust deposition, involves the settling of particles from the air due to gravitational force. It is a total amount of dust, inclusive of all particle size categories. Dustfall or dust deposition includes those particles of sufficient weight to settle from the air by gravity. These particles are generally larger than 20 µm in diameter. TSP deposition generally provides a good estimate of total dustfall. The AAQC for dustfall is 7.0 g/m^2/30 days for an averaging period of one month and 4.6 g/m^2/30 days for an averaging period of 1 year.

In developing an Ambient Air Quality Criterion for dustfall, the MOE used soiling data (i.e. surface build up of dust) from various Ontario towns between 1951 and 1955, which indicated areas of relatively low soiling (11 – 15 g/m^2/30 days), relatively moderate soiling (17 – 24 g/m^2/30 days) and relatively heavy soiling (26 – 34 g/m^2/30 days) (WHO, 1961).

1.3 Other Criteria Air Contaminants

Criteria Air Contaminants (CACs) including nitrogen oxides, sulphur oxides and carbon monoxide are common pollutants released into the air by activities such as the combustion of fossil fuels.

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that is formed in ambient air through the oxidation of nitric oxide (NO). Nitrogen oxides (NO_x) is the term used to describe the sum of NO, NO_2 and other oxides of nitrogen, and plays a major role in the formation of ozone.

Sulphur dioxide (SO_2) is a colourless gas that smells like burnt matches. It can be oxidized to sulphur trioxide, which in the presence of water vapour, is readily transformed to sulphuric acid mist. SO_2 can be oxidized to form acid aerosols, and is a precursor of particulate sulphates, which are one of the main components of respirable particulates in the atmosphere (MOE, 2002).

Carbon monoxide (CO) is a colourless, odourless gas, formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. High concentrations of CO generally occur in areas with heavy traffic congestion.

There are some minor sources of CACs at the proposed Hunsberger pit. These sources include mobile equipment such as haul trucks and front end loaders, as well as stationary equipment such as diesel generators. These sources are not expected to be significant contributors to concentrations of these contaminants at nearby residential locations, due to the proximity of local public roads (which are larger sources of these contaminants). Thus CACs were not included in the dispersion modelling assessment.

2.0 BACKGROUND CONCENTRATIONS

Existing air quality in the area surrounding the proposed Hunsberger Pit, is a combination of emissions from sources in the area (other industry and traffic) plus a component that flows into the area from upwind sources (Toronto, the USA, etc.). When a modelling assessment is completed all of these other "background" sources must be included in order to get an accurate representation of the air quality after the proposed Hunsberger Pit is in operation. To account directly for some of the background levels of dust, traffic data along Katherine Street as provided by the Region of Waterloo, was used to estimate emissions from that source which was then included into the model. In addition, historical measured rural background concentrations for TSP, PM_{10} and $PM_{2.5}$ were added to model-predicted concentrations to capture the upwind portions of background. Consequently, the concentrations presented in this report include potential effects from the background dust sources in the area as well as other upwind sources.

2.1 AIR CONCENTRATIONS

The proposed Hunsberger Pit site will be in a predominantly rural location, therefore TSP, PM_{10} and $PM_{2.5}$ monitoring data from the rural Point Petre station were used for developing background concentrations. Table 2.1 below presents five years of 90^{th} percentile 24-hr measurements for TSP, PM_{10} and $PM_{2.5}$, along with five years of annual average TSP concentrations. The average of the five years of data is provided at the bottom of the table. The 90^{th} percentile values are values that will only be exceeded 10% of the time under adverse meteorological conditions.

TABLE 2.1
TSP MEASUREMENTS FROM THE POINT PETRE STATION

Year	90th Percentile $PM_{2.5}$	90th Percentile PM_{10}	90th Percentile TSP	Annual Average TSP
2000	9	13	27	16
2001	10	15	30	17
2002	10	15	30	17
2003	11	15	30	18
2004	14	19	38	19
Average	**11**	**16**	**31**	**17**

TSP was not measured at the Point Petre Station, the value above was estimated using the observed average relationship TSP= PM10x2

The proposed Hunsberger Pit is located near to active farms, therefore the actual background concentrations in the vicinity of the proposed Hunsberger Pit will likely be greater than the typical rural background concentrations provided above. Therefore, more conservative background concentrations were selected for the proposed Hunsberger Pit as shown in Table 2.2 below.

TABLE 2.2
SELECTED BACKGROUND CONCENTRATIONS FOR TSP, PM_{10} AND $PM_{2.5}$

Averaging Time	Contaminant Background Concentration (µg/m^3)		
	TSP	PM_{10}	$PM_{2.5}$
24-hr	50	25	12.5
Annual	30	n/a	n/a

These numbers were generated as follows. Based on SENES' experience the maximum emissions scenario from an aggregate pit will result in an additional 0.5 µg/m^3 of $PM_{2.5}$ after 2 km of travel. Therefore, assuming that three upwind active farms could line up with the proposed Hunsberger Pit, 1.5 µg/m^3 was added to a background of 11 µg/m^3 for an overall $PM_{2.5}$ background concentration of 12.5 µg/m^3. The factor of 2 rule was applied from $PM_{2.5}$ to PM_{10} and from PM_{10} to TSP to get the other numbers in the table. As $PM_{2.5}$ will travel longer distances this fraction is considered the worst case, and the PM_{10} and TSP values provided in Table 2.2 are likely very conservative.

2.2 DUSTFALL CONCENTRATIONS

A measured background dust deposition rate was not available. However, background values can be estimated from the selected conservative TSP background air concentration of 50 µg/m^3 for 24-hr concentrations, using an equation proposed by Beychok (Beychok, 2005) to convert between averaging periods ranging from 1 day and 365 days. The equation is as follows:

$$C_{long} = C_{short} * (t_{short} / t_{long})^{0.53}$$

The 24-hr TSP background air concentration of 50 µg/m^3 was converted to a 30 day mean concentration where: t_{short} = 1 day, t_{long} = 30 days and C_{short} = 50 µg/m^3

$$C_{30} = 50 * (1/30)^{0.53} = 8.2 \text{ µg/m}^3$$

This mean concentration, with an assumed deposition velocity of 10 cm/s (or 0.1 m/s, which is a conservatively high estimate based on an average particle size of 10 µm) yields a monthly background deposition rate of 2 g/m^2/30 days as shown in the following calculation:

8.2 µg/m^3 * 0.1 m/sec * 1 g/1,000,000 µg * 86,400 sec/day * 30 days/month = 2 g/m^2/30 days

This value was added to the model predicted monthly deposition rates for comparison to the monthly AAQC.

3.0 DISPERSION MODELLING PARAMETERS

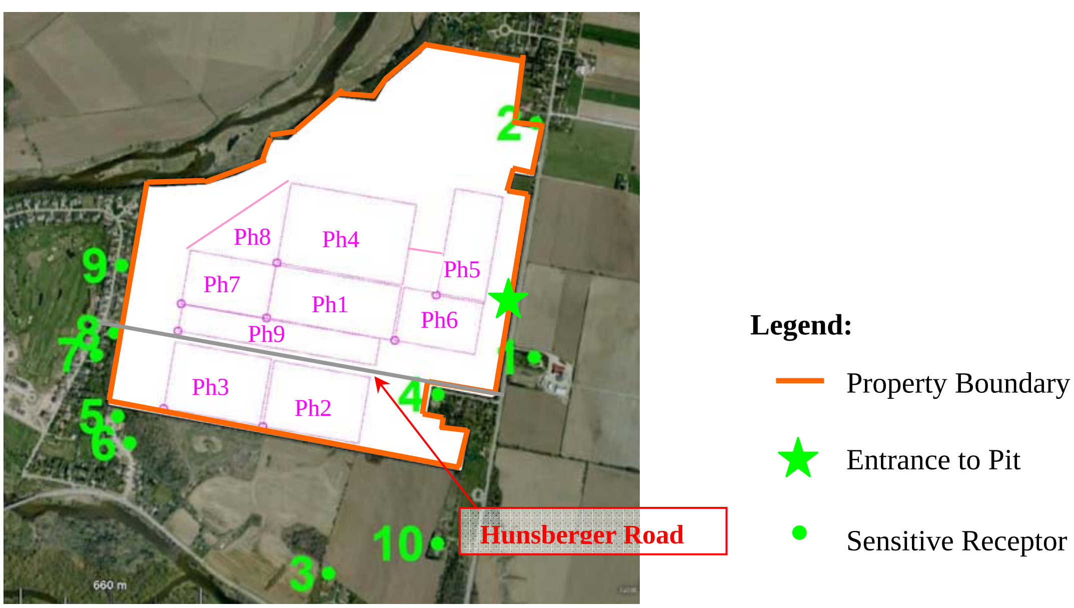
3.1 INTRODUCTION

SENES used the 'Operation Plan' (dated September 30, 2008) provided by IBI Group to obtain the site characteristics needed for dispersion modelling. The Plan included the locations of the Processing Plant, where extraction activities will occur, the on-site haul road and the adjacent public arterial Katherine Street. Additional information was provided through personal communication with IBI Group staff.

Due to the different settling characteristics of TSP, PM_{10}, and $PM_{2.5,}$ these particulate fractions are modelled separately with ISCST3. An emission inventory was developed for each fraction, and ambient, off-site concentrations were modelled on a grid including the Hunsberger Pit. Due to the proximity of several residential homes and outbuildings to the perimeter of the site, these locations were specifically used in the model as sensitive ('discrete') receptors.

During the lifetime of the undertaking, the working face will be located in different regions of the site. However, the processing plant site and the haul road will remain fixed in one location. Figure 3.1 provides a visualization of the Hunsberger Pit, showing the relative locations of roads and residential (discrete receptor) buildings. Berms will be constructed along the west, north and east extraction limits to reduce adverse noise and visual impacts. The berms will range from 1.5m in height to 5.5m, depending on the location of nearby receptors. Berms and existing trees and shrubs surrounding the Pit will act to reduce horizontal dust transport from the Pit area, but these mitigating effects were not taken into account when estimating off site impacts.

FIGURE 3.1
PIT OPERATIONAL LAYOUT WITH DISCRETE RECEPTOR LOCATIONS



During the lifetime of the Pit, there will be nine different phases of operation. During Phases 1 through 9, rehabilitation of processed areas will occur in addition to extraction. A basic description of each operating phase is provided in Table 3.1.

TABLE 3.1
OPERATING PHASES AT HUNSBERGER PIT

Operating Phase	Description of Activities
1	Phase 1 will occur north of Hunsberger Road and reflect extraction generally in the southern half of the mid-northern portion of the site.
2	Phase 2 will occur south of Hunsberger Road and reflect extraction from the mid-point of the parcel, eastward to the pond. Extraction west to east.
3	Phase 3 will occur south of Hunsberger Road and reflect extraction from the mid-point of the parcel westward. Extraction east to west.
4	Phase 4 will occur north of Hunsberger Road and reflect extraction generally in the northern half of the mid-northern portion of the site.
5	Phase 5 will occur north of Hunsberger Road and reflect extraction generally in the north east corner near Katherine Street within the G. Snyder lands.
6	Phase 6 will occur north of Hunsberger Road and reflect extraction generally in the south east corner of the Hunsberger lands, east of the existing site buildings.
7	Phase 7 will occur north of Hunsberger Road and reflect extraction generally in the western portion of the Hunsberger lands.
8	Phase 8 will occur north of Hunsberger Road and reflect extraction generally in the western portion of the G. Snyder lands.
9	Phase 9 will occur north of Hunsberger Road and reflect extraction generally between Hunsberger Road and Phase 1 and 7.

To ensure that the operating scenario potentially resulting in the highest particulate concentrations at each of the nearby ten sensitive receptors was analyzed, Phases 3, 5, and 7 (closest to potential receptors) were analysed. The processing plant will be permanently located in the Phase 1 area and the haul road will be located at the north end of Phase 1 and Phase 6 areas. All other phases are expected to result in lower ground-level dust concentrations due to the location of emission sources.

3.2 METEOROLOGY

The ISCST3 model uses hourly meteorological data records to define the conditions for plume rise, transport and dispersion. The model estimates the concentration or deposition value for each source-receptor combination, for each hour of input meteorology, and calculates short-term averages, such as one-hour, eight-hour and 24-hour averages. The hourly averages can also be combined into longer averages (1-month, seasonal, annual or period). The industry standard is to use five years of hourly meteorological data from a local meteorological station, therefore, five years of meteorological data was used for all model runs in this study.

The 5-year period 2001 – 2005 was used to develop a meteorological input file representative of all possible weather conditions that the proposed Hunsberger Pit would be subjected to during its operation. The ISCST3 model requires hourly values of wind speed, wind direction, ambient temperature, atmospheric stability class[2], and mixing height[3] to determine the air concentrations of particulate matter at sensitive receptors caused by dust emitted from the site. These meteorological variables are determined from hourly surface weather observations, and twice-daily upper air soundings. For the purpose of this study, surface observations were obtained from the Toronto Pearson International Airport (approximately 70 km east of the proposed Hunsberger Pit location) and upper air data was obtained from the National Weather Service station at Buffalo, N.Y (which is geographically the nearest upper-air station to the area being modelled).

3.2.1 Temperature

Generally, the near-surface temperature controls the reaction rates of contaminants, as well as how fast the surface dries. If the temperature is low, the moisture near the surface may remain or it may even freeze, sealing the surface from the effects of wind erosion thereby reducing dust emissions.

Temperature and precipitation normals for the Toronto Lester B. Pearson International Airport (1971-2000) are presented in Table 3.2. The annual mean temperature is 7.5°C at the Toronto Lester B. Pearson International Airport site. The daily mean minimum temperature is –6.3°C in January and daily mean maximum temperature is 20.8°C in July.

[2] Relates to the ease of vertical motion for a parcel of air. Determined from cloud cover, wind speed and time of day.
[3] The maximum vertical distance through which a contaminant released at ground level is able to mix with surrounding volumes of air. Related to solar insolation (heating of the ground) and time of day.

TABLE 3.2 - TORONTO LESTER B. PEARSON INTERNATIONAL AIRPORT CLIMATE NORMALS (1971-2000)

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-6.3	-5.4	-0.4	6.3	12.9	17.8	20.8	19.9	15.3	8.9	3.2	-2.9	7.5
Standard Deviation	3	2.7	2.3	1.7	2	1.5	1.3	1.3	1.2	1.6	1.5	2.7	0.9
Daily Maximum (°C)	-2.1	-1.1	4.1	11.5	18.8	23.7	26.8	25.6	21	13.9	7	0.9	12.5
Daily Minimum (°C)	-10.5	-9.7	-5	1	6.9	11.9	14.8	14	9.6	3.9	-0.7	-6.7	2.5
Precipitation													
Rainfall (mm)	24.9	22.3	36.7	62.4	72.4	74.2	74.4	79.6	77.5	63.4	62	34.7	684.6
Snowfall (cm)	31.1	22.1	19.2	5.7	0.1	0	0	0	0	0.5	7.6	29.2	115.4
Precipitation (mm)	52.2	42.6	57.1	68.4	72.5	74.2	74.4	79.6	77.5	64.1	69.3	60.9	792.7
Days with Rainfall													
>= 0.2 mm	5.1	4.6	8	10.7	11.9	11	10.1	10.8	10.7	11.5	10.6	6.7	111.8
Days With Snowfall													
>= 0.2 cm	12.6	9.4	7.1	2.6	0.07	0	0	0	0	0.4	4	10.3	46.5
Days with Precipitation													
>= 0.2 mm	14.9	11.6	13.1	12.1	11.9	11	10.1	10.8	10.7	11.5	13.2	14.6	145.5
Days with Wind													
Days with Winds >= 52 km/hr	3.4	2.2	3.4	3.2	1.5	0.7	0.6	0.7	0.7	1.8	2.4	3.1	23.8
Days with Winds >= 63 km/hr	1.1	0.8	1	1	0.5	0.2	0.2	0.2	0.3	0.4	0.9	0.6	7.2

Note: Source Environment Canada Website, www.msc-smc.ec.gc.ca/climate/climate_normals/index_e.cfm

3.2.2 Precipitation

Precipitation plays a role in emissions of pollutants from the ground and removal of pollutants from the air. For example, small amounts of precipitation will leave a soil surface mostly dry and available for wind erosion whereas a large amount of precipitation effectively seals the surface against erosion by the wind. Contaminants in the air may be washed out by precipitation; increased precipitation means more pollutant washout.

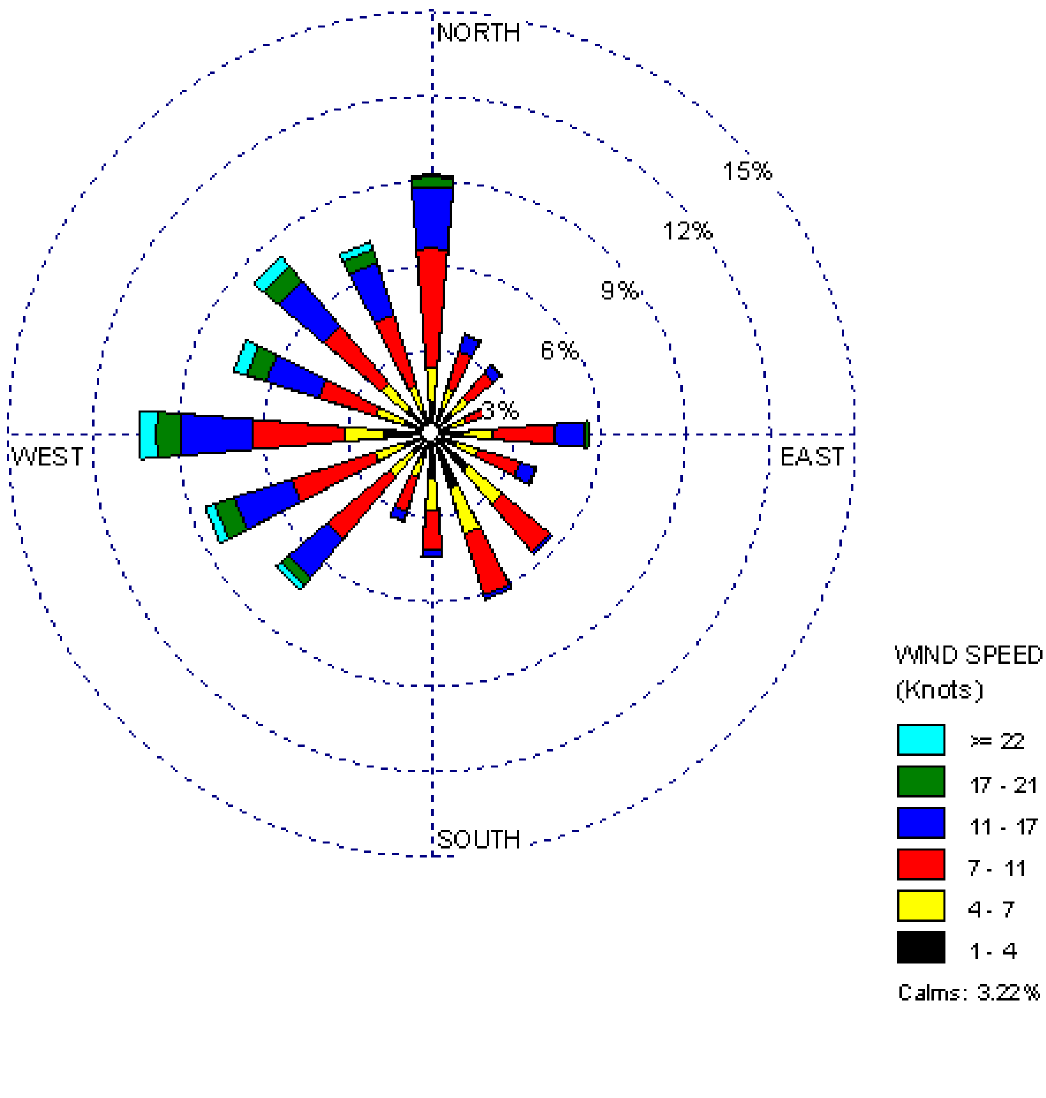
As shown in Table 3.2 above, the Toronto area receives a total of 792.7 mm of precipitation per year, including 684.6 mm of rainfall and 115.4 cm of snowfall. The maximum mean monthly rainfall is 79.6 mm, which occurs in August.

3.2.3 Wind

Wind is the primary driver that carries air pollutants away from a source. The direction and speed of the wind dictates the location and distance from the source that a pollutant may travel, and the receptors that may be impacted. High winds effectively disperse gases and particulates throughout the atmosphere. Concentrations generally decrease with increasing wind speed as a result of dilution. However, these conditions can lead to increased wind erosion and re-suspension of surface-based dust sources. Low wind speeds or no winds can lead to very high pollutant concentrations near the ground. Wind speed also induces mechanical turbulence (which affects dispersion) as a result of flows around obstacles on the surface (topography, buildings, etc.). The amount of mechanical turbulence created depends on the roughness of the surface and the wind speed.

At the Toronto Pearson International Airport meteorological station, calms were reported approximately 3.2% of the time during the 2001-2005 period. Figure 3.2 presents a wind rose for the Toronto Lester B. Pearson International Airport meteorological station for the 2001-2005 time period. A wind rose simply documents the frequency of occurrence of various wind directions and speeds over the period of interest. The figure shows that the prevailing winds are from the west and north and each occurs approximately 10% of the time. Winds from the NW sector occur over 30% of the year.

FIGURE 3.2
WIND ROSE DIAGRAM FOR PEARSON INTERNATIONAL AIRPORT (2001-1005)



3.2.4 Atmospheric Stability

Atmospheric stability is tied to vertical temperature structure, and is a measure of the amount of vertical motion in the atmosphere, and hence its ability to mix pollutants. A stable atmosphere has little vertical motion (is less turbulent) and cannot disperse pollutants as well as a more turbulent, unstable atmosphere. A number of classification schemes have been developed for describing stability classes. These classes reflect the ability of the atmosphere to disperse and dilute pollutants.

An atmospheric stability classification scheme, developed by Pasquill-Gifford and modified by Turner, is now widely used [Turner, 1964]. The atmosphere can have three general stability states – unstable, neutral, or stable. The stability class distribution for the Toronto Lester B. Pearson International Airport for the period 2001-2005 is presented in Table 3.3. At this station, neutral stability conditions {D (neutral) + C (near neutral)} occur approximately 70% of the time and stable conditions (E, F) about 25% of the time. Stable conditions are important because they can produce higher concentrations of contaminants because of reduced turbulent mixing.

TABLE 3.3
STABILITY CLASS DISTRIBUTION TORONTO LESTER B. PEARSON INTERNATIONAL AIRPORT (2001-2005)

Stability Class	Frequency (%)	Descriptor
A	0.30	Unstable
B	4.20	
C	10.48	Neutral
D	58.42	
E	13.23	Stable
F	13.39	

3.2.5 Mixing Height

The mixing height is a vertical measure for estimating the volume of air available for mixing. This is important to characterize because a low mixing height can trap ground-based emissions and cause elevated ground level pollutant concentrations. Mixing heights, which are a regional parameter, are typically estimated from upper air measurements; however there are few stations that measure these upper air data. Upper air data was obtained from the National Weather Service station at Buffalo, N.Y. (which is geographically the nearest upper-air station to the area being modelled) and was used to estimate mixing heights over the area around the proposed Hunsberger Pit.

3.3 SOURCES OF PARTICULATE MATTER

All significant sources of particulate matter were characterized and included in the emission inventories for this gravel pit. Many of the emissions are fugitive in nature. Fugitive dust involves the suspension of dust by material or machinery movement, or erosion. The source emissions are based on seasonal daily maximum extraction rates and include those due to operating machinery, road-based emissions due to the movement of gravel trucks on-site, and particulate emissions due to exhaust from internal combustion engines. Wind blown dust due to the erosion of exposed soil was also determined and included in the total emissions.

Extraction, processing and shipping were assumed to occur 12 hours per day (7 AM until 7 PM), 7 days per week. A summary of the individual sources included and the estimation method used in the dispersion modelling analysis is provided in Table 3.4. Specific individual parameters used in the dispersion model are detailed in Table A.1 in Appendix A.

3.3.1 On-site Emissions

In order to be conservative, a maximum emission scenario was developed to capture expected worst-case maximum daily particulate emissions from the proposed Hunsberger pit. The maximum operating scenario was based upon a maximum daily extraction rate of 3,000 tonnes/day and an hourly maximum extraction rate of 250 tonnes/hour. This scenario also incorporated an estimated maximum daily shipping rate of approximately 84 trucks per day.

TABLE 3.4
SUMMARY OF EMISSION SOURCES USED IN THE DISPERSION MODEL

Activity	Emission Factor Equation	Units	Reference	Comments
Haul Road Truck Travel on Unpaved Roads	E_{24hr} = 281.9 x k x $(s/12)^a$ x $(W/3)^b$ E_{annual} =281.9 x k x $(s/12)^{0.8}$ x $(W/3)^{0.4}$ x ((365-P)/365)	g/VKT	AP-42 13.2.2, November 2006	Unpaved Haul Roads
Haul Road Truck Travel on Paved Roads	E_{24hr} = k x $(sL/2)^{0.65}$ x $(W/3)^{1.5}$-C E_{annual} = [k x $(sL/2)^{0.65}$ x $(W/3)^{1.5}$ –C]x (1-P/4N)	g/VKT	AP-42 13.2.1, November 2006	Paved Entrance Road
Background traffic + Product trucks on Katherine Street and Hunsberger Road				Off-Site Paved Roads
Primary and Secondary Crushing (Uncontrolled)	TSP = 0.0027, PM_{10} = 0.0012 $PM_{2.5}$ = 0.0006	kg/tonne	AP-42, Table 11.19.2-1, August 2004	Permanent Plant, Uncontrolled
Screening (Controlled)	TSP = 0.0011, PM_{10} = 0.00038 $PM_{2.5}$ = 0.000025	kg/tonne	AP-42, Table 11.19.2-1, August 2004	Extraction Face
Screening (Uncontrolled)	TSP = 0.0125, PM_{10} = 0.0043 $PM_{2.5}$ = 0.002	kg/tonne	AP-42, Table 11.19.2-1, August 2004	Permanent Plant, Uncontrolled
Material Drops loading Crusher	E = k x (0.0016) x $(U/2.2)^{1.3}$ x $(M/2)^{-1.4}$	kg/tonne	AP-42 13.2.4, 1995	Based on Maximum Extraction Rate
Material Drops loading off-site haul trucks	E = k x (0.0016) x $(U/2.2)^{1.3}$ x $(M/2)^{-1.4}$	kg/tonne	AP-42 13.2.4, 1995	Based on Maximum Extraction Rate
Wind Erosion - Unvegetated Areas	E = 1.9*s/1.5	kg/ha/day	U.S. EPA	Conservatively Applied at All Wind Speeds
Tailpipe Emissions (excavators and loaders)	E_{10} = 0.724	g/hp-hr	U.S. EPA non-road, 2005	3 Excavators at Working Face, 1 Excavator at Central Plant and Haul Truck Tailpipe
Tailpipe Emissions (diesel generators for crushers, screeners and conveyors)	E_{10} = 0.000721 lb/hp-hr x 454 g/lb = 0.327	g/hp-hr	AP-42 3.3-1, October 1996	1 Small Generator at Working Face and 1 Large Generator at Central Plant

Notes: AP-42 is a U.S. EPA compilation of air contaminant emissions due to various activities. See http://www.epa.gov/ttn/chief/ap42/index.html.
EPA non-road is a compilation of (industrial) emissions from non-road activities. See above site.

Seasonal shipping and production factors assumed are presented in Table 3.5. Operations during the winter will be minimal due to freezing conditions, and thus the seasonal factor was set to 20%.

TABLE 3.5
MAXIMUM EMISSION FACTOR SEASONAL MULTIPLIERS

Season		Production/Shipping
Dec -Feb	Winter	0.20
Mar -May	Spring	1.00
June-Aug	Summer	1.00
Sept -Nov	Fall	1.00

On-Site Road Dust Emissions

Silt content and fleet average vehicle weight are the most important parameters needed for estimating fugitive roadway emissions in the Pit. The majority of on-site haul roads will be unpaved. Site specific analysis of aggregate material within the proposed Hunsberger Pit indicated a maximum silt content of 1.9%, however, SENES conservatively assumed the silt content on the unpaved haul roads to be 2.4%, which is the low end of sampled silt contents at Stone Quarrying and Processing facilities on AP-42 Table 13.2.2-1 [U.S. EPA 2006].

There will be two paved sections of the site haul road: a 75 m crossing of Hunsberger Road and a 30 m section of the site entrance road. SENES assumed the silt loading for the two paved sections of the site haul road were representative of AP-42 Table 13.2.1-3 [U.S. EPA 2006] Ubiquitous Baseline Values for Paved Roadways.

Material was assumed to be transferred from the extraction face to the processing area and off-site by 20 tonne shipping trucks having a load capacity of 35 tonnes. To be conservative, dust reduction by precipitation was not factored into the annual emission rates.

On-Site Tailpipe Emissions

Tailpipe emissions for industrial machinery and heavy-duty vehicles were included in the fugitive emissions from the Hunsberger Pit. Appropriate emission factors were obtained for each vehicle type or piece of machinery from the U.S. EPA [U.S. EPA 2004, U.S. EPA 2006]. For roadworthy vehicles, the emissions estimates are proportional to the total vehicle kilometres travelled per day, which were calculated from the maximum daily number of loads shipped and the on-site road lengths. For loaders and diesel generators, the emission estimates are proportional to the equipment capacities and an estimate of the percent time equipment is operating at maximum capacity.

Material Handling and Processing Emissions

Fugitive dust emissions resulting from material handling, primarily from material drops to vehicles and off of vehicles and equipment, have been estimated using U.S. EPA emission factors [U.S. EPA 2006] in conjunction with maximum hourly extraction rates.

The particulate emissions resulting from the screeners and crushers were estimated using U.S. EPA emission factors [U.S. EPA 2006] in conjunction with the maximum hourly extraction rate. Site specific analyses indicate that the moisture content of the raw material extracted from pits is greater than 2.5% (typically 3 to 4%). When this is the case, "controlled" emission factors may be used to estimate the emissions from screening and handling operations. Thus, "controlled" emission factors were used to estimate emissions from screening activities at the extraction face. It was conservatively assumed that after handling of extracted material the moisture content decreased, therefore uncontrolled emission factors were used for crushing and screening activities in the processing area.

Wind Erosion

Wind eroded dust is typically an event-driven emission, since particles are not suspended unless a sufficient wind speed is reached. Typically, at wind speeds less than 5.14 m/s there would be no emissions caused by wind erosion. For this assessment it was conservatively assumed there would be wind erosion from the on-site unpaved haul roads.

3.3.2 Local Area (Off-Site) Traffic Emissions

Public Roadway Emissions

The public roads in the vicinity of the Hunsberger Pit are Katherine Street, which runs adjacent to the eastern boundary of the Pit, and Hunsberger Road, which runs through the middle of the proposed aggregate pit. Haul truck traffic leaving the Pit will turn right (south) and continue along Katherine Street. Existing 24-hr traffic numbers were obtained from the Region of Waterloo and used to estimate emissions which were then input into the model. Estimated shipping traffic resulting from the proposed Hunsberger Pit was added to the existing traffic, to estimate the total emissions resulting from vehicular traffic on Katherine Street during future operations of the proposed Hunsberger pit.

For these roads, default silt loading values from AP-42 were used. Based on the Annual Average Daily Traffic (AADT) numbers provided to SENES in the Traffic Report, a silt loading of 0.2 g/m^2 was used for Katherine Street since it has an estimated AADT of 3591. The AP-42 emission equation also requires an average vehicle weight, which was estimated to be 4.73 tonnes including site traffic (based on 95% 3-tonne light duty and 5% 37.5 tonne heavy duty vehicles).

As outlined for unpaved site haul roads above, precipitation was not factored into the annual emission rates.

Tailpipe Emissions

Tailpipe emissions from vehicle travel on Katherine Street were calculated by applying a fleet averaged emission factor from the Mobile 6C Emissions model for the year 2007. For the public roads, traffic data was used to determine AADT levels, as detailed above. The data and calculations used to determine the tailpipe emissions from public roads are shown in Table A.1 in Appendix A.

3.4 REDUCTION OF UNCONTROLLED FUGITIVE DUST

Reduction of uncontrolled industrial emissions is commonly achieved by applying a ‘control mechanism’. An example of a control mechanism is simply applying water or another dust suppressant to an unpaved road, or flushing and sweeping paved roads, which dramatically reduces dust emissions. SENES estimated the emissions assuming that sufficient dust control measures will be applied such that the control efficiencies indicated in Table 3.5 will be achieved on all roads. These efficiencies were used to reduce the uncontrolled emission rates estimated with the U.S. EPA emission equations.

TABLE 3.6
CONTROL EFFICIENCIES USED IN DISPERSION MODELLING

Process/Activity	Strategy	Control Efficiency Applied
Unpaved Roads in Pit	chemical suppressant and watering	80%
Paved Entrance Road	Water flushing and sweeping	90%

3.5 ISCST3 SETTINGS

Emissions from most sources were set to originate from approximately the pit floor, or ground level for above-pit sources (off-site road traffic and some on-site haul roads). For sources within the Pit, the 'OPENPIT' source designation was used, which applies the total emissions to the volume of air within the pit, and retains a fraction of the emissions within the pit, depending on the pit's depth. During Phases 3, 5 and 7, it was assumed that the Pit would have an average depth of 4m. Berms were assumed to be placed along the west, north and east edges of the extraction limit. However, the effect of the berms cannot reliably be captured in the modelling and were not taken into account. As a result, expected concentrations will likely be less than those predicted in this assessment.

In previous studies of this nature, SENES has used the CAL3QHCR road emissions dispersion model to estimate concentrations due to fugitive dust and tailpipe emissions[4] near roads, in addition to the ISCST3 model used for other (area or volume) sources in the modelling domain. CAL3QHCR is also an approved U.S. EPA (and MOE) model for fugitive dust emissions. The use of the model for roadway emissions is considered appropriate because the model incorporates the increased dispersion of air contaminants due to turbulence generated behind the moving vehicles. The ISCST3 model treats roads as elongated area sources and does not take this behind vehicle turbulence into consideration, thereby predicting air concentrations near roadways that are much higher than air quality monitoring has shown. Unfortunately, a drawback to using two separate models in an air quality study is that total, combined ground-level concentrations at individual locations are difficult to accurately determine.

Recently, SENES undertook a comprehensive study of the use of ISCST3 for modelling roadway emissions [SENES 2003]. The results of this study show that the ISCST3 model, representing roads as elongated area sources in 'RURAL' dispersion conditions, can reproduce CAL3QHCR estimates when modelled emission rates are reduced by a factor of 3.5. The net effect of applying this reduction factor accounts for the turbulent mixing that occurs behind a vehicle. This study was presented at an Air and Waste Management Association (AWMA) Conference. A detailed account of the study, with supporting figures, is presented in Appendix B. On-site and off-site public roads within the modelling domain were modelled as elongated area sources in ISCST3 using a reduction factor of 3.5. This reduction factor was not applied to roadway emissions in the Pit, since total emissions from the Pit were classified as an OPENPIT source.

Model 'switches' used were rural dispersion (as opposed to urban), dry deposition and plume depletion (due to settling of plume material). In addition, terrain was assumed to be flat. A sample ISCST3 input file is shown in Appendix C.

[4](example) SENES Consultants Limited, 2002. *Benchmark Air Quality Assessment for Dust in the Caledon Area*.

4.0 MODELLING RESULTS

Several dispersion model runs were undertaken to predict maximum 24-hour and annual average ground-level concentrations at sensitive receptor locations and at gridded receptor locations. A tiered receptor grid was set up including receptor locations at increasing spacing with increasing distance from the property line. Receptors within 500 m of the property centre were spaced at 50 m intervals, while receptors were spaced at 100 m intervals further away from the property. In addition, fence line locations at 25 m intervals along the Hunsberger Pit property line as well as ten residential (discrete) receptor locations were included in all model runs.

The pollutant concentrations presented here are the sum of modelled worst case concentrations and estimated background concentrations (as discussed in Chapter 2). This modelling enabled a determination of the number of exceedances of federal and provincial air quality standards/guidelines expected to occur over the span of five years at any off-site receptor locations, and a visualization of the maximum ‘footprint’ of the Pit’s activity in the area. The dispersion modelling was undertaken for Phases 3, 5 and 7. In addition, maximum monthly and annual deposition of dust (TSP) was determined.

It should be noted that a sensitivity analysis was completed to determine the worst case of the following three potential operating scenarios:

1. Extracted material is screened at the face and then shipped directly off-site;
2. Extracted material is transported via haul trucks to the processing area where crushing and screening is completed prior to shipment off-site; and,
3. Half the extracted material is screened at the face and half is crushed and screened in the processing area prior to shipment off-site.

It was determined that the worst case scenario is based on all extracted material being transported via haul trucks to the processing area where crushing and screening is completed prior to shipment off-site. Figures of the modelling results are presented in Appendix D.

4.1 TOTAL SUSPENDED PARTICULATE (TSP)

Table 4.1 presents the maximum predicted 24-hour and annual average TSP concentrations at the ten discrete receptors (shown previously on Figure 3.1) for the three phases assessed. As indicated in Table 4.1, the maximum predicted concentrations at all ten discrete receptors are below the 24-hour MOE AAQC for TSP of 120 $\mu g/m^3$ and below the annual average MOE AAQC for TSP of 60 $\mu g/m^3$.

Figure 4.1 presents an off-property visualization of the predicted annual average TSP concentrations in the vicinity of the proposed Hunsberger Pit for Phase 3. For TSP, the model predicted annual average concentrations are very similar for all three phases, with no predicted off-site exceedances for any of the three phases modelled, including the nearby ten sensitive receptors.

TABLE 4.1
MODEL PREDICTED TSP CONCENTRATIONS

Receptor	Annual Average Concentration (µg/m^3)			Maximum 24-hour Concentration (µg/m^3)		
	Phase			Phase		
	3	5	7	3	5	7
R1	32	32	32	69	71	69
R2	32	33	32	72	72	72
R3	30	30	30	57	58	57
R4	31	31	31	66	69	66
R5	30	30	30	60	59	57
R6	30	30	30	57	56	55
R7	30	30	30	59	60	58
R8	31	30	30	60	60	59
R9	31	30	31	69	71	75
R10	30	30	30	54	54	54
Maximum	**33***			**75***		
AAQC	**60**			**120**		

*Values include background concentrations of 50µg/m^3 for 24-hr values and 30µg/m^3 for annual values.

FIGURE 4.1
PREDICTED ANNUAL AVERAGE TSP CONCENTRATIONS – PHASE 3

TSP Annual Average AAQC = 60 µg/m^3

Figures 4.2, 4.3, and 4.4 present off-property visualizations of the predicted maximum 24-hour TSP concentrations in the vicinity of the proposed Hunsberger Pit for Phases 3, 5 and 7, respectively. The maximum predicted concentration for all three phases is immediately adjacent to the site entrance road, with slightly higher predicted impacts for Phase 5 operations due to the proximity of this phase to the site entrance road. Other areas of elevated TSP concentrations were immediately adjacent to Katherine Street, which is primarily a result of existing traffic along this road.

The site emission inventory and dispersion modelling was conducted on a "maximum effects" basis. Although seasonal variations in production were considered, the emissions were based on seasonal maximum activity, rather than seasonal average activity, which yield conservatively high results on an annual basis.

It is also important to note that the maximum 24-hour TSP concentrations at each location shown on Figures 4.2 through 4.4 represent a hypothetical worst case scenario, since the maxima at each receptor occur during different meteorological conditions. As a result, the figure is only representative of the maximum concentrations that can occur at each location, rather than a snapshot of any actual 24-hour period, since the maximum concentrations at each location most likely occur on different days.

FIGURE 4.2
PREDICTED 24-HOUR AVERAGE TSP CONCENTRATIONS - PHASE 3

TSP 24-hr Average AAQC = 120 μg/m³

FIGURE 4.3
PREDICTED 24-HOUR AVERAGE TSP CONCENTRATIONS - PHASE 5

FIGURE 4.4
PREDICTED 24-HOUR AVERAGE TSP CONCENTRATIONS - PHASE 7

TSP 24-hr Average AAQC = 120 µg/m^3

Table 4.2 presents the maximum predicted monthly and annual average TSP deposition rates for each of the ten discrete receptors based on the full five years of meteorological data. As can be seen in Table 4.2, the deposition rates are below the MOE criteria at the sensitive receptor locations.

TABLE 4.2
MAXIMUM MONTHLY AND ANNUAL AVERAGE TSP DEPOSITION

Receptor	Maximum Deposition Rate (g/m^2/30 days)			Annual Average Deposition Rate (g/m^2/30 days)		
	Phase			Phase		
	3	5	7	3	5	7
R1	2.3	2.3	2.3	1.4	1.4	1.4
R2	2.5	2.5	2.5	1.4	1.4	1.4
R3	2.1	2.1	2.1	1.2	1.2	1.2
R4	2.2	2.2	2.2	1.3	1.3	1.3
R5	2.1	2.1	2.1	1.2	1.2	1.2
R6	2.1	2.1	2.1	1.2	1.2	1.2
R7	2.1	2.1	2.1	1.2	1.2	1.2
R8	2.2	2.2	2.2	1.3	1.3	1.3
R9	2.1	2.1	2.1	1.2	1.2	1.2
R10	2.1	2.1	2.1	1.2	1.2	1.2
Maximum	**2.5***			**1.4***		
AAQC	**7**			**4.6**		

Note: Deposition rates reflect loading rates that do not account for mitigation from precipitation scavenging.
*Values include background concentrations of 2g/m^2/30 days for monthly values and 1.2 g/m^2/30 days for annual values.

4.2 PARTICULATE MATTER LESS THAN 10 MICRONS (PM_{10})

The model predicted results for PM_{10} at the nearby residential receptors are presented in Table 4.3. The table shows that the maximum 24-hour PM_{10} concentrations are below the 24-hr Ontario interim standard of 50 µg/m^3 at all sensitive receptor locations for all three phases assessed.

TABLE 4.3
MODEL PREDICTED PM_{10} CONCENTRATIONS

Receptor	Maximum 24-hour Concentration (µg/m^3)		
	Phase		
	3	5	7
R1	36	36	36
R2	31	32	31
R3	30	31	30
R4	37	38	36
R5	32	31	30
R6	30	29	28
R7	31	32	31
R8	32	32	31
R9	38	39	43
R10	27	28	28
Maximum	**43***		
AAQC	**50**		

*Values include background concentrations of 25µg/m^3

Figures 4.5, 4.6, and 4.7 present the 24-hour maximum PM_{10} off-property concentrations, over five years of meteorological data, in the vicinity of the proposed Hunsberger Pit for Phases 3, 5 and 7, respectively. As with TSP, the areas of maximum predicted concentrations are similar for all three phases. The figures illustrate that the PM_{10} 24-hr Ontario interim standard of 50 µg/m^3 may be exceeded immediately adjacent to the site entrance road under restricted dispersion conditions (calm winds late in the season). However, modelling predicts there will be only three days where the standard will be exceeded over a five year period.

It should be noted that there are no provincial or federal air quality standards for annual average PM_{10} concentrations.

FIGURE 4.5
PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS – PHASE 3

FIGURE 4.6
PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS – PHASE 5

PM_{10} 24-hr Average AAQC = 50 μg/m^3

FIGURE 4.7
PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS – PHASE 7

PM_{10} 24-hr Average AAQC = 50 μg/m^3

4.3 PARTICULATE MATTER LESS THAN 2.5 MICRONS ($PM_{2.5}$)

Figure 4.8 presents the 24-hour maximum $PM_{2.5}$ off-property concentrations in the vicinity of the proposed Hunsberger Pit for Phase 5 using five years of meteorology. As can be seen in Figure 4.8, there are no predicted exceedances of the CWS at any off-site location.

The predicted off-property $PM_{2.5}$ concentrations are very similar for all three phases. Therefore, while Figure 4.8 specifically presents off-property $PM_{2.5}$ concentrations resulting from Phase 5, it is representative of all three phases.

FIGURE 4.8
PREDICTED 24-HOUR AVERAGE $PM_{2.5}$ CONCENTRATIONS – PHASE 5

$PM_{2.5}$ 24-hr Average AAQC = 30 μg/m^3

The maximum predicted $PM_{2.5}$ concentrations at the nearby residential locations for the three phases assessed are presented below in Table 4.4.

TABLE 4.4
MODEL PREDICTED $PM_{2.5}$ CONCENTRATIONS

Receptor	Maximum 24-hour Concentration ($\mu g/m^3$)		
	Phase		
	3	5	7
R1	18	18	18
R2	15	16	15
R3	16	16	16
R4	20	20	20
R5	17	16	15
R6	17	15	15
R7	16	16	16
R8	18	17	17
R9	20	20	24
R10	14	14	14
Maximum	**24**		
AAQC	**30***		

*Values include background concentrations of 12.5μg/m[3]

It should be noted the CWS for $PM_{2.5}$ represents a target concentration in ambient air that is to be achieved by 2010. According to the guidance documents provided by the CCME, achievement of the CWS will be based on community-oriented monitoring sites i.e., sites located where people live, work and play rather than at the expected maximum impact point for specific emission sources (CCME, 2000).

4.4 PERSPECTIVE ON FUGITIVE DUST AND AIR DISPERSION MODELLING

In summary, the dispersion modelling results indicate that using the maximum expected activity at the proposed Hunsberger Pit during any of the three phases assessed will not result in any exceedances of the relevant Provincial or Federal standards for TSP, PM_{10}, or $PM_{2.5}$ at any of the ten nearby discrete residential receptor locations. The model predicted very infrequent exceedances (i.e., up to 3 days over a 5 year period) of applicable 24-hr TSP and PM_{10} standards immediately adjacent to the site entrance road.

A comprehensive review of fugitive dust and air dispersion modelling was conducted in 1998 involving a panel of experts including several members of the U.S. EPA [Watson and Chow, 2000]. One of the statements the panel made was to indicate that particles that might be suspended by activities are not necessarily transportable particles, and that the majority (60-90%) of suspended TSP and PM_{10} remains within one to two metres above the ground. As a result, deposition to the ground or impaction on a vertical structure (fence, bush, etc.) occurs within less than 100 metres of its release point significantly reducing downwind concentrations.

Although the development of a vegetated barrier (berm and existing trees) along the west, north and east extraction limits would likely cause a significant reduction in ambient dust concentrations beyond the property fence line, models such as ISC3 currently are not able to parameterize such a feature. Indeed, one of the suggestions from the experts was to account for the fact that (AP-42) road emission factors can over-estimate effective emissions from these sources. In addition, the workshop concluded that

> *"there is insufficient accounting for deposition losses and horizontal impaction in dispersion models"*

Since up to 90% of the horizontal flux of suspended dust will remain within 2 m of the ground, it is probable that most, if not all of this amount will be prevented from being transported up and over a berm, particularly if there is sufficient vegetation to act as an impaction source. Therefore, vegetation to be located along the property line is expected to significantly reduce the transport of fugitive dust from the pit area, which will result in actual dust concentrations being significantly lower than those predicted in this dust assessment.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The analysis completed here illustrates that even using a conservatively high emission scenario (e.g. an overestimate of the real situation), the applicable 24-hour standards for TSP, PM_{10}, and $PM_{2.5}$ were not predicted to be exceeded at any of the ten nearby sensitive receptors. Very infrequent exceedances (i.e., up to 3 occurrences in 5 years) of applicable TSP and PM_{10} standards were predicted to occur at the site entrance road. It should also be noted that each of these exceedances assumes that the pit is operating at maximum capacity.

It should be noted that modelling indicates that the exceedances occur early in Spring or late Fall when aggregate extraction activity is ramping up or down. Therefore, our assumption of full activity during these periods is conservatively high, which causes the predicted exceedances.

Concentrations were predicted to be below the annual average MOE AAQC for TSP of 60 $\mu g/m^3$ and the CWS for $PM_{2.5}$ of 30 $\mu g/m^3$ at all off-site locations, including the nearby ten sensitive receptors.

Due to the conservatively high emissions used for the modelling used in this study, and the presence of vegetated berms around the site, the maximum concentrations are expected to be lower than predicted.

The three phases analysed, each representing a different location for the active pit, were found to have similar emissions as well as similar maximum off-property concentrations.

5.2 RECOMMENDATIONS

The analysis assumed a reasonable level of mitigation, including efficient dust control (e.g., watering) of site haul roads. The intent is to ensure that only limited amounts of dust are carried out from the site. In addition, good dust management practices will ensure that any effect associated with material handling and transportation of materials is minimized. These practices are outlined in the Dust Best Management Plan (BMP) that is presented in Appendix E.

In order to ensure that the conclusions of this study remain valid, the following recommendations are made:

- dust mitigation activities on site should meet or exceed those used in this Dust Impact Assessment;

- on-site haul roads should be watered and chemical suppressants applied, as appropriate to reduce dust emissions; and,
- ensure that existing and proposed vegetation surrounding the pit be maintained, to act as a barrier to dust transport.

6.0 REFERENCES

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APPENDIX A

DETAILED EMISSIONS TABLES

Summary of Variables Used for Emission Estimates on Worksheets

Soil & Truck Volume Assumptions

Variable	Assumed Value	Units	Comments
Moisture Content of extracted material	4%	%	See also Material handling Below
Construction days per year	220	days per year	
Construction Days per week	5	days per week	
Construction Hours per Day	12.0	(hours)	
Haul Trucks per hour	7	units	one way only
Average Haul Truck Weight	37.5	tonnes	Average of 55 tonnes full and 20 tonnes empty
Therefore tonnes per hour processing rate	250	tonnes/hr	35 tonnes per load x seven loads per hour rounded up to 250 tonnes/hr

Material Handling
Calculation Method: Drop Equation AP-42 13.2.4, November 2006

Variable	Assumed Value	Units	Comments
Moisture Content of extracted material	4%	%	Site specific information from hydrogeologists (see also Soil & Truck Volumes above)
Wind Speed	5	m/s	MOE Outdoor default wind speed - Guideline A-10: Procedure for Preparing an ESDM Report, July 2(
			Table C-2: Summary of Some Useful Equations and General Guidance
tonnes per hour for material handling activities	various	tonnes per hour	see Soil & Truck Volumes calculations worksheet
Control Efficiency	50%	%	50% Control Efficiencies applied for drops to hopper as walls reduce wind exposure
Control Efficiency	0%	%	No Control Efficiencies for drops to haul trucks and drops to stockpile

Crushing and Screening
Calculation Method: Crushed Stone Processing AP-42 11.19.2, August 2004

Variable	Assumed Value	Units	Comments
tonnes per hour	various	tonnes per hour	see Soil Volume and Truck Count calculations worksheet

Unpaved Haul Road Emissions
Calculation Method: Unpaved Road Emissions, AP-42 13.2.2-4, November 2006

Variable	Assumed Value	Units	Comments
On-site haul trucks (gravel roads) - Silt %	2.4%	(%)	Site Specific Analysis @ Maximum of 1.8% however, used
			AP-42 Table 13.2.2-1 Typical Silt Contents - Sone Quarrying 2.4% as low end of sampled data
On-site haul trucks - Fleet Average Weight	37.5	tonnes	Average of 55 tonnes full and 20 tonnes empty
Passes per day	various	tonnes per hour	see Soil Volume and Truck Count calculations worksheet
ISC Calibration Factor for Roads Emissions comparable to CAL3Q	3.5	unitless	
On-site haul roads - Control Efficiency	80%	(%)	Based on chemical suppressants and watering
Active Pit haul road - Control Efficiency	80%	(%)	Based on chemical suppressants and extensive watering

Haul Truck Tailpipe Emissions
Calculation Method: Mobile 6C (Haul Trucks)

Variable	Assumed Value	Units	Comments
Haul trucks - g/VKT	various	g PM/VKT	Based on Mobile 6C EF's for Haul Trucks - EF depends on vehicle weight

Stationary Equipment Tailpipe Emissions
Calculation Method: AP-42 Section 3.3 & 3.4 - Emissions from Large Diesel Generators (>600 hp) and Small Diesel Generators (<600 hp)

Variable	Assumed Value	Units	Comments
Equipment hp rating for screener at face	70	hp	Assumption based on SENES experience
Equipment hp rating for crusher at processing plant	425	hp	Assumption based on SENES experience

NonRoad Equipment Tailpipe Emissions
Calculation Method: US EPA Nonroad (Excavators & Loaders)

Variable	Assumed Value	Units	Comments
Percent of Time Excavator Equipment is Operating	57%	%	Assumption based on URBEMIS2007 Model Appendix G for each piece of Equipment
Equipment hp rating for loader	268	hp	Actual hp ratings from assumed equipment

Paved Road Vehicle Counts

Variable	Assumed Value	Units	Comments
Avg Weight for Off-Site Road Light Duty Vehicles	3	tonnes	Typical, based on SENES' experience - Considered conservative as mid-sized SUV's are approximat
Avg Weight for Haul Trucks and Off-Site Heavy Duty Vehicles	37.5	tonnes	Conservative - Typical off-site truck weight is 12 tonnes, haul trucks are 37.5 tonnes

Paved Roads
Calculation Method: Paved Road Emissions, AP-42 13.2.1, November 2006

Variable	Assumed Value	Units	Comments
ISC Calibration Factor for Roads Emissions comparable to CAL3Q	3.5	unitless	
On-site Paved Roads - Control Efficiency	90%	(%)	Based on high pressure flushing and/or vacuum sweeping

Wind Erosion
Calculation Method: AWMA Air Pollution Engineering Manual, 1992, page 137

Variable	Assumed Value	Units	Comments
Silt (%)	1.9%	%	Site Specific Analysis Greatest Silt Content of 1.9%
Frequency Wind > 5.4 m/s (%)	23.4	%	Pearson Airport Climate Normals

Material Handling Particulate Matter Emissions | **34863 Hunsberger Pit**

Material Handling Emissions	k			M (%)	U (m/s)	Emission Factor in kg/tonne			Tonnes Handled per Hour*	Uncontrolled (g/s)			Assumed Control Efficiency (%)	Controlled (g/s)		
	TSP	PM_{10}	$PM_{2.5}$			TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Phase 3																
Front End Loader drop to Screener Hopper @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	0	0.0000	0.0000	0.0000	50%	0.0000	0.0000	0.0000
Drop from Stacker to Stockpile @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	0	0.0000	0.0000	0.0000	0%	0.0000	0.0000	0.0000
Front End Loader drop to Haul Truck @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Haul Truck Drop to Surge Pile @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	0%	0.0906	0.0428	0.0065
Front End Loader drop to Crusher Hopper @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Drop from Stacker to Stockpile @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	0%	0.0906	0.0428	0.0065
Front End Loader drop to Haul Truck @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Phase 5																
Front End Loader drop to Screener Hopper @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	0	0.0000	0.0000	0.0000	50%	0.0000	0.0000	0.0000
Drop from Stacker to Stockpile @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	0	0.0000	0.0000	0.0000	0%	0.0000	0.0000	0.0000
Front End Loader drop to Haul Truck @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Haul Truck Drop to Surge Pile @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	0%	0.0906	0.0428	0.0065
Front End Loader drop to Crusher Hopper @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Drop from Stacker to Stockpile @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	0%	0.0906	0.0428	0.0065
Front End Loader drop to Haul Truck @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Phase 7																
Front End Loader drop to Screener Hopper @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	0	0.0000	0.0000	0.0000	50%	0.0000	0.0000	0.0000
Drop from Stacker to Stockpile @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	0	0.0000	0.0000	0.0000	0%	0.0000	0.0000	0.0000
Front End Loader drop to Haul Truck @Face	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Haul Truck Drop to Surge Pile @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	0%	0.0906	0.0428	0.0065
Front End Loader drop to Crusher Hopper @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032
Drop from Stacker to Stockpile @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	0%	0.0906	0.0428	0.0065
Front End Loader drop to Haul Truck @Processing Plant	0.74	0.35	0.053	4%	5.00	0.00130	0.00062	0.00009	250	0.0906	0.0428	0.0065	50%	0.0453	0.0214	0.0032

* Tonnes handled per hour are based on the worst case operational scenario with 100% of material processed in the central processing plant

Emission Factor Equation	Reference
$E = k \times (0.0016) \times (U/2.2)^{1.3} / (M/2)^{1.4}$	AP-42 13.2.4
	November 2006

Parameter	TSP	PM_{10}	$PM_{2.5}$
k	0.74	0.35	0.053

E = emission factor in kg/megagram
k = particle size multiplier for particulate size range and units of interest
U = mean wind speed (m/s)
M = material moisture content (%)

Crushing and Screening Particulate Matter Emissions **34863 Hunsberger Pit**

Description	Emission Factor in kg/tonne			Tonnes Loaded per Hour*	Emission Rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Phase 3							
Screening @Face	0.0011	0.00037	0.000025	0	0.0000	0.0000	0.0000
Primary Crushing @Processing Plant	0.0027	0.0012	0.0006	250	0.1875	0.0833	0.0417
Secondary Crushing @Processing Pla	0.0027	0.0012	0.0006	250	0.1875	0.0833	0.0417
Screening @Processing Plant	0.0125	0.0043	0.0020	250	0.8681	0.2986	0.1389
Phase 5							
Screening @Face	0.0011	0.00037	0.000025	0	0.0000	0.0000	0.0000
Primary Crushing @Processing Plant	0.0027	0.0012	0.0006	250	0.1875	0.0833	0.0417
Secondary Crushing @Processing Pla	0.0027	0.0012	0.0006	250	0.1875	0.0833	0.0417
Screening @Processing Plant	0.0125	0.0043	0.0020	250	0.8681	0.2986	0.1389
Phase 7							
Screening @Face	0.0011	0.00037	0.000025	0	0.0000	0.0000	0.0000
Primary Crushing @Processing Plant	0.0027	0.0012	0.0006	250	0.1875	0.0833	0.0417
Secondary Crushing @Processing Pla	0.0027	0.0012	0.0006	250	0.1875	0.0833	0.0417
Screening @Processing Plant	0.0125	0.0043	0.0020	250	0.8681	0.2986	0.1389

* Tonnes loaded per hour are based on the worst case operational scenario with 100% of material processed in the central processing plant

EMISSION FACTORS (kg/Mg of material throughput)[1]			
Source	**TSP**	**PM_{10}**	**$PM_{2.5}$**
Primary Crushing	0.0027	0.0012	0.0006
Secondary Crushing	0.0027	0.0012	0.0006
Tertiary Crushing	0.0027	0.0012	0.00005
Screening	0.0125	0.0043	0.002
Screening (controlled)	0.0011	0.00037	0.000025

(1) All emission factors from AP-42 Table 11.19.2-1

Note: AP-42 Section 11.19.2 describes the stages of the crushing process as follows:

Type of Crushing Activity	**Crusher Output Sizing**
Primary Crushing - Jaw, Impact or Gyratory Crusher	7.5 to 30 cm (3 to 12 inches) diameter
Secondary Crushing - Cone Crusher	2.5 to 10 cm (1 to 4 inches) diameter
Tertiary Crushing - Cone or Impact Crusher	0.5 to 2.5 cm (3/16th to 1 inch) diamete

[orange shaded cells] uses tertiary EF's as upper limits as No Data was available for Primary or Secondary Crushing

On-Site Unpaved Haul Roads Particulate Matter Emissions **34863 Hunsberger Pit**

Unpaved Road Emissions (see description on Soil & Truck Volumes worksheet)	k (lb/VMT)			s (%)	W (tonnes)	Emission Factor in g/VKT			Annual EF	Total # vehicle passes per hour (in and out)	One way length (km)	ISC Calibration Factor for Roads	Uncontrolled (g/s)				Assumed Control Efficiency (%)	Controlled (g/s)			
	TSP	PM_{10}	$PM_{2.5}$			TSP	PM_{10}	$PM_{2.5}$	TSP***				TSP	PM_{10}	$PM_{2.5}$	Annual TSP***		TSP	PM_{10}	$PM_{2.5}$	Annual TSP***
Phase 3																					
AREA3 - Haul Road 1	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.115	3.5	0.178	0.040	0.004	0.105	80 %	0.04	0.01	0.00	0.02
AREA4 - Haul Road 2	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.060	3.5	0.093	0.021	0.002	0.055	80 %	0.02	0.00	0.00	0.01
AREA5 - Haul Road 3	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.150	3.5	0.233	0.052	0.005	0.137	80 %	0.05	0.01	0.00	0.03
AREA6 - Unpaved Entrance Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.400	3.5	0.620	0.138	0.014	0.365	80 %	0.12	0.03	0.00	0.07
Pit 1 - Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.450	1.0**	2.442	0.542	0.054	1.438	80 %	0.49	0.11	0.01	0.29
Pit 3 - Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.360	1.0**	1.953	0.433	0.043	1.151	80 %	0.39	0.087	0.01	0.23
Phase 5																					
AREA6 - Unpaved Entrance Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.550 *	3.5	0.853	0.189	0.019	0.502	80 %	0.17	0.04	0.00	0.10
Pit 1 - Haul Road (in & out)	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.900 *	1.0**	4.883	1.083	0.108	2.876	80 %	0.98	0.22	0.02	0.58
Pit 5 - Haul Road (in & out)	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.360	1.0**	1.953	0.433	0.043	1.151	80 %	0.39	0.09	0.01	0.23
Phase 7																					
AREA6 - Unpaved Entrance Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.400	3.5	0.620	0.138	0.014	0.365	80 %	0.12	0.03	0.00	0.07
Pit 1 - Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.450	1.0**	2.442	0.542	0.054	1.438	80 %	0.49	0.11	0.01	0.29
Pit 7 - Haul Road	4.9	1.5	0.15	2.4	37.50	1395	310	31	822	14	0.300	1.0**	1.628	0.361	0.036	0.959	80 %	0.33	0.07	0.01	0.19

* **Phase 5** it was assumed all haul trucks travelled to the processing area and then back off site for shipping - therefore: **AREA6** = 0.4 km (unpaved entrance rd length) + 0.15 km (distance above grade from Pit 5 to Pit 1) and **Pit 1** = 0.45 km x 2 (distance in to processing and back)

** ISC Calibration factor for roads is based on increased mixing from vehicle wakes, however, the OPENPIT algorithm accounts for mixing of all sources within a pit. Therefore, no calibration factor is applied to road sources within the pit.

*** Annual rates were not used, to be conservative the 24-hr values were applied to annual meteorology.

Emission Factor Equation	Reference	
$E_{unpaved} = k \times (s/12)^a \times (W/3)^b$	AP-42 13.2.2-4, November 2006	industrial sites

Constant	Industrial Roads		
	TSP	PM_{10}	$PM_{2.5}$
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

SILT CONTENT (%)	Location	Low	High	Average
sand and gravel processing	plant road	4.1	6.0	4.8

E = size speific emission factor (lb/VMT)
s = surface materal silt content (%)
W = mean vehicle weight (tons)
1 lb/VMT = 281.9 g/VKT
$E_{ext} = E \times [(365-P)/365]$
E_{ext} = annual size-specific emission factor for natural mitigation, lb/VMT
P = number of days in a year with at least 0.254 mm of precipitation

Haul Truck Tailpipe Emissions **34863 Hunsberger Pit**

Vehicle Use (see description on Soil & Truck Volumes worksheet)	One-way road length (km)	Total Number of Haul Trucks per hour two-ways	TSP	PM_{10}	$PM_{2.5}$
Phase 3			(g/s)	(g/s)	(g/s)
AREA3 - Haul Road 1	0.115	14	0.0001	0.0001	0.0001
AREA4 - Haul Road 2	0.060	14	0.0000	0.0000	0.0000
AREA5 - Haul Road 3	0.150	14	0.0001	0.0001	0.0001
AREA6 - Unpaved Entrance Haul Road	0.400	14	0.0003	0.0003	0.0003
Pit 1 - Haul Road	0.450	14	0.0003	0.0003	0.0003
Pit 3 - Haul Road	0.360	14	0.0003	0.0003	0.0002
Phase 5					
AREA6 - Unpaved Entrance Haul Road	0.550	14	0.0004	0.0004	0.0004
Pit 1 - Haul Road (in & out)	0.900	14	0.0007	0.0007	0.0006
Pit 5 - Haul Road (in & out)	0.360	14	0.0003	0.0003	0.0002
Phase 7					
AREA6 - Unpaved Entrance Haul Road	0.400	14	0.0003	0.0003	0.0003
Pit 1 - Haul Road	0.450	14	0.0003	0.0003	0.0003
Pit 7 - Haul Road	0.300	14	0.0002	0.0002	0.0002

Mobile 6C Emission Factors - Year 2007

Vehicle Type	Average Vehicle Weight (tonnes)	TSP	PM_{10}	$PM_{2.5}$
Off-Site Haul Trucks	37.5	0.199	0.199	0.164

All Emission Factors are g/VKT

Stationary Diesel Equipment Tailpipe Emissions **34863 Hunsberger Pit**

Vehicle Use	Power Rating (hp)[1]	Uncontrolled (g/s)		
		TSP	PM_{10}	$PM_{2.5}$
Phase 3				
Diesel Generator for Screener @Face	70	0.0194	0.0194	0.0194
Diesel Generator for Primary and Secondary Crushers @Processing Plant	425	0.1181	0.1181	0.1181
Phase 5				
Diesel Generator for Screener @Face	70	0.0194	0.0194	0.0194
Diesel Generator for Primary and Secondary Crushers @Processing Plant	425	0.1181	0.1181	0.1181
Phase 7				
Diesel Generator for Screener @Face	70	0.0194	0.0194	0.0194
Diesel Generator for Primary and Secondary Crushers @Processing Plant	425	0.1181	0.1181	0.1181

(1) All DG hp ratings based on SENES experience with aggregate pits

AP-42 Emission Factors for Diesel Generators (lb/hp-hr)			
Vehicle Type	**TSP**	**PM_{10}**	**$PM_{2.5}$**
Small Diesel Generators (less than 600 hp) Table 3.3-1 and Table 3.3-2	0.0022	0.0022	0.0022

NOx Emissions Sample Calculation for 70 hp diesel generator:

NOx Emission =

$$power(hp) \times \frac{0.031 lb}{hp - hr} \times \left(\frac{1 hr}{3{,}600 \sec} \right) \times \left(\frac{1 kg}{2.2 lb} \right) \times \left(\frac{1000 g}{kg} \right)$$

Tailpipe Emissions - Working Face Excavators and Loaders **34863 Hunsberger Pit**

Vehicle Use	Power Rating (hp)	Emission Factor (g/hp-hr)	Transient Adjustment Factor (TAF)	BSFC	PM Adj g/hp.hr	Emission Factor in g/hp-hr			Frequency of Operation (%)	Uncontrolled (g/s)		
		PM EF_{ss}	PM TAF			TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Phase 3												
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Processing Plant	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
Phase 5												
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Processing Plant	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
Phase 7												
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Face	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185
10T Excavator (CAT 330D L) @Processing Plant	268	0.402	1.23	1.01	0.0584	0.436	0.436	0.436	57%	0.0185	0.0185	0.0185

Note: EF_{ss} values are from US EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling--Compression-Ignition, April 2004 (EPA420-P-04-009), TAF and BSFC values are from EPA420-P-04-009, Page A9, based on SCC 2270002069, Tier 0.

Emission Factors are calculated based on calculation outlined on EPA420-P-04-009 page 6

On-Site Paved Roads Particulate Matter Emissions

Road Emissions - TSP	24 hr AADT	sL (g/m^2)	Average Vehicle Weight (tonnes)	Road Dust Emission Factor in g/VKT SPM	One way length (km)	ISC Calibration Factor for Roads	Control (%)	TSP - Emission Rate (g/s) Hour of the Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Phase 3																														
Hunsberger Rd Paved Crossing	168	8.2	37.5	2653.8	0.075	3.5	90%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	0.0000	0.0000	0.0000	0.0000
Hunsberger Rd	100	0.6	4.73	21.6	1.500	3.5	0%	0.0013	0.0014	0.0016	0.0013	0.0014	0.0036	0.0102	0.0190	0.0181	0.0112	0.0117	0.0119	0.0107	0.0114	0.0141	0.0194	0.0245	0.0262	0.0174	0.0105	0.0124	0.0066	0.0058
Paved Entrance Road	168	8.2	37.5	2653.8	0.030	3.5	90%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0000	0.0000	0.0000	0.0000
Katherine Street South	3591	0.2	4.73	10.5	0.620	3.5	0%	0.0096	0.0101	0.0117	0.0096	0.0101	0.0259	0.0736	0.1375	0.1304	0.0812	0.0847	0.0858	0.0771	0.0822	0.1020	0.1401	0.1766	0.1893	0.1259	0.0761	0.0893	0.0477	0.0416
Katherine Street North	3591	0.2	4.73	10.5	0.980	3.5	0%	0.0152	0.0160	0.0184	0.0152	0.0160	0.0409	0.1163	0.2174	0.2061	0.1283	0.1340	0.1356	0.1219	0.1299	0.1612	0.2214	0.2791	0.2992	0.1989	0.1203	0.1412	0.0754	0.0658
Phase 5 and Phase 7																														
Hunsberger Rd Paved Crossing	0	0.6	37.5	484.8	0.075	3.5	80%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Road Emissions - PM_{10}	24 hr AADT	sL (g/m^2)	Average Vehicle Weight (tonnes)	E = Road Dust Emission Factor in g/VKT PM_{10}	One way length (km)	ISC Calibration Factor for Roads	Control (%)	PM_{10} - Emission Rate (g/s) Hour of the Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Phase 3																														
Hunsberger Rd Paved Crossing	168	8.2	37.5	508.5	0.075	3.5	90%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0000	0.0000	0.0000	0.0000
Hunsberger Rd	100	0.6	4.73	4.0	1.500	3.5	0%	0.0002	0.0003	0.0003	0.0002	0.0003	0.0007	0.0019	0.0036	0.0034	0.0021	0.0022	0.0022	0.0020	0.0021	0.0026	0.0036	0.0046	0.0049	0.0033	0.0020	0.0023	0.0012	0.0011
Paved Entrance Road	168	8.2	37.5	508.5	0.030	3.5	90%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0000	0.0000	0.0000	0.0000
Katherine Street South	3591	0.2	4.73	1.9	0.620	3.5	0%	0.0018	0.0018	0.0021	0.0018	0.0018	0.0047	0.0134	0.0250	0.0237	0.0147	0.0154	0.0156	0.0140	0.0149	0.0185	0.0254	0.0321	0.0344	0.0228	0.0138	0.0162	0.0087	0.0076
Katherine Street North	3591	0.2	4.73	1.9	0.980	3.5	0%	0.0028	0.0029	0.0033	0.0028	0.0029	0.0074	0.0211	0.0395	0.0374	0.0233	0.0243	0.0246	0.0221	0.0236	0.0293	0.0402	0.0507	0.0543	0.0361	0.0218	0.0256	0.0137	0.0119
Phase 5 and Phase 7																														
Hunsberger Rd Paved Crossing	0	0.6	37.5	92.8	0.075	3.5	80%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Road Emissions - $PM_{2.5}$	24 hr AADT	sL (g/m^2)	Average Vehicle Weight (tonnes)	Road Dust Emission Factor in g/VKT $PM_{2.5}$	One way length (km)	ISC Calibration Factor for Roads	Control (%)	$PM_{2.5}$ - Emission Rate (g/s) Hour of the Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Phase 3																														
Hunsberger Rd Paved Crossing	168	8.2	37.5	72.9	0.075	3.5	90%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0000	0.0000	0.0000	0.0000
Hunsberger Rd	100	0.6	4.73	0.5	1.500	3.5	0%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0004	0.0004	0.0003	0.0003	0.0003	0.0002	0.0003	0.0003	0.0004	0.0006	0.0006	0.0004	0.0002	0.0003	0.0002	0.0001
Paved Entrance Road	168	8.2	37.5	72.9	0.030	3.5	90%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000
Katherine Street South	3591	0.2	4.73	0.2	0.620	3.5	0%	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0013	0.0025	0.0024	0.0015	0.0015	0.0016	0.0014	0.0015	0.0019	0.0026	0.0032	0.0035	0.0023	0.0014	0.0016	0.0009	0.0008
Katherine Street North	3591	0.2	4.73	0.2	0.980	3.5	0%	0.0003	0.0003	0.0003	0.0003	0.0003	0.0007	0.0021	0.0040	0.0038	0.0023	0.0024	0.0025	0.0022	0.0024	0.0029	0.0040	0.0051	0.0055	0.0036	0.0022	0.0026	0.0014	0.0012
Phase 5 and Phase 7																														
Hunsberger Rd Paved Crossing	0	0.6	37.5	13.2	0.075	3.5	80%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Assumption: Average vehicle weight for off-site roads based on the assumption that 95% of vehicles are light duty (3 tonnes) and 5% are heavy duty (37.5 tonnes). Therefore, 0.95*3+0.05*37.5=4.73 tonnes

Emission Factor Equation	Reference
$E_{paved} = k \times (sL/2)^{0.65} \times (W/3)^{1.5} - C$	AP-42 13.2.1.3 November 2006

Industrial Roads Constant	$PM_{2.5}$	PM_{10}	TSP	Units
k	0.66	4.6	24.0	g/VKT
C	0.1005	0.1317	0.1317	g/VKT

E = particulate emission factor
k = particle size multilier for particulate size range and units of interest
sL = road surface silt loading (g/m^2)
W = average weight (tonnes) of vehicles travelling on the road
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear

Silt Loading in g/m^2	AADT Category <500	500-5000	5000-10000	>10000	Information Source
Ubiquitous Baseline	0.6	0.2	0.06	0.03	**AP-42 Table 13.2.1-3**
Stone Quarry Unpaved Roads	8.2	n/a	n/a	n/a	**AP-42 Table 13.2.1-4**

Paved Road Tailpipe Emissions

Road Emissions - TSP	One way length (km)	ISC Calibration Factor for Roads	Emission Rate (g/s) TSP																								Maximum Hourly Emission Rate (g/s)
Phase 3			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	
Hunsberger Rd Paved Crossing	0.075	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-05
Hunsberger Rd	1.500	3.5	2.88E-06	3.03E-06	3.48E-06	2.88E-06	3.03E-06	7.73E-06	2.20E-05	4.11E-05	3.89E-05	2.42E-05	2.53E-05	2.56E-05	2.30E-05	2.45E-05	3.05E-05	4.18E-05	5.27E-05	5.65E-05	3.76E-05	2.27E-05	2.67E-05	1.42E-05	1.24E-05	1.14E-05	5.65E-05
Paved Entrance Road	0.030	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.64E-06
Katherine Street South	0.620	3.5	4.27E-05	4.50E-05	5.17E-05	4.27E-05	4.50E-05	1.15E-04	3.26E-04	6.09E-04	5.78E-04	3.60E-04	3.76E-04	3.80E-04	3.42E-04	3.64E-04	4.52E-04	6.21E-04	7.83E-04	8.39E-04	5.58E-04	3.37E-04	3.96E-04	2.11E-04	1.84E-04	1.69E-04	8.39E-04
Katherine Street North	0.980	3.5	6.75E-05	7.11E-05	8.18E-05	6.75E-05	7.11E-05	1.81E-04	5.15E-04	9.63E-04	9.14E-04	5.69E-04	5.94E-04	6.01E-04	5.40E-04	5.76E-04	7.14E-04	9.81E-04	1.24E-03	1.33E-03	8.82E-04	5.33E-04	6.26E-04	3.34E-04	2.91E-04	2.67E-04	1.33E-03
Phase 5 and Phase 7																											
Hunsberger Rd Paved Crossing	0.075	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Road Emissions - PM_{10}	One way length (km)	ISC Calibration Factor for Roads	PM_{10} - Emission Rate (g/s) Hour of the Day																								Maximum Hourly Emission Rate (g/s)
Phase 3			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	
Hunsberger Rd Paved Crossing	0.075	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	1.66E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-05
Hunsberger Rd	1.500	3.5	2.88E-06	3.03E-06	3.48E-06	2.88E-06	3.03E-06	7.73E-06	2.20E-05	4.11E-05	3.89E-05	2.42E-05	2.53E-05	2.56E-05	2.30E-05	2.45E-05	3.05E-05	4.18E-05	5.27E-05	5.65E-05	3.76E-05	2.27E-05	2.67E-05	1.42E-05	1.24E-05	1.14E-05	5.65E-05
Paved Entrance Road	0.030	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	6.64E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.64E-06
Katherine Street South	0.620	3.5	4.27E-05	4.50E-05	5.17E-05	4.27E-05	4.50E-05	1.15E-04	3.26E-04	6.09E-04	5.78E-04	3.60E-04	3.76E-04	3.80E-04	3.42E-04	3.64E-04	4.52E-04	6.21E-04	7.83E-04	8.39E-04	5.58E-04	3.37E-04	3.96E-04	2.11E-04	1.84E-04	1.69E-04	8.39E-04
Katherine Street North	0.980	3.5	6.75E-05	7.11E-05	8.18E-05	6.75E-05	7.11E-05	1.81E-04	5.15E-04	9.63E-04	9.14E-04	5.69E-04	5.94E-04	6.01E-04	5.40E-04	5.76E-04	7.14E-04	9.81E-04	1.24E-03	1.33E-03	8.82E-04	5.33E-04	6.26E-04	3.34E-04	2.91E-04	2.67E-04	1.33E-03
Phase 5 and Phase 7																											
Hunsberger Rd Paved Crossing	0.075	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Road Emissions - $PM_{2.5}$	One way length (km)	ISC Calibration Factor for Roads	$PM_{2.5}$ - Emission Rate (g/s) Hour of the Day																								Maximum Hourly Emission Rate (g/s)
Phase 3			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	
Hunsberger Rd Paved Crossing	0.075	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	1.37E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-05
Hunsberger Rd	1.500	3.5	2.10E-06	2.21E-06	2.54E-06	2.10E-06	2.21E-06	5.62E-06	1.60E-05	2.99E-05	2.83E-05	1.76E-05	1.84E-05	1.86E-05	1.68E-05	1.79E-05	2.22E-05	3.04E-05	3.84E-05	4.11E-05	2.74E-05	1.65E-05	1.94E-05	1.04E-05	9.04E-06	8.27E-06	4.11E-05
Paved Entrance Road	0.030	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	5.48E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E-06
Katherine Street South	0.620	3.5	3.11E-05	3.27E-05	3.77E-05	3.11E-05	3.27E-05	8.35E-05	2.37E-04	4.44E-04	4.21E-04	2.62E-04	2.73E-04	2.77E-04	2.49E-04	2.65E-04	3.29E-04	4.52E-04	5.70E-04	6.11E-04	4.06E-04	2.46E-04	2.88E-04	1.54E-04	1.34E-04	1.23E-04	6.11E-04
Katherine Street North	0.980	3.5	4.92E-05	5.18E-05	5.95E-05	4.92E-05	5.18E-05	1.32E-04	3.75E-04	7.01E-04	6.65E-04	4.14E-04	4.32E-04	4.37E-04	3.93E-04	4.19E-04	5.20E-04	7.14E-04	9.00E-04	9.65E-04	6.42E-04	3.88E-04	4.55E-04	2.43E-04	2.12E-04	1.94E-04	9.65E-04
Phase 5 and Phase 7																											
Hunsberger Rd Paved Crossing	0.075	3.5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Mobile 6C Emission Factors - Year 2007				
Vehicle Type	**Average Vehicle Weight**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
Haul Trucks and Off-Site Heavy Duty Vehicles	37.5	0.199	0.199	0.164
Off-Site Light Duty Vehicles	3.0	0.0296	0.0296	0.0194

All Emission Factors are g/VKT

Wind Erosion Particulate Matter Emissions

Wind Erosion Source	s %	f (%)	Road Length (m)	Area (ha)	E (kg/ha/day)			Uncontrolled (g/s)			Assumed Control Efficiency (%)	Controlled (g/s)		
					TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$		TSP	PM_{10}	$PM_{2.5}$
Phase 3														
Phase 3 Pit - Active Roads	1.9	23.4	360	0.36	3.754	1.877	0.751	0.01564	0.00782	0.00313	0%	0.01564	0.00782	0.00313
Phase 1 Processing Pit - Active Roads	1.9	23.4	450	0.45	3.754	1.877	0.751	0.01955	0.00978	0.00391	0%	0.01955	0.00978	0.00391
Phase 5														
Phase 5 Pit - Active Roads	1.9	23.4	360	0.36	3.754	1.877	0.751	0.01564	0.00782	0.00313	0%	0.01564	0.00782	0.00313
Phase 1 Processing Pit - Active Roads	1.9	23.4	900	0.9	3.754	1.877	0.751	0.03911	0.01955	0.00782	0%	0.03911	0.01955	0.00782
Phase 7														
Phase 7 Pit - Active Roads	1.9	23.4	300	0.3	3.754	1.877	0.751	0.01304	0.00652	0.00261	0%	0.01304	0.00652	0.00261
Phase 1 Processing Pit - Active Roads	1.9	23.4	450	0.45	3.754	1.877	0.751	0.01955	0.00978	0.00391	0%	0.01955	0.00978	0.00391

Equation	Reference
E = k*1.9 *(s/1.5) *(f / 15)	AWMA - Air Pollution Engineering Manual, 1992, page 137

E = emission factor (kg/day)
k = particle size multilier for particulate size range of interest
f = Percentage of the time that the wind speed is > 5.4 m/s
s = Silt Content in %

Parameter	TSP	PM_{10}	$PM_{2.5}$
k	1.0	0.5	0.2

APPENDIX B

SENES ISC3 vs. CAL3QHCR STUDY

Modelling Line Sources

An air dispersion model is a mathematical model that simulates how pollutant emissions to the air from specified sources are dispersed in the environment. There are a number of MOE-approved models that can be used to predict concentrations resulting from the landfill operations. These are the Fugitive Dust Model (FDM), CAL3QHCR and the Industrial Source Complex Version 3 (ISCST3) Model. SENES' initial evaluation of the models identified a combination of ISCST3 and CAL3QHCR as the most appropriate model selection.

This combination approach was chosen to account for the ISC3 model's limitations with respect to line sources (such as roads) and the initial dispersion from vehicle movements along these line sources. More specifically, the US EPA suggests that for their sources, a 1:10 aspect ratio be used. For long roads, this results in the development of a significant number of small sources, which then leads to excessive model run times.

SENES completed the initial baseline modelling using the combined approach. During this complex and time consuming exercise, SENES became aware of recent publications which suggested the ISC3 model could be run with significantly larger aspect ratios than 1:10 for their sources. SENES subsequently contacted the ISC3 model developer, Roger Brode of MACTEC Federal Programs to confirm the literature. The model developer agreed that ISC3 can be used to model roads but observed that it tended to over-predict concentrations close to the line sources.

As a result of this new information, SENES revised their model selection to use an adjusted ISC3 model for all sources including roads. The ISC model adjustment for roads is described below, from a previous study completed by SENES.

Case Study – ISC3 Model Adjustment for Line Sources (Roads)

Three different road links covering the entire modelling domain were examined. The links modelled were: a part of Highway 401, 6619 m in length; Side Road 10 (SR10), 1100m in length; and the Entrance Ramp to Westbound Highway 401, 280m in length.

The modelling exercise indicated good agreement between the ISC3 and CAL3QHCR models could be achieved if the ISC3 emission rates are reduced by a factor of 3.5. This emission reduction is required when the ISC3 is used in the RURAL mode. It is well known that the CAL3QHC dispersion coefficients had been increased to capture the mechanical mixing caused by traffic movements. For the ISC3 model running in the URBAN mode, the adjustment factor is different but that factor was not determined for this study. Examination of the figures presented below indicates that the ISC3 Model, with a correction of 3.5, under-predicts beyond 500 m from the edge of the roads. What was not clear was, on the whole modelling domain, what was happening close to the road.

In order to clarify this situation, detailed modelling was undertaken for two links 1 km in length, oriented North-South with the traffic volume of 1621 vehicles northbound and 1275 vehicles southbound with an emission factor of 0.117 g/mi/vehicle (PM_{10} tailpipe emissions). The meteorology used for these runs was Toronto Pearson International Airport for 2001. Predictions downwind of two different locations on these links were used in order to assess the impact of the length of a road segment. Those two locations were (1) the end of a link and (2) the middle of a link.

PM_{10} was modelled perpendicular to the link end and the results of predictions with the distance are presented in Figures B.1, B.2 and B.3, for a 1-hour, 24-hour and annual prediction, respectively. It is clear that close to the road the ISC3 Model still over predicts but after a few hundred metres it is only under-predicting by about 10-15%. In order to ensure that the impact of road sources was properly modelled at the houses very close to the road, SENES Consultants calculated an appropriate reduction factor of 3.5 for this study. This slight under-prediction at distances of about 500 m was not considered to be significant because the concentrations at these distances are very small. Figures B.2 and B.3 show some under-prediction using this method for the 24-hour and annual averaging periods.

Figures B.4, B.5 and B.6 present the same concentration curves for a location near the middle of a link for the 1-hour, 24-hour and annual averaging times, respectively. For almost all distances and averaging times, the ISC3 Model over-predicts the concentrations.

FIGURE B.1
CAL3QHC VS. ISC3 – CONCENTRATIONS WITH DISTANCE
1 HOUR – LINK END

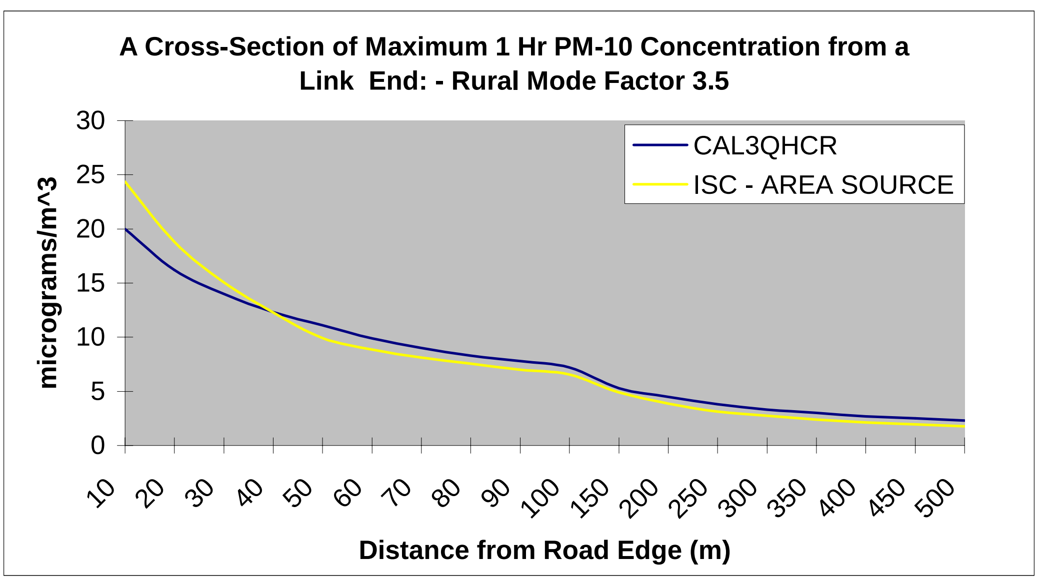


FIGURE B.2
CAL3QHC VS. ISC3 – CONCENTRATIONS WITH DISTANCE
24 HOUR – LINK END

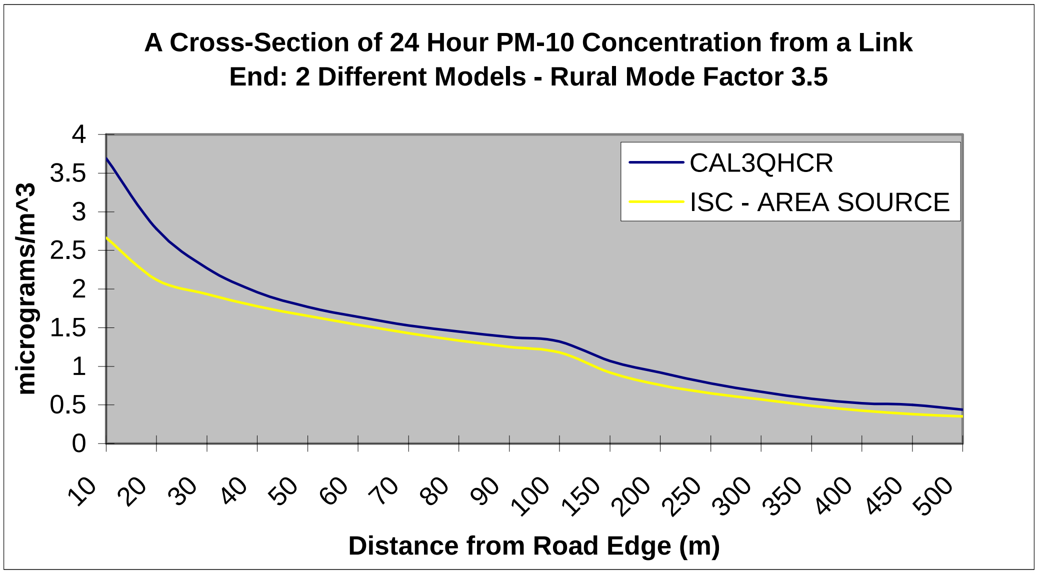


FIGURE B.3
CAL3QHC VS. ISC3 – CONCENTRATIONS WITH DISTANCE
ANNUAL AVG. – LINK END

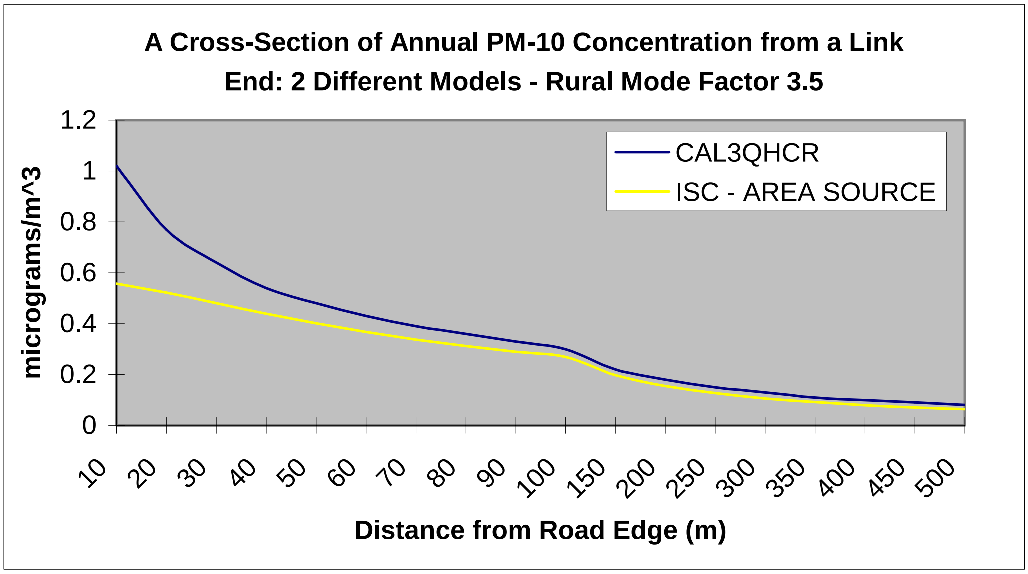


FIGURE B.4
CAL3QHC VS. ISCST3 – CONCENTRATIONS WITH DISTANCE
1 HOUR –LINK MIDDLE

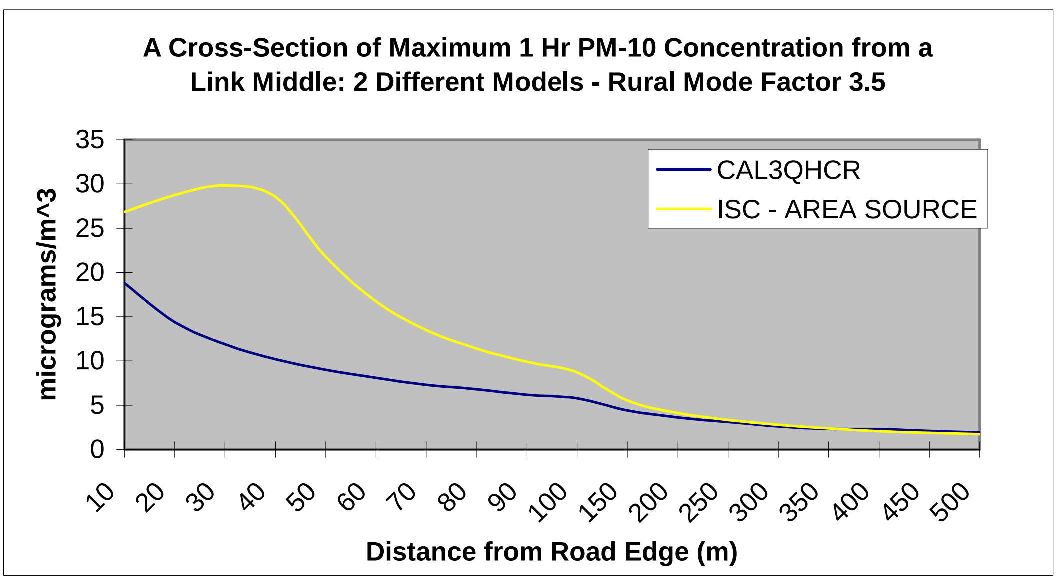


FIGURE B.5
CAL3QHC VS. ISCST3 – CONCENTRATIONS WITH DISTANCE
24 HOUR –LINK MIDDLE

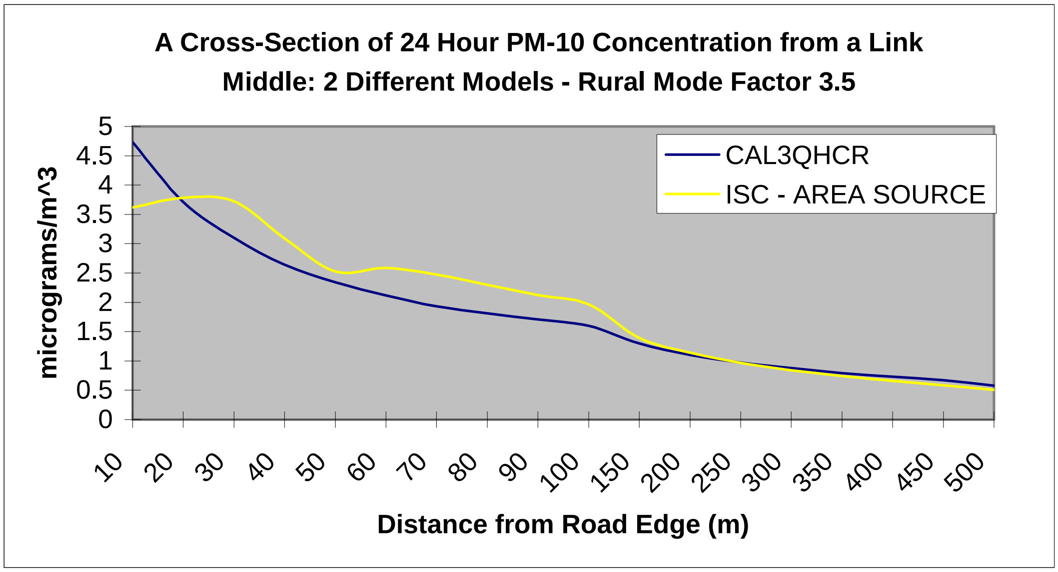
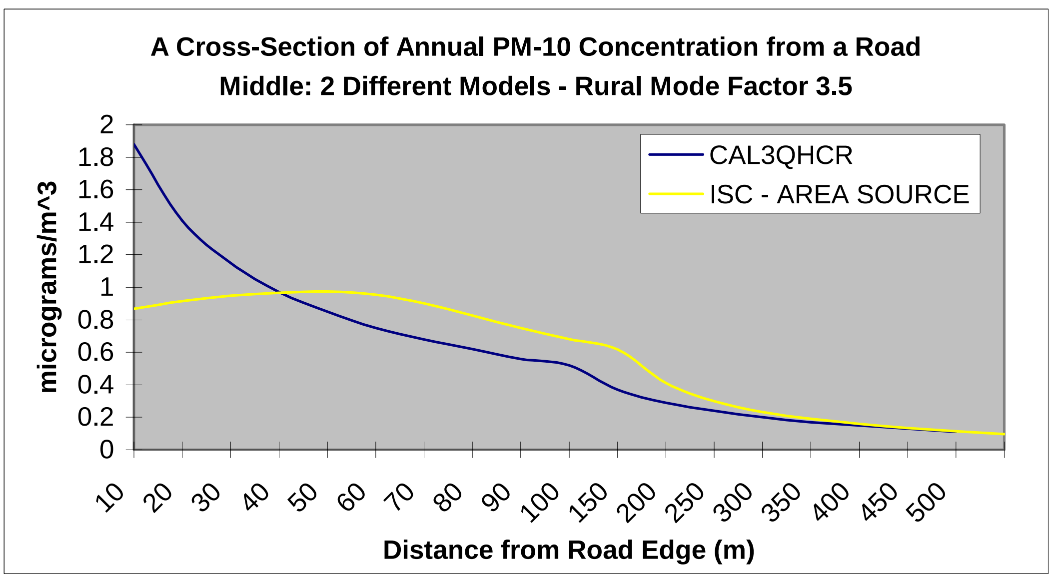


FIGURE B.6
CAL3QHC VS. ISCST3 – CONCENTRATIONS WITH DISTANCE
ANNUAL AVG.–LINK MIDDLE



Based on the results presented here, it is clear that the concentrations vary significantly with distance from the road. For the application to the Study Site, the comparison of the performance of the two models was based on looking at all discrete receptors and modelling all on-site and off-site roads for the base case scenario. The CALINE3 Model (the foundation of the CAL3QHCR) over predicts the hourly concentrations for E and F stability by about 40 – 60% and at close receptors it can over predict by more than 80% (CALINE 3 – Interim Report, 1979).

Also all of the CALINE3 validation runs were based on hourly concentrations. In summary, based on the validation studies, CALINE3 tends to over-predict concentrations. In the approach that SENES used, the comparison between the ISC3 and CAL3QHCR at discrete receptors shows good agreement at critical receptors and under-predictions of up to 30% further from the landfill. Since CALINE3 over-predicts, it is concluded that the agreement between the ISC3 and CALINE3 is a reasonable representation of the reality around the Study Site.

In summary, the links and discrete receptors were all tested because they had different lengths, angle orientation and distances from the road as well as different emission levels. Based on this sensitivity test, it is concluded that ISC3 with an adjusted emission factor of 3.5 can be used for road modelling for majority of the receptors, especially those within about 100 m of roads. Receptors further from a road, where the contribution is small, may be under-predicted. (in the range of 15 –30 %).

It is important to note that the observed concentrations at the background monitoring station, located just downwind of a road, for the baseline study were in the range of 30 – 40 $\mu g/m^3$. The ISC3 model predicted concentrations, using this approach, were also in the same range.

APPENDIX C

SAMPLE ISC INPUT FILE

```
****************************************
**
** ISCST3 Input Produced by:
** AERMOD View Ver. 6.0.0
** Lakes Environmental Software Inc.
** Date: 1/14/2009
** File: D:\30000 - Projects\34863 Hunsberger Pit\Lakes\Ph3 PM10 Process Only\Ph3P10Pr.INP
**
****************************************
** ISCST3 Control Pathway
****************************************
**
CO STARTING
   TITLEONE D:\30000 - Projects\34863 Hunsberger Pit\Lakes\Phase 3 TSP\ph3tsp.is
   MODELOPT CONC DDEP DRYDPLT  RURAL TOXICS AREADPLT
   AVERTIME 24 PERIOD
   POLLUTID TSP
   TERRHGTS FLAT
   RUNORNOT RUN
CO FINISHED
**
****************************************
** ISCST3 Source Pathway
****************************************
**
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
   LOCATION PH3 OPENPIT 541397.637 4821339.626
** DESCRSRC Phase 3 Pit
   LOCATION AREA1 AREA 541773.462 4821512.263
** DESCRSRC Hunsberger Rd Paved Crossing
   LOCATION HUNSRD AREA 541175.630 4821672.330
** DESCRSRC Hunsberger Road
   LOCATION AREA3 AREA 541791.948 4821579.384
** DESCRSRC Haul Rd 1
   LOCATION AREA4 AREA 541685.519 4821626.999
** DESCRSRC Haul Rd 2
   LOCATION PH7 OPENPIT 541462.925 4821728.224
** DESCRSRC Phase 7 Pit
   LOCATION AREA5 AREA 541697.038 4821687.622
** DESCRSRC Haul Rd 3
   LOCATION PH1 OPENPIT 541778.485 4821673.823
** DESCRSRC Phase 1 Pit
   LOCATION AREA6 AREA 542274.188 4821790.194
** DESCRSRC Entrance Haul Unpaved
   LOCATION AREA7 AREA 542669.418 4821720.574
** DESCRSRC Paved Entrance
```

```
   LOCATION KATHSTH AREA 542595.170 4821109.120
** DESCRSRC Katherine Street South
   LOCATION PH5 OPENPIT 542405.619 4821759.494
** DESCRSRC Phase 5 Pit
   LOCATION KATHNTH AREA 542698.766 4821704.842
** DESCRSRC Katherine Street North
** Source Parameters **
   SRCPARAM PH3 1.642E-06 2.000 360.000 250.000 360000.000 10.000
   SRCPARAM AREA1 5.672E-06 1.000 10.000 75.000 10.000 1.000
   SRCPARAM HUNSRD 3.301E-07 1.000 10.000 1500.000 101.460 1.000
   SRCPARAM AREA3 6.957E-06 1.000 10.000 115.000 -68.320 1.000
   SRCPARAM AREA4 6.95E-06 1.000 10.000 60.000 11.000 1.000
   SRCPARAM PH7 0 2.000 320.000 200.000 256000.000 10.000
   SRCPARAM AREA5 6.933E-06 1.000 10.000 150.000 41.600 1.000
   SRCPARAM PH1 9.03E-06 2.000 470.000 200.000 376000.000 10.000
   SRCPARAM AREA6 6.95E-06 1.000 10.000 400.000 100.000 1.000
   SRCPARAM AREA7 5.673E-06 1.000 10.000 30.000 100.000 1.000
   SRCPARAM KATHSTH 5.677E-06 1.000 10.000 620.000 10.000 1.000
   SRCPARAM PH5 0 2.000 180.000 400.000 288000.000 10.000
   SRCPARAM KATHNTH 5.678E-06 1.000 10.000 980.000 9.700 1.000

** Variable Emissions Type: "By Season / Hour"
** Variable Emission Scenario: "Scenario 1"
** Winter
   EMISFACT PH1 SEASHR 0 0 0 0 0 0
   EMISFACT PH1 SEASHR 0 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH1 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH1 SEASHR 0.2 0 0 0 0 0
** Spring
   EMISFACT PH1 SEASHR 0 0 0 0 0 0
   EMISFACT PH1 SEASHR 0 1 1 1 1 1
   EMISFACT PH1 SEASHR 1 1 1 1 1 1
   EMISFACT PH1 SEASHR 1 0 0 0 0 0
** Summer
   EMISFACT PH1 SEASHR 0 0 0 0 0 0
   EMISFACT PH1 SEASHR 0 1 1 1 1 1
   EMISFACT PH1 SEASHR 1 1 1 1 1 1
   EMISFACT PH1 SEASHR 1 0 0 0 0 0
** Fall
   EMISFACT PH1 SEASHR 0 0 0 0 0 0
   EMISFACT PH1 SEASHR 0 1 1 1 1 1
   EMISFACT PH1 SEASHR 1 1 1 1 1 1
   EMISFACT PH1 SEASHR 1 0 0 0 0 0
** Winter
   EMISFACT PH3 SEASHR 0 0 0 0 0 0
   EMISFACT PH3 SEASHR 0 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH3 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH3 SEASHR 0.2 0 0 0 0 0
```

```
** Spring
   EMISFACT PH3 SEASHR 0 0 0 0 0 0
   EMISFACT PH3 SEASHR 0 1 1 1 1 1
   EMISFACT PH3 SEASHR 1 1 1 1 1 1
   EMISFACT PH3 SEASHR 1 0 0 0 0 0
** Summer
   EMISFACT PH3 SEASHR 0 0 0 0 0 0
   EMISFACT PH3 SEASHR 0 1 1 1 1 1
   EMISFACT PH3 SEASHR 1 1 1 1 1 1
   EMISFACT PH3 SEASHR 1 0 0 0 0 0
** Fall
   EMISFACT PH3 SEASHR 0 0 0 0 0 0
   EMISFACT PH3 SEASHR 0 1 1 1 1 1
   EMISFACT PH3 SEASHR 1 1 1 1 1 1
   EMISFACT PH3 SEASHR 1 0 0 0 0 0
** Winter
   EMISFACT PH5 SEASHR 0 0 0 0 0 0
   EMISFACT PH5 SEASHR 0 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH5 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH5 SEASHR 0.2 0 0 0 0 0
** Spring
   EMISFACT PH5 SEASHR 0 0 0 0 0 0
   EMISFACT PH5 SEASHR 0 1 1 1 1 1
   EMISFACT PH5 SEASHR 1 1 1 1 1 1
   EMISFACT PH5 SEASHR 1 0 0 0 0 0
** Summer
   EMISFACT PH5 SEASHR 0 0 0 0 0 0
   EMISFACT PH5 SEASHR 0 1 1 1 1 1
   EMISFACT PH5 SEASHR 1 1 1 1 1 1
   EMISFACT PH5 SEASHR 1 0 0 0 0 0
** Fall
   EMISFACT PH5 SEASHR 0 0 0 0 0 0
   EMISFACT PH5 SEASHR 0 1 1 1 1 1
   EMISFACT PH5 SEASHR 1 1 1 1 1 1
   EMISFACT PH5 SEASHR 1 0 0 0 0 0
** Winter
   EMISFACT PH7 SEASHR 0 0 0 0 0 0
   EMISFACT PH7 SEASHR 0 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH7 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
   EMISFACT PH7 SEASHR 0.2 0 0 0 0 0
** Spring
   EMISFACT PH7 SEASHR 0 0 0 0 0 0
   EMISFACT PH7 SEASHR 0 1 1 1 1 1
   EMISFACT PH7 SEASHR 1 1 1 1 1 1
   EMISFACT PH7 SEASHR 1 0 0 0 0 0
** Summer
   EMISFACT PH7 SEASHR 0 0 0 0 0 0
   EMISFACT PH7 SEASHR 0 1 1 1 1 1
```

EMISFACT PH7 SEASHR 1 1 1 1 1 1
EMISFACT PH7 SEASHR 1 0 0 0 0 0
** Fall
EMISFACT PH7 SEASHR 0 0 0 0 0 0
EMISFACT PH7 SEASHR 0 1 1 1 1 1
EMISFACT PH7 SEASHR 1 1 1 1 1 1
EMISFACT PH7 SEASHR 1 0 0 0 0 0
** Winter
EMISFACT AREA1 SEASHR 0 0 0 0 0 0
EMISFACT AREA1 SEASHR 0 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA1 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA1 SEASHR 0.2 0 0 0 0 0
** Spring
EMISFACT AREA1 SEASHR 0 0 0 0 0 0
EMISFACT AREA1 SEASHR 0 1 1 1 1 1
EMISFACT AREA1 SEASHR 1 1 1 1 1 1
EMISFACT AREA1 SEASHR 1 0 0 0 0 0
** Summer
EMISFACT AREA1 SEASHR 0 0 0 0 0 0
EMISFACT AREA1 SEASHR 0 1 1 1 1 1
EMISFACT AREA1 SEASHR 1 1 1 1 1 1
EMISFACT AREA1 SEASHR 1 0 0 0 0 0
** Fall
EMISFACT AREA1 SEASHR 0 0 0 0 0 0
EMISFACT AREA1 SEASHR 0 1 1 1 1 1
EMISFACT AREA1 SEASHR 1 1 1 1 1 1
EMISFACT AREA1 SEASHR 1 0 0 0 0 0
** Winter
EMISFACT AREA3 SEASHR 0 0 0 0 0 0
EMISFACT AREA3 SEASHR 0 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA3 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA3 SEASHR 0.2 0 0 0 0 0
** Spring
EMISFACT AREA3 SEASHR 0 0 0 0 0 0
EMISFACT AREA3 SEASHR 0 1 1 1 1 1
EMISFACT AREA3 SEASHR 1 1 1 1 1 1
EMISFACT AREA3 SEASHR 1 0 0 0 0 0
** Summer
EMISFACT AREA3 SEASHR 0 0 0 0 0 0
EMISFACT AREA3 SEASHR 0 1 1 1 1 1
EMISFACT AREA3 SEASHR 1 1 1 1 1 1
EMISFACT AREA3 SEASHR 1 0 0 0 0 0
** Fall
EMISFACT AREA3 SEASHR 0 0 0 0 0 0
EMISFACT AREA3 SEASHR 0 1 1 1 1 1
EMISFACT AREA3 SEASHR 1 1 1 1 1 1
EMISFACT AREA3 SEASHR 1 0 0 0 0 0
** Winter

EMISFACT AREA4 SEASHR 0 0 0 0 0 0
EMISFACT AREA4 SEASHR 0 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA4 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA4 SEASHR 0.2 0 0 0 0 0
** Spring
EMISFACT AREA4 SEASHR 0 0 0 0 0 0
EMISFACT AREA4 SEASHR 0 1 1 1 1 1
EMISFACT AREA4 SEASHR 1 1 1 1 1 1
EMISFACT AREA4 SEASHR 1 0 0 0 0 0
** Summer
EMISFACT AREA4 SEASHR 0 0 0 0 0 0
EMISFACT AREA4 SEASHR 0 1 1 1 1 1
EMISFACT AREA4 SEASHR 1 1 1 1 1 1
EMISFACT AREA4 SEASHR 1 0 0 0 0 0
** Fall
EMISFACT AREA4 SEASHR 0 0 0 0 0 0
EMISFACT AREA4 SEASHR 0 1 1 1 1 1
EMISFACT AREA4 SEASHR 1 1 1 1 1 1
EMISFACT AREA4 SEASHR 1 0 0 0 0 0
** Winter
EMISFACT AREA5 SEASHR 0 0 0 0 0 0
EMISFACT AREA5 SEASHR 0 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA5 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA5 SEASHR 0.2 0 0 0 0 0
** Spring
EMISFACT AREA5 SEASHR 0 0 0 0 0 0
EMISFACT AREA5 SEASHR 0 1 1 1 1 1
EMISFACT AREA5 SEASHR 1 1 1 1 1 1
EMISFACT AREA5 SEASHR 1 0 0 0 0 0
** Summer
EMISFACT AREA5 SEASHR 0 0 0 0 0 0
EMISFACT AREA5 SEASHR 0 1 1 1 1 1
EMISFACT AREA5 SEASHR 1 1 1 1 1 1
EMISFACT AREA5 SEASHR 1 0 0 0 0 0
** Fall
EMISFACT AREA5 SEASHR 0 0 0 0 0 0
EMISFACT AREA5 SEASHR 0 1 1 1 1 1
EMISFACT AREA5 SEASHR 1 1 1 1 1 1
EMISFACT AREA5 SEASHR 1 0 0 0 0 0
** Winter
EMISFACT AREA6 SEASHR 0 0 0 0 0 0
EMISFACT AREA6 SEASHR 0 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA6 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
EMISFACT AREA6 SEASHR 0.2 0 0 0 0 0
** Spring
EMISFACT AREA6 SEASHR 0 0 0 0 0 0
EMISFACT AREA6 SEASHR 0 1 1 1 1 1
EMISFACT AREA6 SEASHR 1 1 1 1 1 1

```
   EMISFACT AREA6 SEASHR 1 0 0 0 0 0
** Summer
   EMISFACT AREA6 SEASHR 0 0 0 0 0 0
   EMISFACT AREA6 SEASHR 0 1 1 1 1 1
   EMISFACT AREA6 SEASHR 1 1 1 1 1 1
   EMISFACT AREA6 SEASHR 1 0 0 0 0 0
** Fall
   EMISFACT AREA6 SEASHR 0 0 0 0 0 0
   EMISFACT AREA6 SEASHR 0 1 1 1 1 1
   EMISFACT AREA6 SEASHR 1 1 1 1 1 1
   EMISFACT AREA6 SEASHR 1 0 0 0 0 0
** Winter
   EMISFACT AREA7 SEASHR 0 0 0 0 0 0
   EMISFACT AREA7 SEASHR 0 0.2 0.2 0.2 0.2 0.2
   EMISFACT AREA7 SEASHR 0.2 0.2 0.2 0.2 0.2 0.2
   EMISFACT AREA7 SEASHR 0.2 0 0 0 0 0
** Spring
   EMISFACT AREA7 SEASHR 0 0 0 0 0 0
   EMISFACT AREA7 SEASHR 0 1 1 1 1 1
   EMISFACT AREA7 SEASHR 1 1 1 1 1 1
   EMISFACT AREA7 SEASHR 1 0 0 0 0 0
** Summer
   EMISFACT AREA7 SEASHR 0 0 0 0 0 0
   EMISFACT AREA7 SEASHR 0 1 1 1 1 1
   EMISFACT AREA7 SEASHR 1 1 1 1 1 1
   EMISFACT AREA7 SEASHR 1 0 0 0 0 0
** Fall
   EMISFACT AREA7 SEASHR 0 0 0 0 0 0
   EMISFACT AREA7 SEASHR 0 1 1 1 1 1
   EMISFACT AREA7 SEASHR 1 1 1 1 1 1
   EMISFACT AREA7 SEASHR 1 0 0 0 0 0

** Variable Emissions Type: "By Hour-of-Day"
** Variable Emission Scenario: "Scenario 3"
   EMISFACT HUNSRD HROFDY 0.051 0.054 0.062 0.051 0.054 0.137
   EMISFACT HUNSRD HROFDY 0.389 0.727 0.689 0.429 0.448 0.453
   EMISFACT HUNSRD HROFDY 0.408 0.434 0.539 0.74 0.933 1
   EMISFACT HUNSRD HROFDY 0.665 0.402 0.472 0.252 0.22 0.201
   EMISFACT KATHNTH HROFDY 0.051 0.054 0.062 0.051 0.054 0.137
   EMISFACT KATHNTH HROFDY 0.389 0.727 0.689 0.429 0.448 0.453
   EMISFACT KATHNTH HROFDY 0.408 0.434 0.539 0.74 0.933 1
   EMISFACT KATHNTH HROFDY 0.665 0.402 0.472 0.252 0.22 0.201
   EMISFACT KATHSTH HROFDY 0.051 0.054 0.062 0.051 0.054 0.137
   EMISFACT KATHSTH HROFDY 0.389 0.727 0.689 0.429 0.448 0.453
   EMISFACT KATHSTH HROFDY 0.408 0.434 0.539 0.74 0.933 1
   EMISFACT KATHSTH HROFDY 0.665 0.402 0.472 0.252 0.22 0.201
   PARTDIAM PH7 1.6 3.9 7.8
   PARTDIAM AREA1 1.6 3.9 7.8
```

```
  PARTDIAM AREA3 1.6 3.9 7.8
  PARTDIAM AREA4 1.6 3.9 7.8
  PARTDIAM AREA5 1.6 3.9 7.8
  PARTDIAM AREA6 1.6 3.9 7.8
  PARTDIAM AREA7 1.6 3.9 7.8
  PARTDIAM HUNSRD 1.6 3.9 7.8
  PARTDIAM KATHNTH 1.6 3.9 7.8
  PARTDIAM KATHSTH 1.6 3.9 7.8
  PARTDIAM PH1 1.6 3.9 7.8
  PARTDIAM PH3 1.6 3.9 7.8
  PARTDIAM PH5 1.6 3.9 7.8
  MASSFRAX PH7 0.363 0.225 0.411
  MASSFRAX AREA1 0.363 0.225 0.411
  MASSFRAX AREA3 0.363 0.225 0.411
  MASSFRAX AREA4 0.363 0.225 0.411
  MASSFRAX AREA5 0.363 0.225 0.411
  MASSFRAX AREA6 0.363 0.225 0.411
  MASSFRAX AREA7 0.363 0.225 0.411
  MASSFRAX HUNSRD 0.363 0.225 0.411
  MASSFRAX KATHNTH 0.363 0.225 0.411
  MASSFRAX KATHSTH 0.363 0.225 0.411
  MASSFRAX PH1 0.363 0.225 0.411
  MASSFRAX PH3 0.363 0.225 0.411
  MASSFRAX PH5 0.363 0.225 0.411
  PARTDENS PH7 2 2 2
  PARTDENS AREA1 2 2 2
  PARTDENS AREA3 2 2 2
  PARTDENS AREA4 2 2 2
  PARTDENS AREA5 2 2 2
  PARTDENS AREA6 2 2 2
  PARTDENS AREA7 2 2 2
  PARTDENS HUNSRD 2 2 2
  PARTDENS KATHNTH 2 2 2
  PARTDENS KATHSTH 2 2 2
  PARTDENS PH1 2 2 2
  PARTDENS PH3 2 2 2
  PARTDENS PH5 2 2 2
  SRCGROUP UNPAVEDR AREA3 AREA4 AREA5 AREA6
  SRCGROUP PHASE3PI PH3
  SRCGROUP PROCESSI PH1
  SRCGROUP ALL
SO FINISHED
****************************************
** ISCST3 Receptor Pathway
****************************************
RE STARTING
** DESCRREC "" ""
  DISCCART    542766.09   4821529.73
```

```
   DISCCART    542772.60   4822396.33
   DISCCART    542007.47   4820728.70
   DISCCART    542411.68   4821391.74
   DISCCART    541227.63   4821310.05
   DISCCART    541271.94   4821211.51
   DISCCART    541149.41   4821536.96
   DISCCART    541215.96   4821620.13
   DISCCART    541242.61   4821868.97
   DISCCART    542409.67   4820840.23
…
RE FINISHED
****************************************
** ISCST3 Meteorology Pathway
****************************************
ME STARTING
   INPUTFIL D:\30000-~1\34863H~1\Lakes\to0105df.met
   ANEMHGHT 10 METERS
   SURFDATA 61444 2001 LONDON
   UAIRDATA 72632 2001
ME FINISHED
****************************************
** ISCST3 Output Pathway
****************************************
OU STARTING
   RECTABLE ALLAVE 1ST
   RECTABLE 24 1ST
   MAXTABLE ALLAVE 200
   MAXIFILE 24 ALL 25 PH3P10PR.IS\ph3pm10.MAX
** Auto-Generated Plotfiles
   PLOTFILE 24 ALL 1ST PH3P10PR.IS\24H1GALL.PLT
   PLOTFILE PERIOD ALL PH3P10PR.IS\PE00GALL.PLT
   PLOTFILE 24 UnpavedR 1ST PH3P10PR.IS\24H1G001.PLT
   PLOTFILE PERIOD UnpavedR PH3P10PR.IS\PE00G001.PLT
   PLOTFILE 24 Phase3Pi 1ST PH3P10PR.IS\24H1G002.PLT
   PLOTFILE PERIOD Phase3Pi PH3P10PR.IS\PE00G002.PLT
   PLOTFILE 24 Processi 1ST PH3P10PR.IS\24H1G003.PLT
   PLOTFILE PERIOD Processi PH3P10PR.IS\PE00G003.PLT
OU FINISHED
****************************************
** Project Parameters
****************************************
** PROJCTN  CoordinateSystemUTM
** DESCPTN  UTM: Universal Transverse Mercator
** DATUM    North American Datum 1983
** DTMRGN   CONUS
** ZONE     17
```

APPENDIX D

WORST CASE SCENARIO SENSITIVITY ANALYSIS

FIGURE D3-1 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 3 – 100% SCREENING AT FACE

FIGURE D3-2 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 3 – 100% PROCESSING

PM_{10} 24-hr Average AAQC = 50 µg/m^3

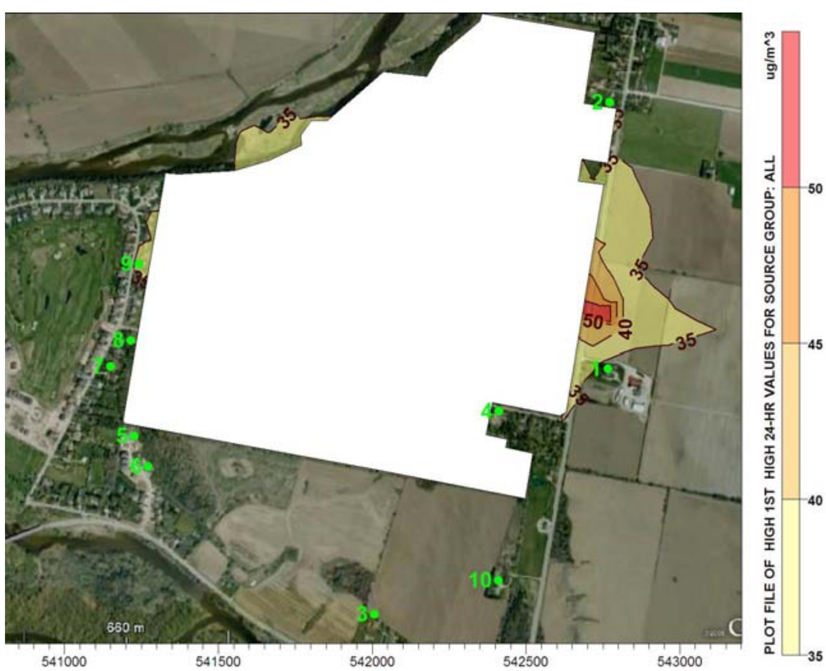
FIGURE D3-3 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 3 – 50% SCREENING AT FACE 50% PROCESSING

FIGURE D5-1 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 5 – 100% SCREENING AT FACE

PM_{10} 24-hr Average AAQC = 50 μg/m^3

FIGURE D5-2 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 5 – 100% PROCESSING

FIGURE D5-3 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 5 – 50% SCREENING AT FACE 50% PROCESSING



PM_{10} 24-hr Average AAQC = 50 µg/m^3

FIGURE D7-1 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 7 – 100% SCREENING AT FACE

FIGURE D7-2 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 7 – 100% PROCESSING

PM_{10} 24-hr Average AAQC = 50 μg/m^3

FIGURE D7-3 – PREDICTED 24-HOUR AVERAGE PM_{10} CONCENTRATIONS PHASE 7 – 50% SCREENING AT FACE 50% PROCESSING

PM_{10} 24-hr Average AAQC = 50 µg/m³

APPENDIX E

PROPOSED BEST MANAGEMENT PLAN FOR FUGITVE DUST

D.0 BEST MANAGEMENT PLAN

The following presents potential sources of fugitive dust at the Hunsberger Pit as well as actions to control and mitigate these sources.

D.1 POTENTIAL SOURCES OF FUGITIVE DUST

Due to the nature of activities at a sand and gravel operation, there are several on-site sources at the Hunsberger Pit that could potentially contribute to fugitive dust emissions. These are as follows:

- truck travel on site entrance road;
- loader travel on unpaved roads;
- material processing and handling (conveying, loading, crushing and screening of aggregate); and
- stockpiling (raw and processed materials).

The fugitive dust generated by these sources and activities arises from processing or pulverizing crustal materials, and thus generally does not have significant amounts of other contaminants associated with it. Also, a significant portion of the fugitive dust from these sources is in the coarse fraction which tends to result in nuisance effects; only a small fraction of the dust is in the respirable range, which is of most concern from a health perspective.

In many instances, fugitive dust emissions depend on the wind speed at any given time as well as the activity rates. Thus the amount of effort necessary to control such emissions is greater during windy conditions than during calm conditions.

D.2 REQUIRED CONTROL ACTIONS

In general, most approaches for controlling fugitive dust involve the application of water to prevent the fugitive emissions from being generated. Depending on the source, there are other measures that are used to remove the source of the dust, and/or reduce the impact of the emissions when they occur. These are discussed in the following sections.

D.2.1 Application of Water to the Site Entrance Road and Internal Haul Route

As required by the Ministry of Natural Resources (MNR), water will be applied to the site entrance road and internal loader routes to mitigate fugitive dust. In the assessment, sufficient water was assumed to be applied to achieve a control efficiency of 80% on the paved entrance road and unpaved site roads travelled by non-road equipment (loaders, etc) and by product trucks that will be used to ship finished materials off site. These levels of control are reasonably achievable, and necessary to prevent excessive off-site emissions.

In order to achieve the level of control that is required to meet the levels that were used in the completion of this study, the following actions are recommended:

- all unpaved roads should be watered at a sufficient frequency to control dust generation due to vehicle travel;
- vehicle speeds on unpaved haul roads should remain at 20 km/h or less;
- the site entrance road should be hard surfaced to reduce dust emissions and prevent track-out;
- a site water truck should be equipped with both drip/spray bars as well as a high power canon spray to flush mud/dust off of paved roads; and
- the site entrance road should be cleaned periodically using high pressure flushing and/or vacuum sweeping (as practicable) to prevent mud track out onto Katherine Street and reduce dust generation.

An operational watering scheme that is based on the activity levels and meteorological conditions will be developed and followed by trained site personnel, to ensure that watering is completed frequently enough to adequately control fugitive dust emissions. For the purpose of illustration, the following scheme is included as an example of the type of system that could be developed at the Hunsberger Pit.

D.2.1.1 Example Operational Watering Scheme

Internal haul routes (both within the pit and at grade) will be treated with water as necessary for dust control. The capability for main internal haul truck watering will provide for the required number of passes per hour, as needed to achieve the recommended dust control efficiency.

For operational purposes, a scheme based on the type of day (hot/dry/windy, warm/overcast, cool/overcast, rainy) that prescribes the recommended watering frequency based on the number of truck passes and the length of road, is suggested, as presented below:

- During very hot, dry and sunny conditions (typical of July or August) or windy days (i.e. greater than 20 km/h), sufficient water will be applied to all in-pit roads for these conditions, depending on the traffic level;

- During moderately warm, dry conditions (late spring & fall), sufficient water will be applied to in-pit unpaved roads for these conditions, depending on the traffic level; and

- During wet or rainy periods, the roads generally will not be watered.

The scheme presented above will be adjusted as conditions dictate. For example, roads will definitely be watered regardless of the "rules" if there is visible, or blowing dust. A site specific watering table will be produced as part of the dust management plan following approval of the final site design.

D.2.2 Application of Water to Material Handling and Processing

This assessment was completed assuming that crushing and screening equipment will not have any water sprays to reduce dust emissions. The assessment assumed that no controls will be used on material drops from loaders, excavators and stackers. However, should problems with fugitive dust arise, installation of spray bars on processing equipment will be considered.

D.2.3 Application of Water to Material Storage Piles

Depending on the amount of "fines" present in the material, windblown dust from material storage piles can occur. The assessment was completed with the conservative assumption that wind erosion will occur at all wind speeds. In addition, it was assumed that no controls will be specifically employed to mitigate this source. Should emissions from storage piles become a problem, the piles will be sprayed with water or another approved dust suppressant as necessary to reduce windblown dust.

D.2.4 Record Keeping

A daily log of water applications and other dust control procedures and observations should be kept at the site to demonstrate, if necessary, that dust control actions are being taken.

D.2.5 Control of On-site Contractors

On-site contractors will be required to meet the same requirements as set out in this Best Management Plan at all times that they are on-site.

D.3 RECOMMENDED ACTIONS FOR IMPROVED CONTROL

In addition to the procedures outlined above, SENES recommends that the following options also be considered to further reduce the potential for off-site dust emissions:

- Apply calcium chloride or other chemical dust suppressants annually or semi-annually, if permitted by the ARA license; and
- Ensure that the site perimeter berms and surrounding area be sufficiently vegetated.
    - It is important to note that as trees and shrubs grow, some will become tall, while others will remain short; some will spread, while others will remain columnar. The mature plant characteristics of the selected species should be examined to determine the appropriate plant spacing and placement, such that a good screen is produced once all plants reach their ultimate height and spread.
    - The plantings should contain a mix of coniferous and deciduous species, such that some screening potential remains after the leaves have fallen off of the deciduous plants.

D.4 ENVIRONMENTAL COMPLAINT DOCUMENTATION AND RESPONSE PROCEDURE

SENES recommends that a complaint documentation and response procedure be established for the Hunsberger Pit, such that standardized procedures are followed in the event that a complaint is made by a member of the public. The documentation should include the date and time of the complaint, the nature of the problem, and whether any follow-up action was taken. The complaint information should be maintained in an on-site log that is available for review by the MOE, if requested.

A sample form is included on the following page.

RECORD OF ENVIRONMENTAL COMPLAINT AND RESPONSE

1. Location: ____

2. Date and Time Complaint Received: ________________________________

3. Name of Complainant: ____

   Address: ____

   Telephone Number: ____

4. Form of Complaint and Summary: Visit:[ ] Telephone Call:[ ] Letter:[ ] Attach Copy
   Other ____

5. Complaint Referred to Technical Services: No [ ] Yes [ ] and provide details:
   ____

6. Contact Made With Government Official(s): No [ ] Yes [ ]
   If Yes, Complete and Attach Record of Government Environmental Official Contact Form -- Yes [ ]

7. Details Concerning Investigation Made by Company Concerning Complaint:
   ____
   ____

8. Response to Complainant:
   Letter [ ] Date ____________________ Attach copy of letter to this form.

   Telephone Call [ ] Date __________________ Time ________________

   Summary of Telephone Call:
   ____
   ____

9. Follow-up Action Required and/or Taken by Company: None [ ] Details:
   ____
   ____
   ____

10. Filed Original Form in the Plant Environmental Manual: Yes [ ]

   Date ____________________ ______________________________
   Employee Signature, Name & Position