ATMOSPHERIC IMPACT ASSESSMENT

FOR THE PROPOSED EXPANSION OF MASKAM LIME MINE

Commissioned by:

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Table of Contents

1 INTRODUCTION....1

1.1 Terms of Reference....1

2 ENTERPRISE DETAILS....2

2.1 Enterprise Details....2

2.2 Location and Extent of Plant....3

2.3 Atmospheric Emission Licence and Other Authorisations....4

3 NATURE OF PROCESS....5

3.1 Listed Activities....5

3.2 Mining and Processing Description....5

3.3 Unit Processes....6

4 TECHNICAL INFORMATION....8

4.1 Raw Materials Used....8

4.2 Production Rates....8

4.3 Materials Used in Energy Sources....8

4.4 Appliances and Abatement Equipment Control Technology....8

5 ATMOSPHERIC EMISSIONS....9

5.1 Point Source Parameters....9

5.2 Point Source Maximum Emission Rates (normal operating conditions)....9

5.3 Point Source Maximum Emission Rates (start-up, shut-down, upset and maintenance conditions)....10

5.4 Fugitive Emissions (area and or line sources)....10

5.5 Emergency Incidents....15

6 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT....16

6.1 Analysis of Emissions' Impact on Human Health....16

6.2 Analysis of Emissions' Impact on the Environment....31

7 COMPLAINTS....38

8 PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS....39

9 COMPLIANCE AND ENFORCEMENT HISTORY....40

10 ADDITIONAL INFORMATION....41

11 FORMAL DECLARATIONS....42

12 REFERENCES....43

List of Figures page

Figure 2-1. Locality Map 4
Figure 3-1. Process Flow Diagram 7
Figure 6-1. Monthly Temperature Profile 20
Figure 6-2. Monthly Precipitation Profile 21
Figure 6-3. Wind Roses & Wind Speed Frequency Distribution: All-hours, Daytime and Night-time 22
Figure 6-4. Wind Roses & Wind Speed Frequency Distribution: Winter and Summer 23
Figure 6-5. Dust Daily Deposition (Guideline: 600 $mg/m^2/day$) 25
Figure 6-6. Maximum 24-Hour PM_{10} Concentrations (Guideline: 75 $\mu g/m^3$) 26
Figure 6-7. Maximum Annual PM_{10} Concentrations (Guideline: 40 $\mu g/m^3$) 27
Figure 6-8. NO_2 1-hr Concentrations 99th Percentile (Guideline: 200 $\mu g/m^3$) 28
Figure 6-9. NO_2 Annual Concentrations (Guideline: 40 $\mu g/m^3$) 29
Figure 6-10. CO 1-hr Maximum Concentrations (Guideline 30,000 $\mu g/m^3$) 30
Figure 6-11. GHG Protocol Scopes and Emissions Overview 33

List of Tables page

Table 2-1. Enterprise Details 2
Table 2-2. Contact Details of Responsible Person 2
Table 2-3. Location and Extent of Plant 3
Table 3-1. Listed Activities 5
Table 3-2. Operating Hours 6
Table 3-3. Unit Processes 6
Table 4-1. Raw Materials 8
Table 4-2. Production Rates 8
Table 4-3. Materials Used in Energy Sources 8
Table 4-4. Raw Materials 8
Table 5-1. Point Source Parameters 9
Table 5-2. Point Source Emission Rates during Normal Operating Conditions 9
Table 5-3. Waste and Ore Production Rates 12
Table 5-4. Emission Factors for Open Pit Mining 12
Table 5-5. Emission Factors for Crushing 13
Table 5-6. Stockpiles 13
Table 5-7. Constants for Equation 4-1 14
Table 5-8. Emission Quantities 15
Table 6-1. National Ambient Air Quality Standards 16
Table 6-2. Four-band Scale Evaluation Criteria for Dust Deposition (SANS 1929:2011) 17
Table 6-3. Target, Action and Alert Thresholds for Dust Deposition (SANS 1929:2011) 17
Table 6-4. Acceptable Dust Fall Rates 18
Table 6-5. Emission Limits: Drying and Calcining 18
Table 6-6. Emission Limits: Lime Production 19
Table 6-7. Operational Impact 31
Table 6-8. Plant-Specific Limestone Analysis 34

Table 6-9. Emission Factor 34
Table 6-10. CO_2 Emissions Summary 36
Table 6-11. Net CO_2 Emissions 37

GLOSSARY AND ABBREVIATIONS

$CaCO_3$	Calcium carbonate
CaO	Calcium oxide
DDA	DDA Environmental Engineers
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
EIA	Environmental Impact Assessment
GHG	Greenhouse gas
LKD	Limekiln dust
Kg/d	Kilogram per day
Kwh	Kilowatt-hour
m/s	Meter per second
Mg	Megagram
$MgCO_3$	Magnesium carbonate
$mg/m^2/day$	Milligram per square meter per day
mg/Nm^3	Milligram per normal cubic meter
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
P_2O_5	Phosphorus pentoxide
PM_{10}	Particulate matter with aerodynamic diameters of 10 micrometres or less.
$PM_{2.5}$	Particulate matter with aerodynamic diameters of 2.5 micrometres or less.
SANS	South African National Standard
SO_2	Sulphur dioxide
TJ	Terajoule, = 10^{12} joules
USEPA	US Environmental Protection Agency
UTM	Universal Transverse Mercator coordinate system

1 INTRODUCTION

Cape Lime (Pty) Ltd, a subsidiary of Afrimat Ltd, currently mine and process limestone and dolomite on the Farm Vaderlandsche Rietkuil in Matzikama Municipality on the West Coast, Western Cape Province. Cape Lime is proposing to expand its operation due to high market demands for lime products.

The proposed mining area is situated on Portion 4 of Farm Welverdiend No 511. The site lies adjacent to the N7 road, approximately 6 km south of Vanrhynsdorp and 13 km north-east of Klawer. The proposed project entails the clearing of ±40 ha of virgin (undeveloped) land for mining limestone deposits, the erection of a crushing plant, 4 Fluid Bed Lime Calciners and associated supporting services.

DDA Environmental Engineers (DDA) was appointed by Afrimat (Pty) Ltd to undertake the atmospheric impact assessment for the establishment of the proposed mine and associated infrastructure. This report identifies, quantifies the mining and processing-related air pollution and assesses the resulting impacts that are likely to occur in the surrounding areas of the proposed mine. The report forms part of the Draft and Final Environmental Impact Assessment (EIA) Report and Environmental Management Programme of the project mentioned above.

1.1 Terms of Reference

The terms of reference of the air quality impact study are as follows:

- Identify air pollutants emitted during the mining and processing operations for the atmospheric impact assessment;
- Establish an emissions inventory for identified air pollutants;
- Predict the highest daily and annual air pollutant concentrations utilising atmospheric dispersion modelling;
- Compare the resulting concentrations against relevant South African standards and guidelines;
- Assess the expected impacts due to the operation of the proposed mine; and
- Identify emission reduction opportunities and cost-effective emission abatement strategies, if necessary.

2 ENTERPRISE DETAILS

2.1 Enterprise Details

The details of the Dolomitic Limestone Mine are summarised in Table 2-1. The contact details of the responsible person, the emission control officer, are provided in Table 2-2.

Table 2-1. Enterprise Details

Enterprise Name	Cape Lime (Pty) Ltd
Trading As	
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc	Company
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture)	1999/002171/07
Registered Address	Karoovlakte, Vredendal
Postal Address	PO Box 400, Vredendal, 8160
Telephone Number (General)	027 2133090
Fax Number (General)	027 2132573
Industry Type/Nature of Trade	Mining
Land Use Zoning as per Town Planning Scheme	Agriculture, with a 30-year land use departure authorization for mining activities.
Land Use Rights if outside Town Planning Scheme	

Table 2-2. Contact Details of Responsible Person

Responsible Person Name:	Gerhard Terblanche
Responsible Person Post:	Managing Director
Telephone Number	027 2011202
Cell Phone Number	0825531734
Fax Number	027 2132573
E-mail Address	gerhard.terblanche@afrimat.co.za
After Hours Contact Details	082 5531734

2.2 Location and Extent of Plant

Table 2-3. Location and Extent of Plant

Physical Address of the Plant	The Dolomitic Limestone Mine
Description of Site (Where No Street Address)	Portion 4 of Farm Welverdiend No 511
Coordinates of Approximate Centre of Operations	North-south: 31°41'16.35"S East-west: 18°42'33.81"E
Extent (km²)	0.44
Elevation Above Mean Sea Level (m)	126
Province	Western Cape
Metropolitan/District Municipality	West Coast District Municipality
Local Municipality	Matzikama Local Municipality
Designated Priority Area	N/A

Description of surrounding land use (within 5 km radius)

The proposed mining area is situated on Portion 4 of Farm Welverdiend No 511. The site lies adjacent to the N7 road, approximately 8.5 km south of Vanrhynsdorp and 13 km north-east of Klawer. The total footprint of the mining development on the Remainder of Farm 511 will be ± 34 ha for the process plant and ±10 ha for the logistical facilities (see Figure 2-1 below).

The site is almost entirely undeveloped natural veld and is currently zoned for agriculture (Agriculture I). The surrounding area is mostly untransformed and used for grazing (sheep farming).

There are no communities exist within the close vicinity of the proposed site. The only dwellings within the 5 km radius are two farm houses to the east and south of the mine. The nearest town is Vanrhynsdorp, approximately 8.5 km north of the mine.

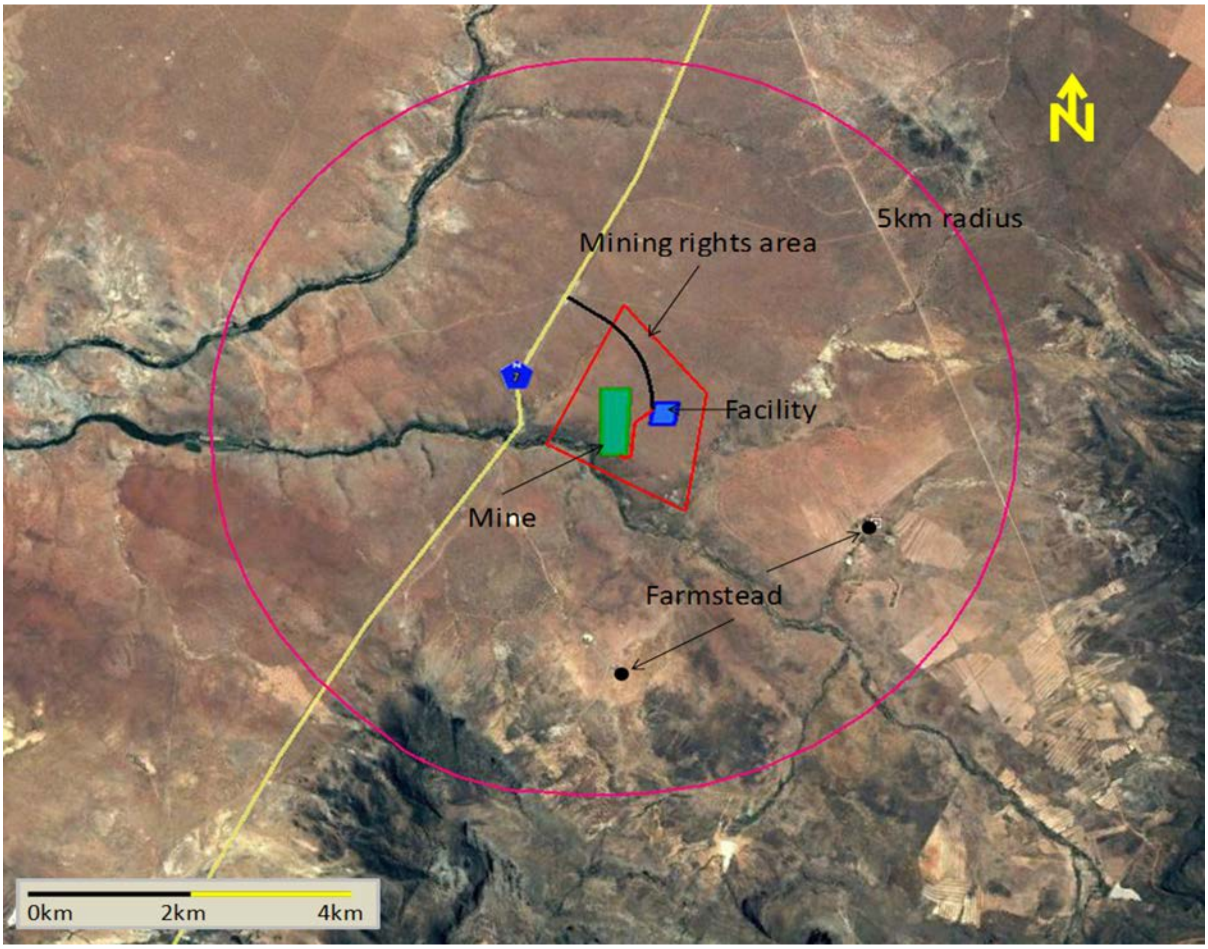


Figure 2-1. Locality Map

2.3 Atmospheric Emission Licence and Other Authorisations

There is no atmospheric emission licence or other authorisations for the plant.

3 NATURE OF PROCESS

3.1 Listed Activities

The listed activity to be undertaken at the mine is shown in Table 3-1.

Table 3-1. Listed Activities

Category of Listed Activity	Sub-category of the Listed Activity	Description of the Listed Activity
4: Metallurgical Industry	4.1: Drying and Calcining	Drying and calcining of mineral solids including ore. Facilities with a capacity of more than 100 tons/month product.
5: Mineral Processing, Storage and Handling	5.6 Lime Production	Processing of lime, magnesite, dolomite and calcium sulphate.

3.2 Mining and Processing Description

The proposed project entailed the clearing of ±40 ha of virgin (undeveloped) land for mining limestone deposits, the erection of a crushing plant, four Fluid Bed Lime Calciners and associated supporting services. The proposed layout will allow for the phased introduction of four kilns into the process line, as and when they are required and justified. The infrastructure will also include related logistical facilities, workshops and an office complex. The air quality impact study is based on the full production capacity, which entails the simultaneous operation of four kilns.

Access roads to the facilities will be extended from the existing tarred access road from the N7.

Mining:

The mining process will be as follows. The overburden is firstly removed to expose the ore before drilling and blasting can take place, according to a structured mining plan. Blasted ore is loaded by an excavator on three twenty-tonne trucks and transported to the crushing plant. The distance from the mining site (quarry) to the crushing plant is approximately 500 m. The mining operation will be conducted on a 42.5 hour per week basis.

Crushing Plant:

The crushing plant can be separated into two sections – namely the primary and secondary sections. Run-of-mine from the quarry is tipped into the feed bin from where the ore is fed via a grizzly feeder into a jaw crusher. The grizzly feeder removes the material with a particle size less than 120 mm. The oversize material from the feeder is directed through the jaw crusher joins to be crushed and the undersize on a conveyor belt that feeds a stockpile.

The stockpiled material is then processed through a series of screening and further crushing stages (Secondary Crushing). The products produced during this comminution stages are crusher dust (< 4 mm), agricultural lime (< 1 mm) and kiln feed stockpile (1mm to 6mm).

Limestone Calcination Plant:

The lime kilns will be fed by a common limestone feed conveyor, drawing from underneath the limestone stockpile. The coal to be used as fuel in the kilns will also be fed from underneath a coal stockpile, via a common coal conveyor, to the respective kilns. Limestone ($CaCO_3$) is calcined at ±920°C to obtain quicklime (CaO) using coal as fuel. The plant is fully automated, and all of the process parameters are to be monitored and controlled.

Lime produced will be stored in silos before being dispatched to various clients in bulk tanker or bulk bags. The operation of the kilns will be, by nature of the process, a continuous operation.

All exhaust gas streams pass through bag filter units to be cleaned before being released into the atmosphere. The material obtained at the bag filter units is stored separately as Product and Preheater material. The Product bag filter material is routed to the final product stream and transferred to the product silos. The Preheater material is a waste and will be dumped.

Quicklime production at the calcination units will take place on a 24 hour per day basis.

The process flow diagram is shown in Figure 3-1. The operation hours of various activities at the mine are as follows:

Table 3-2. Operating Hours

Activity	Hours/day	Actual hours/day	Utilization	Days/Annum
Mining	8.5	6.8	80%	244
Crushing plant-primary	8.5	6.8	80%	244
Crushing plant-secondary	24	19.2	80%	330
Calcination plant	24	22.8	95%	330

3.3 Unit Processes

Table 3-3. Unit Processes

Unit Process	Unit Process Function	Batch or Continuous Process
Crushing Plant	The run-of-mine is fed through a series of crushing and screening stages and size reduced to 1mm-6mm.	Continuous
Fluid bed lime calciners (x 4)	Limestone is calcined at ±920°C to obtain quicklime using coal as fuel.	Continuous

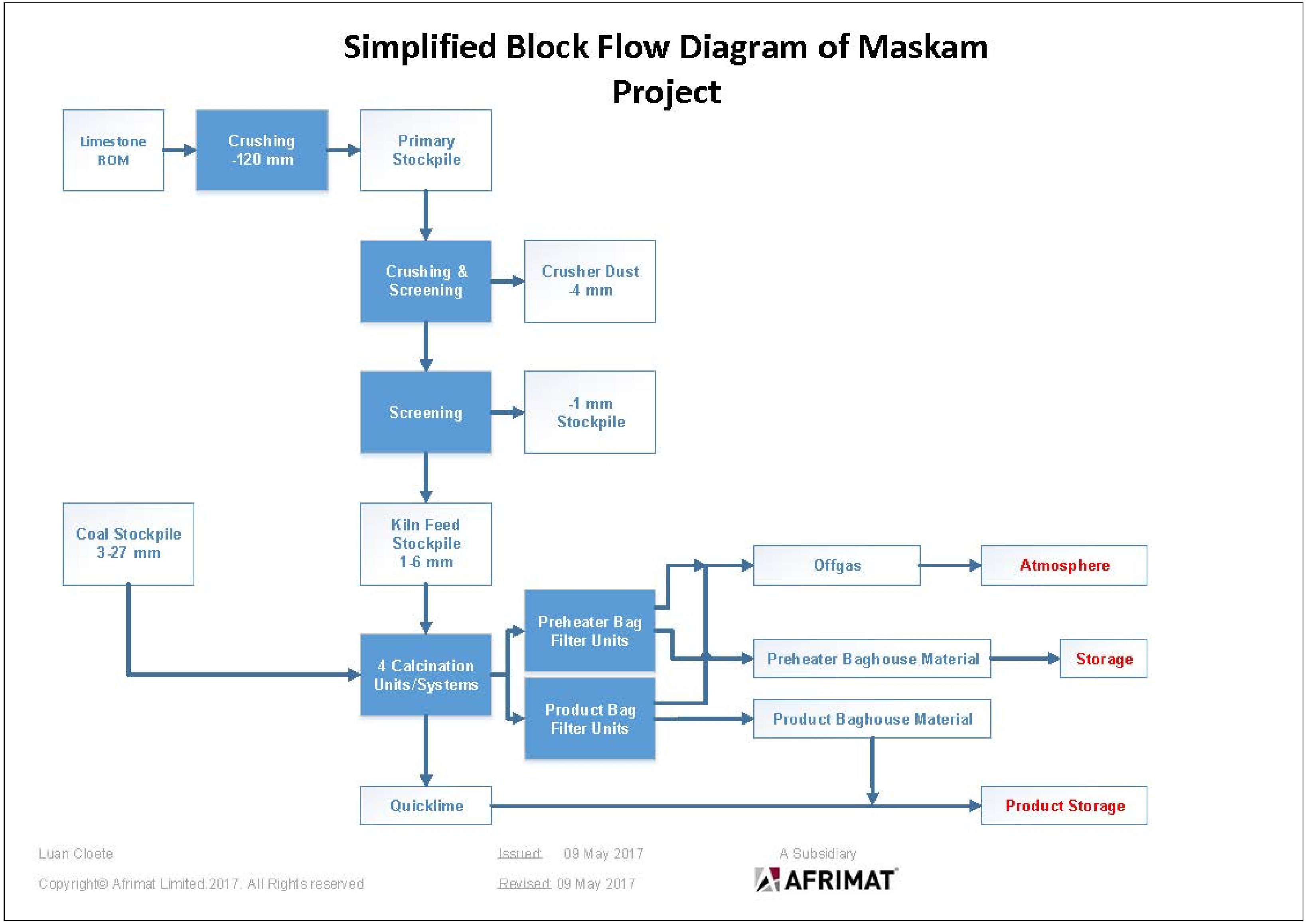


Figure 3-1. Process Flow Diagram

4 TECHNICAL INFORMATION

4.1 Raw Materials Used

Table 4-1. Raw Materials

Unit Process	Raw Material Type	Design Consumption Rate	Units
Fluid bed lime calciners (x 4)	Crushed limestone (1mm-6mm)	302,400	Tonnes/annum
Design capacity is calculated based on 80% utilization.			

4.2 Production Rates

Table 4-2. Production Rates

Product	Design Production Capacity (volume)	Units (quantity/period)
Crusher dust [a]	172,800	Tonnes/annum
Agricultural lime [a]	100,800	Tonnes/annum
Quick lime (CaO) [b]	151,200	Tonnes/annum
[a.] The products from mining section. [b.] The product from calcination section.		

4.3 Materials Used in Energy Sources

Table 4-3. Materials Used in Energy Sources

Materials for Energy	Sulphur Content of the Material	Ash Content of Material (%)	Design Consumption Rate	Units (quantity/period)
Coal	< 0.67%	14%	102.2	Tonnes/day

4.4 Appliances and Abatement Equipment Control Technology

Table 4-4. Raw Materials

Appliance Name	Appliance Type / Description	Appliance Function / Purpose
Bag filter unit	Fabric filter	The baghouse/fabric filter is an air pollution control device that removes particulates out of the exhaust air released from the calcination process.

5 ATMOSPHERIC EMISSIONS

5.1 Point Source Parameters

Table 5-1. Point Source Parameters

Point source number	Point source name	Point source coordinates	Height of Release Above Ground (m)	Height Above Nearby Building (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow (m³/hr)	Actual Gas Exit Velocity (m/s)	Type of emission (continuous / batch)
ST1	Calcination stack	-31.686005° 18.715935° (preliminary)	33	23	1.5	116	114,384	17.98	continuous

5.2 Point Source Maximum Emission Rates (normal operating conditions)

Table 5-2. Point Source Emission Rates during Normal Operating Conditions

Point Source Number	Point Source Name	Pollutant Name	Average emission Rate		Duration of Emissions
			(mg/Nm³)	Averaging Period	
ST1	Calcination stack	NO_x	169	Hourly	24 hours, 330 days per annum
		SO_2	0	Hourly	
		PM	2	Hourly	

The emissions are based on the stack emissions testing results at the existing mine. (Yellowtree, 2016).

The Minimum Emission Standards are 500 mg/Nm^3 for NOx, 400 mg/Nm^3 for SO_2 and 50 mg/Nm^3 for PM for a new lime production plant. Therefore, the Minimum Emission Standards are expected to be met.

5.3 Point Source Maximum Emission Rates (start-up, shut-down, upset and maintenance conditions)

According to the mine engineers, the start-up and shut-down conditions are of short duration, and the emissions are not expected to differ greatly from those under normal operating conditions. As such, the impacts under normal operating conditions are expected to be similar and applicable to those under start-up and shut-down.

5.4 Fugitive Emissions (area and or line sources)

5.4.1 Construction Phase

The construction phase of the project is anticipated to last for 12 months. The working hours will be 9 hours a day, 5 days a week. The construction phase will comprise site preparation and construction of all mine-related infrastructures. A construction camp, which includes an office complex, workshops, storage, etc., will be established during the construction phase.

Key activities that will be undertaken during the construction phase include:

- Construction of an access road;
- Pre-stripping;
- Site clearance;
- Earthmoving, grading, compaction, terracing;
- Construction of bulk services facilities (i.e. power infrastructure, waste facilities, stormwater control and water supply system);
- Construction of civil works (including all mine infrastructures and facilities);
- Construction of structures;
- Installation of equipment; and
- Commissioning.

Large equipment expected to be utilised during the construction are:

- Cranes,
- Excavators,
- Trucks,
- Front-end Loaders,
- Bulldozers, and
- Graders.

Depending on the daily-specific construction activities, dust emissions during the construction phase may vary significantly from day to day. Since the sequence and level of activities during construction are not known at this stage of the project, the emissions and impact will be assessed qualitatively.

In general, it is known that the emissions from the construction phase are normally much lower than those during the operational phase. The construction phase emission impact is expected to be short-term and localised to the working face and access road.

Good practice mitigation measures are recommended to be implemented to minimise emission quantities during construction. The general dust suppression measures include:

- Water spraying:
    - During materials handling and transfer operations;
    - On unpaved roads;
    - During earthmoving operations.
- Speed control for vehicles travelling on unpaved roads;
- Early paving of the access road; and
- Early re-vegetation around open/exposed areas.

5.4.2 Operational Phase

The main fugitive emissions during the operational phase are dust and suspended particulate matter emitted from the vehicle movements on paved and unpaved roads, the aggregate handling and storage piles, the operations of the excavators, graders, truck loading and offloading, as well as wind erosion of exposed areas.

The emissions from the mining and ore processing operations are often estimated with emission factors that are available internationally. The most commonly used sources of emission factors are:

- The United States Environmental Protection Agency (USEPA) AP-42 'Compilation of Air Pollutant Emission Factors';
- Australian National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Mining, 2012;

5.4.2.1 Mining Operations

The open pit strip mining method will be utilised at the mine. With this method, the overburden is removed to expose the ore and after that drilling and blasting take place according to a structured mining plan. The Run of Mine (ROM) is then loaded by excavator onto three 20-tonne trucks and transported to the crushing plant, where it is tipped into the ROM Bin. The crushing plant is moveable, and its distance from the mining site (quarry) is estimated to be approximately 500 m. The mining operation will be conducted on a 42.5-hour basis per week.

The ROM fed into the primary section of the crushing plant will pass through a jaw crusher to produce a feed stockpile for the secondary section of the crushing plant. 12 500 tons of crushed ROM will be stockpiled as the feed to the crusher plant's secondary section. Several stockpiles will be produced as the material passes through the secondary section, namely the crusher dust, agricultural lime and the kiln feed stockpiles.

The sections below, describe the quantities of the waste and ROM, as well as the produced Stockpiles and the resulting emissions from the various operations at the mine.

The expected quantities that will be mined in terms of topsoil, overburden and lime on a monthly and annual basis are shown in Table 5-3. The generated dust and PM_{10} emissions were based on these quantities, in accordance with the methodology described below.

Table 5-3. Waste and Ore Production Rates

Material	Amount Removed Monthly (tonnes)	Amount Removed Annually (tonnes)
Topsoil & Subsoil	960	11,520
Overburden	9600	115,200
ROM	48,000	576,000

The applicable emission factors utilised for the determination of the dust emission quantities due to the mining operations are shown in Table 5-4. These factors are obtained from the NPI document and USEPA. The drilling at the opencast mine will be a continuous process and the emission factors utilised are based on the number of holes drilled (USEPA). The provided units for these emissions are kg of TSP or PM_{10} per drill hole.

The area mined per year is estimated to be 3700 m^2/annum according to the engineers, and the blasts that will be required per annum is four. No control methods are available for blasting. The PM_{10} and TSP emissions resulting from unmitigated drilling and blasting operations are shown as part of the in-pit operations and are allocated to the total annual mining area.

Table 5-4. Emission Factors for Open Pit Mining

Operations	Emission Factor	
	TSP	**PM_{10}**
Excavators/shovels/front-end loaders (on overburden)	0.025 (kg/tonne)	0.012 (kg/tonne)
Truck unloading	0.012 (kg/tonne)	0.0043 (kg/tonne)
Drilling	0.59 kg/hole	0.31 kg/hole
Blasting	$0.00022\ A^{1.5}$	$0.52(0.00022\ A^{1.5)}$
A= the area blasted (m^2)		

5.4.2.2 Crushing and Screening

Crushing operations, if uncontrolled, may be significant dust-generating sources. Dust fallout in the vicinity of crushers also gives rise to the potential for the re-entrainment of dust emitted by vehicles or by the wind. The large percentage of fines in this dustfall material enhances the potential for it to become airborne. The emission factors for lime manufacturing are given in USEPA AP42 and can be seen in the table below. The emission factors for PM_{10} are not available, and it is assumed that 40% of the TSP emissions is PM_{10}.

According to the mine engineers, a water spraying system will be integrated into the crushing plant to control and minimize dust generation. And the secondary crusher will be fitted with fabric filters. Control efficiencies of 50% and 83% were thus applied in the emission calculations for the primary and secondary crushing respectively.

Table 5-5. Emission Factors for Crushing

Operations	Emission Factor (kg/tonne)	
	TSP	PM_{10}
Primary crusher	0.0083	0.00332
Secondary crusher	0.31	0.124
Product transfer and conveying	1.1	0.44

5.4.2.3 Aggregate Handling and Storage Piles

The particulate emissions from the stockpiles can result from the following activities:

- Loading of aggregate onto storage piles (batch or continuous drop operations);
- Equipment traffic in the storage area;
- Wind erosion of pile surfaces and ground areas around piles;
- Loadout of aggregate for backfilling.

The emissions during loading of aggregate onto storage piles were estimated according to the following Equation (5-1) (USEPA, 2006b):

$$E = \frac{k \cdot (0.0016) \cdot (u/2.2)^{1.3}}{(M/2)^{1.4}} \qquad (5\text{-}1)$$

Where:

E = Emission factor per hour of operation (kg/Mg)
k = Particle size multiplier (dimensionless)
PM10 fraction: 0.35
PM2.5 fraction: 0.11
TSP fraction: 0.74
u = Mean wind speed at the site (3.57 m/s)
M = Material moisture content (2 %)

The various stockpiles at the mine are shown in the table below.

Table 5-6. Stockpiles

Stockpile	Quantity Handled (tonne/day)
Primary stockpile	2500
Crusher dust stockpile	200
Limestone stockpile	1380
<1mm stockpile	920
Coal stockpiles	102.2

5.4.2.4 Unpaved Road Emissions

When a vehicle travels an unpaved road, the force of the wheels on the road surface causes particles to be lifted and dropped from the rolling wheels. The road surface is exposed to strong air currents in turbulent shear with the surface, as well as the air wake behind the vehicle. The quantity of dust emissions from a given segment of the unpaved road varies linearly with the volume of traffic.

The size-specific particulate emissions from an unpaved road, per vehicle km travelled, can be calculated with the use of the equation (5-2) below (USEPA, 2006a):

$$E = k \cdot 281.9 \cdot (s/12)^a \cdot (W/3)^b \cdot \frac{(365 - p)}{p} \qquad (5\text{-}2)$$

Where:

E	=	Emission factor (g/VKT)
k ,a, b	=	Empirical constants (see table below)
281.9	=	Conversion factor from lb/VMT to g/VKT
s	=	Percentage of surface material silt content (%)
W	=	Mean vehicle weight (Mg)
p	=	Number of days with at least 0.254 mm of precipitation per year

The constants k, a, b in the equation above for different particle sizes are shown in the table below.

Table 5-7. Constants for Equation 4-1

Constant	Industrial Roads (Equation (5-2))		
	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9
a	0.9	0.9	0.7
b	0.45	0.45	0.45
* Assumed equivalent to total suspended particulate matter (TSP)			

Blasted ore is loaded by an excavator on three 20-tonne trucks and transported to the crushing plant. The distance from the mining site (quarry) to the crushing plant is approximately 500 m. The average number of days with precipitation is 49.5 in a year (Climate Vanrhynsdorp). It is assumed that the precipitation is at least 0.254 mm on the precipitation days. The silt content for the ROM handled was assumed to be 1% (USEPA, 2006).

As a worst-case scenario, it was assumed no mitigation measures would be applied to suppress the dust, e.g. water spraying on the haul roads. Thus no dust suppression efficiency was applied to the emissions calculated.

5.4.2.5 Wind Erosion

The emission factor for wind erosion of an exposed area is given as 0.85 Mg of TSP per hectare per year (USEPA). The estimated exposed area of 2 hectares was used in the calculation of emissions due to wind erosion. There is no PM_{10} emission factor specified for wind erosion. However, it is assumed that 40% of the TSP emission is in the PM_{10} range.

5.4.2.6 Emission Quantities

Based on the emission factors and the assumptions in the previous sections, the emission quantities per day during the operational phase are shown in Table 5-8.

Table 5-8. Emission Quantities

Operations	Emissions (kg/d)		Emission Hours
	TSP	PM_{10}	
Mining with excavators	73.2	35.1	Daytime only
Truck off-loading	35.1	12.6	Daytime only
Drilling	20.7	10.9	Daytime only
Blasting *	0.2	0.1	Daytime only
Primary crushing	5.2	1.8	Daytime only
Secondary crushing	121.2	42.4	24 hours
Aggregate handling and storage piles	11.3	5.4	Daytime only
Unpaved road emissions	61.6	11.5	Daytime only
Wind erosion	4.7	1.9	All hours
Total	333.1	121.6	
Emissions during daytime were assumed to be between 08:00-16:00 (8 hours).			

5.5 Emergency Incidents

The calcination plant will be a new installation, such that no emergency incident data is available at this stage.

6 IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

6.1 Analysis of Emissions' Impact on Human Health

6.1.1 Air Quality Regulations

6.1.1.1 National Ambient Air Quality Standards

The South African legislation and guidelines on the environmental management and air quality emission standards are:

- The National Environmental Management Act (Act 107 of 1998) as amended.
- The National Environmental Management Act, Air Quality Act (Act No. 39 of 2004);
- The South African National Ambient Air Quality Standards (24 December 2009); and
- The National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter Less Than 2.5 Micron Meters ($PM_{2.5}$) (29 June 2012).

The South African National Ambient Air Quality Standards are presented in Table 6-1 below.

Table 6-1. National Ambient Air Quality Standards

Pollutant	Molecular Formula	Averaging Period	Concentration		Frequency of Exceedance	Compliance Date
			µg/m³	ppb		
Sulphur Dioxide	SO_2	10 minute	500	191	526	Immediate
		1 hour	350	134	88	Immediate
		24 hour	125	48	4	Immediate
		1 year	50	19	0	Immediate
Nitrogen Dioxide	NO_2	1 hour	200	106	88	Immediate
		1 year	40	21	0	Immediate
Carbon Monoxide	CO	1 hour	30,000	26,000	88	Immediate
		8 hour	10,000	8,700	11	Immediate
Particulate Matter	PM_{10}	24 hour	120	-	4	Immediate – 31 Dec 2014
			75	-	4	1 Jan 2015
		1 year	50	-	0	Immediate – 31 Dec 2014
			40	-	0	1 Jan 2015
	$PM_{2.5}$	24 hour	65	-	4	Immediate – 31 Dec 2015
		24 hour	40	-	4	1 Jan 2016 – 31 Dec 2029
		24 hour	25	-	4	1 January 2030
		1 year	25	-	0	Immediate – 31 Dec 2015
		1 year	20	-	0	1 Jan 2016 – 31 Dec 2029
		1 year	15	-	0	1 January 2030
Ozone	O_3	8 hour	120	61	11	Immediate
Benzene	C_6H_6	1 year	10	3.2	0	Immediate – 31 Dec 2014
			5	1.6	0	1 Jan 2015

6.1.1.2 Dust Fallout Guidelines

The South African Bureau of Standards has published dust deposition standards that are based on the cumulative dustfall levels in South African National Standard (SANS) 1929:2011. Four bands have been developed against which dust fallout can be evaluated (see Table 6-2). These dust fall levels were taken into consideration for the determination of the levels of nuisance in surrounding communities.

Target, action and alert thresholds for ambient dust deposition and permissible frequency of exceedances are given in Table 6-3.

Table 6-2. Four-band Scale Evaluation Criteria for Dust Deposition (SANS 1929:2011)

No	Band Description Label	Dust Fallout Rate (D) (mg/m^2/day) (30-day average)	Comments
1	Residential	D < 600	Permissible for residential and light commercial.
2	Industrial	D < =1200	Permissible for heavy commercial and industrial.
3	Action	1200 < D < =2400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	D > 2400	Immediate action and remediation required following the first incidence of the dust fallout rate being exceeded. Incident report to be submitted to the relevant authority.

Table 6-3. Target, Action and Alert Thresholds for Dust Deposition (SANS 1929:2011)

Level	Dust Fallout Rate (D) (mg/m^2/day) (30-days average)	Averaging Period	Permitted Frequency of Exceeding Dust Fall Rate
Target	300	Annual	N/A
Action Residential	600	30 days	Three within any year, no two sequential months.
Action Industrial	1,200	30 days	Three within any year, not sequential months.
Alert Threshold	2,400	30 days	None. The first incidence of dustfall rate being exceeded requires remediation and compulsory report to the relevant authorities.

On the 1st of November 2013, the Government Notice 827 - National Dust Control Regulations published regarding Section 53(o) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) was promulgated. The Regulations prescribe general measures for the control of dust in all areas. A standard for the acceptable dustfall rate is set out in these Regulations for residential and non-residential areas, which can be seen in Table 6-4 below.

Table 6-4. Acceptable Dust Fall Rates

Restriction Area	**Dust Fall Rate (D) ($mg/m^2/day$) (30-days average)**	**Permitted Frequency of Exceeding Dust Fall Rate**
Residential area	D < 600	Two within a year, not sequential months.
Non-residential area	600 < D < 1200	Two within a year, not sequential months.

6.1.1.3 Atmospheric Emissions Licence

According to Section 21 of the National Environmental Management: Air Quality Act, the Minister of Environmental Affairs is required to publish a list of activities which result in atmospheric emissions and to establish minimum emission standards in respect of a substance or mixture of substances resulting from those listed activities. The consequence of the listing is that to conduct a listed activity in the Republic; any person requires a Provisional Atmospheric Emissions License or an Atmospheric Emission License.

The list of activities which result in atmospheric emissions which have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage was published on 22 November 2013 (DEA, 2013). The emission limits for Calcining and Lime production are set out in the Listed Activities in Category 4 and 5, Subcategory 4.1 and 5.6 respectively (DEA, 2013).

Table 6-5. Emission Limits: Drying and Calcining

Description:	**Drying and calcining of mineral solids including ore**		
Application:	Facilities with a capacity of more than 100 tonnes/month product.		
Substance or Mixture of Substances		Plant Status	mg/Nm^3 under normal condition of 273k and101.3 kPa
Common Name	Chemical symbol		
Particulate Matter	N/A	New	50
		Existing	100
Sulphur Dioxide	SO_2	New	1000
		Existing	1000
Oxides of Nitrogen	NO_X expressed as NO_2	New	500
		Existing	1200

Table 6-6. Emission Limits: Lime Production

Description:	**Processing of lime, magnesite, dolomite and calcium sulphate**		
Application:	All installations		
Substance or Mixture of Substances		Plant Status	mg/Nm^3 under normal condition of 273k and101.3 kPa
Common Name	Chemical symbol		
Particulate Matter	N/A	New	50
		Existing	100
Sulphur Dioxide	SO_2	New	400
		Existing	400
Oxides of Nitrogen	NO_X expressed as NO_2	New	500

6.1.2 Atmospheric Dispersion Modelling

6.1.2.1 Background Ambient Air Quality

According to the Regulations Regarding Air Dispersion Modelling (DEA, 2014), compliance with NAAQS must be defined, such that all significant local and regional contributions to the background concentrations are accounted for. For each averaging time, the sum of the model predicted concentration and the background concentration applicable must be compared to the NAAQS. However, for an isolated facility not influenced by other sources, and the background concentration being insignificant, only the model predicted concentrations need to be compared with the NAAQS.

The area around the proposed mine is that of a typical rural environment with limited pollution sources, such that the air quality in the area is expected to be of a good standard with low pollution levels. The mine is an isolated facility, as there are no other pollution sources within a 5 km radius of the mine. The existing mine owned by Cape Lime is located more than 7 km away to the west. However, there is no relevant air quality monitoring data for the primary air pollutants within and around the mining area. Therefore, background concentrations have not been considered further in the present study.

6.1.2.2 Area's Meteorology

Turbulent, high-velocity winds such as pre-cold front winds help to both dilute air pollutants at their source and disperse them as they travel downwind, whereas gentle breezes under stable atmospheric conditions do little to dilute or disperse air pollution.

Cold, gentle winds flow down the slope on calm nights under clear skies, also flowing into hollows and into and down valleys. Such winds travel at less than 1 metre per second. Walls, steep embankments and tree plantations can impede this air and mix it with the air above, thus helping to reduce the impact on air quality.

The minimum requirements for dispersion modelling are knowledge of the wind speed, wind direction, atmospheric turbulence parameters, the ambient temperature, as well as the mixing height. The atmospheric boundary during the day is normally unstable, as a result of the sun's heating effect on the earth's surface. The thickness of the mixing height depends strongly on solar radiation, amongst other parameters. This mixing layer gradually increases in height from sunrise, to reach a maximum at about five to six hours after sunrise. Cloudy conditions, surface and upper air temperatures also affect the final mixing height and its growth. During these conditions, dispersion plumes can be trapped in this layer and result in high ground-level concentrations. This dispersion process is known as Fumigation and is more pronounced during the winter months due to strong night-time inversions, weak wind conditions and slower developing mixing layers.

6.1.2.2.1 Temperature

The air temperature is utilised in the dispersion modelling as one of the incorporated parameters for the parametrisation of the atmospheric conditions. Temperature plays an important role in the transportation and dispersion of the air pollutants, since it affects the plume buoyancy and the atmospheric boundary layer development.

The historical monthly average maximum and minimum temperature profile of Vanrhynsdorp is presented in Figure 6-1 below. The mean daily temperature in the Vanrhynsdorp area ranges between 32°C and 6°C during the summer and winter months respectively.

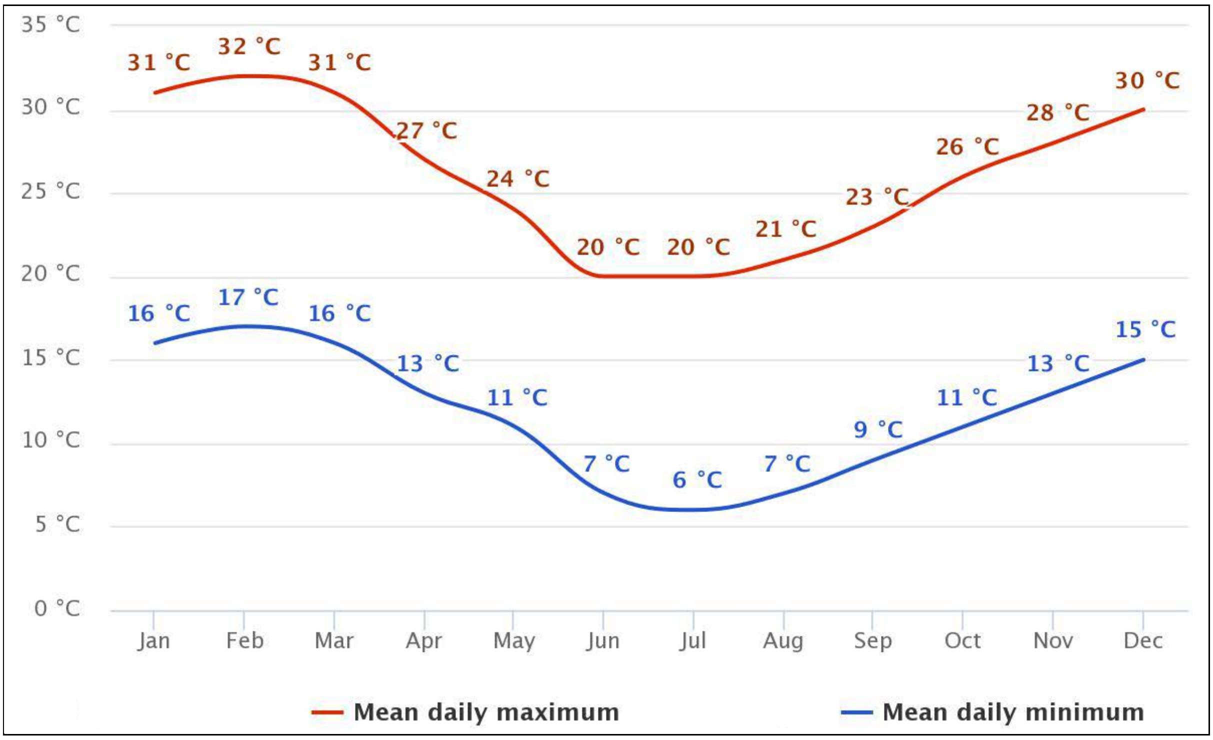


Figure 6-1. Monthly Temperature Profile

6.1.2.2.2 Precipitation and Air Pollution

Precipitation assists in the removal of air pollutants from the atmosphere. Gaseous air pollutants and particulate matter are removed by the falling rain droplets through adsorption and deposition.

West Coast is a semi-arid region, with a Mediterranean climate. It receives most of its rainfall in winter months. The historical average monthly precipitation profile is shown in Figure 6-2 below. As can be seen, the highest monthly maximum precipitation is 30 mm in June. Precipitation in January and February is minimal, only 4 mm in each month.

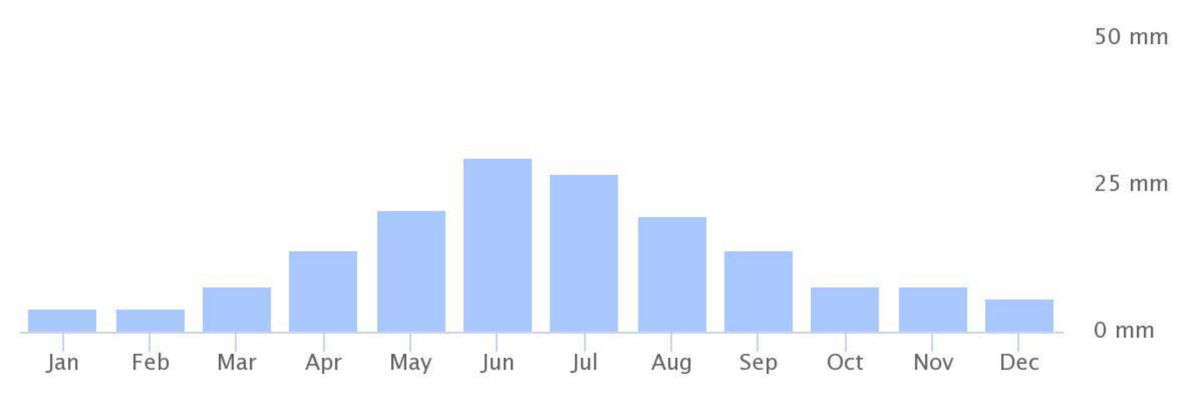


Figure 6-2. Monthly Precipitation Profile

6.1.2.2.3 Local Wind Field

Since meteorological data is not available at the project site, meteorological data from the Department of Environmental Affairs and Development Planning (DEADP) was used for the air pollution dispersion modelling. This set of data was generated by utilising a prognostic mesoscale model called the Weather Research and Forecast Model and a modelling resolution of 3 km. The data that is most applicable to the study area is located south-east of the site (latitude: -31.67946° and longitude: 18.64372°). Three years (2008-2010) of hourly surface and upper air meteorological data was used as input into the model.

The wind roses and wind frequencies for all hours, daytime and night-time are shown in Figure 6-3 overleaf.

As can be seen, the westerly and south-westerly winds are predominant, which account for approximately 41% of the time. The daytime and night-time wind patterns show a diurnal variation. During daytime, south-westerly and westerly winds are most frequent, while southerly and northerly winds are minimal. At night-time, the south-easterly winds increase to approximately 11% of the time. Furthermore, the south-westerly winds decrease. The average wind speed during daytime is 4.14 m/s and 3.57 m/s for night-time respectively.

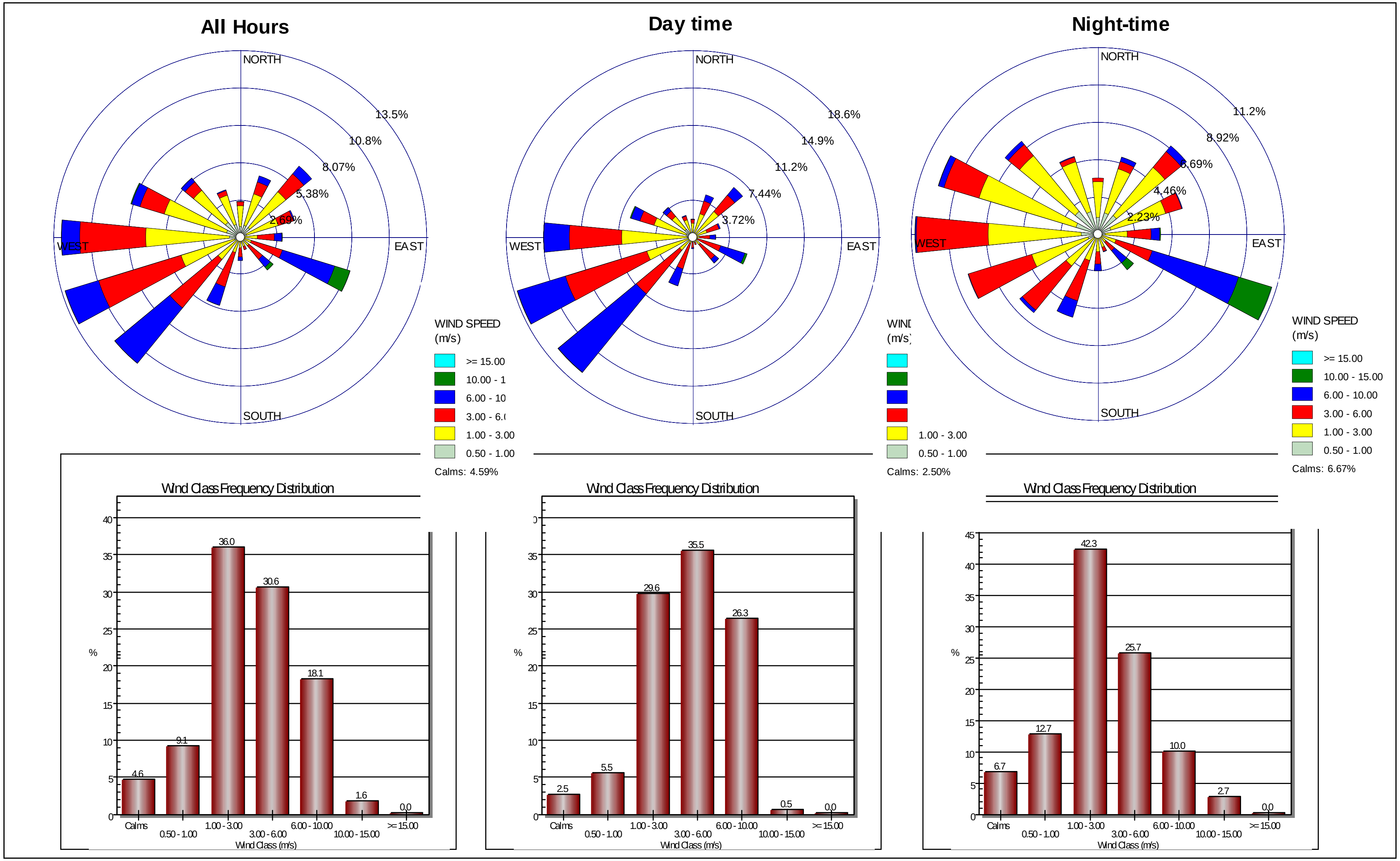


Figure 6-3. Wind Roses & Wind Speed Frequency Distribution: All-hours, Daytime and Night-time

The winter and summer wind patterns are presented in Figure 6-4 below. In winter, the north-easterly winds are predominant, whereas, in summer, the south-westerly winds are the most predominant. The wind speeds in winter and summer are comparable, with average wind speeds of 3.39 m/s and 3.87 m/s respectively.

Calm wind conditions occur 6.37% of the time during winter-time, compared to 2.56% during summer.

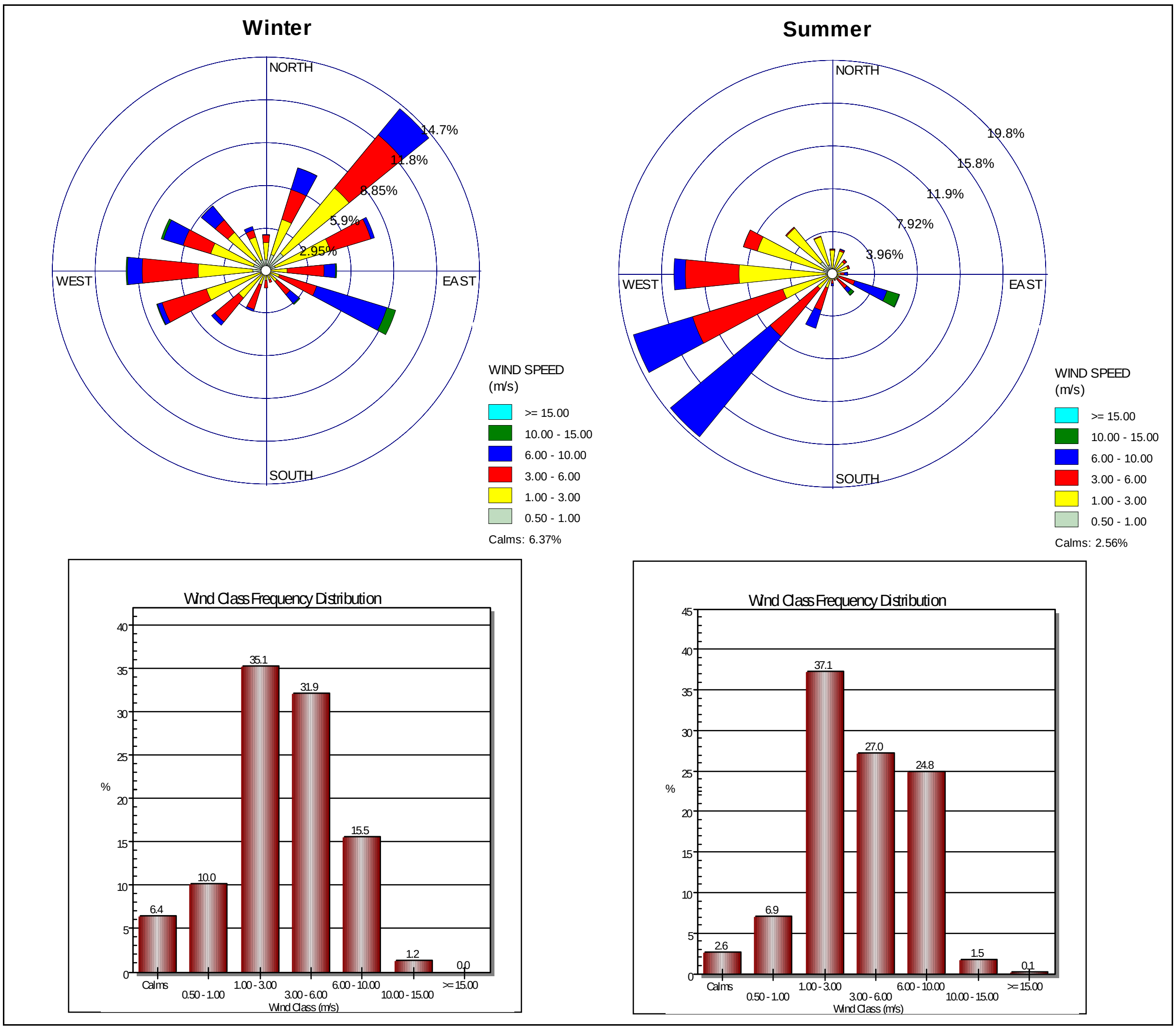


Figure 6-4. Wind Roses & Wind Speed Frequency Distribution: Winter and Summer

6.1.2.3 Atmospheric Dispersion Model

The AERMOD View from Lakes Environmental, Version 9.4 was utilised for the air pollution dispersion modelling. The AERMOD View is an air dispersion modelling system, which incorporates the popular USEPA models AERMOD, ISCST3 and ISC-PRIME into one interface.

The AERMOD model was used for this dispersion modelling. The USEPA AERMOD model is a steady-state Gaussian plume air dispersion model. It is based on the planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. It is used to model air dispersions up to 50 km from the source.

Special features of AERMOD include its ability to treat the vertical non-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three-plume model for the convective boundary layer and limitation of vertical mixing in the stable boundary layer.

Additional details on the AERMOD dispersion algorithms, model characteristics, as well on the AERMET, the meteorological pre-processor, can be found in the description of model formulation and the model's user guide respectively (USEPA, 2004a and USEPA, 2004b).

6.1.2.4 Model Set-up and Data Input

The source configuration and emission quantities for the mine and the calcination stack were used as input into the model. The settings utilised within the model included:

- Regulatory options: Default
- Terrain height option: Elevated;
- Dispersion coefficient: Rural
- Output type: Concentration and dry deposition;
- Flagpole height: 0 m

In addition to the emissions input, the AERMOD model requires hourly meteorological data as input. Three years (2008-2010) of hourly meteorological data obtained from the DEADP was utilised in the modelling.

The dispersion modelling that was carried out for CO, NO_2 and PM_{10}, was based on the recommendation of the Regulations Regarding Air Dispersion Modelling (DEA, 2014). In accordance with these regulations, for the short-term concentrations (i.e. 1-hr and 24-hr), the 99^{th} percentiles were calculated for comparison against the NAAQS.

The modelling domain was set to be a 10 km x 10 km grid with the mine at the centre. For the modelling of the ground-level concentrations, a Cartesian grid with a spacing of 100 m was utilised.

6.1.2.5 Dispersion Simulation Results

6.1.2.5.1 Dust Deposition

The dust deposition due to the mining activities can be seen in Figure 6-5. The daily dust deposition was calculated from the modelled maximum monthly dust deposition. The maximum dust fallout level occurred only within the quarry and reached the industrial limit of 1200 mg/m^2/day. For areas away from the mining face, the dust deposition off-site dropped below the residential guideline of 600 mg/m^2/day. The farmsteads near the mine are expected to have minimal dust impact, as the dust deposition outside the mining rights area was predicted to be below 10 mg/m^2/day.

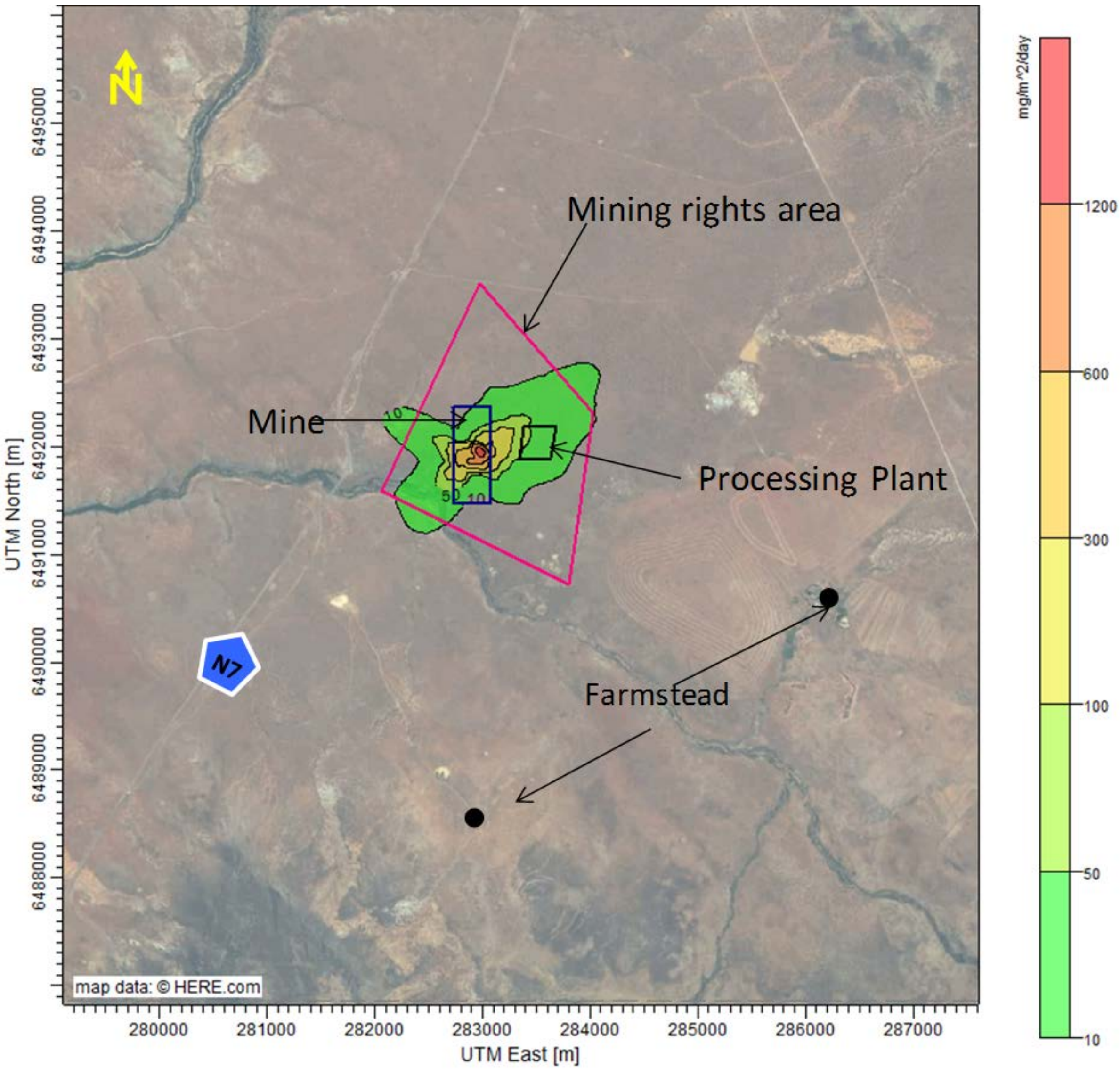


Figure 6-5. Dust Daily Deposition (Guideline: 600 mg/m^2/day)

6.1.2.5.2 PM_{10} Concentrations

The PM_{10} ambient concentrations due to emissions from the mining activities and the calcination stack were modelled. The resulting modelled 24-hr (99th percentile) and the annual maximum concentrations contours for PM_{10} are shown in Figure 6-6 and Figure 6-7. As can be seen, the 24-hr PM_{10} concentrations reached the guideline level of 75 µg/m^3 at approximately 500 m – 800 m to the southwest and southeast of the quarry. The 24-hr PM_{10} concentrations were below the guideline at areas 1km away.

The maximum annual concentrations reached 40 µg/m^3 at and within the immediate areas of the quarry. However, the concentrations reduced rapidly and dropped to 10 µg/m^3 at about 500 m away.

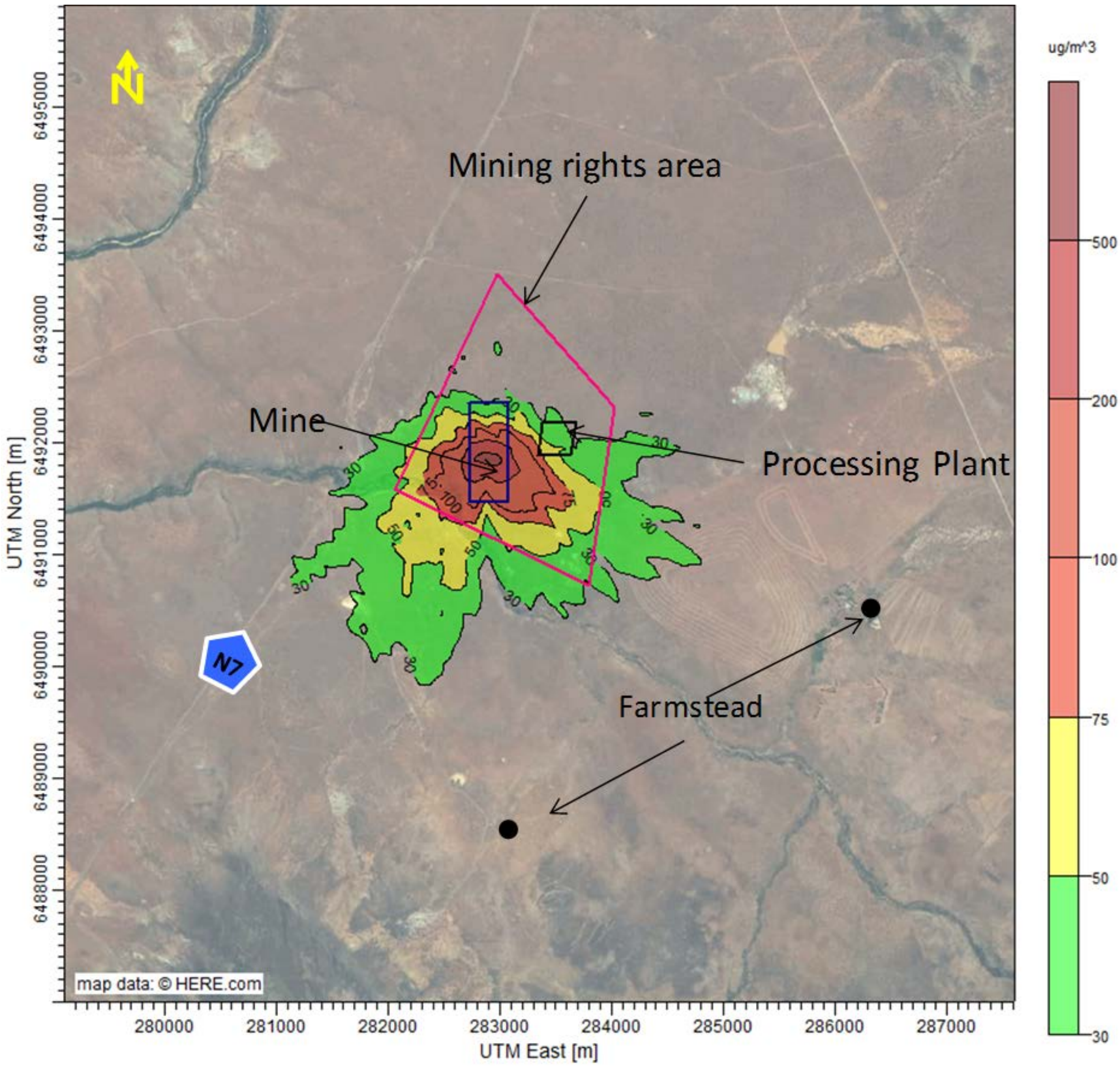


Figure 6-6. Maximum 24-Hour PM_{10} Concentrations (Guideline: 75 µg/m^3)

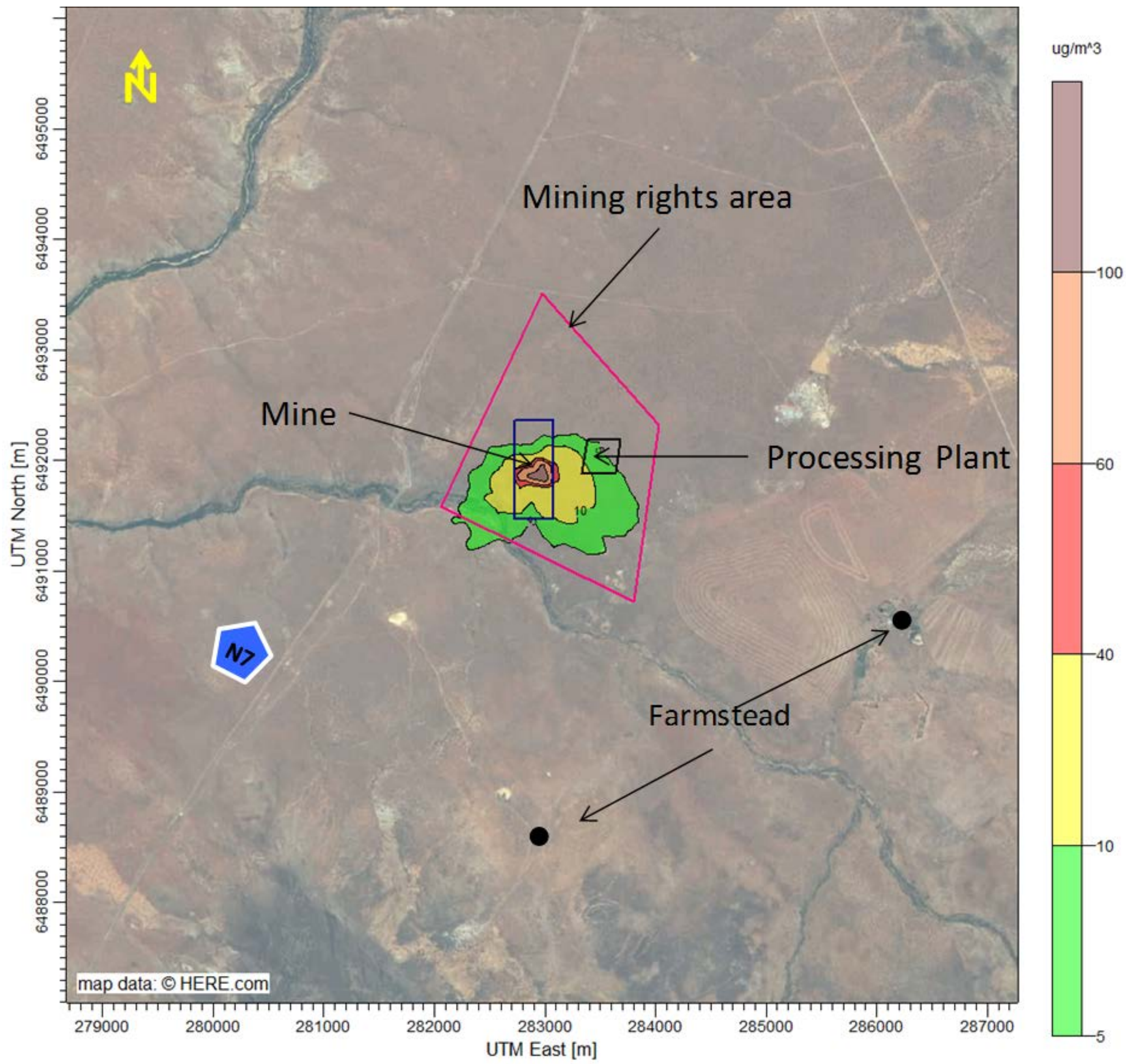


Figure 6-7. Maximum Annual PM_{10} Concentrations (Guideline: 40 µg/m^3)

6.1.2.5.3 Nitrogen Dioxide concentrations

The nitrogen oxides emissions from the calcination stack were modelled using the Tier 1: Total Conversion Method. As such, a total conversion of the NO to NO_2 was assumed as the worst case scenario.

The modelled 1-hr (99th percentile) and maximum annual concentrations for NO_2 are shown in Figure 6-8 and Figure 6-9 below. The 1-hr NO_2 concentrations were well below the guideline of 200 µg/m^3. As can be seen, the 1-hr NO_2 concentrations in areas 500 m away were below 10 µg/m^3.

The annual NO_2 concentrations were very low and well within the guideline of 40 µg/m^3.

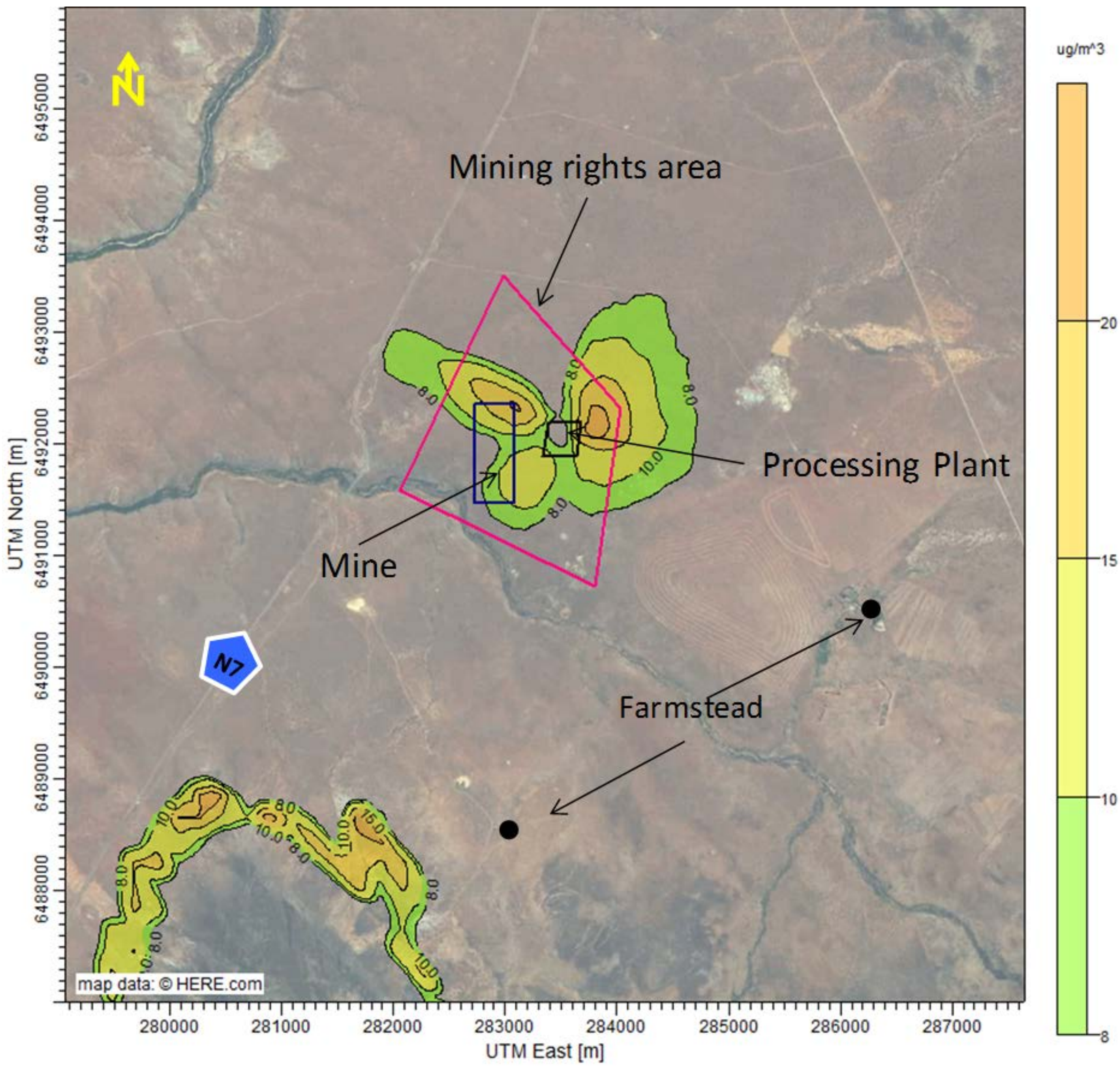


Figure 6-8. NO_2 1-hr Concentrations 99th Percentile (Guideline: 200 µg/m^3)

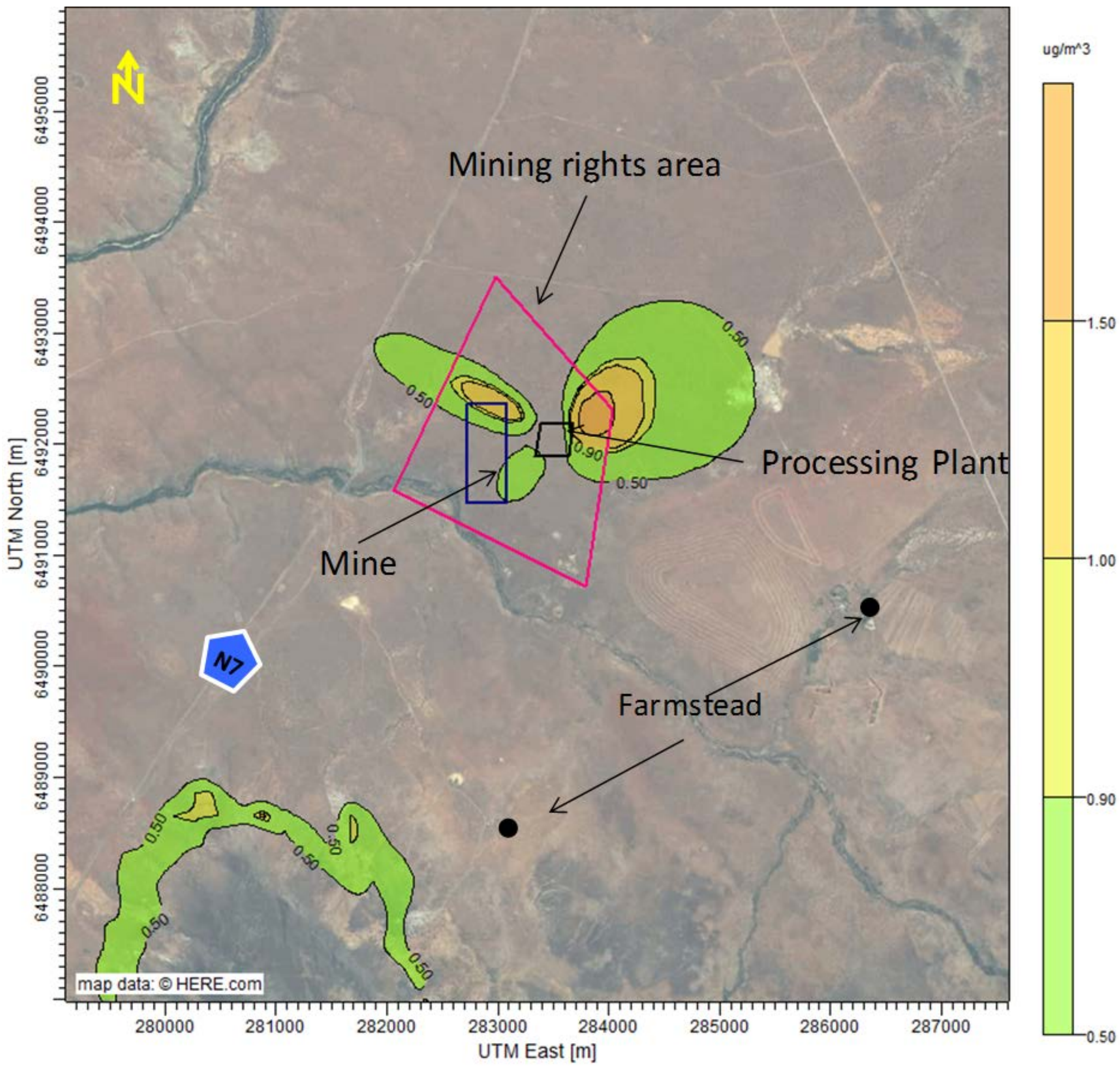


Figure 6-9. NO_2 Annual Concentrations (Guideline: 40 µg/m^3)

6.1.2.5.4 Carbon Monoxide

The carbon monoxide emissions from the calcination stack were modelled as well, despite its low emission level. Figure 6-10 below shows the maximum 1-hr concentration isopleths of CO. As can be seen; the modelled CO concentrations were well below the guideline of 30,000 µg/m^3.

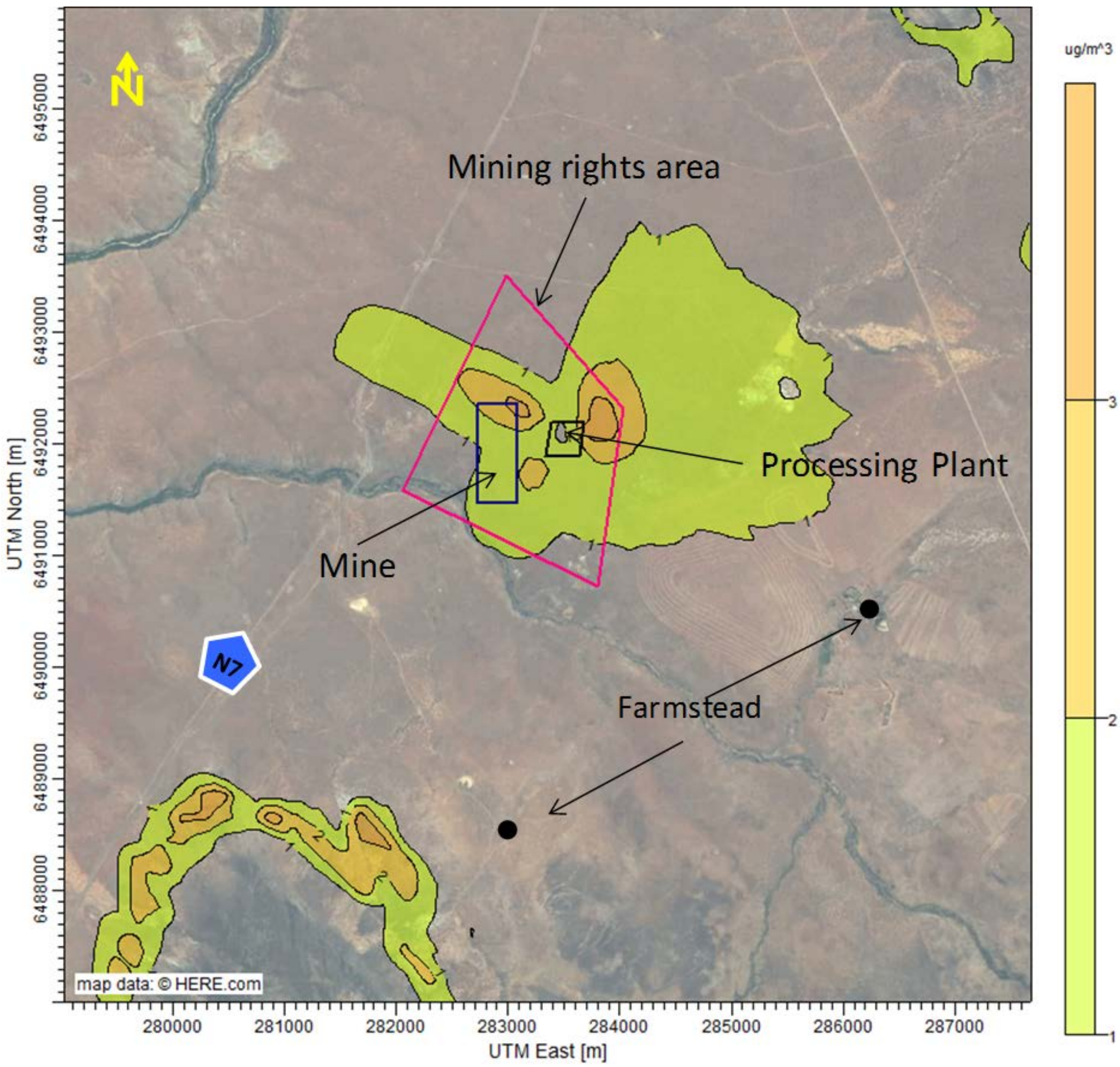


Figure 6-10. CO 1-hr Maximum Concentrations (Guideline 30,000 μg/m^3)

6.1.3 Assumptions and Limitations

The main assumptions and limitations of the study are:

- Since the mine is still in the proposal phase, the emissions from the kilns' stack were based on stack emissions monitoring from similar kilns at the existing mine.
- In the calculations of the fugitive dust emissions, two mitigation measures were considered, i.e. water spraying at the primary crusher and dust extraction (using fabric filters) at the secondary crusher.
- The proposed project is situated in a rural area, and the mine is considered an isolated facility, due to the fact that there are no other significant emission sources in close proximity. Therefore, the existing ambient concentration levels of the various pollutants examined in the present air quality impact study are considered to be

extremely low or negligible. Therefore, when assessing compliance with the NAAQS, the background levels were considered negligible.

- Air pollutants released from vehicle exhausts and blastings, such as SO_2, NO_x and CO, were not included in the detailed calculations, as they will be presented in relatively very small quantities and will only have a limited and localised impact.

6.1.4 Impact Assessment

The expected air quality impacts of the proposed mine were quantified via dispersion modelling. The impact ratings are summarised in Table 6-7 below. The impact rating methodology can be found in **Appendix A**.

Based on the dispersion modelling results, the daily dust deposition, as well as the ambient concentrations of PM_{10}, NO_2 and CO, were well within their respective guidelines. Therefore, based on the above-mentioned methodology, the extent of the impact is considered ***local***. The duration of the impact and the impact phase will be ***long-term***. The ambient air quality is likely to be *negatively* affected, with **low consequence.** The probability of the impact occurring was considered ***probable***. Based on the provided methodology rating system, the resulting overall impact rating is ***Low***.

Based on the modelling results, no additional mitigation measures are considered necessary, other than those indicated in the emission calculation sections. As such, no separate mitigated impacts were assessed.

Table 6-7. Operational Impact

	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Impact Rating**
Without Mitigation	Local	Low	Long-term	Low	Probable	Low
	1	1	3	5	3	
With Mitigation	Not Applicable					

6.2 Analysis of Emissions' Impact on the Environment

6.2.1 South African Legislation on Greenhouse Gas

In South Africa, the Department of Environmental Affairs (DEA) is the central coordinating and policy-making authority concerning environmental conservation. The DEA is also responsible for the management of all climate change-related information such as mitigation, adaptation, monitoring and evaluation programs including the compilation and update of greenhouse gas (GHG) emission inventories.

The DEA was the main architect for the development of the national climate policy called National Climate Change Response White Paper, that was approved by the Cabinet in 2011.

(Gazette No. 34695, Notice No. 757, 19 October 2011). The White Paper is South Africa's first policy focusing specifically on climate.

The White Paper also postulates that reporting of emissions data will be made mandatory for companies that emit more than 100,000 tonnes of GHGs annually, or that consume electricity which results in more than 100,000 tonnes of emissions from the electricity sector.

Furthermore, the White Paper also refers to the carbon tax as a potential instrument to contribute to emission reductions. The carbon tax policy paper was released for comment in May 2013 and outlines the proposed carbon tax.

The national greenhouse gas emission reporting regulations 2016 (DEA, 2017) came into effect on 3 April 2017. In the document, a list of activities for which GHG emissions must be reported is set out.

GHG emissions generated from an entity can be classified into three different scopes based on the source of emissions (GHG Protocol):

- Scope 1: All direct GHG emissions from sources that are owned or controlled by the entity. It includes:
    - Stationary combustion: emissions from the combustion of fossil fuel from stationary sources, e.g. boilers, kilns, etc.
    - Mobile combustion: emissions from the combustion of fossil fuels used in the operation of vehicles, equipment and machinery.
    - Process emissions: emissions released from the industrial processes.
- Scope 2: Indirect GHG emissions associated with the consumption of purchased electricity and heat or steam.
- Scope 3: Other indirect GHG emissions, e.g. the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the entity, the transmission and distribution losses associated with the purchased activity, which is not covered in Scope 2, as well as outsourced activities and waste disposal, etc.

An overview of the scopes mentioned above is shown in Figure 6-11 below.

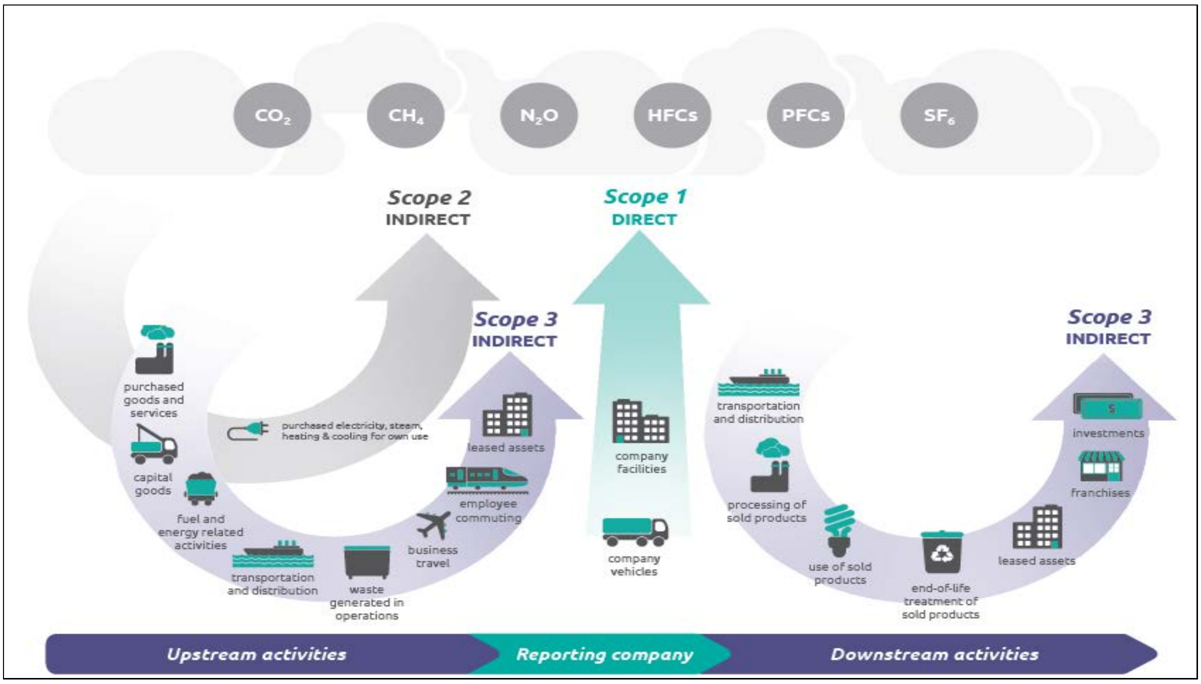


Figure 6-11. GHG Protocol Scopes and Emissions Overview

The South African mandatory reporting guidelines focus on Scope 1 emissions only. In alignment with the IPCC Guidelines, Scope 1 emissions are reported on under the following categories: Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use and Land use and Waste.

Scope 2 emissions are not accounted for in the national inventory because these emissions are already accounted for in power generation, which is largely due to Eskom's emissions. Also, the Scope 3 emissions from bunker fuels, such as fuels in international aviation and marine navigation are estimated but are not necessarily added to the national total.

6.2.2 Greenhouse Gas Emissions

6.2.2.1 Limestone Calcination

The heating of limestone and the consequential decomposition of carbonates produces calcium oxide (CaO or quicklime). The specific methodology to determine the emissions associated with lime production is detailed in Volume 3, Chapter 2.3 of the 2006 IPCC guidelines.

There are three basic methodologies for estimating emissions from lime production: an output-based approach that uses default values (Tier 1), an output-based approach that estimates emissions from CaO and CaO·MgO production and country-specific information for correction factors (Tier 2) and an input-based carbonate approach (Tier 3).

The Tier 3 approach is based on the collection of plant-specific data on the types and quantities of carbonate(s) consumed, as well as a correction for limekiln dust (LKD). LKD is a by-product of the lime manufacturing process. It is made up of quicklime and inert materials. The Tier 3 approach includes an adjustment to subtract any uncalcined carbonate within LKD. If the LKD is fully calcined, this LKD correction factor becomes zero. Tier 3 is still considered to be good practice in instances where inventory compilers do not have access to data on uncalcined LKD. The equation used for estimating emissions for Tier 3 is shown below.

Tier 3: Emissions Based on Carbonate Inputs

$$CO2\ Emissions = \sum_i (EF_i * M_i * F_i) - M_d * C_d * (1 - F_d) * EF_d$$

Where:

- CO_2 Emissions = emissions of CO_2 from lime production, tonnes
- EF_i = emission factor for carbonate *i*, tonnes CO_2/tonne carbonate
- M_i = weight or mass of carbonate i consumed, tonnes
- F_i = fraction calcination achieved for carbonate *i*, fraction
- M_d = weight or mass of LKD, tonnes
- C_d = weight fraction of original carbonate in the LKD, fraction.
- F_d = fraction calcination achieved for LKD, fraction
- EF_d = emission factor for the uncalcined carbonate in LKD, tonnes CO_2/tonne carbonate

For purposes of estimating emissions, it is assumed that

- the degree of calcination achieved is 100 percent (i.e., Fi = 1.00);
- no LKD is recycled to the kiln;
- full calcination achieved for LKD, i.e., Fd = 1.00, which zeroes out the subtraction correction for uncalcined carbonate remaining in LKD.

The plant-specific limestone analysis is shown in Table 6-8 and the emission factors in Table 6-9.

Table 6-8. Plant-Specific Limestone Analysis

Composition	Percentage
$CaCO_3$	97.45%
$MgCO_3$	0.96%
Insoluble	0.51%
Fe_2O_3	0.05%
-	-

Table 6-9. Emission Factor

Carbonate	Mineral Name(s)	Formula Weight	Emission Factor (tonnes CO_2/tonne carbonate)
$CaCO_3$	Calcite or aragonite	100.0869	0.43971
$MgCO_3$	Magnesite	84.3139	0.52197

Based on the calcination plant annual feed of 302,400 tonnes, the CO_2 emissions are calculated as follows:

CO_2 emissions = 302,400*(97.45%*0.43971+0.96%*0.52197)

= 131,093 tonnes/annum

6.2.2.2 Other GHG Emissions

Other CO_2 emissions include uses of equipment and machinery during construction and operational phases, as well as the coal burning at the calcination plant. According to IPCC, the emissions can be estimated using three-tiers approach:

- Tier 1: fuel combustion from national energy statistics and default emission factors;
- Tier 2: fuel combustion from national energy statistics, together with country-specific emission factors, where possible, derived from national fuel characteristics;
- Tier 3: fuel statistics and data on combustion technologies applied together with technology-specific emission factors; this includes the use of models and facility level emission data where available.

The present report uses the combination of Tier 1 and Tier 2. Default emission factors are used for diesel and coal burning, which South African factor is used for electricity uses.

Greenhouse gas emissions due to fuel consumption are calculated as:

$$Emissions_{GHG,\ fuel} = Fuel\ Consumption \bullet Emission\ Factor_{GHG,\ fuel}$$

Where:
- EmissionsGHG , fuel = emissions of a given GHG by type of fuel,
- Fuel Consumptionfuel = amount of fuel combusted,
- Emission FactorGHG, fuel = default emission factor of a given GHG by type of fuel.

The CO_2 emissions from the stationary and mobile sources at the plant can be seen in Table 6-10 below. These emissions are calculated based on the IPCC emissions factors and the fuel consumption supplied by the engineers. The global warming potential for CH_4 and N_2O used are 25 and 298.

It should be noted that the consumption of lime as a product may in some cases not result in net emissions of CO_2 to the atmosphere. The use of hydrated lime for water softening, for example, results in CO_2 reacting with lime to re-form calcium carbonate, resulting in no net emissions of CO_2 to the atmosphere. Similarly, precipitated calcium carbonate, which is used in the paper industry as well as for other industrial applications, is a product derived from reacting hydrated high-calcium quicklime with CO_2. The calculated net CO_2 emissions are shown in Table 6-11. The CO_2 emissions due to electricity consumption and as well as the CO_2 consume as a result of lime usage are included.

Table 6-10. CO_2 Emissions Summary

Category	Consumption (litres/tonnes per Annum)	Calorific value (TJ/litre or TJ/tonne)	Emission Factor (per TJ or per tonne) a			Emission (tonnes/annum)				Scope type
			kg CO_2	kg CH_4	kg N_2O	CO_2	CH_4	N_2O	CO2e	
Construction phase:										
Mobile combustion: Machinery/equipment (diesel)	224,500	0.00	74,100	4.15	28.60	646	0.04	0.25	721	1
Sub-total (construction phase)									**721**	
Operational phase:										
Mobile combustion: Machinery/equipment (diesel)	146,800	0.00	74,100	4.15	28.60	422	0.02	0.16	472	1
Stationary combustion: Calcination plant (coking coal)	33,708	0.02775	94,600	1.00	1.50	88,487	0.94	1.40	88,929	1
Limestone calcination	302,400	-	**433.51**	-	-	131,093	-	-	131,093	1
Sub-total (operational phase)									**220,493**	

a: IPCC, 2016;
b: calculated according to IPCC, 2006. See section above;

Table 6-11. Net CO_2 Emissions

Category	**Consumption (kWh or Tonnes/annum)**	**Emission/Consumption Factor (/TJ)**				**Emission (tonnes/annum)**	**Scope type**
		kg CO_2e	**kg CO_2**	**kg CH_4**	**kg N_2O**	**CO2e**	
Operational phase scope 1 emissions						220,493	1
Operational phase electricity usage	29,700,000	1.03	-	-	-	30,591	2
CO2 consumptions as a result of consumption of lime	151,200	-	-0.79	-	-	-118,800	-
Net-total (operational phase)						**132,284**	

a: Tonnes of CO_2 emissions per MWh sold for the 12-month period from 1 April 2014 to 31 March 2015. (Eskom, 2015);
b: CO_2 consumption factor=formula mass of CO_2/formula mass of CaO (44/56)

7 COMPLAINTS

The mine and the processing plant will be a new installation. The mine will have complaints registry in place as soon as the mine is operational.

8 PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

The planned air quality management interventions include the following:

- Mining Area and Haul Roads:
  - Progressive rehabilitation will be implemented to minimise exposed areas. The proposed mining method for the project is strip mining. This approach enables pit spoiling to start within the two years of commencement of mining.
  - Water trucks and water cannons will be used only when it’s absolutely necessary.

- Wind Erosion of Stockpiles:
  - Covered conveyors will be used for transporting the crusher ROM and calcination plant feed.
  - The irrigation system will be utilised at the outlet of the product (agricultural lime).

  The control efficiency of for the above control measures is 95%.

- Calcination stack emissions:

Several bag filter units will be installed to ensure the emissions released into the atmosphere meets the requirements set by Atmospheric Emissions License. Also, the stack will also be monitored daily, and the bag filters are regularly inspected to make sure it is in good working condition. Taking the above mentioned into consideration the control efficiency of up to 99 % can be achieved.

9 COMPLIANCE AND ENFORCEMENT HISTORY

The mine and the processing plant will be a new installation, thus no compliance and enforcement history available at this stage.

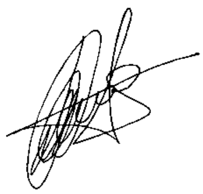
10 ADDITIONAL INFORMATION

There is no additional information to supply in respect of this Atmospheric Impact Report.

11 FORMAL DECLARATIONS

DECLARATION OF CONSULTANT'S INDEPENDENCE- PRACTITIONER

The author of this report, Demos Dracoulides, does hereby declare that he is an independent consultant appointed by Afrimat (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of the specialist performing such work. All opinions expressed in this report are his own.



Demos Dracoulides:

September 2017

12 REFERENCES

Climate Vanrhynsdorp. Available online: https://www.meteoblue.com/en/weather/forecast/modelclimate/vanrhynsdorp_south-africa_3360078. Accessed on 30 August 2017

DEA, 2009. National Ambient Air Quality Standards. Notice No.1210. 24 December 2009. Government Gazette No. 32816.

DEA (2011). National Climate Change Response White Paper. Notice No.757 Government Gazette 34695.

DEA, 2012. National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter Less Than 2.5 Micron Metres (PM2.5). Notice No.486. 29 June 2012. Government Gazette No. 35463.

DEA, 2013. List of Activities Which Result in Atmospheric Emissions Which Have or May Have a Significant Detrimental Effect on the Environment, Including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage. Notice No. 893. 22 November 2013. Government Gazette No. 37054.

DEA, 2014. Regulations Regarding Air Dispersion Modelling. Government Gazette No. 37804, Notice No. R.533. 11 July 2014.

DEA, 2017. National Greenhouse Gas Emission Reporting Regulations, 2016. Government Gazette No. 40762. 3 April 2017.

DEAT, 2006. Government Gazette, National Environmental Management Air Quality Act, 2004, No. 28899.

Eskom, 2015. Eskom Fact Sheets 2015. Available online: http://www.eskom.co.za/IR2015/Documents/Eskom_fact_sheets_2015.pdf

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories.

USEPA, 2004a. AERMOD: Description of Model Formulation. Office of Air Quality Planning and Standards. Research Triangle Park, NC: U.S. Environmental Protection Agency.

USEPA, 2004b. User’s Guide for the AMS/EAP Regulatory Model – AERMOD. Office of Air Quality Planning and Standards. Research Triangle Park, NC: U.S. Environmental Protection Agency.

USEPA, 2006. AP42, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. Chapter 13: Miscellaneous Sources. Section 13.2.4: Aggregate Handling and Storage Piles.

Yellowtree, 2016. Cape Lime Vredendal Emissions Report.

Appendix AAssessment Methodology

The assessment of the impacts has been conducted according to a synthesis of criteria required by the guideline documents to the EIA regulations (2006) and integrated environmental management series published by the Department of Environmental Affairs and Tourism (DEAT) currently Department of Environmental Affairs (DEA). In addition to this, it is a requirement of the National Environmental Management Act (NEMA) 2014 Regulations, Appendices 1 and 2 that an Impact and Risk Assessment process be undertaken for Basic Assessments and Environmental Impact Reporting.

Below is the assessment methodology utilized in determining the significance of the construction, operational and decommission impacts of the proposed activities, and where applicable the possible alternatives, on the biophysical and socio-economic environment.

SIGNIFICANCE = CONSEQUENCE X PROBABILITY

WHERE Consequence = Extent + Intensity + Duration

The criteria used to determine impact consequence are presented in the tables below. Each rating has been allocated a score weighting

Table A-1. Criteria used to determine the Consequence of the Impact

Rating	Definition of Rating	Score
A. Extent - the area over which the impact will be experienced		
Local	Limited to the immediate area(s) around the project site -	1
Regional	Extends over a larger area that would include a major portion of an area or province	2
National/International	Nationally or beyond	3
B. Intensity - the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. Duration– the lifetime of the impact, that is measured in relation to the lifetime of the proposed development and its reversibility		
Short-term	(0 to 3 years)	1
Medium-term	(3 to 10 years) confined to the construction period	2
Long-term	(more than 10 years)	3

Rating	Definition of Rating	Score
Permanent	beyond the anticipated lifetime of the project	4

The combined score of these three criteria corresponds to a Consequence Rating, as follows:

Table A-2. Method used to determine the Consequence Score

Combined Score (A+B+C)	3 – 4	5	6	7	8 - 9
Consequence Rating	Very low	Low	Medium	High	Very high

Once the consequence was derived, the probability of the impact occurring was considered, using the probability classifications presented in the table below.

Table A-3. Probability Classification

Probability– the likelihood of the impact occurring	
Improbable	1
Possible	2
Probable	3
Definite	4

The overall significance of impacts was determined by considering consequence and probability using the rating system prescribed below

Table A-4. Impact significance ratings

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	Low	VERY LOW	VERY LOW	LOW	LOW
	Medium	LOW	LOW	MEDIUM	MEDIUM
	High	MEDIUM	MEDIUM	HIGH	HIGH
	Very High	HIGH	HIGH	VERY HIGH	VERY HIGH

Practicable mitigation and optimisation measures are recommended and impacts are rated in the prescribed way both without and with the assumed effective implementation of mitigation and optimisation measures.

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- Insignificant: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity/development.
- Very Low: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity/development.
- Low: the potential impact may not have any meaningful influence on the decision regarding the proposed activity/development.
- Medium: the potential impact should influence the decision regarding the proposed activity/development.
- High: the potential impact will affect the decision regarding the proposed activity/development.
- Very High: the proposed activity should only be approved under special circumstances.

Cumulative impact: Consideration must be given to the extent of any cumulative impact that may occur due to the proposed development. In relation to an activity, means the impact of an activity that in itself may not be significant but which may become significant when considered together with the potential impacts eventuating from similar or diverse activities or undertakings in the area. Such impacts will be either positive or negative and will be graded as being of negligible, low, medium or high impact. Potential cumulative impacts identified for the proposed development include dust generation from crushing in the plant, materials handling, and vehicle travelling on unpaved roads; noise from the screening and crushing plant, vehicles collecting the material and the bricks.

Degree of confidence in predictions: The specialist should state what degree of confidence (low, medium or high) is there in the predictions based on the available information and level of knowledge and expertise.