Environmental and Engineering Consultants

PROPOSED NEWCASTLE COAL MINING PROJECT

AIR QUALITY IMPACT ASSESSMENT REPORT

August 2023

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Information contained in this report was based on the last information received from Cabanga Environmental between February and April 2023. Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Rayten Engineering Solutions (Pty) Ltd for incomplete or inaccurate data supplied by others. We are aware of the fact that there might have been changes since this report was submitted, however this report and its findings is based on the last information received from the client between February and April 2023. To the best of our knowledge the assumptions and findings are correct at the time of submission of the specialist report. Should any of the assumption or findings prove to be incorrect subsequent to submission of the report, we as the specialist cannot be held accountable. Note that although every effort has been made by Rayten Engineering Solutions (Pty) Ltd to obtain the correct information and to carry out an appropriate, independent, impartial and competent study, Rayten Engineering Solutions (Pty) Ltd cannot be held liable for any incident which directly or indirectly relates to the work in this document, and which may have an effect on the client or on any other third party.

CONFIDENTIALITY

DECLARATION OF PRACTITIONER

PROJECT TITLE

Proposed Newcastle Coal Mine - Air Quality Impact Assessment Report

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Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the National Environmental Management Air Quality Act (NEM:AQA) (No. 39 of 2004):

<u>I Gertrude Mafusire, declare that – General declaration</u>

I am independent of the applicant;
I have the necessary expertise to conduct the assessments required for the report; and
I have performed and will continue to perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I will disclose to the applicant and the air quality officer and/or competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority (i.e. the Department of Mineral Resources and Energy).
The information provided in this AQIA report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer and/or competent authority is a criminal offence in terms of section 51(1)(g) of the NEM:AQA (No.39 of 2004).

Signature of the specialist:

Rayten Engineering Solutions (Pty) Ltd

Name of company (if applicable):

23 August 2023

Date

EXECUTIVE SUMMARY

Rayten Engineering Solutions (Pty) Ltd was appointed by Cabanga Environmental to compile an Air Quality Impact Assessment report (AQIAr) for the proposed Newcastle Coal Mine (hereafter referred to as "the proposed mine", proposed by Minetek Resources (Pty) Ltd, and located approximately 5km west of the town of Newcastle, within the Amajuba District Municipality, in the KwaZulu-Natal (KZN) Province.

Mining at the proposed mine will comprise of an initial open pit mining component on the eastern portion, and a future underground mining component on the western portion of the Application Area. Opencast mining will be by means of conventional truck and shovel operations, with concurrent rehabilitation during the operational phase by means of the roll over method. Run of Mine (ROM) will be transported via trucks to in-pit ROM stockpiles, with the option of using conveyors also a considered alternative, and then processed at a mobile and in-pit crushing and screening plant, before being transported via haulage or conveyor to the product stockpile area. Product coal will either be sold or transported offsite (via road-trucks or via a proposed conveyor system) for further processing before being sold. The offsite processing will take place under toll-washing agreements with existing coal washing plants in the area. Environmental Authorisation (EA) is required for the proposed mining operations, with an Environmental Impact Assessment (EIA) process currently underway to obtain the EA. This AQIAr has been compiled as a supporting document for the EA application process for the proposed mine.

The main objective of the AQIA is to determine the potential impact of emissions associated with the operational activities at the proposed mine on ambient air quality in terms of dustfall, PM_{10} and $PM_{2.5}$.

As part of the AQIA, a baseline air quality assessment was undertaken to determine the following:

- the prevailing meteorological conditions at the site;
- baseline concentrations of key air pollutants of concern;
- identify existing sources of emissions; and
- identify key sensitive receptors surrounding the project site.

The land use immediately surrounding the proposed mine consists mostly of cultivated land, grassland, and forested land. Additionally, built-up areas, mines and quarries, barren land, waterbodies and wetlands occupy part of the land use within a 20km radius, but to a minimal extent. Barren land, waterbodies and wetlands are scattered in surrounding areas, while mines and quarries and built-up areas are in localised areas north-northeast to south-east of the proposed mine. The larger area surrounding the project site is classified as rural in nature. Few existing key sources of air pollution surrounding the proposed mine were identified during a desktop exercise and include:

- Agricultural activity (seasonal) and potential biomass burning (surrounding areas);
- Vehicle dust entrainment on unpaved roads (surrounding areas); and
- Planted forest/Plantations (mainly south-west and north-west of proposed mine).

MM5 meteorological data for the project area for the period 01 January 2020 – 31 December 2022 was used for input into the dispersion model and to determine prevailing meteorological conditions for the project site. Based on the prevailing wind fields for the period January 2020 to December 2022, emissions from activities at the proposed mine will likely be transported towards the south-easterly quadrant. Higher topographical features located north-west and west-southwest of the proposed mine could also enhance the dispersion of emissions impacting on nearby areas located south-east and north-east of the proposed mine, as evident in the dispersion model plots in Sections 6.3.1 and 6.3.2. Moderate to fast wind speeds observed during all the time periods, may result in effective dispersion and dilution of emissions from the proposed mining operations; however, higher winds speeds can also facilitate fugitive dust emissions from open exposed areas such as stockpiles and opencast areas. Removal of particulates via wet depositional processes would be evident during the warmer (wet) seasons (spring – early autumn), thus, lower ambient concentrations of dust could be expected during these seasons. Over the remainder of the year higher ambient concentrations of particulates could be expected.

The existing air quality situation is usually evaluated using available monitoring data from nearby government owned air quality monitoring stations (AQMS), which are accessible via the online South African Air Quality Information System (SAAQIS) portal. The nearest AQMS to the project site is located at the Newcastle station (-27.734167°S, 29.980139°E), located ~9km east-northeast of the proposed mine. However, there was no ambient air quality monitoring data available from the station as it appears to be malfunctioning, with no data recorded over the past few years. Thus, the baseline air quality status at the project area could not be determined. Moreover, dustfall data could not be provided in this AQIA report as there are no available dustfall networks operated near the project site, that could be determined.

The main conclusions of the AQIA for the project can be summarised as follows:

Dustfall, PM_{10} and $PM_{2.5}$ are key pollutants of concern associated with operations at the proposed mine and will be emitted from the following key sources:

Particulate Emissions:

- Construction activity;
- Drilling and blasting at the opencast pits;
- Bulldozing;
- Material handling operations (truck loading/offloading operations);
- Miscellaneous/conveyor transfer points;
- Crushing and screening;
- Wind erosion from exposed areas: the opencast pits, exposed surfaces and material stockpiles;
- Excavators (loading dump trucks at pit area, loading crusher at mobile plant, loading off-site haulage trucks; and
- Vehicle dust entrainment on unpaved roads.

Two scenarios were modelled in this assessment, i.e:

a) The **construction phase scenario**, where emissions associated with construction activity (e.g., establishment of access and haul roads, setting out material stockpile areas, construction of pollution control dams, etc) due to the development of infrastructure associated with the proposed mine, were modelled.

b) The **actual operating scenario**, where emissions from surface mining activities associated with operations at the proposed mine were modelled. This scenario represents the potential impacts if the proposed mine were emitting under normal operating conditions and considered 3 multi-pit mining options (i.e. i.e. Pits 1 to 3: located closest to the Newcastle area; Pits 2 to 6: maximum Pit combination proposed for Year 9; and Pits 5 & 6: to represent minimum pit combination, with one of the Pits (i.e. Pit 5) located nearest to receptors within the proposed mine boundary), since it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site.

Both scenarios were modelled without mitigation since limited information on planned mitigation measures was known at the time of modelling. This also represents the worst-case scenario.

Based on the dispersion model output plots for the construction phase, predicted incremental dustfall rates, PM_{10} and $PM_{2.5}$ concentrations are moderately high but mostly in compliance with the applicable limits over the project area (i.e. area within the 20km x 20km modelling domain), especially for dustfall, $PM_{2.5}$ and annual PM_{10}, for which predicted concentrations at offsite locations in nearby surrounding areas are only projected to exceed the applicable limits just outside the eastern mine boundary, but within a maximum radius of 300m. Inside the proposed mine boundary, predicted concentrations for the same pollutants fall well below the standards, except at localised areas near the planned areas of construction activity where exceedances are observed. For daily PM_{10}, while predicted incremental concentrations fall below the daily standard of 75 µg/m^3 over most of the project area, higher concentrations, including exceedances of the standards are projected over a wider area inside the mine boundary, and at offsite locations north-east and south-east of the proposed mine, within a maximum radius of 2.3km. It is noted that all exceedances predicted under the construction phase are without mitigation.

For the operational phase, predicted incremental dustfall rates and PM (PM_{10} and $PM_{2.5}$) concentrations are higher than those projected under the construction phase, but still comply with applicable standards over most of the project area modelled for dustfall, $PM_{2.5}$ and annual PM_{10}. While exceedances are projected outside the mine boundary for the same pollutants (dustfall, $PM_{2.5}$ and annual PM_{10}), they are mostly restricted to offsite areas located south-east and north-east of the proposed mine, within maximum radii of 2.3km, 3.7km and 2.6km for dustfall, $PM_{2.5}$, and annual PM_{10}, respectively. Predicted incremental daily PM_{10} concentrations are relatively high, with exceedances of the daily standard extending from the mine boundary to offsite areas up to 10.7km towards the south-east and north-east. All exceedances predicted under the operational phase are without mitigation. Inside the proposed mine boundary, exceedances of the standards are also observed for the modelled pollutants and are mostly localised near to the proposed surface mining activities (open pits, drilling, blasting, loading/offloading operations, haul routes, material stockpile areas, transfer points and proposed material stockpile/exposed areas) for dustfall and annual $PM_{2.5}$, which contrasts with the larger spatial extent projected in PM_{10} (daily and annual) and daily $PM_{2.5}$ exceedances. However, it should be noted that the projected exceedances are without mitigation.

Among the three multi-pit mining options considered for the operational phase, the options involving 3 Pits and 5 Pits generally resulted in higher maximum predicted concentrations compared to the option involving 2 Pits, as seen in the isopleth plots in Section 6.3.2 . The spatial extent of exceedances projected outside the north-eastern and south-eastern proposed mine boundaries (without mitigation) is also indicated to be greater for the 3 Pit and 5 Pit options, and lesser for the 2 Pit option. The offsite exceedances are projected within specific radii indicated below:

- 2 Pit option – 855m (for dustfall), 2.2km (for daily $PM_{2.5}$), 1.4km (for annual PM_{10}) and 7.3km (for daily PM_{10}), with annual $PM_{2.5}$ exceedances restricted to a small portion of the proposed eastern mine boundary.
- 5 Pit option – 2.3km (for dustfall), 850m (for annual $PM_{2.5}$), 3.6km (for daily $PM_{2.5}$), 2.3km (for annual PM_{10}), and 9.3km (for daily PM_{10}).
- 3 Pit option – 2.3km (for dustfall), 1.3km (for annual $PM_{2.5}$), 3.7km (for daily $PM_{2.5}$), 2.6km (for annual PM_{10}), and 10.7km (for daily PM_{10}).

Nearby sensitive receptors located within a 20km radius from the proposed mine boundary are not indicated to be impacted by the projected exceedances under the construction phase, since predicted concentrations mostly fall below the dustfall and PM standards, except at DR1 (dwellings just outside the northern mine boundary) where an exceedance of the daily PM_{10} standard is projected. Under the operational phase, several discrete receptors downwind of the project site, i.e. within a 10.7km radius south-east and north-east of the proposed mine (mostly schools and residential areas in Newcastle) are indicated to be mostly impacted by predicted exceedances in daily PM_{10} concentrations, and could thus be at high risk under the unmitigated scenario. Receptors located south-west and north-west of the proposed mine are likely to experience low concentrations of all modelled pollutants.

As dust, which also contains the smaller PM_{10} and $PM_{2.5}$ particles, is the key pollutant of concern associated with activities at the proposed mine, it is recommended that dust mitigation measures be implemented. For the construction phase, mitigation measures that can be considered for implementation are described in more detail in Section 7 of this report and include vegetative stabilisation, use of wind barriers, limiting the size of areas that need clearing and earth-moving management. For the operational phase, under which relatively high concentrations and dustfall rates are projected (i.e. without mitigation), a dust management plan (DMP) should be implemented to reduce additional levels in background concentrations at the site. Measures that can be considered for inclusion in the DMP include vehicle restrictions, reducing the height of material transfer at the crushing and screening plant, enclosure of material transfer points, water sprays during material handling operations, and the use rock armour at large stockpiles prone to wind erosion (refer to Section 7 of report). Further, the DMP must be reviewed and updated on an annual basis. It is further recommended that the proposed mine undertake monthly dustfall monitoring and continuous (daily) PM_{10} monitoring during the operational phase. Dustfall monitoring before commencement of operations is also recommended to determine baseline conditions.

In conclusion, the dispersion modelling results (i.e. without mitigation) indicate relatively high daily dustfall rates and PM (PM_{10} and $PM_{2.5}$) concentrations for the operational phase of the proposed mine, with exceedances of the applicable standards at offsite locations projected towards the north-east and south-east, within maximum radii of 2.3km, 3.7km and 10.7km for dustfall, $PM_{2.5}$ and PM_{10}, respectively. In contrast, comparatively lower incremental dustfall rates, and PM concentrations are projected for the construction phase. However, exceedances are still projected at offsite locations just outside the eastern mine boundary within a 300m radius (for dustfall, $PM_{2.5}$ and annual PM_{10}), as well as outside the north-eastern and south-eastern mine boundaries for daily PM_{10}. Discrete receptors located south-east and north-east of the proposed mine are indicated to be most impacted by emissions from the proposed mine. Furthermore, a total of 22 receptors are projected to fall within the domain of projected exceedances for daily PM_{10}, while only four receptors are indicated to be impacted by exceedances projected for dustfall, $PM_{2.5}$ and annual PM_{10} for the different multi-pit options considered in this assessment (Table E1).

Table E1: Discrete receptors located within the domain of projected exceedances for dustfall, $PM_{2.5}$ and PM_{10} (operational phase).

Discrete Receptor ID	Discrete Receptor Name	Multi-Pit Option		
		3-Pits	5-Pits	2-Pits
	Dustfall			
DR3	Dwellings (Zebra Lodge)		x	
DR41	Residential Area (Fernwood, Sunset View)		x	
	Daily $PM_{2.5}$			
DR7	Residential Area (Lennoxton)		x	
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	
DR41	Residential Area (Fernwood, Sunset View)	x	x	
	Annual $PM_{2.5}$			
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x		
DR41	Residential Area (Fernwood, Sunset View)	x	x	
	Daily PM_{10}			
DR1	Dwellings (farm workers'houses)	x	x	
DR3	Dwellings (Zebra Lodge)		x	
DR4	Dwellings (Game Goose Game Lodge)	x		x
DR7	Residential Area (Lennoxton)	x	x	x
DR8	Residential Area (Newcastle CBD & Newcastle Central)/Edu (unknown)	x	x	x
DR9	Residential Area (Arbor Park, Equarand,Vlam)	x	x	
DR10	Residential Area (Newcastle CBD)/Edu (unknown)	x	x	x
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	x
DR12	Residential Area (Hennenman)	x		x
DR14	Residential Area (Pioneer Park)	x		x
DR16	Educational Facility (unknown)	x		x

DR17	Educational Facility (Ferum High school)	x		x
DR18	Educational Facility (Majuba TVET College)	x	x	x
DR19	Residential Area (Barry Hertzog Park)	x		
DR20	Residential Area (Amajuba Park)	x		
DR21	Educational Facility (Amajuba School, Newcastle Training Centre, Majuba FETC)	x		
DR22	Residential Area (Sunnyridge)			x
DR24	Residential Area (Ncandu Park)/Edu (Hope High School)	x		
DR39	Dwellings (Thornhill Country Estate)			x
DR40	Dwellings (unknown)			x
DR41	Residential Area (Fernwood, Sunset View)	x	x	x
DR42	Residential Area (Sunset View, Fairleigh, Gandhi Park)	x	x	x
	Annual PM_{10}			
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	
DR41	Residential Area (Fernwood, Sunset View)		x	

Should the proposed development go ahead, the implementation of dust mitigation measures summarised above (and detailed in Section 7 of this report) during construction and operation of the proposed mine is advised, to reduce dust emissions from proposed key emission sources as far as possible, and to reduce the impact on nearby sensitive receptors. Most of the mitigation measures have mitigation potentials/control efficiencies ranging between 25% and 75%, with only a few of the measures being 90 – 100% effective. Thus, should the dispersion model be run again with mitigation, it is likely that lesser concentrations will be predicted. However, the level of emission reduction will depend on the choice of mitigation. But it is noted that mitigation measures will help reduce the impacts at the receptor points.

The proposed development is projected to result in **low to medium and medium negative air quality impacts during construction and operation, respectively, after the implementation of mitigation measures.**

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AEL	Atmospheric Emissions License
AERMOD	AMS/EPA Regulatory Model
AMS	Alternative Monitoring System
AQIA	Air Quality Impact Assessment
AQIAr	Air Quality Impact Assessment Report
AQMP	Air Quality Management Plan
AQMS	Air Quality Monitoring Station
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
$CO_{2\text{-eq}}$	Carbon dioxide equivalent
DEA	Department of Environmental Affairs (now known as the Department of Forestry, Fisheries and the Environment: DFFE)
DMP	Dust Management Pan
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
DR	Discrete Receptor
GHG	Greenhouse gas
GMT	Greenwich Meridian Time
HFC	Hydrofluorocarbons
KZN	KwaZulu Natal
NAEIS	National Atmospheric Emissions Inventory System
NAAQS	National Ambient Air Quality Standards
NEMA	National Environmental Management Act
NEM:AQA	National Environmental Management Air Quality Act
NPI	National Pollutant Inventory
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
N_2O	Nitrous Oxide
Mtpa	Million tonnes per annum
OB	Overburden
O_3	Ozone
PBL	Planetary Boundary Layer
PCD	Pollution Control Dam
PFC	Perfluorocarbons
PM_{10}	Particulate Matter, aerodynamic diameter equal to or size less than 10µm
$PM_{2.5}$	Particulate Matter, aerodynamic diameter size equal to or less than 2.5µm
PRIME	Plume Rise Model Enhancements
ROM	Run of Mine
SAGERS	South African Greenhouse Gas Emissions Reporting System
SAAQIS	South African Air Quality Information System

SF_6	Sulphur hexafluoride
SO_2	Sulphur Dioxide
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

Rayten Engineering Solutions (Pty) Ltd was appointed by Cabanga Environmental to compile an Air Quality Impact Assessment report (AQIAr) for the proposed Newcastle Coal Mine (hereafter referred to as “the proposed mine”, proposed by Minetek Resources (Pty) Ltd, and located approximately 5km west of the town of Newcastle, within the Amajuba District Municipality, in the KwaZulu-Natal (KZN) Province.

The main objective of the AQIA is to determine the potential impact of emissions associated with the operational activities at the proposed mine on ambient air quality in terms of dustfall, PM_{10} and $PM_{2.5}$.

As part of the AQIA for the proposed mine, a baseline air quality assessment was undertaken through a review of meteorological monitoring data, available air quality monitoring data, air quality legislation and the identification of nearby sensitive receptors and existing emissions sources surrounding the project site. The potential impact of emissions from the mining activities associated with the proposed mine on air quality is evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using the AMS (Alternative Monitoring System)/EPA (Environmental Protection Agency) Regulatory Model (AERMOD). Comparison of predicted concentrations for criteria air pollutants is made with the South African National Ambient Air Quality Standards (i.e. Government Gazette No. 32816, GN 1210, of 24 December 2009 and Government Gazette No. 35463, GN 486, of 29 June 2012) and the South African National Dust Control Regulations, GN R827, 2013, where applicable.

1.1. Project Details

Applicant	Minetek Resources (Pty) Ltd
Mine	Proposed Newcastle Mining Project
Co-ordinates	27.753582°S 29.863807°E
Municipality and Province	Amajuba District Municipality, KZN Province.
AEL number	Not required
Mining Right Application Reference Number	KZN30/5/1/2/2/10122
Designated Air Quality Priority Area	N/A
Modelling contractor	Rayten Engineering Solutions (Pty) Ltd *Gertrude Mafusire (MPhil.)* *Snr Air Quality Specialist* *6.5 years working experience.* *0117920880* *info@rayten.co.za*

1.2. Brief Project Description

Mining at the proposed mine will comprise of an initial open pit mining component on the eastern portion, and a future underground mining component on the western portion of the Application Area. This study focused on operational activities associated with opencast mining only, as this is where most of the pollutants and air quality impacts will emanate from.

Opencast mining will be by means of conventional truck and shovel operations, with concurrent rehabilitation during the operational phase by means of the roll over method. The extent of the mining right application area is 3268.7ha, with a projected Life on Mine of 15 years for opencast mining and 10+ years for underground mining. The coal reserve at the proposed mine occupies seven proposed pits (i.e. Pits 1 to 6 & Pit D1). The pits will be mined in sequence (starting at Pit 1), as per the planned mining schedule, and not all seven pits will be open at any given time. However, given the variable coal qualities, it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site, to meet the required product qualities.

Surface mining operations will include removal/stripping of topsoil (and vegetation) using bulldozers, removal of soft overburden using excavators and trucks, drilling and blasting into hard overburden and removal using bulldozers, excavators and dumpers, drilling and blasting into coal (only when necessary, as it is expected that most of the coal can be excavated without blasting (by means of free digging)) and removal using excavators and trucks for transport to the in-pit and mobile plant for dry crushing, screening, and sorting. Product coal will then be transported via haulage trucks or conveyor to the product stockpile area, from where the coal will either be sold or transported offsite (via road-trucks) for further processing before being sold.

The focus of this study is to quantify emissions of dustfall, PM_{10} and $PM_{2.5}$ associated with operational activities at the proposed mine, which include:

- Construction activity;
- Drilling and blasting at the opencast pits;
- Bulldozing;
- Material handling operations (truck loading/offloading operations);
- Miscellaneous/conveyor transfer points;
- Crushing and screening;
- Wind erosion from exposed areas: the opencast pits, exposed surfaces and material stockpiles;
- Excavators (loading dump trucks at pit area, loading crusher at mobile plant, loading off-site haulage trucks; and
- Vehicle dust entrainment on unpaved roads.

A preliminary site layout diagram is given in Figure 1-1. This was considered as the preferred layout plan for the proposed mine and was used in this AQIAr for modelling purposes.

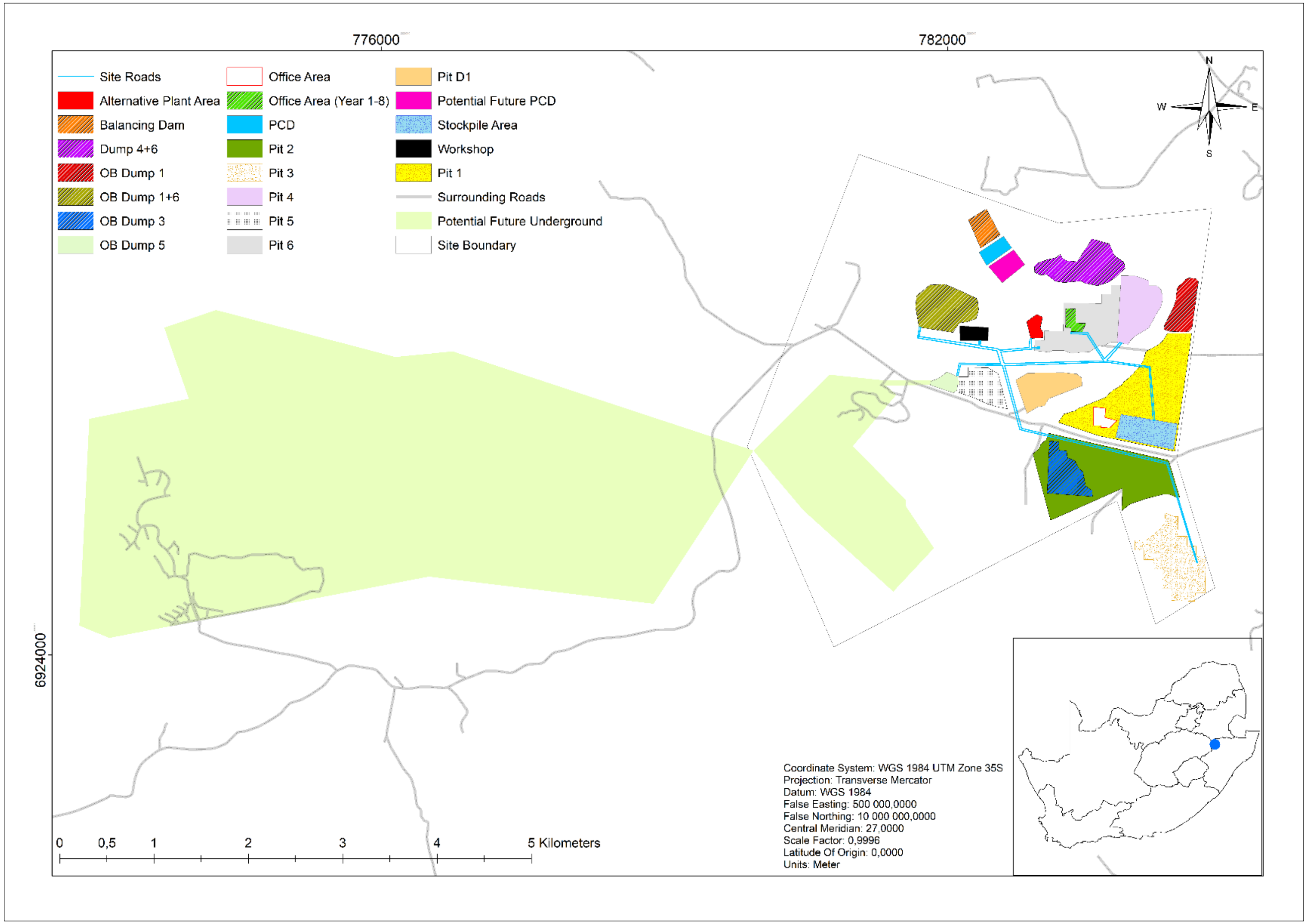


Figure 1-1: Proposed Mine Preferred Layout Plan.

1.3. Terms of Reference

The scope of work for the AQIA is as follows:

- A review of the study site and activities;
- An overview of the prevailing meteorological conditions in the area which influence the dilution and dispersion of pollutants in the atmosphere;
- The identification of existing sources of emissions;
- The identification of key air pollutants of concern that may be emitted from proposed mining activities (dustfall, PM_{10} and $PM_{2.5}$);
- Characterisation of the ambient air quality within the area using available air quality monitoring data;
- A review of the current South African legislative and regulatory requirements for air quality;
- The identification of sensitive receptors, such as local communities, surrounding the study area;
- The compilation of an emission inventory for key sources of emissions;
- Dispersion modelling simulations of ground level particulate emissions for incremental impacts; and
- Provision of general recommendations for the mitigation and management of identified potential impacts.

1.4. Outline of Report

An overview of the site location including surrounding receptors is given in **Section 2**. National Ambient Air Quality Standards, dust control regulations and associated health impacts for the relevant criteria pollutants are discussed in **Section 3**. The local meteorological conditions and baseline air pollutants concentrations are provided in **Section 4**. Potential emissions and their impact on air quality associated with proposed operations are outlined in **Section 5**. Mitigation measures, recommendations and a summary report are detailed in **Section 6**.

2. SITE CHARACTERISTICS

2.1. Site Location

The proposed mine is located approximately 5km west of the town of Newcastle, within the Amajuba District Municipality, in the KZN Province of South Africa (27.753582°S; 29.863807°E) (Figure 2-1). The provincial R34 and national N11 routes run north and east of the proposed mine, respectively. The project area does not fall within a Nationally Declared Air Quality Priority Area.

2.2. Surrounding Land Use

The land use immediately surrounding the proposed mine consists predominantly of cultivated land, grassland, and forested land. Additionally, built-up areas, mines and quarries, barren land, waterbodies and wetlands occupy part of the land use within a 20km radius, but to a minimal extent. Barren land, waterbodies and wetlands are scattered in surrounding areas, while mines and quarries and built-up areas are in localised areas north-northeast to south-east of the proposed mine (Figure

2-2). The Ncandu Nature Reserve is also located ~20km south-southwest of the project site. The larger area surrounding the project site is classified as rural in nature.

2.3. Topography

The topography surrounding the proposed mine is shown in Figure 2-3. Surrounding elevations range from 1047 – 2328 m above sea level. The project site is situated approximately 1200 – 1375 m above sea level; with increasing elevation towards the west-southwest and north-west (Figure 2-3).

2.4. Sensitive Receptors

A sensitive receptor is defined as a person or place where involuntary exposure to air pollutants released by the site's activities could occur. Identified sensitive receptors, which are located within a 20 km radius of the proposed mine are given in Figure 2-4.

The discrete receptors given in Table 2-1, were used for modelling purposes. Maximum predicted incremental concentrations are provided for the identified discrete receptors. These points are located at the centre of residentials areas, or near schools, hospitals, and old age homes, in order to determine the maximum concentrations that could be expected near sensitive receptors. Discrete points are not plotted for each individual sensitive receptor but are used to represent a group of sensitive receptors located near to each other (e.g., several Schools).

Table 2-1: Discrete receptors within a 20km radius of the proposed mine. Receptors were identified through a desktop study.

SURROUNDING RECEPTORS (<20KM)				
Discrete Receptor ID	Name Edu = educational/school/training facilities HC = healthcare/clinic/hospital facilities Old = old age home Residential = Dwellings/ farm houses	UTM Co-ordinates (35S)		Elevation (m)
		X (m)	Y (m)	
DR1	Dwellings	782442.1	6928970	1250.56
DR2	Dwellings (Narumija Boerdery)	782434.9	6930067.78	1253.37
DR3	Dwellings (Zebra Lodge)	783561.82	6925041.31	1274.83
DR4	Dwellings (Grey Goose Game Lodge)	785313.48	6928794.24	1236.79
DR5	Dwellings (Newcastle Country Lodge)	785137.37	6929974.04	1270.21
DR6	Lowveld Hunters & Game Conservation	778012.03	6932060.14	1444.92
DR7	Res (Lennoxton)	787941.07	6924827.49	1202.03
DR8	Res (Newcastle CBD & Newcastle Central)/Edu (unknown)	788777.85	6925946.72	1194.63
DR9	Res (Arbor Park, Equarand,Vlam)	790829.59	6924650.99	1228.24
DR10	Res (Newcastle CBD)/Edu (unknown)	789709.51	6926174.29	1204.16
DR11	Res (Sury Avile)/Edu (St Dominics)	786807.37	6925757.52	1193.4
DR12	Res (Hennenman)	788806.17	6928259.37	1209.08
DR13	Edu (Amiel Park, Hutten Heights)	787830.29	6929991.45	1262.25
DR14	Res (Pioneer Park)	789245.17	6929139.14	1217.09
DR15	Res (Schuinshoogte)	788790.78	6930698.04	1237.78

DR16	Edu (unknown)	789433.87	6929973.84	1228.04
DR17	Edu (Ferum High school)	790617.38	6929082.33	1229.2
DR18	Edu (Majuba TVET College)	790510.11	6928029.03	1215.49
DR19	Res (Barry Hertzog Park)	791173.65	6928442.4	1217.8
DR20	Amajuba Park	792191.9	6929307.48	1228.14
DR21	Edu (Amajuba School, Newcastle Training Centre, Majuba FETC)	791675.11	6929205.78	1228.25
DR22	Res (Sunnyridge)	790439.09	6929708.12	1238.17
DR23	Edu (Adamsonvlei Primary School)	790533.39	6931098.39	1331.57
DR24	Res (Ncandu Park)/Edu (Hope High School)	793278.43	6929587.32	1221.83
DR25	Dwellings/Edu (unknown)	785227.47	6934471.13	1320.22
DR26	Res (Madadeni A & B, Kwamathukuza)/Edu (several)	797870	6926369.98	1196.29
DR27	Res (Madadeni G)/Edu (several)	798951.47	6927591.98	1208.48
DR28	Res (Madadeni K & J)/Edu (several)	800171	6927906.77	1182.51
DR29	Res (Madadeni E)/Edu (several)	800608.19	6926313.7	1201.22
DR30	HC (Madadeni Hospital)	800792.27	6925242.94	1220.13
DR31	Res (Madadeni H & L)	802472	6923921.17	1240.46
DR32	Res (Madadeni)/Edu (Celani Primary School)	802379.96	6926130.13	1196.78
DR33	Res (Jan Clliers Park)	795015.52	6920367.02	1194.92
DR34	Dwellings/Edu (Ziphakamiseni Secondary School	791975.67	6917147.11	1225.78
DR35	Dwellings (Anew Resort Vulintaba)	774292.01	6924413.17	1424.69
DR36	Edu (Mullerspass farm Primary School)	771915.11	6915654.76	1445.26
DR37	Edu (Botha's Pass Farm Primary School)	770508.55	6938527.89	1532.67
DR38	Edu (Emthunzini Primary School)	792525.93	6939969.82	1202.86
DR39	Dwellings (DJ Browning Farming - Craig Farm, Thornhill Country Estate)	781298.04	6926872.78	1285.12
DR40	Dwellings	780548.85	6927445.81	1296.29
DR41	Res (Fernwood, Sunset View)	785551.54	6924369.38	1199.81
DR42	Res (Sunset View/Fairleigh Gandhi Park)	787465.28	6923744.41	1230.8
Notes: *DR = discrete receptor *<5 hospitals/healthcare/clinic facilities within 20km of site (located in surrounding areas). *>10 school/training/educational facilities within 20km of site (located in surrounding areas). *No old age home facilities identified within 20km of the project site. *Numerous dwellings/residential areas in surrounding areas				

Site characteristics are presented in Figure 2-1 to Figure 2-4, however, only the eastern half of the application area is shown an all four maps as this is where surface activities associated with the proposed opencast mining operations are located, and thus, where most of the pollutants and air quality impacts will emanate from.

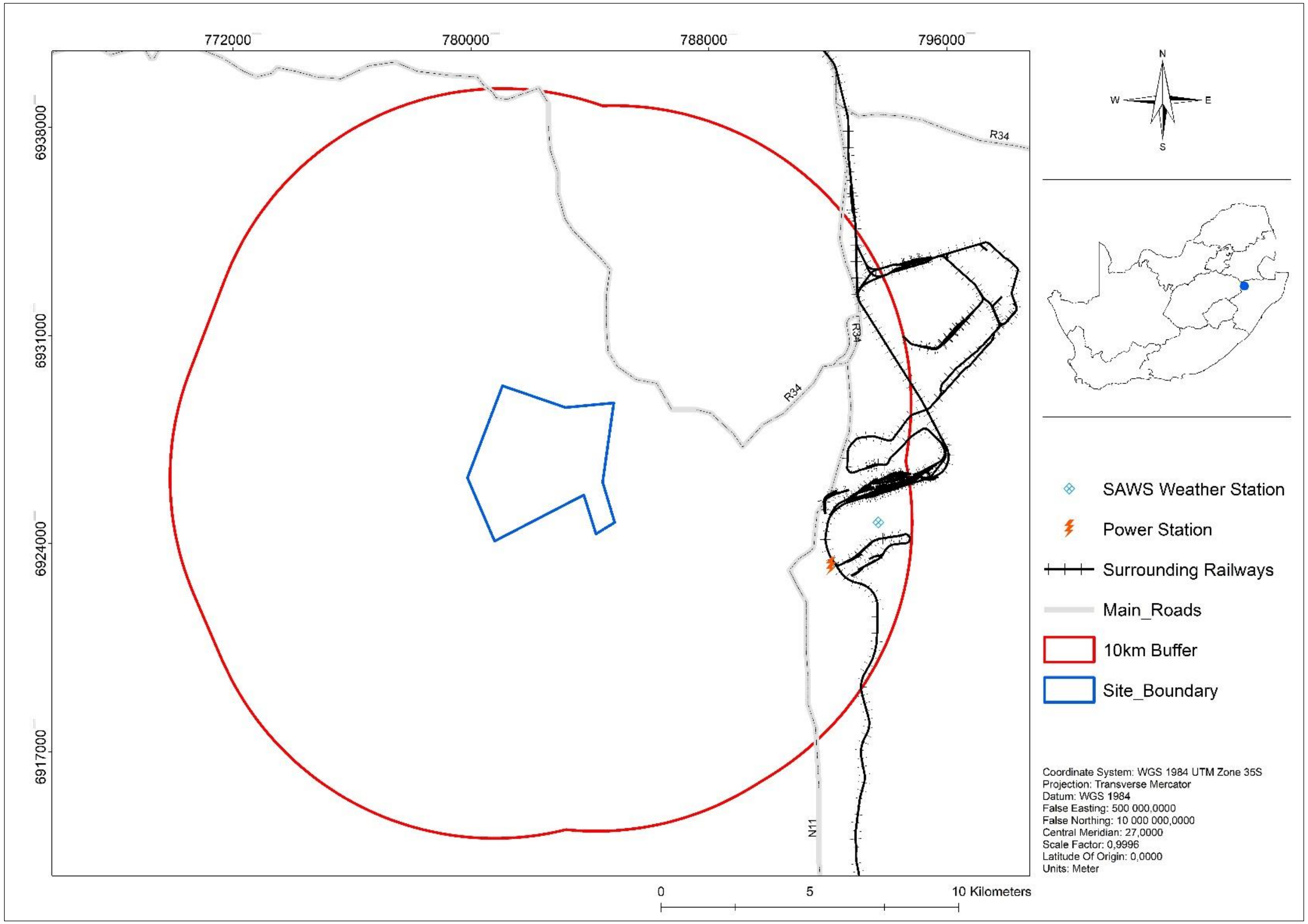


Figure 2-1: Site locality for the proposed mine.

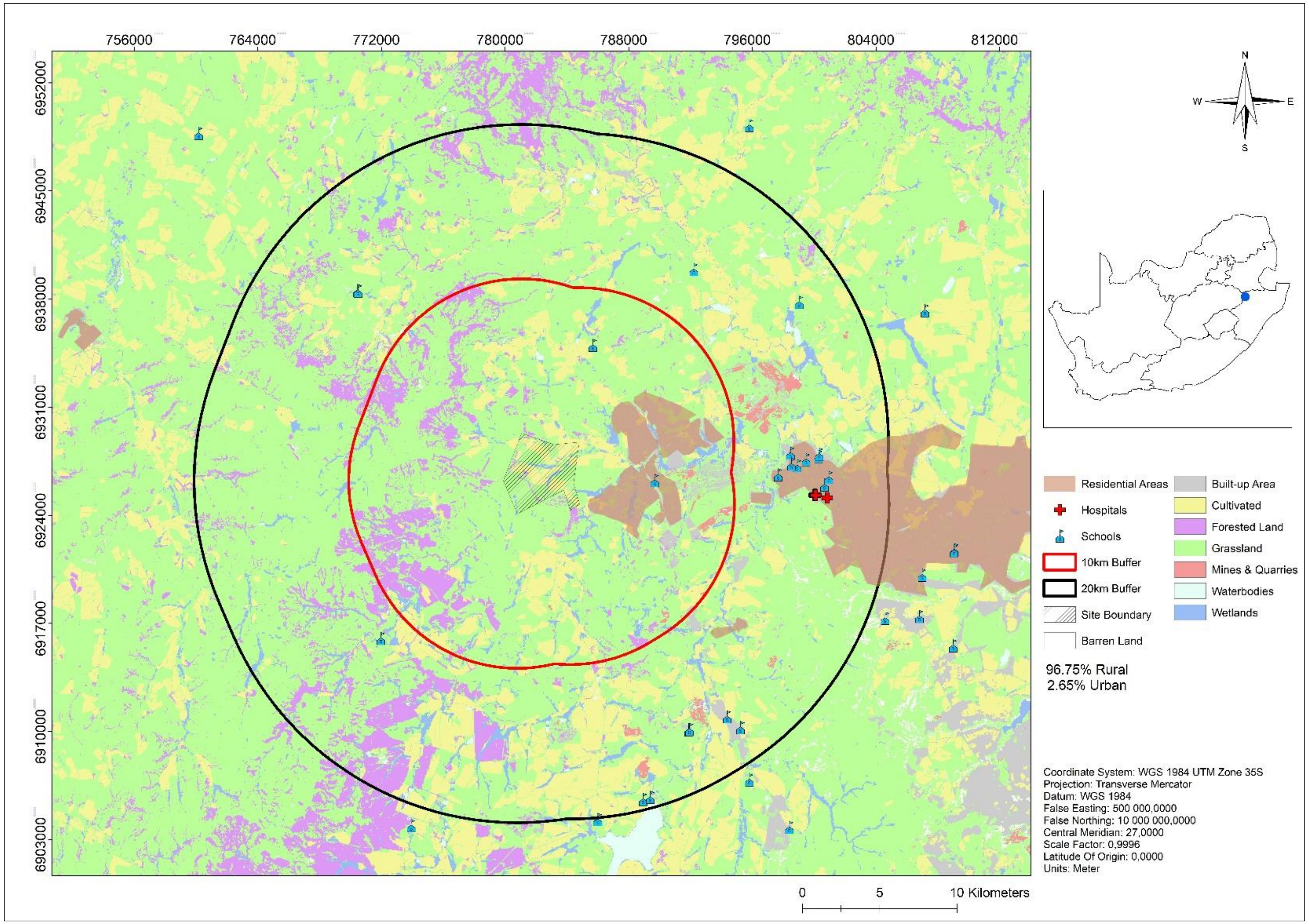


Figure 2-2: Land use surrounding the proposed mine.

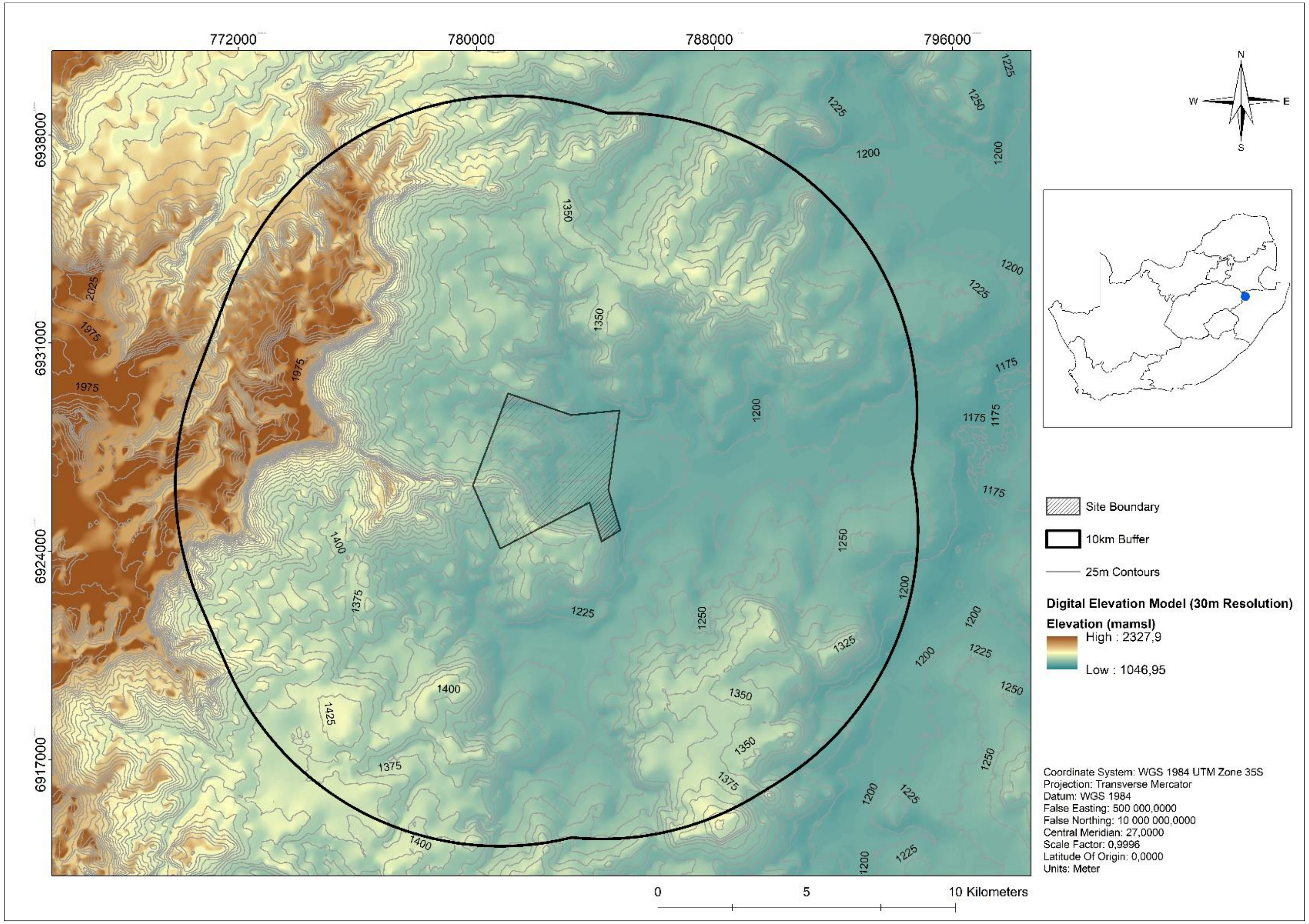


Figure 2-3: Topography surrounding the proposed mine.

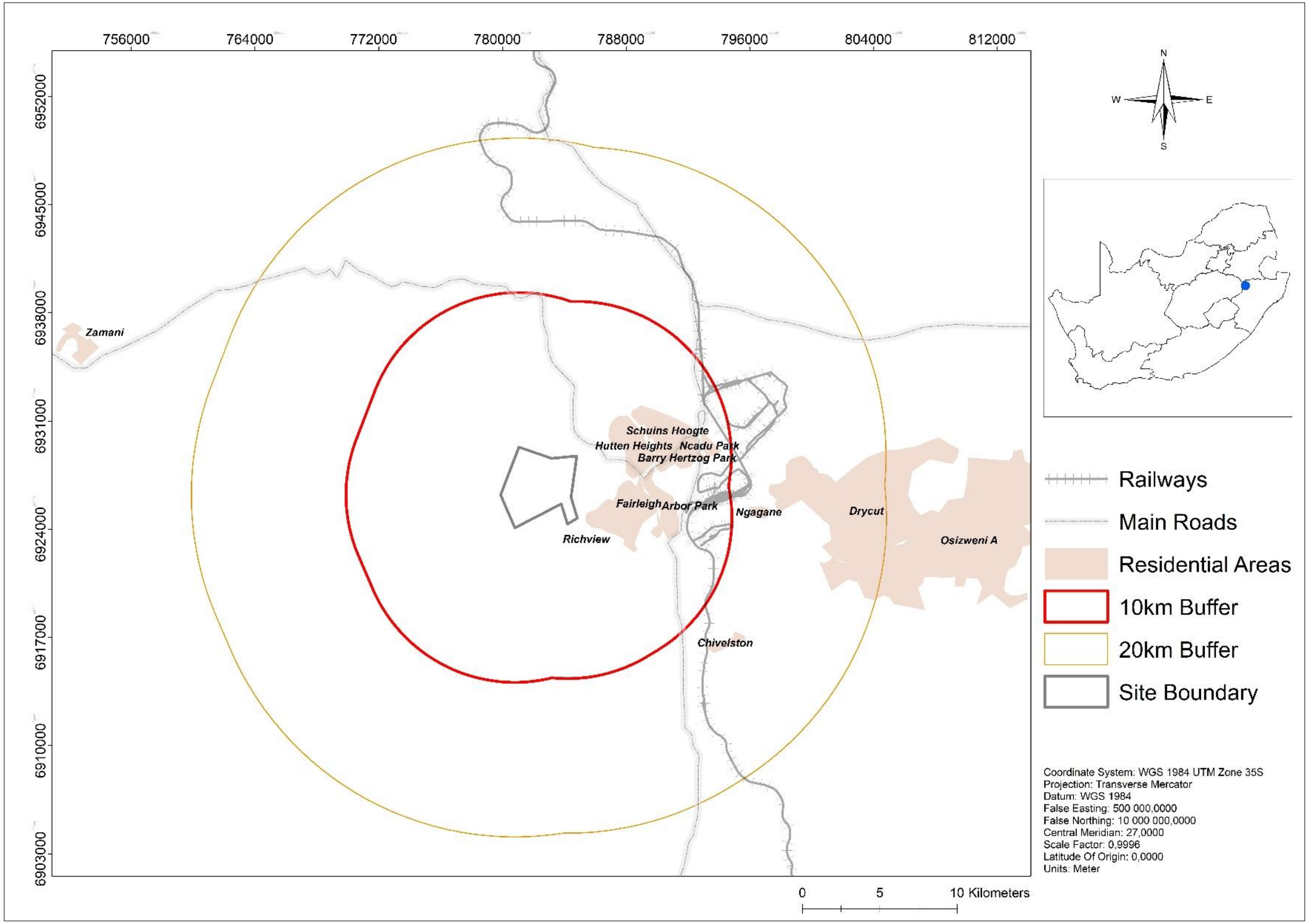


Figure 2-4: Sensitive receptors surrounding the proposed mine.

3. LEGISLATION

3.1. National Environmental Management: Air Quality Act

The National Environmental Management: Air Quality Act 39 of 2004 (NEM: AQA), has shifted the approach of air quality management from source-based control to receptor-based control. The main objectives of the Act are to;

- protect the environment by providing reasonable measures for—
    i. the protection and enhancement of the quality of air in the Republic;
    ii. the prevention of air pollution and ecological degradation; and
    iii. securing ecologically sustainable development while promoting justifiable economic and social development; and
- generally, to give effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and wellbeing of people.

The Act makes provisions for the setting and formulation of National Ambient Air Quality Standards for “substances or mixtures of substances which present a threat to health, well-being or the environment”. More stringent standards can be established at the provincial and local levels.

The control and management of emissions in the NEM: AQA relates to the listing of activities that are sources of emissions and the issuing of Atmospheric Emission Licences (AEL). Listed activities are defined as activities which “result in atmospheric emissions and are regarded as having a significant detrimental effect on the environment, including human health”. Listed activities have been identified by the Minister of the Department of Environmental Affairs (DEA) (now known as the Department of Forestry, Fisheries and the Environment (DFFE) and atmospheric emission standards have been established for each of these activities. These listed activities now require an AEL to operate. The issuing of AELs for listed activities is the responsibility of the Metropolitan and District Municipalities, with the exception of those associated within mining operations.

In addition, the Minister may declare any substance contributing to air pollution as a priority pollutant. Any industries or industrial sectors that emit these priority pollutants will be required to implement a Pollution Prevention Plan. Municipalities are required to “designate an air quality officer to be responsible for co-ordinating matters pertaining to air quality management in the Municipality”. The appointed Air Quality Officer is responsible for the issuing of AELs.

3.2. Listed Activities and Minimum Emission Standards

The NEM: AQA requires all persons undertaking listed activities in terms of Section 21 of the Act to obtain an AEL. The listed activities and associated minimum emission standards were issued by the DEA on 31 March 2010 (Government Gazette No. 33064 of 31 March 2010) and were amended in:

- 2013 (Government Gazette No. 37054 of 22 November 2013);
- 2015 (Government Gazette No. 38863 of 12 June 2015);
- 2018 (Government Gazette No.41650 of 25 May 2018; Government Gazette No.42013 of 31 October 2018);
- 2019 (Government Gazette No.42472 of 22 May 2019); and
- 2020 (Government Gazette No. 43174 of 27 March 2020).

The proposed mine will not trigger any of the S21 listed activities based on their proposed operations.

South Africa launched an online National reporting system, referred to as the National Atmospheric Emissions Inventory System (NAEIS). The NEM:AQA requires all emission source groups identified in terms of the National Atmospheric Emission Reporting Regulations (Government Gazette No. 38633 of 02 April 2015), to register and report emissions on the NAEIS. Mines are classified as Group C emitters (i.e. Mines and Quarries) and thus are required to report annually and comply with the National Atmospheric Emission Reporting Regulations.

Once operational, the proposed mine must register on the NAEIS and report on their fugitive dust emissions annually before the 31 March each year.

3.3. Ambient Air Quality Standards

National Ambient Air Quality Standards (NAAQS), including permitted frequencies of exceedance and compliance timeframes, were issued by the Minister of Water and Environmental Affairs on 24 December 2009 (Table 3-1). National standards for $PM_{2.5}$ were established by the Minister of Water and Environmental Affairs on 29 June 2012.

Table 3-1: National Ambient Air Quality Standards for Criteria Pollutants.

POLLUTANT	AVERAGING PERIOD	CONCENTRATION ($\mu g/m^3$)	FREQUENCY OF EXCEEDANCE(3)
Sulphur dioxide (SO_2)	10 minutes	500 (191)	526
	1 hour	350 (134)	88
	24 hours	125 (48)	4
	1 year	50 (19)	0
Nitrogen dioxide (NO_2)	1 hour	200 (106)	88
	1 year	40 (21)	0
Particulate Matter (PM_{10})	24 hours	75	4
	1 year	40	0
Particulate Matter ($PM_{2.5}$)	24 hours	40(1) 25(2)	0
	1 year	20(1) 15(2)	0
Ozone (O_3)	8 hours (running)	120 (61)	11
Benzene (C_6H_6)	1 year	5 (1.6)	0
Lead (Pb)	1 year	0.5	0
Carbon monoxide (CO)	1 hour	30 000 (26 000)	88
	8 hours (calculated on 1 hourly averages)	10 000 (8 700)	11

Notes:

*Values indicated in blue are expressed in part per billion (ppb)

(1) Compliance required by 1 January 2016 – 31 December 2029.

(2) Compliance required by 1 January 2030.

(3) Frequency of exceedance refers to the number of times an exceedance is allowed within a calendar year.

3.4. Dust Deposition Standards

The DEA issued National Dust Control Regulations on 1 November 2013 (Table 3-2). The purpose of the regulations is to prescribe general measures for the control of dust in all areas. The regulations prohibit activities which give rise to dust in such quantities and concentrations that the dustfall at the boundary or beyond the boundary of the premises where it originates exceeds:

a) 600 mg/m^2/day averaged over 30 days in residential areas measured using reference method ASTM D1739.
b) 1 200 mg/m^2/day averaged over 30 days in non-residential areas measured using reference method ASTM D1739.

Updated draft National Dust Control Regulations were published on 25 May 2018. The regulations prescribe the method that should be used for undertaking dustfall monitoring, which includes the use of dust bucket stations with a wind shield.

Table 3-2: South African National Dust Control Regulations.

RESTRICTION AREAS	DUSTFALL RATE (D) (1)	REQUENCY OF EXCEEDANCE
Residential Areas	D < 600 mg/m^2/day	Two within a year, no two sequential months (2)
Non-residential areas	600 < D < 1200 mg/m^2/day	Two within a year, no two sequential months (2)

Notes:
(1) Averaged over 1 month (30±2-day average) (mg/m^2/day)
(2) Per dustfall monitoring site.

Any person who has exceeded the dustfall standard must, within three months after submission of a dustfall monitoring report, develop and submit a dust management plan (DMP) to the air quality officer for approval. The DMP must:

a) Identify all possible sources of dust within the affected site;
b) Detail the best practicable measures to be undertaken to mitigate dust emissions;
c) Develop an implementation schedule;
d) Identify the line management responsible for implementation;
e) Incorporate the dustfall monitoring plan;
f) Establish a register for recording all complaints received by the person regarding dustfall, and for recording follow up actions and responses to the complainants.

The DMP must be implemented within a month of the date of approval. An implementation progress report must be submitted to the air quality officer at agreed time intervals.

3.5. Greenhouse Gas Emissions

On 14 March 2014, the following six greenhouse gases (GHGs) were declared as priority air pollutants in South Africa:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

National GHG Emission Reporting Regulations (Government Gazette No. 40762 of 3 April 2017), as amended (General Notice 994 in Government Notice 43712 of 11 September 2020), were published by the DEA (now known as the DFFE). A person identified as a Category A data provider in terms Annexure 1 of these regulations, must register their facilities using the online South African Greenhouse Gas Emissions Reporting System (SAGERS) (https://ghgreporting-public.environment.gov.za/GHGlanding/). Once registered the data provider must submit a GHG emissions inventory, activity data and report in the required format given under Annexure 3 of these regulations on an annual basis. All data must be provided annually, by the 31 March of the following year.

National Pollution Prevention Plan Regulations (Government Gazette No. 40996) were published on 21 July 2017 by the DEA. A pollution prevention plan will be required should the development do the following:

a) Undertake any of the following activities identified in Annexure A of the National GHG Emission Reporting Regulations (Government Gazette No. 40762 of 3 April 2017), as amended (General Notice 994 in Government Notice 43712 of 11 September 2020), which involves the direct emission of GHG more than 0.1 Megatonnes (Mt) annually measured as carbon dioxide equivalents ($CO_{2\text{-eq}}$); or
b) Undertake any of the following activities identified in Annexure A of the National Pollution Prevention Plan Regulations (Government Gazette No. 40996 of 21 July 2017) as a primary activity, which involves the direct emission of GHG more than 0.1 Megatonnes (Mt) annually measured as carbon dioxide equivalents ($CO_{2\text{-eq}}$);

<u>Annexure A activities in terms of the National Pollution Prevention Plan Regulations include:</u>

- Coal mining
- Production and /or refining of crude oil
- Production and/or processing of natural gas
- Carbon black production
- Iron & steel production
- Ferro-alloys production
- Aluminium production
- Polymers production

- Production of liquid fuels from coal or gas
- Cement production
- Glass production
- Ammonia production
- Pulp and paper production
- Electricity production
- Nitric acid production

Mining falls under category 1A2i (i.e. Mining and Quarrying) in terms of Annexure 1 of the National GHG emission reporting regulations (Government Gazette No. 40762 of 3 April 2017), as amended (General Notice 994 in Government Notice 43712 of 11 September 2020). All facilities conducting this activity (i.e. Mining and Quarrying) are required to register and report on their GHG emissions by the 31 March of every year, should they have combustion installations that have a cumulative installed design capacity equal to or greater than 10MW.

3.6. Carbon Tax Act

The Carbon Tax Act No. 15 of 2019 was promulgated on the 23 May 2019 and is implemented using a phased approach, allowing emitters time to transition to cleaner and more efficient technologies resulting in lower GHG emissions. Phase One is effective from 1 June 2019 to 31 December 2022 (extended to 31 December 2025) and focuses on Scope 1 (direct) emissions, while phase 2, running from 31 December 2022 (extended to 2025) to 31 December 2030, will include Scope 2 (indirect) emissions.

Any person, company or entity who undertakes an activity (above a certain threshold) and is responsible for the release of GHG emissions is required to report on their emissions to the DEA by the 31 March each year and pay tax on those emissions by July each year.

The base tax rate when the Act was published was R120 per tonne of $CO_{2\text{-eq}}$ (carbon dioxide equivalent) emitted by the generation facility or entity for the relevant reporting period, but it is now at R144 per tonne of $CO_{2\text{-eq}}$. However, there are tax-free allowances that apply that can make the overall effective tax rate much lower between R6 and R48 per tonnes of $CO_{2\text{-eq}}$ emitted. Tax free allowances are capped at 95% and include:

- A basic tax-free allowance of 60% during Phase One (until December 2022 [extended to 31 December 2025]).
- An additional tax-free allowance of 10% for process emissions.
- An additional tax-free allowance of 10% for fugitive emissions.
- An additional tax-free allowance of up to a maximum of 10% for trade exposed sectors.
- An additional tax-free performance allowance of 5% based on performance against intensity benchmarks.
- An additional tax-free allowance of 5% for companies who participate in the carbon budget system.
- An additional tax-free carbon offset allowance of 5% or 10%.

4. HUMAN HEALTH EFFECTS

4.1. Dustfall

Dustfall are particles with an aerodynamic diameter greater than 20 µm that have been entrained into the air by a physical process such as wind, movement of vehicles, stack emissions or from fugitive dust. These particles are generally too heavy to remain in suspension in the air for any period and fall out of the air over a relatively short distance depending on a combination of various factors such as particle size, density, temperature (of the air and particle), emission velocity or method, ambient wind speed and humidity. These particles are therefore commonly known as “dustfall”. Particulates in this range are generally classified as a nuisance dust and can cause physical damage to property and physical irritation to plants, animals and humans.

4.2. Particulates (PM_{10} & $PM_{2.5}$)

Particles can be classified by their aerodynamic properties into coarse particles, PM_{10} (particulate matter with an aerodynamic diameter equal to or less than 10 µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter equal to or less than 2.5 µm). The fine particles mostly contain secondary formed aerosols such as sulphates and nitrates, combustion particles and re-condensed organic and metal vapours. The coarse particles mostly contain earth crust materials and fugitive dust from roads and industries (Harrison and van Grieken, 1998) (Fenger, 2002).

In terms of health impacts, particulate air pollution is associated with effects on the respiratory system (WHO, 2000). When looking at human health particle size is an important factor to consider because it controls where in the respiratory system a given particle will be deposited. Fine particles are thought to be more damaging to human health than coarse particles as larger particles do not penetrate deep into the lungs compared to smaller particles. Larger particles are deposited into the extra thoracic part of the respiratory tract while smaller particles are deposited into smaller airways that lead to the respiratory bronchioles (WHO, 2000).

Recent studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m^3). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Long-term exposure to low concentrations (~10 µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics and children.

5. BASELINE ASSESSMENT

5.1. Meteorological Overview

Meteorological processes will determine the dispersion and dilution potential of pollutants emitted into the atmosphere. The vertical dispersion of pollution is governed by the stability of the atmosphere as well as the depth of the surface mixing layer. Horizontal dispersion of pollution is defined by dominant wind fields. Therefore, meteorological parameters including temperature, precipitation, wind speed and wind direction are of significance as they will influence the degree to which pollution will accumulate or disperse in the atmosphere.

As per the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014), representativeness of the meteorological data is influenced by the following four factors:

- Proximity of the meteorological site to the area being modelled;
- Complexity of the terrain;
- Exposure of the meteorological measurement site; and
- Period of data collection.

MM5 modelled meteorological data was used for the project area. MM5 meteorological data was obtained from Lakes Environmental for the period January 2020 to December 2022. MM5 is a PSU/NCAR meso-scale model used to predict meso-scale and regional-scale atmospheric circulation. The model provides integrated model meteorological data, which can be used in a wide range of applications. This model is often used to create weather forecasts and climate projections. Details of the meteorological data obtained are summarised in Table 5-1 below.

The South African dispersion modelling regulations requires a minimum of 3-years of meteorological data for input into the dispersion model. The meteorological overview given in this section is with reference to the data used for input into the model. The modelled meteorological data correlates fairly with real-time data for the Newcastle area due to the similarities in observed wind fields. In real-time, high frequency-westerly winds are known to prevail in Newcastle from March to December, with additional low frequency easterly winds also observed from December to March (https://weatherspark.com, accessed 24 July 2023). This is similar to wind field data associated with the modelled data for the January 2020 – December 2022 period (Section 5.1.1). Additionally, fast periodic winter wind fields originating from the west-northwest, west, and north-west are associated with the modelled data (Section 5.1.1), similar to real-time wind fields observed in August.

Table 5-1: Meteorological Data Details.

Meteorological Data Details	
Met Data Information	**Description**
Met data type	MM5 AERMET-Ready (Surface & Upper Air Data)
Datum	WGS 84
Closest Town	Newcastle - South Africa
Co-ordinates of centre of met grid:	
Latitude	27.753582°S
Longitude	29.863807°E
Time zone	UTC +2 hours
Period of record	January 2020 - December 2022
Met Station Parameters	**Description**
Anemometer height	14 m
Station base elevation	1417 m
Upper air adjustment	-2 hours
Grid Cell Information	

Cell centre	27.753582°S, 29.863807° E
Cell dimension	12km * 12km
Surface Met Data	**Description**
File format	SAMSON file
Output interval	Hourly
Upper Air Data	**Description**
Format	TD-6201- Fixed Length
Reported in	GMT
Output interval	00Z and 12Z
Models used to process met data	
Model used to process data for wind roses	WR Plot
Model used to process data for AERMOD	AERMET

5.1.1. Local Wind Field

Figure 5-1 provides the period wind rose plot for the proposed mine for the period January 2020 to December 2022. The predominant wind directions for the period are observed from the west-northwest (~15% of the time) and north-west (~13.5%), with additional less frequent westerly, easterly and east-southeasterly winds (~10.5%). Wind speeds for the three-year period were generally moderate to fast with calm conditions, defined as wind speeds less than 1 m/s, observed for 2.68% of the time (Figure 5-1).

The morning (AM) and evening (PM) period wind rose plots for the period January 2020 to December 2022 are given in Figure 5-2 and show diurnal variation in the wind field data. During the morning (AM) period, high frequency winds are observed from the north-western quadrant; as opposed to the evening (PM) period, where easterly and east-southeasterly winds prevail (Figure 5-2).

There is slight seasonal variation in winds at the proposed mine, as shown in Figure 5-3. During summer, winds mainly originate from the east-southeast and east. In contrast, autumn, winter and spring are characterised by winds from the north-western quadrant (i.e. west-northwesterly, westerly and north-westerly winds). Additionally, less frequent north-westerly, easterly, and east-southeasterly winds are observed in summer, autumn and spring, respectively. Wind speeds were generally high during all seasons, which could subsequently facilitate dust emissions from stockpiles, onsite and offsite activities.

Based on the prevailing wind fields for the period January 2020 to December 2022, emissions from activities at the proposed mine will likely be transported towards the south-easterly quadrant. Higher topographical features located north-west and west-southwest of the proposed mine could also enhance the dispersion of emissions impacting on nearby areas located south-east and north-east of the proposed mine, as evident in the dispersion model plots in Sections 6.3.1 and 6.3.2. Moderate to fast wind speeds observed during all the time periods, may result in effective dispersion and dilution of emissions from the proposed mining operations; however, higher winds speeds can also facilitate fugitive dust emissions from open exposed areas such as stockpiles and opencast areas.

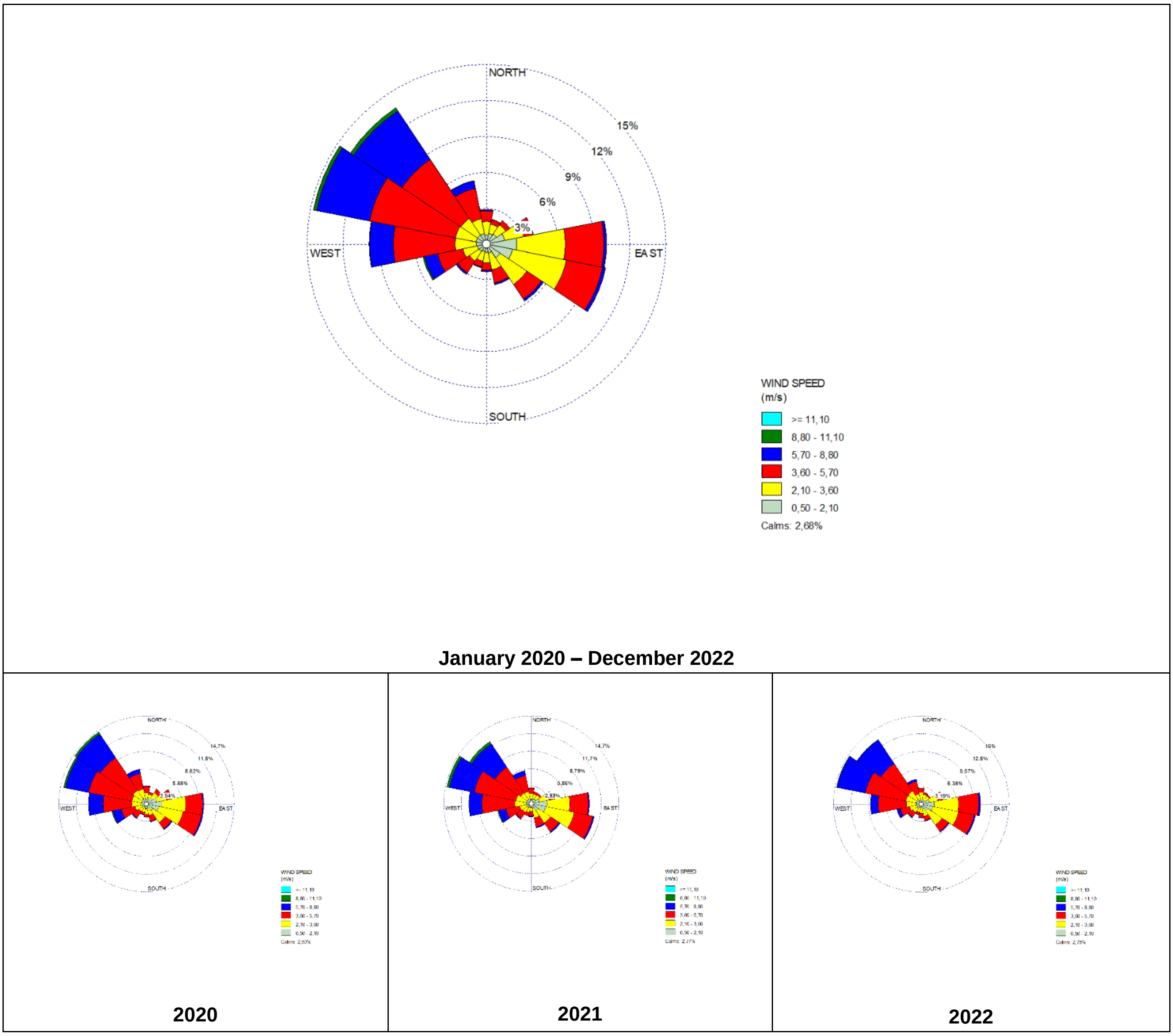
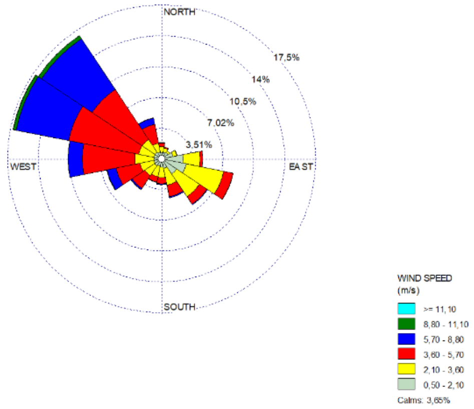
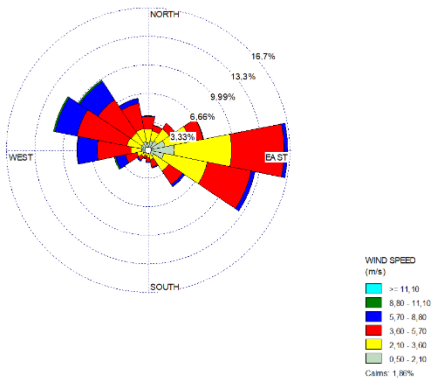


Figure 5-1: Period Wind Rose Plots for the proposed mine for the period January 2020 - December 2022.



Morning (AM) (00:00 – 12:00)



Evening (PM) (12:00 – 23:00)

Figure 5-2: Morning (AM) (00:00 - 12:00) and Evening (PM) (12:00 - 23:00) Period Wind Rose Plots for proposed mine for the Period January 2020 - December 2022.

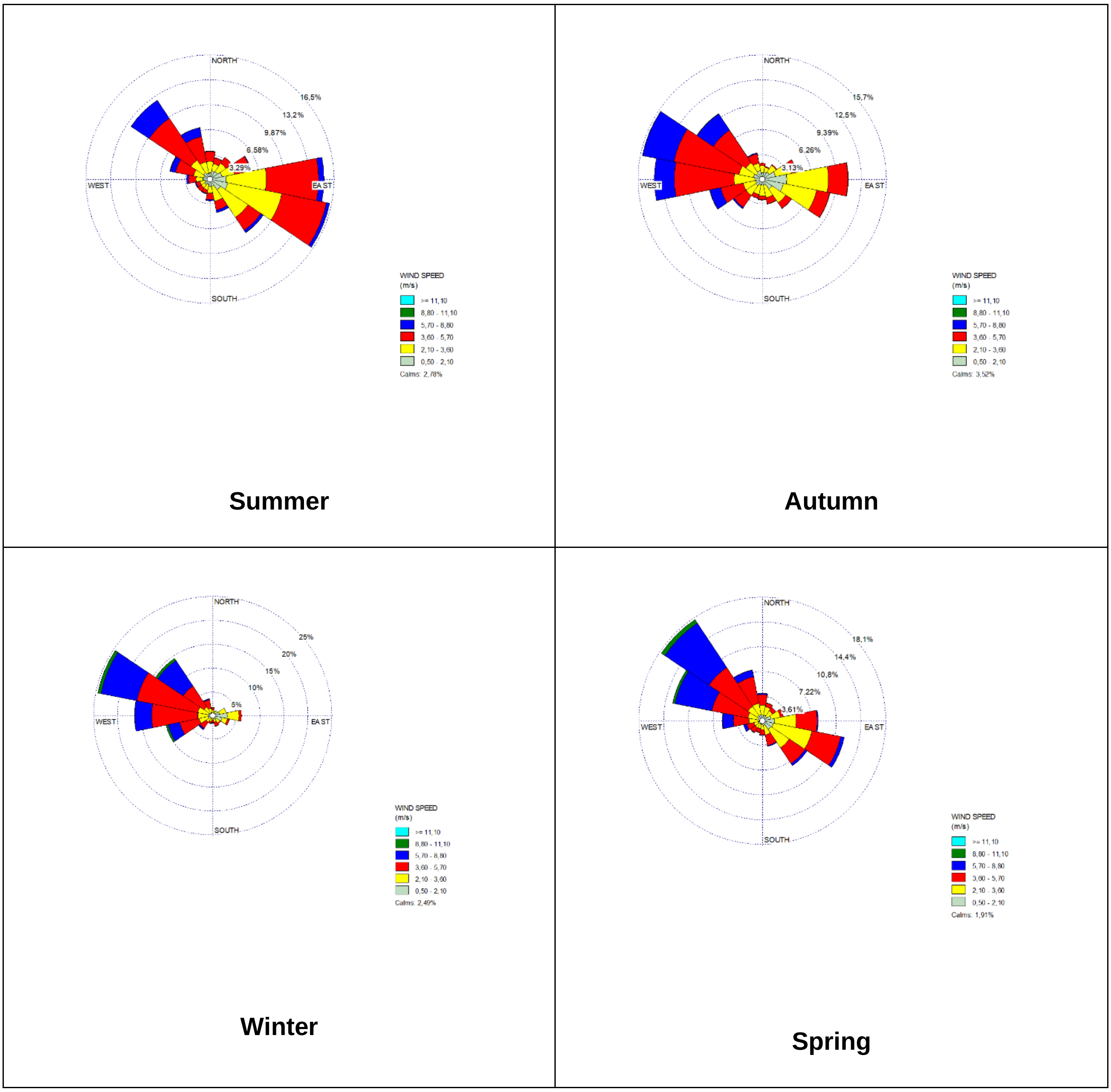


Figure 5-3: Seasonal Variation of Winds for the proposed mine for the Period January 2020 - December 2022.

5.1.2. Temperature and Relative Humidity

Temperature affects the formation, action and interactions of pollutants in various ways. Temperature provides an indication of the rate of development and dissipation of the mixing layer, which is largely controlled by surface inversions. Surface temperature inversions play a major role in air quality, especially during the winter months when these inversions are the strongest. Higher ambient temperatures will facilitate the dispersion of air pollutants which can result in lower ambient concentrations.

Chemical reaction rates also tend to increase with temperature and the warmer the air, the more water it can hold and therefore the higher the humidity. When relative humidity exceeds 70%, light scattering by suspended particles begins to increase, as a function of increased water uptake by the particles. This results in decreased visibility due to the resultant haze. Many pollutants may also dissolve in water to form acids.

The KZN Province generally experiences a varied climate with warm, rainy summers and cold winters. Monthly average temperatures and relative humidity profiles at the project site for the period January 2020 to December 2022 are presented in Figure 5-4 below. Average monthly temperatures range from 9.6 – 21.1 ºC (Table 5-2). Highest temperatures are observed during the spring, summer and autumn months (September – April) and minimum temperatures are observed during the late autumn and winter months (May – August). The relative humidity profile for the project site exhibits a similar annual trend to the temperature profile (Figure 5-4).

Table 5-2: Hourly Minimum, Maximum and Monthly Average Temperatures for January 2020 - December 2022 (Source: Lakes Environmental's Mesoscale Model 5 meteorological data).

MINIMUM, MAXIMUM AND MONTHLY AVERAGE TEMPERATURES (ºC)												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Minimum	11.2	9.0	9.2	4.0	2.1	0.8	-0.9	-0.4	4.0	4.2	8.6	8.1
Maximum	30.0	31.2	29.6	27.6	23.1	20.6	19.8	23.1	27.9	31.6	33.8	32.2
Average	20.8	20.1	18.7	15.8	12.9	9.8	9.6	11.8	15.5	17.9	19.7	21.1

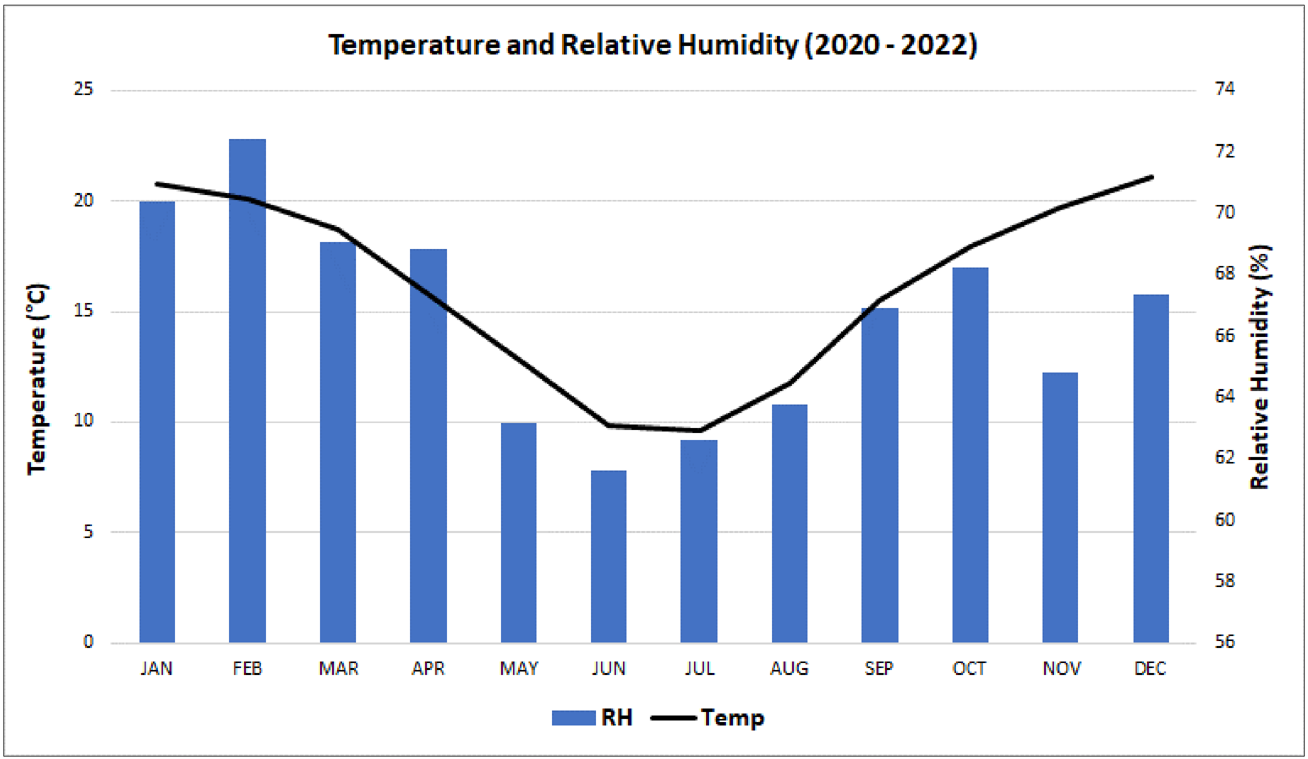


Figure 5-4: Monthly Average Temperature and Relative Humidity profiles for the proposed mine for January 2020 - December 2022 (Source: Lakes Environmental's Mesoscale Model 5 meteorological data).

5.1.3. Precipitation

Precipitation has an overall dilution effect and cleanses the air by washing out particles suspended in the atmosphere. Monthly total rainfall at the project site for the period January 2020 to December 2022 is presented in Figure 5-5. The area receives most of its rainfall during the spring, summer autumn seasons during the months September - April. Little to no rainfall is observed during the late-autumn and winter seasons from May to August (Table 5-3). Removal of particulates via wet depositional processes would be evident during the warmer (wet) seasons, thus lower ambient concentrations of dust could be expected during these seasons. Over the remainder of the year higher ambient concentrations of particulates could be expected.

Table 5-3: Total Monthly Rainfall for January 2020 - December 2022 (Source: Lakes Environmental's Mesoscale Model 5 meteorological data).

TOTAL MONTHLY RAINFALL (mm)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
2020	288.5	237.5	162.3	67.6	0.0	6.1	5.3	11.9	41.4	86.4	241.3	300.7	1449.1
2021	488.7	348.2	64.5	31.2	6.9	0.0	0.0	1.3	30.5	29.5	143.5	289.8	1434.1
2022	331.7	75.9	41.1	25.4	2.5	0.0	1.0	1.5	34.8	78.2	244.1	202.7	1039.1

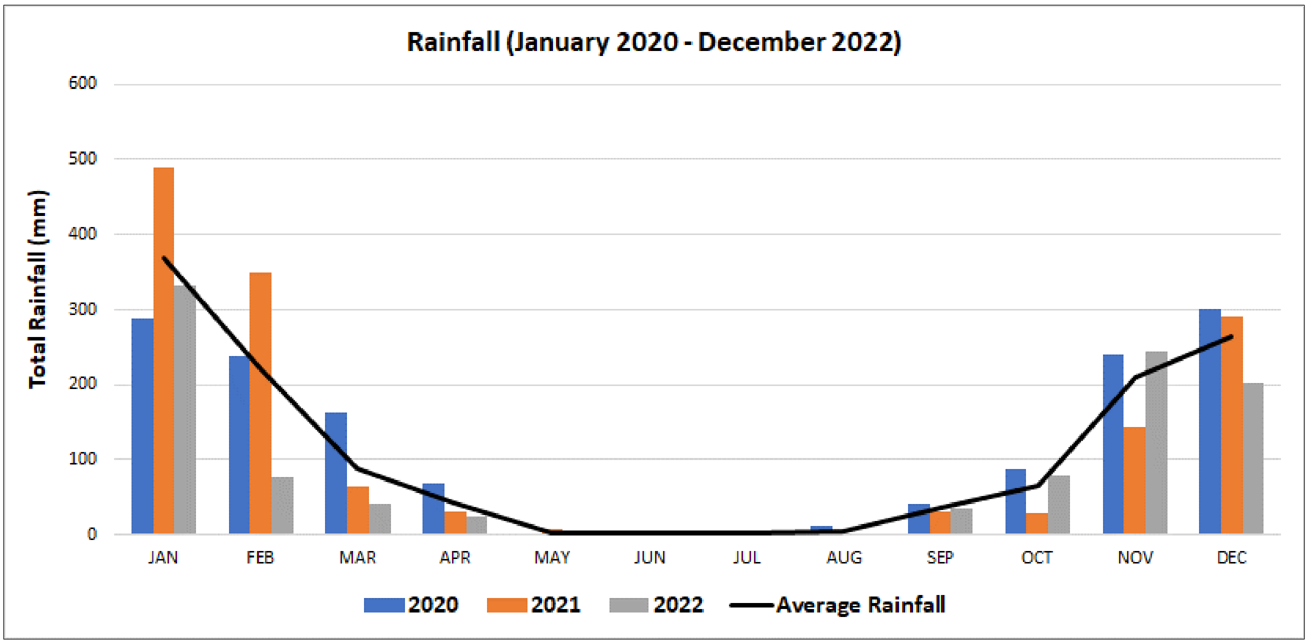


Figure 5-5: Total Monthly and Average Rainfall (mm) for the proposed mine for the period January 2020 - December 2022 (Source: Lakes Environmental's Mesoscale Model 5 meteorological data).

5.2. Baseline Air Quality Concentrations

The existing air quality situation is usually evaluated using available monitoring data from nearby government owned air quality monitoring stations (AQMS), which are accessible via the online South African Air Quality Information System (SAAQIS) portal. The nearest AQMS to the project site is located at the Newcastle station (-27.734167°S, 29.980139°E), located ~9km east-northeast of the proposed mine. However, there was no ambient air quality monitoring data available from the station as it appears to be malfunctioning, with no data recorded over the past few years. Thus, the baseline air quality status at the project area could not be determined. Moreover, dustfall data could not be provided in this AQIA report as there are no available dustfall networks operated near the project site, that could be determined.

5.3. Surrounding Sources of Air Pollution

Few existing key sources of air pollution surrounding the proposed mine were identified during a desktop exercise and include (Figure 5-6 and Figure 5-7):

- Agricultural activity (seasonal) and potential biomass burning (surrounding areas);
- Vehicle dust entrainment on unpaved roads (surrounding areas); and
- Planted forest/Plantations (mainly south-west and north-west of proposed mine).

Exposed areas, extraction and mining sites, industrial activities, waste and resource dumps and informal settlements were identified as additional sources of air pollution but to a lesser extent. Exposed areas are scattered in surrounding areas, while extraction and mining sites, as well as waste and resource dumps are in localised areas north-northeast to south-east of the proposed mine (e.g., Southern Coal located ~18km south-southeast of proposed mine, Future Coal's Chelmsford Colliery located ~15km south of the proposed mine, and Gardinia Colliery on Farm Gardinia 8486 ~15km to the south). Industrial areas within a 20km radius of the proposed mine include Acellor Mittal – Newcastle (~10 – 12km north-northeast), Riverside Industrial (~8km east), Newcastle CBD (~4 – 5 km east) and Airport Industrial (~7.8km south-east). In addition, the Madadeni informal settlement is located ~13 – 20km east of the proposed mine.

Wind erosion from exposed areas, extraction/mining sites and waste and resource dumps (e.g., stockpiles and landfills) is a key source of dust, while decomposition at waste dumps (e.g., landfills) is a key source of hazardous air pollutants (e.g., hydrogen sulphide (H_2S), chlorinated and mercaptan compounds, etc), methane and several other non-methane volatile organic compounds (VOCs). Informal settlements are normally associated with solid fuel combustion for cooking and indoor heating purposes, which results mainly in emission of carbon monoxide (CO) and particulates. If coal is being used, sulphur dioxide (SO_2) and H_2S might also be emitted in relatively smaller quantities. Industrial areas are emitters of particulates, VOCs, and gaseous pollutants, which are produced from chemical treatment and processing activities, furnaces, fuel combustion installations, stacks, etc.

The key sources of air pollution identified are explained in more detail below (Sections 5.3.1 to 5.3.3).

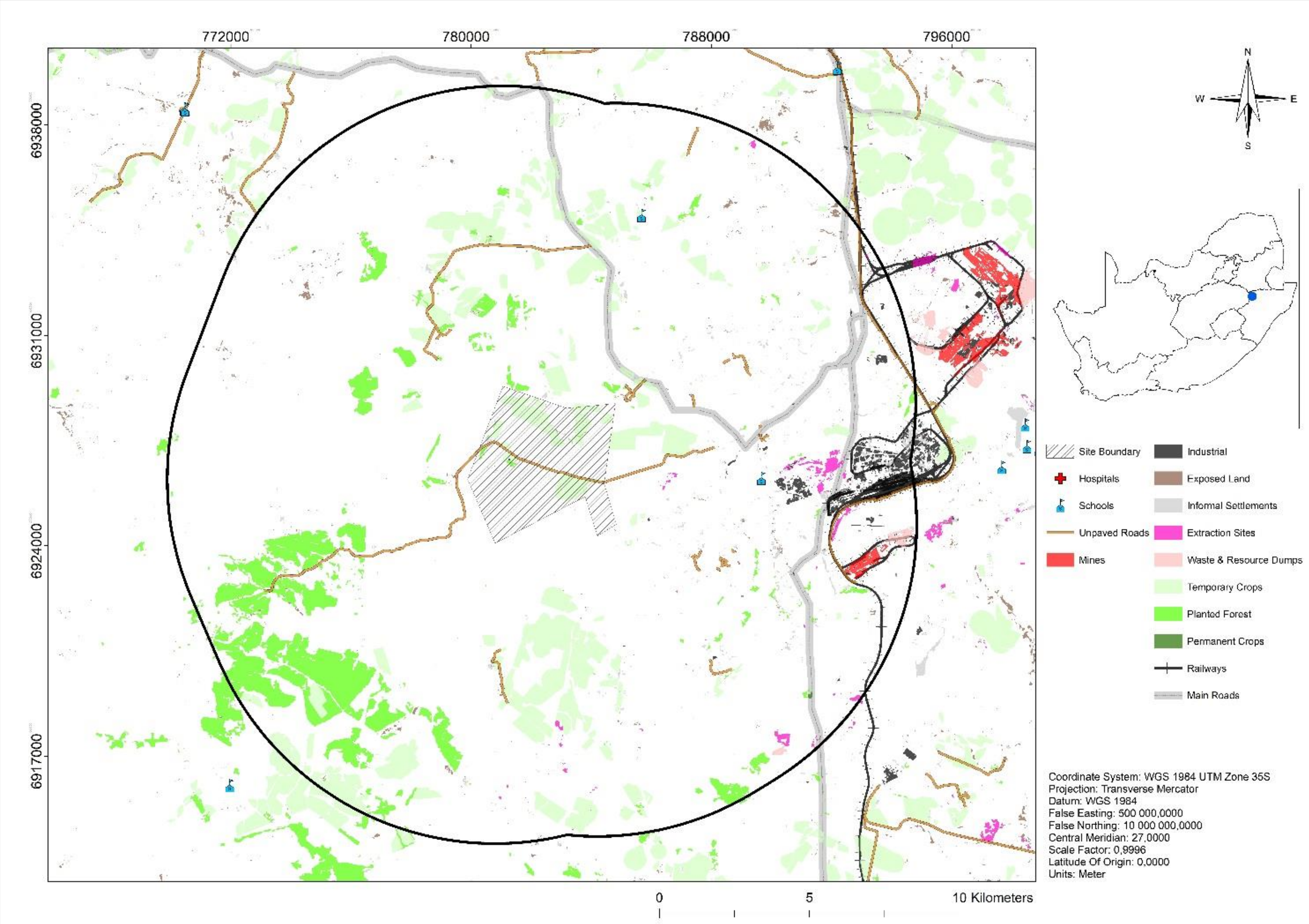


Figure 5-6: Identified surrounding emission sources within 10km of the proposed mine.

**Note: Temporary crops indicated in the legend on the map refer to seasonal crops*.*

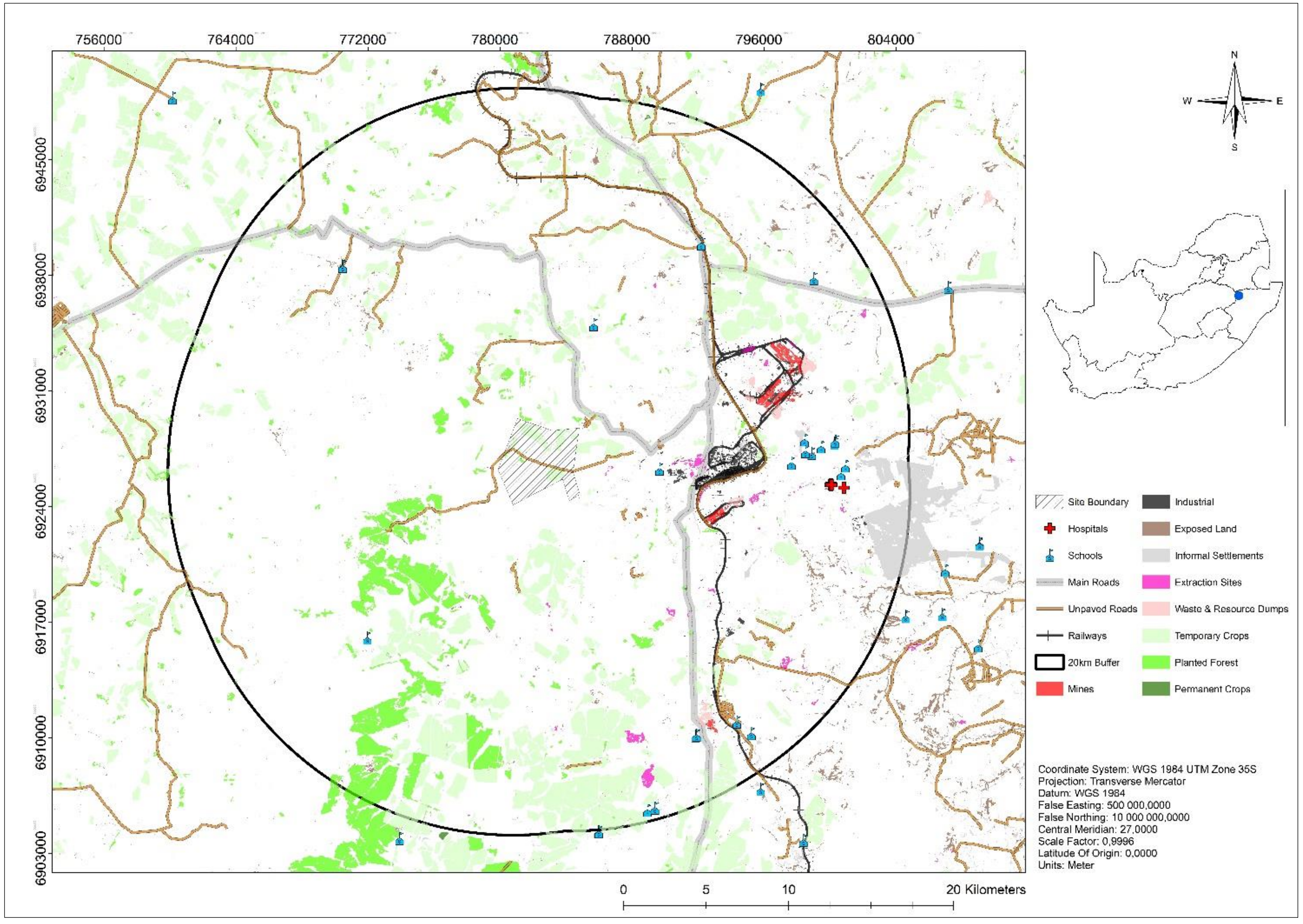


Figure 5-7: Identified surrounding emission sources within 20km of the proposed mine.

**Note: Temporary crops indicated in the legend on the map refer to seasonal crops*.*

5.3.1. Agricultural Activity and Potential Biomass Burning

There are several agricultural areas surrounding the proposed mine. Emissions from agricultural activities are difficult to control due to the seasonality of emissions and the large surface area producing emissions. Expected emissions resulting from agricultural activities include particulates associated with wind erosion and burning of crop residue, chemicals associated with crop spraying, and odiferous emissions resulting from manure, fertilizer and crop residue. Dust associated with agricultural practices may contain seeds, pollen and plant tissue, as well as agrochemicals, such as pesticides. The application of pesticides during temperature inversions increases the drift of the spray and the area of impact.

Dust entrainment from farming vehicles travelling on gravel roads may also cause increased particulates in an area. Dust from traffic on gravel roads increases with higher vehicle speeds, more vehicles and lower moisture conditions. The seasonal burning of the veld from July to September for field clearing in preparation for planting is also a source of smoke. The nature of the activity has a potential impact on air quality in the area.

Livestock on surrounding grazing lands located within the application area and a poultry-type farming business on Matandu farm to the north, also act as sources of odiferous emissions in the area.

5.3.2. Vehicle Dust Entrainment on Unpaved Roads

Vehicle-entrained dust emissions from the surrounding unpaved roads in the area potentially represent a key source of fugitive dust. When a vehicle or truck travels on an unpaved road, the force of the wheels on the road surface causes the pulverisation of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

5.3.3. Plantations

Several relatively large plantations exist mainly south-west and north-west of the proposed mine, most of which belong to Sappi. The effects of plantations on ambient air quality are dependent on the type of plantations. Oil tree plantations, for example, are associated with production of high levels of VOCs, particularly isoprene. In general, plantations result in an increase in ambient NOx concentrations due to the frequent and heavier use of fertiliser (https://nerc.ukri.org/planetearth/stories/561). The use of mobile equipment and trucks during land preparation and removal of trees are also a source of emissions such as PM, SO_2 and NOx.

In addition. plantations generally have sawmills. Air pollutants generated from sawmill operations are mainly associated with combustion processes such as wood recycling and disposal, as well as boilers. Additional sources of pollutants include wood drying in kilns, sawing, machining and sanding operations. Pollutants associated with boilers are dependent on the type of wood and fuel used to power the boilers and may include sulphur oxides (SOx), PM, NOx, CO, and VOCs. VOCs are also emitted from wood drying in kilns and during the application of solvents, coatings and lacquers to wood. Wood dust is an additional pollutant mainly associated with sawing, machining and sanding operations (Environmental, Health, and Safety Guidelines – Sawmilling and Manufactured Wood Products, International Finance Corporation).

6. AIR QUALITY IMPACT ASSESSMENT

Dustfall, PM_{10} and $PM_{2.5}$ are key pollutants of concern associated with operational activities at the proposed mine and will be emitted from the following key sources:

Particulate Emissions:

- Construction activity;
- Drilling and blasting at the opencast pits;
- Bulldozing;
- Material handling operations (truck loading/offloading operations);
- Miscellaneous/conveyor transfer points;
- Crushing and screening;
- Wind erosion from exposed areas: the opencast pits, exposed surfaces and material stockpiles;
- Excavators (loading dump trucks at pit area, loading crusher at mobile plant, loading off-site haulage trucks; and
- Vehicle dust entrainment on unpaved roads.

The above-mentioned sources were identified for the proposed mine based on the information provided by the client. A detailed questionnaire was given to the client prior to modelling to obtain specific details needed for input into the model and for calculation of emission rates. The conservative scenario was assumed where information was not known for input into the model. Please refer to Section 6.4 for more details about the assumptions made in this study.

To investigate the potential impact of operations associated with the proposed mine on local ambient air quality, the following air pollutants were chosen in the quantification of emissions for the construction and operational phases of the project:

- Dustfall;
- Particulate matter (PM_{10} and $PM_{2.5}$).

This project focused on dust emissions as this is a key pollutant emitted associated with mining activities at the proposed mine.

In this study two scenarios were modelled:

a) The **construction phase scenario**, where emissions associated with construction activity (e.g., establishment of access and haul roads, setting out material stockpile areas, construction of pollution control dams, etc) due to the development of infrastructure associated with the proposed mine, were modelled.

b) The **actual operating scenario**, where emissions from surface mining activities associated with operations at the proposed mine were modelled. This scenario represents the potential impacts if the proposed mine were emitting under normal operating conditions and considered 3 multi-pit mining options (i.e. Pits 1 to 3: located closest to the Newcastle area; Pits 2 to 6: maximum Pit combination proposed for Year 9; and Pits 5 & 6: to represent minimum pit combination, with one of the Pits (i.e. Pit 5) located nearest to receptors within the proposed mine boundary), since it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site.

In the quantification of emissions, use was made of published predictive emission factor equations given in the United States Environmental Protection Agency (USEPA) AP-42 documents, Australian National Pollutant Inventory (NPI) Emission Estimate Technique (EET) Manual and the Missouri Department of Natural Resources, Haul Road Fugitive Emissions Worksheet Instructions. The South African Regulations regarding Air Dispersion Modelling recommends the use of published emission factors for national consistency, such as the USEPA AP-42 and NPI emissions factors.

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Emission factors are always expressed as a function of the weight, volume, distance or duration of the activity emitting the pollutant. The general equation used for the estimation of emissions is:

$$E = A \times EF \times \left(1 - \frac{ER}{100}\right)$$

Where:
E = emission rate
A = activity rate
EF = emission factor
ER = overall emission reduction efficiency (%)

The emission factors and equations used in the assessment for the proposed mine are described in Section 6.1. Material throughputs are based on the information provided by the client and include:

- A maximum annual production rate of 1,800,000 tonnes of coal from the opencast pits at the proposed mine;
- A maximum annual production rate of ~19,980, 000 tonnes of overburden from the opencast pits at the proposed mine;
- An hourly throughput of 205 tonnes of coal tipped into the mobile crushing and screening plant;
- An hourly throughput of 205 tonnes of coal processed at the crushing and screening units; and
- A maximum annual production rate of 1,500,000 tonnes of product coal from the crushing and screening plant.

A summary of the activities modelled in this study is given below in Table 6-1. The fugitive emission source locations, descriptions and dimensions that were used for input into the model are given in Appendix C.

The margins of uncertainty/accuracy associated with the emission factors used are given in Section 6.1. NPI Emission factor symbols and ratings can be summarised as follows (NPI, 2015):

- A – Excellent;
- B – Above average;
- C – Average;
- D – Below Average;
- E – Poor; and

- U – Unrated.

An A or B rating indicates a higher degree of certainty, whereas a D or E rating indicates a lower degree of certainty. A rating of U indicates that the emission factor uncertainty has not been rated (e.g. for emission factors generated by modelling rather than actual test results) (NPI, 2015).

Table 6-1: Modelled sources of emissions associated with the proposed mine.

POLLUTANT	SOURCES OF EMISSIONS	
	CONSTRUCTION PHASE	**OPERATIONAL PHASE**
Dustfall and Particulate emissions (PM_{10} & $PM_{2.5}$)	• **Area Source Activity:** ○ Construction activity (access roads, storm water management systems & stockpile areas)	• **Area and Volume Source Activities:** ○ Drilling and blasting at the opencast pits; ○ Bulldozing; ○ Material handling operations (truck loading/offloading operations); ○ Miscellaneous/conveyor transfer points; ○ Crushing and screening ○ Wind erosion from exposed areas: the opencast pits, exposed surfaces and material stockpiles; ○ Excavators (loading dump trucks at pit area, loading crusher at mobile plant, loading off-site haulage trucks; and ○ Vehicle dust entrainment on unpaved roads.

6.1. Surface Mining Operations (Newcastle Coal Mining project) - Emission Rates.

6.1.1. Construction

The USEPA provides an emissions equation for general construction operations. Dust is the main pollutant of concern emitted during heavy construction activities. The impact of dust emissions associated with construction is generally limited to the period of construction where the impact is significantly reduced once construction activities have stopped. Dust emissions from construction activities are associated with land clearing, ground excavation, material handling (loading/offloading), vehicle dust entrainment from trucks, stockpiling and the construction of infrastructure such as access roads and storm water management systems. Dust emissions from construction activities will vary depending on the level of activity and prevailing meteorological conditions (USEPA, 1995).

Emissions from the construction activities were calculated using the following equation:

$$\mathrm{E} = 2.69\ \mathrm{Mg/hectare/month\ of\ activity}$$

<u>Where:</u>
E = Emission rate (Mg/Hectare/month activity)
Emission factor rating symbol is unknown

The emission factor and equation used to estimate emissions from construction activities were obtained from the USEPA AP-42 document, Section 13.2.3 *Heavy Construction Operations* (USEPA, 1995). The value is most applicable to construction operations with medium activity level, moderate silt contents and semi-arid climate.

The following general assumptions were made in order to model the construction activity (based on information provided by the client):

- Construction was assumed to occur during the day for 10 hours a day for 7 days a week, 365 days a year, based on information provided by the client.
- No mitigation measures were applied to construction activity to represent the worst-case scenario.
- Construction will be done using a phased approach and was thus assumed to take place mainly over areas designated for surface infrastructure associated with Pit 1 (including the access roads, storm water management infrastructure including the main Pollution Control Dam (PCD), overburden dump areas, etc). Thus, a total of eight different areas/sections were considered for the initial phase of construction.
- Maximum height of release for construction area was assumed to be 0.5m since construction occurs at ground level.
- A conservative approach was undertaken where emissions associated with all construction activities were assumed to be covered under *Heavy Construction Activity.* In other words, emissions were not calculated separately for each individual activity.

The emission rates for total suspended particulates (TSP), PM_{10} and $PM_{2.5}$ and the input parameters for the construction area are given in Table 6-2.

Table 6-2: Input parameters for construction area.

SOURCE (2,3,4)	EMISSION RATE (g/s)			MAX HEIGHT (m) (1)	MAX LENGTH (m) (1)	MAX WIDTH (m) (1)
	TSP	PM_{10}	$PM_{2.5}$			
Construction Phase						
Haul road 1 (from pit 1 to overburden (OB) dump 1+6	6.09	3.04	0.30	0.5	Based on site layout	
Haul road 2 (from pit 1 to OB dump 1)	3.30	1.65	0.17	0.5	Based on site layout	
OB dump 1 preparation	32.78	16.39	1.64	0.5	Based on site layout	
OB dump 1+6 preparation	64.19	32.10	3.21	0.5	Based on site layout	
Main PCD	11.21	5.61	0.56	0.5	Based on site layout	
Potential future PCD (5)	16.49	8.25	0.82	0.5	Based on site layout	
Balancing dam (5)	19.11	9.56	0.96	0.5	Based on site layout	
Pre-stripping (at Pit 1)	1.2	0.6		0.5	Based on site layout	

Notes:

1. Dimensions, locality and footprint of source assumed based on conceptual layout provided by client.
2. No emission control efficiency was considered for construction activity, which represents the worst-case scenario.
3. Emission duration assumed to be 10 hours (daylight only) for 7 days a week, based on information provided by client.
4. Construction activity assumed to occur over eight sections within Application Area (365 days/year).

5.	The future PCD and Balancing Dam will only be required at a later stage to manage the operational balance but were considered under the construction phase to represent the worst-case scenario.

6.1.2. Wind Erosion from Exposed Surfaces (i.e. Stockpiles, Storage Piles, etc.)

Wind erosion from exposed surfaces such as dumps and stockpiles, are a significant source of dust emissions. Physical properties namely the shape, size, height, the surface area coverage, moisture content and the surface compaction of the stockpiles together with prevailing meteorological conditions will influence the rate at which dust is emitted. Significant amounts of dust will be eroded from the stockpiles under wind speeds greater than 5.4 m/s (i.e. threshold friction velocity of 0.26 m/s). Fugitive dust generation resulting from wind erosion under high winds (i.e. > 5.4 m/s) is directly proportional to the wind speed.

In the estimation of fugitive dust emissions from the stockpiles and exposed areas at the proposed mine, emissions were calculated by use of the emission factors for wind erosion given in the NPI, EET manual for mining (NPI, 2012). The emission factors for dustfall (as TSP), PM_{10} and $PM_{2.5}$ used are given below:

$$E_{TSP} = 0.4\ \text{kg/Ha/hr}$$

$$\mathrm{E}_{\mathrm{PM10}} = 0.2\ \text{kg/Ha/hr}$$

$$E_{PM2.5} = 5\%\ of\ TSP$$

<u>Where:</u>
E = Emission rate (Kg/Hectare/hour)
Emission factor rating symbol = U

The emission rates for dustfall, PM_{10} and $PM_{2.5}$ and the input parameters for the exposed areas and stockpiles are given in Table 6-3.

Table 6-3: Input parameters for stockpiles and exposed areas.

SOURCE [3,4]	EMISSION RATE (g/s)			MAX HEIGHT (m) [2]	MAX LENGTH (m) [1]	MAX WIDTH (m) [1]
	TSP	PM_{10}	$PM_{2.5}$			
Proposed Newcastle Coal Mine						
open pit / void at Pit 1	0.053	0.027	0.0027	27.2 (depth)	120	40
exposed area at Pit 1	0.21	0.11	0.011	0	240	80
open pit / void at Pit 2	0.053	0.027	0.0027	38.2 (depth)	120	40
exposed area at Pit 2	0.21	0.11	0.011	0	240	80
open pit / void at Pit 3	0.053	0.027	0.0027	29.2 (depth)	120	40
exposed area at Pit 3	0.21	0.11	0.011	0	240	80
open pit /void at Pit D1	0.053	0.027	0.0027	24.1 (depth)	120	40
exposed area at Pit D1	0.21	0.11	0.011	0	240	80
open pit / void at Pit 4	0.053	0.027	0.0027	30.4 (depth)	120	40
exposed area at Pit 4	0.21	0.11	0.011	0	240	80
open pit /void at Pit 5	0.053	0.027	0.0027	50.9 (depth)	120	40
exposed area at Pit 5	0.21	0.11	0.011	0	240	80

open pit / void at Pit 6	0.053	0.027	0.0027	53.5 (depth)	120	40
exposed area at Pit 6	0.21	0.11	0.011	0	240	80
stockpile 1 (OB dump 1)	1.44	0.73	0.073	23.5	multiple	multiple
stockpile 2 (OB dump 1+6)	2.82	1.44	0.14	34.3	multiple	multiple
stockpile 3 (OB Dump 3)	1.89	0.96	0.096	25.8	multiple	multiple
stockpile 4 (product stockpile)	1.74	0.89	0.089	5	multiple	multiple
Stockpile 5 (OB dump 4+6)	2.87	1.46	0.15	26.7	multiple	multiple
Stockpile (OB dump 5)	0.47	0.24	0.024	23.35	multiple	multiple

Notes:

1. Source dimensions for pit areas and exposed areas were assumed based on source dimensions at a similar mine, as the exact dimensions were not known at the time of modelling; source dimensions for the stockpile areas were assumed based on information provided by the client.
2. Max heights (including pit depth), exact footprints and locality for sources at the proposed mine were assumed based on information (i.e. Mine Works Programme & conceptual layout plan) provided by the client.
3. No emission control efficiency was considered for wind erosion.
4. Emission duration assumed to be 24 hours for 7 days a week.

6.1.3. Front-End-Loaders and Excavators

Excavators will be used at the proposed mine to load material (ROM and overburden) onto dump trucks at the opencast pit, and to load product coal onto off-site haulage trucks. It was also assumed that an excavator will be used to reclaim coal at the in-pit ROM stockpile and tip the coal into the mobile crushing and screening plant. A total of 12 excavators were thus assumed to be used at any given time, based on information provided by the client. The USEPA does not have an emission factor or equation specific for calculating emissions from excavators, front-end-loaders or shovels. The Australian NPI, however, provides the same equation as for tipping to be applied to excavators, shovels and front-end-loaders.

Emissions of dustfall, PM_{10} and $PM_{2.5}$ due to excavator activities at the proposed mine were quantified using the NPI EET manual for mining (NPI, 2012)'s emission factors for excavators, shovels and front-end-loaders on coal and overburden:

Excavators/shovels & front-end-loaders – Overburden (NPI, Mining, Table 2):

$$E_{TSP} = 0.025 \text{ kg/ton}$$

$$E_{PM10} = 0.012 \text{ kg/ton}$$

$$E_{PM2.5} = 5\% \text{ of TSP}$$

Excavators/shovels & front-end-loaders – Coal (NPI, Mining, Table 2):

$$E_{TSP} = 0.029 \text{ kg/ton}$$

$$E_{PM10} = 0.014 \text{ kg/ton}$$

$$E_{PM2.5} = 5\% \text{ of TSP}$$

Where:
E = Emission rate (kg/ton)
Emission factor rating symbol = U for excavators/front-end-loaders on overburden.
Emission factor rating symbol = C for excavators/front-end-loaders on coal.

The emission rates for dustfall, PM_{10} and $PM_{2.5}$ for excavator activity at the proposed mine are given in Table 6-4.

Table 6-4: Input parameters for front-end loader and excavator activity.

SOURCE [1,2,3]	EMISSION RATE (g/s)			THROUGHPUT (TONNES/HOUR)
	TSP	PM_{10}	$PM_{2.5}$	
Proposed Newcastle Coal Mine				
x2 excavators at pit void – loading trucks with ROM	0.83	0.40	0.041	102.70 (per truck) [4]
x8 excavators at exposed pit area – loading trucks with overburden (softs & hards)	1.98	0.95	0.099	285.13 (per truck) [5]
x1 excavator at crushing and screening plant – loading ROM onto primary crusher	1.65	0.80	0.083	205.00 [6]
x1 excavator at product stockpile – loading product onto off-site haulage trucks	1.38	0.67	0.069	171.00 (per truck) [7]

Notes:
1. No emission control efficiency was considered for material handling.
2. The dimensions of sources (on-site and offsite trucks) were assumed based on the specifications given by Richie Specs for a CAT 777 rock truck (90T) and a CAT 740 ADT (38T), respectively. Dimensions of the crusher were assumed based on crusher dimensions at a similar mine.
3. All loading operations assumed to occur for 24 hours a day for 7 days a week, which represents the worst-case scenario.
4. Maximum production values for ROM from the opencast pit were provided by the client, i.e. 1,800,000 tonnes/year. Loading operations assumed to occur for 24 hours a day for 7 days a week, with two 90T trucks assumed to be loaded per hour, thus the hourly throughput of ROM was estimated to be 102.70 tonnes/hour.
5. Maximum production values for overburden (softs and hards) from the opencast pit were provided by the client i.e. 19, 980,000 tonnes/year. Loading operations assumed to occur for 24 hours a day for 7 days a week, with eight 90T trucks assumed to be loaded per hour, thus the hourly throughput of overburden was estimated to be 285.13 tonnes/hour.
6. Maximum production values for ROM from the opencast pit were provided by the client, i.e. 1,800,000 tonnes/year. Loading operations assumed to occur for 24 hours a day for 7 days a week, with one excavator assumed to be loading the crusher per hour, thus the hourly throughput of ROM was estimated to be 205 tonnes/hour.
7. Maximum production values for product coal were provided by the client, i.e. 1,500,000 tonnes/year. Loading operations assumed to occur for 24 hours a day for 7 days a week, with one excavator assumed to be loading trucks for off-site transport per hour, thus the hourly throughput of product coal was estimated to be 171 tonnes/hour.

6.1.4. Truck Offloading Activities & Material Transfer Points

Trucks will be used at the proposed mine to transport overburden material (inclusive of softs and hards) from the opencast pit area to the respective stockpile areas. Coal from the proposed mine will be hauled to the in-pit ROM stockpile prior to dry processing, which comprises crushing and screening. Material transfer at the crushing and screening plant was assumed to be via miscellaneous transfer points. After processing, the product will be transferred to the product stockpile area via haul trucks (or a conveyor system), from where the coal will either be sold or transported offsite (via road-trucks) for further processing before being sold.

Material offloading from the trucks and miscellaneous transfer points will result in dust emissions. Emissions of dustfall, PM_{10} and $PM_{2.5}$ due to truck offloading operations and miscellaneous transfer points are quantified using the NPI emission factors provided in the NPI EET manual for mining (NPI, 2012) for:

Truck dumping – Coal (NPI, Mining, Table 2):

$$E_{TSP} = 0.01 \text{ kg/ton}$$

$$E_{PM10} = 0.0042 \text{ kg/ton}$$

$$E_{PM2.5} = 5\% \text{ of TSP}$$

Truck dumping – Overburden (NPI, Mining, Table 2):

$$E_{TSP} = 0.012 \text{ kg/ton}$$

$$E_{PM10} = 0.0043 \text{ kg/ton}$$

$$E_{PM2.5} = 5\% \text{ of TSP}$$

Where:
E = Emission rate (kg/tonne)
Emission factor rating symbol = U for trucks dumping overburden
Emission factor rating symbol is unknown for trucks dumping coal

Miscellaneous transfer points (including conveying) (NPI, Mining, Table 2):

$$E_{TSP} = 0.00032 \text{ kg/ton}$$

$$E_{PM10} = 0.00015 \text{ kg/ton}$$

$$E_{PM2.5} = 5\% \text{ of TSP}$$

Where:
E = Emission rate (kg/tonne)
Emission factor rating symbol = U

Emission rates for dustfall, PM_{10} and $PM_{2.5}$ from truck offloading operations and miscellaneous transfer points at the proposed mine are given in Table 6-5.

Table 6-5: Input parameters for truck offloading activities & conveyor transfer points.

SOURCE [1,2,3,4]	Material Type [12]	THROUGHPUT TONNES/HOUR	EMISSION RATE (g/s)		
			TSP	PM_{10}	$PM_{2.5}$
Proposed Newcastle Coal Mine					
x2 trucks offloading at ROM stockpile	ROM	102.70 (per truck) [6]	0.29	0.12	0.014
x8 trucks offloading at overburden stockpile	Overburden (softs & hards)	285.13 (per truck) [7]	0.95	0.34	0.048
x2 trucks offloading at product stockpile	Product Coal	85.60 (per truck) [8]	0.24	0.10	0.012
x1 transfer point (load secondary crusher) [5]	ROM	205.00 (per transfer) [9]	0.02	0.01	0.001
x1 transfer point (load screening unit) [5]	ROM	205.00 (per transfer) [9]	0.02	0.01	0.001
x1 transfer point (load feeder) [5]	Product coal	171.00 (per transfer) [10]	0.015	0.007	0.001
x1 transfer point (load road truck) [5]	Product coal	171.00 (per transfer) [10]	0.015	0.007	0.001

Notes:

1. No control efficiency was considered for material handling operations.
2. Truck offloading operations at material stockpiles and material transfer assumed to occur for 24 hours for 7 days a week, which represents the worst-case scenario.
3. The dimensions of the truck offloading sources were assumed based on the specifications given by Ritchie Specs for a CAT 777 rock truck (90T); dimensions of transfer points were assumed based on dimensions of transfer points at a similar mine.
4. Moisture % assumed to be less than 4% thus low moisture.
5. Locality of material transfer points was assumed using google earth based on conceptual layout plan provided by the client.
6. Maximum production values for ROM from the opencast pit were provided by the client, i.e. 1,800,000 tonnes/year. Offloading operations assumed to occur for 24 hours a day for 7 days a week, with two 90T trucks assumed to be offloading per hour, thus the hourly throughput of ROM was estimated to be 102.70 tonnes/hour per truck.
7. Maximum production values for overburden (softs and hards) from the opencast pit were provided by the client i.e. 19, 980,000 tonnes/year. Offloading operations assumed to occur for 24 hours a day for 7 days a week, with eight 90T trucks assumed to be offloading per hour, thus the hourly throughput of overburden was estimated to be 285.13 tonnes/hour per truck.
8. Maximum production values for product coal were provided by the client, i.e. 1,500,000 tonnes/year. Offloading operations assumed to occur for 24 hours a day for 7 days a week, with two trucks assumed to be offloading at product stockpile per hour, thus the hourly throughput of product coal was estimated to be 85.60 tonnes/hour per truck.
9. Maximum production values for ROM from the opencast pit were provided by the client, i.e. 1,800,000 tonnes/year. Processing operations assumed to occur for 24 hours a day for 7 days a week, thus the hourly throughput for crushing and screening was estimated to be 205 tonnes/hour.
10. Hourly throughput for feeder and road truck assumed to be the same as maximum hourly production value for crushed coal (i.e. 171 tonnes/hour).

6.1.5. *Crushing and screening*

Crushing and screening of coal will occur at the mobile crushing and screening plant at the proposed mine, to obtain the required product sizes. Both primary and secondary crushing were assumed, since a Jaw crusher and a Cone crusher are proposed for the crushing activities. Emissions of dustfall, PM_{10} and $PM_{2.5}$ due to crushing and screening activity were quantified using the NPI emission factors provided in the NPI EET manual for mining (NPI, 2012) for crushing and screening low moisture content ores:

Primary Crushing low moisture content ores (NPI, Mining, Table 3):

$$E_{TSP} = 0.2 \text{ kg/ton}$$

$$E_{PM10} = 0.02 \text{ kg/ton}$$

$$E_{PM2.5} = \text{assumed to be 5\% of TSP}$$

Where:
E = Emission rate (kg/tonne)
Emission factor rating symbol = C

Secondary Crushing low moisture content ores (NPI, Mining, Table 3):

$$E_{TSP} = 0.6 \text{ kg/ton}$$

$$E_{PM10} = \text{assumed to be } 0.08 \text{ kg/ton}$$

$$E_{PM2.5} = \text{assumed to be 5\% of TSP}$$

Where:
E = Emission rate (kg/tonne)
Emission factor rating symbol = D

Screening low moisture content ores (NPI, Mining, Table 3):

$$E_{TSP} = 0.08 \text{ kg/ton}$$

$$E_{PM10} = 0.06 \text{ kg/ton}$$

$$E_{PM2.5} = \text{assumed to be 5\% of TSP}$$

Where:
E = Emission rate (kg/tonne)
Emission factor rating symbol = C

The emission rates for dustfall, PM_{10} and $PM_{2.5}$ and the input parameters for the crushing and screening units are given in Table 6-6.

Table 6-6: Input parameters for crushing and screening activities.

SOURCE [1,2]	EMISSION RATE (g/s)			THROUGHPUT (TONNES/HOUR) [3,4]	DIMENSIONS		
	TSP	PM_{10}	$PM_{2.5}$		LENGTH (m)	WIDTH (m)	HEIGHT (m)
Proposed Newcastle Coal Mine							
Primary crushing	11.4	1.1	0.6	205.00	2.8	1.9	3.5
Secondary crushing	34.2	4.6	1.7	205.00	2.5	1.4	3.7
Screening	4.6	3.4	0.2	205.00	4.0	2.0	4.0

Notes:
1. The dimensions for the crushing and screening units were estimated based on crusher and screen dimensions at a similar mine (height includes height of unit above ground).
2. No emission control efficiency was considered at the mobile crushing and screening area (worst-case).
3. An hourly throughput of 205 tonnes per hour of coal assumed to be processed by the crushing and screening units, calculated based on annual ROM production of 1,800,000 tonnes and 24/7 operations.
4. Moisture % assumed to be less than 4% thus low moisture. Actual moisture content of material unknown.

6.1.6. Bulldozing

Bulldozing activities will occur at different areas of the proposed mine and will be used for vegetation and topsoil removal, moving overburden and shaping stockpiles. A total of 6 bulldozers were assumed to be used at any given time, based on information provided by the client. Emissions of dustfall, PM_{10} and $PM_{2.5}$ due to bulldozing activity at the proposed mine were quantified using the NPI emission factors provided in Emission Estimation Manual for Mining for bulldozing:

<u>Bulldozing material – coal (NPI, Mining, Table 2):</u>

$$\mathrm{E_{TSP}} = 102 \text{ kg/hour/vehicle}$$

$$\mathrm{E_{PM10}} = 32.5 \text{ kg/hour/vehicle}$$

$$\mathrm{E_{PM2.5}} = \text{assumed to be 5\% of TSP}$$

<u>Bulldozing material – Overburden/topsoil/softs (NPI, Mining, Table 2):</u>

$$E_{TSP} = 17 \text{ kg/hour/vehicle}$$

$$E_{PM10} = 4.1 \text{ kg/hour/vehicle}$$

$$E_{PM2.5} = 5\% \; of \; TSP$$

<u>Where:</u>
E = Emission rate (kg/hour/vehicle)
Emission factor rating symbol = B

The emission rates for dustfall, PM_{10} and $PM_{2.5}$ are given in Table 6-7.

Table 6-7: Input parameters for bulldozing activities.

SOURCE [1,2,3]	EMISSION RATE (g/s)			Material
	TSP	PM_{10}	$PM_{2.5}$	
Proposed Newcastle Coal Mine				
X1 dozer at pit area removing vegetation	4.72	1.14	0.24	Vegetation
x1 dozer at pit area (removal of topsoil)	4.72	1.14	0.24	Topsoil
x1 dozer at pit area dozing overburden	4.72	1.14	0.24	Overburden (softs & hards)
x1 dozer at overburden/softs stockpile (shaping)	4.72	1.14	0.24	Overburden (softs & hards)
x1 dozer at overburden/hards stockpile (shaping)	4.72	1.14	0.24	Overburden (softs & hards
x1 dozer at ROM stockpile (shaping)	28.33	9.03	1.42	ROM

Notes:

1. The dimensions for the source were assumed based on specifications provided by Richie Specs for a D10 bulldozer.
2. Assumed bulldozing will occur intermittently for 16 hours a day (06:00 – 22:00), 7 days a week (worst-case).
3. No emission control efficiency was considered for bulldozing activities

6.1.7. Blasting

Blasting of overburden will occur inside the pit area at the proposed mine. Blasting was assumed to occur approximately twice a week, based on blasting times at other similar coal mines. A blast area of approximately 2 400 m^2/blast was assumed to be blasted as the exact size of the blast area was not known at the time of modelling. Fugitive dust emissions from blasting activities at the proposed mine were calculated using the following equations taken from the USEPA, AP-42 document, Section 11.9 western surface coal mining and Table 11.9.2:

<u>Blasting at coal mines:</u>

$$E_{TSP} = 0.00022(A)^{1.5}$$

$$E_{PM10} = [0.00022(A)^{1.5}]*0.52$$

$$E_{PM2.5} = [0.00022(A)^{1.5}]*0.03$$

<u>Where:</u>

E = Emission rate (kg/blast)

Emission factor rating symbol = C

The emission rates for dustfall, PM_{10} and $PM_{2.5}$ are given Table 6-8.

Table 6-8: Input parameters for blasting activities.

SOURCE (1,2,3,4)	EMISSION RATE (g/s)			Blast Area (m^2)
	TSP	PM_{10}	$PM_{2.5}$	
Proposed Newcastle Coal Mine				
Blasting at pit area	7.19	3.74	0.36	2 400

Notes:
1. The dimensions for the source were assumed based on a similar mine.
2. Blast times assumed to be for 1 hour in the afternoon (15:00 – 16:00), twice a week.
3. Blast area was assumed based on blast area at a similar mine.
4. No control efficiency applied for blasting activities.

6.1.8. Drilling

Drilling into overburden will occur inside the pit area at the proposed mine. Drilling was assumed to occur twice a week for 8 hours a day, based on drilling hours at similar coal mines. Approximately 30 drill holes were assumed to be done per day as the exact number was unknown at the time of the modelling. Fugitive dust emissions of dustfall, PM_{10} and $PM_{2.5}$ due to drilling activity at the proposed mine were quantified using the USEPA, AP-42 document, Section 11.9.2 western surface coal mining:

Drilling at coal mines:

$$\mathrm{E_{TSP}} = 0.59\ \mathrm{kg/hole/day}$$

$$\mathrm{E_{PM10}} = \text{assumed to be } 50\% \text{ of TSP}$$

$$\mathrm{E_{PM2.5}} = \text{assumed to be } 5\% \text{ of TSP}$$

Where:
E = Emission rate (kg/hole/day)
Emission factor rating symbol = C

The emission rates for dustfall, PM_{10} and $PM_{2.5}$ are given Table 6-9.

Table 6-9: Input parameters for drilling activities.

SOURCE (1,2,3,4)	EMISSION RATE (g/s)			Number of holes
	TSP	PM_{10}	$PM_{2.5}$	
Proposed Newcastle Coal Mine				
Drilling at pit area	0.62	0.31	0.031	30 per day (assumed)

Notes:
1. A drill diameter of 80 mm was assumed.
2. Assumed a total of 30 drill holes per day.
3. Drilling will occur for 8 hours a day, twice a week (assumed).

4.	70% control efficiency applied to drilling activities due to use of water sprays. Control efficiency % based on values given in the Australian NPI EET manual for Mining, v3.1.

6.1.9. Vehicle Dust Entrainment on Unpaved Roads

Material (ROM and overburden) from the opencast area at the proposed mine will be transported via trucks on unpaved haul roads to the respective ROM and overburden stockpile areas, while product coal will be hauled (or conveyed) from the crushing and screening plant to the product stockpile, also via unpaved haul roads. However, conveying of product was not included in the emissions inventory, only truck hauling was considered (worst-case). Additionally, hauling to the ROM stockpile was excluded as this was assumed to be over a short distance since the ROM stockpile is proposed to be an in-pit stockpile. Vehicle-entrained dust emissions from the movement of hauling trucks and working vehicles on unpaved haul roads potentially represent a significant source of fugitive dust at the site.

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. In addition to the volume of traffic, emissions also depend on source parameters which characterise the condition of a road and the associated vehicle traffic. These parameters include vehicle speeds, mean vehicle weight, average number of wheels per vehicle and road surface moisture (EPA, 1995). Although vehicle entrainment on unpaved roads is found to result in high fugitive dust emissions, these impacts are often limited close to the source.

Fugitive dust emissions from hauling trucks, are quantified using the following equations provided in the Missouri Department of Natural Resources, Haul Road Fugitive Emissions Worksheet Instructions (Missouri Department of Natural Resources, 2009):

$$E \;= K\,(\frac{s}{12})^{a}\;x\;(\frac{W1+W2}{6})^{b}$$

$$Annual\,VMT \;= \frac{2\;x\;(length\;of\;haul\;road)\;x\;(annual\;amount\;hauled)}{(average\;weight\;of\;material\;per\;load)}$$

<u>Where:</u>
E = emission factor (lb/VMT) (lb/VMT x 281.9 = g/VKT)
VMT = Vehicle miles travelled
VKT = Vehicle kilometres travelled
s = surface material silt content (%)
K = empirical constant (K_{TSP}, K_{PM10} & $K_{PM2.5}$)
a = empirical constant (a_{TSP}, a_{PM10} & $a_{PM2.5}$)
b = empirical constant (b_{TSP}, b_{PM10}, $b_{PM2.5}$)
W1 = Weight of unloaded truck
W2 = Weight of loaded truck

A surface material silt content of 8.4 % was assumed for the haul roads at the pit area of the proposed mine. This value was assumed based on the typical silt content values provided by the USEPA for western surface coal mines (haul road to/from pit) and can be found in Table 13.2.2-1 of the USEPA AP-42 document. The weights of the trucks were estimated based on a CAT 777 rock truck (90T) rock truck. The empirical constants K, a and b were chosen for industrial roads based on the values provided in the USEPA, AP-42 document, Section 13.2 unpaved haul roads (Table 6-10).

A summary of input parameters for the hauling trucks at the proposed mine is given in Table 6-11. Emission rates for dustfall, PM_{10} and $PM_{2.5}$ due to vehicle dust entrainment from hauling trucks are given in Table 6-12.

A 40% emission reduction efficiency was considered for hauling, since dust suppression using water sprays was assumed for the haul roads, based on dust suppression methods at other similar coal mines. This assumption was only made for modelling purposes; dust suppression on the haul routes at the proposed mine will depend on the weather conditions and operational activities at the time.

Table 6-10: Empirical constants used in the calculation for dust emissions from hauling trucks (USEPA, 1995: Section 13.2, Table 13.2.2).

Constant	Industrial Roads (Equation 1a)			Public Roads (Equation 1b)		
	PM-2.5	PM-10	PM-30*	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9	0.18	1.8	6.0
a	0.9	0.9	0.7	1	1	1
b	0.45	0.45	0.45	-	-	-
c	-	-	-	0.2	0.2	0.3
d	-	-	-	0.5	0.5	0.3
Quality Rating	B	B	B	B	B	B

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 6-11: Source parameters for hauling trucks.

SOURCE	TRUCK PARAMETERS (1)				
	UNLOADED WEIGHT (Tonnes)	LOADED WEIGHT (Tonnes)	LENGTH (m)	WHEEL WIDTH (m)	HEIGHT (m)
Hauling on unpaved road surfaces					
Truck hauling activity on unpaved road from Pit 1 to overburden stockpile	73.98	163.29	12.23	6.49	5.17
Truck hauling activity on unpaved road from mobile crushing and screening plant to product stockpile	73.98	163.29	12.23	6.49	5.17

Notes:
1. Parameters were assumed based on the specifications provided for a CAT 777 (90T) rock truck.

Table 6-12: Input parameters for vehicle dust entrainment due to truck hauling activities on unpaved road surfaces.

SOURCE [1,2]	VKT [3]	EMISSION RATE (g/s)		
		TSP	PM_{10}	$PM_{2.5}$
Hauling on unpaved road surfaces				
Truck hauling activity on unpaved road from Pit 1 to overburden stockpile	653 200	69.98	19.95	2.00
Truck hauling activity on unpaved road from mobile crushing and screening plant to product stockpile	6.55	1.87	7.12	0.19

Notes:
1. Truck hauling hours: 24 hours for 7 days a week, which represents the worst-case scenario.
2. 40% control efficiency applied due to assumed water spraying for dust suppression. Control efficiency % value based on the Australian NPI EET for Mining, v3.1.
3. VKT = vehicle kilometres travelled and was based on annual throughputs of approx. 19,980,000 tonnes/year (overburden); and 1,500,000 tonnes/year for product coal.

6.2. Model Overview

6.2.1. AERMOD View

AERMOD, a state-of-the-art Planetary Boundary Layer (PBL) air dispersion model, was developed by the American Meteorological Society and USEPA Regulatory Model Improvement Committee (AERMIC). AERMOD utilizes a similar input and output structure to ISCST3 and shares many of the same features, as well as offering additional features. AERMOD fully incorporates the PRIME building downwash algorithms, advanced depositional parameters, local terrain effects, and advanced meteorological turbulence calculations.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources.
- A meteorological data pre-processor (AERMET) for surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux.
- A terrain pre-processor (AERMAP) which provides a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

AERMOD includes Plume Rise Model Enhancements (PRIME) building downwash algorithms which provide a more realistic handling of building downwash effects. PRIME algorithms were designed to address two fundamental features associated with building downwash; enhanced plume dispersion coefficients due to the turbulent wake and to reduce plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake. AERMOD is suitable for a wide range of near field applications in both simple and complex terrain. The evaluation results for AERMOD, particularly for complex terrain applications, indicate that the model represents significant improvements compared to previously recommended models.

AERMOD has been used in various dispersion modelling studies in the United States and around the world (Perry *et al*., 2004).

6.2.2. Model Requirements

The approach to this dispersion modelling study is based on the Code *of Practice for Air Dispersion Modelling in Air Quality Management in South Africa* (DEA, 2014). As per the *Code of Practice*, this assessment is a Level 2 assessment. Level 2 assessments should be used for air quality impact assessment in standard/generic licence or amendment processes where:

- The distribution of pollutant concentrations and depositions are required in time and space;
- Pollutant dispersion can be reasonably treated by a straight-line, steady-state, Gaussian plume model with first order chemical transformation. Although more complicated processes may be occurring, a more complicated model that explicitly treats these processes may not be necessary depending on the purposes of the modelling and the zone of interest.
- Emissions are from sources where the greatest impacts are in the order of a few kilometres (less than 50 km) downwind.

A summary of the key variables input into the AERMOD model is given in Table 6-13. Data input into the model includes MM5 modelled meteorological data (surface and upper air) for 01 January 2020 – 31 December 2022. Terrain data at a resolution of 90 m (SRTM90) is used for input into the model, as generated by the terrain pre-processor, AERMAP. A modelling domain of 20 km × 20 km is used. A multi-tier grid with a grid receptor spacing of 250m (5 km from facility), 500 m (10 km from facility) and 1000 m (20 km from facility) (3 tiers) was used.

Table 6-13: Key Variables to be used in the modelling study.

Parameter	Model Input
Model	**Input**
Assessment level	Level 2
Dispersion model	AERMOD Version 11.0.0
Supporting models	AERMET Version 11.0.0 AERMAP Version 11.0.0
Emissions	**Input**
Pollutants to be modelled	Dustfall, PM_{10} and $PM_{2.5}$
Scenarios	Construction and Operational
Chemical transformations	N/A

Exponential decay	Rural
Settings	**Input**
Terrain setting	Elevated
Terrain data	SRTM90
Terrain data resolution (m)	90
Land use characteristics	Grassland, Cultivated land & Forested land
Grid receptors	**Input**
Farm boundary (m)	50
Modelling domain (km)	20 x 20
Fine grid resolution (m)	250 (5 km from facility)
Medium grid resolution (m)	500 (10 km from facility)
Large grid resolution (m)	1000 (beyond 20 km from facility)

6.3. Dispersion Modelling Results

Dispersion simulations were undertaken for the following scenarios to determine:

- Predicted ground-level impacts from all key sources for dustfall, PM_{10} and $PM_{2.5}$ for activities associated with construction at the proposed mine.
- Predicted ground-level impacts from all key sources for dustfall, PM_{10} and $PM_{2.5}$ for surface mining activities associated with the operation of the proposed mine. This scenario considered 3 multi-pit mining options (i.e. Pits 1 to 3: located closest to the Newcastle area; Pits 2 to 6: maximum Pit combination proposed for Year 9; and Pits 5 & 6: to represent minimum pit combination, with one of the Pits (i.e. Pit 5) located nearest to receptors within the proposed mine boundary), since it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site.

The Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014), recommends the use of the 99th percentile concentrations for short-term assessment with the National Ambient Air Quality Standards since the highest predicted ground-level concentrations can be considered outliers due to complex variability of meteorological processes. This might cause exceptionally high concentrations that the facility may never actually exceed in its lifetime.

Isopleth plots of predicted dustfall rates and PM_{10} and $PM_{2.5}$ concentrations are given in Figure 6-1 to Figure 6-5 for the construction phase, and Figure 6-6 to Figure 6-20 for the operational phase. For short term averaging periods, the predicted 99th percentile concentrations are provided.

Comparison of the predicted PM_{10} and $PM_{2.5}$ ambient concentrations is made with the South African National Ambient Air Quality Standards to determine compliance. Comparison of the predicted dustfall rates is made with the South African National Dust Control Regulations, 2013. In determining compliance, (as determined beyond the site boundary) predicted incremental concentrations are compared against the applicable standards. Inside the site boundary, air pollutant concentrations are required to comply with occupational health and safety standards. In this case, the proposed Newcastle Coal mine boundary (around opencast activities only) is considered.

6.3.1. Construction Phase

The dispersion model output plots for dustfall rates, PM_{10} and $PM_{2.5}$ concentrations due to activities associated with construction at the proposed mine are given in Figure 6-1 to Figure 6-5, with dispersion towards the south-eastern and/or north-eastern quadrants projected. Areas where exceedances of the ambient air quality standards are projected are indicated in red in the PM_{10} and $PM_{2.5}$ figures. For dustfall, areas of exceedance with the residential and non-residential area limits are indicated in yellow and red, respectively.

It should be noted that the USEPA emission factor used to quantify emissions associated with construction activity is referenced to TSP and assumes that the construction activity occurs over 30 days. Therefore, use of this emission factor to estimate emissions of TSP and PM_{10} does result in conservatively high estimates. Dustfall rates and PM_{10} concentrations due to construction activity at the proposed mine may be slightly lower in reality.

Predicted incremental dustfall rates, PM_{10} and $PM_{2.5}$ concentrations are moderately high but mostly in compliance with the applicable limits over the project area (i.e. area within the 20km x 20km modelling domain). For dustfall, predicted deposition rates mostly comply with the applicable limits at offsite locations, except at nearby areas just outside the eastern boundary of the proposed mine, where the residential (600 mg/m^2/day) and non-residential area (1 200mg/m^2/day) standards are exceeded within maximum radii of 300m and 80m, respectively. Inside the mine boundary, exceedances are observed near to the planned areas of construction activity (Figure 6-1). All exceedances projected are without mitigation.

Predicted incremental annual PM_{10} concentrations mostly comply with the annual standard of 40 µg/m^3 at most offsite locations, except at the area just outside the eastern mine boundary (within a 300m radius), where exceedances of the annual standard are observed. Predicted incremental daily PM_{10} concentrations comply with the daily standard of 75 µg/m^3 beyond the north-western and south-western mine boundaries. At offsite locations north-east and just outside the south-eastern mine boundaries, predicted daily PM_{10} concentrations are projected to exceed the daily standard within a maximum radius of 2.3km. In addition, exceedances of the daily and annual standards are projected inside the mine boundary, with daily standard exceedances extending over a wider area compared to annual standard exceedances (Figure 6-2 to Figure 6-3). However, it must be noted that all exceedances projected are without mitigation.

Predicted incremental $PM_{2.5}$ concentrations mostly fall below the applicable daily and annual standards of 40 µg/m^3 and 20 µg/m^3, respectively, with exceedances at offsite locations only projected for daily concentrations outside the eastern nine boundary, within a 250m radius. Inside the mine boundary, localised exceedances are projected near to the planned areas of construction activity (Figure 6-4 to Figure 6-5). As with dustfall and PM_{10}, all exceedances projected for $PM_{2.5}$ are without mitigation.

Maximum predicted incremental dustfall rates and PM concentrations at nearby sensitive receptors located within a 20km radius from the proposed mine boundary are given in Table 6-15, while maximum predicted concentrations at the boundary of the proposed mine are given in Table 6-19, for the construction phase. Most of the discrete receptors, except DR1, are not indicated to be impacted by the projected exceedances under the construction phase, since predicted concentrations mostly fall below the dustfall and PM standards. At DR1 (farm workers' houses just outside the northern mine boundary) an exceedance of the daily PM_{10} standard is projected. Thus, DR1 could be at high risk due to probable exposure to elevated daily PM_{10} concentrations from the proposed construction activities (Figure 6-2). The proposed mine should thus implement dust mitigation measures as far as possible to limit the impact on nearby receptors during the construction phase.

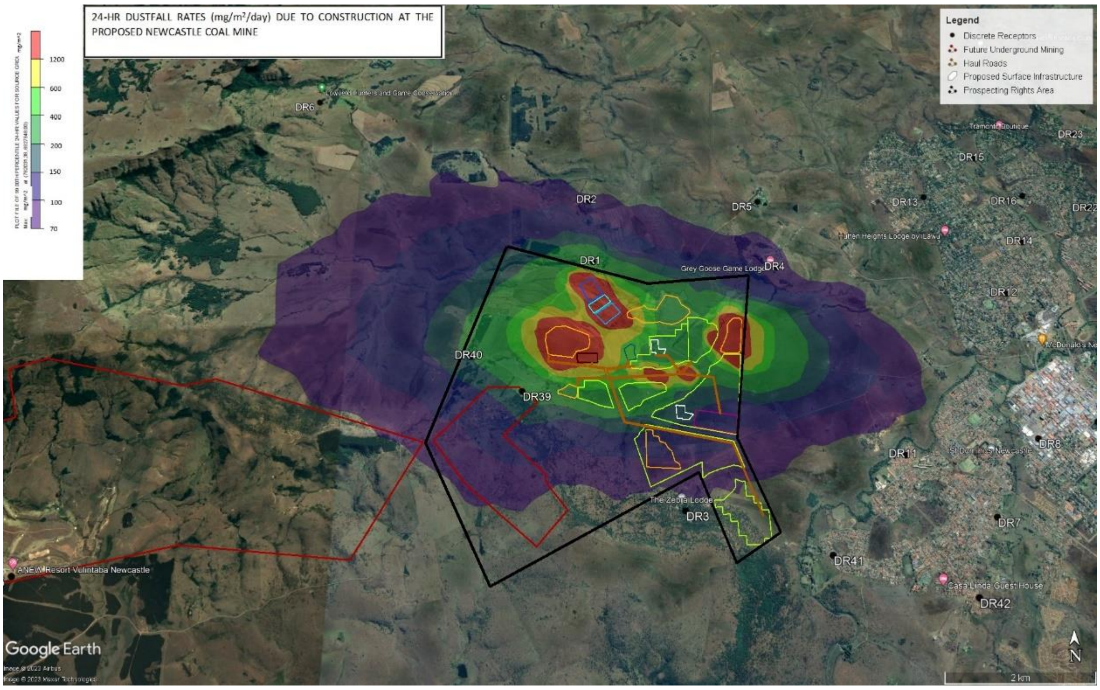


Figure 6-1: Predicted Dustfall Rates at the proposed mine - Construction Phase.

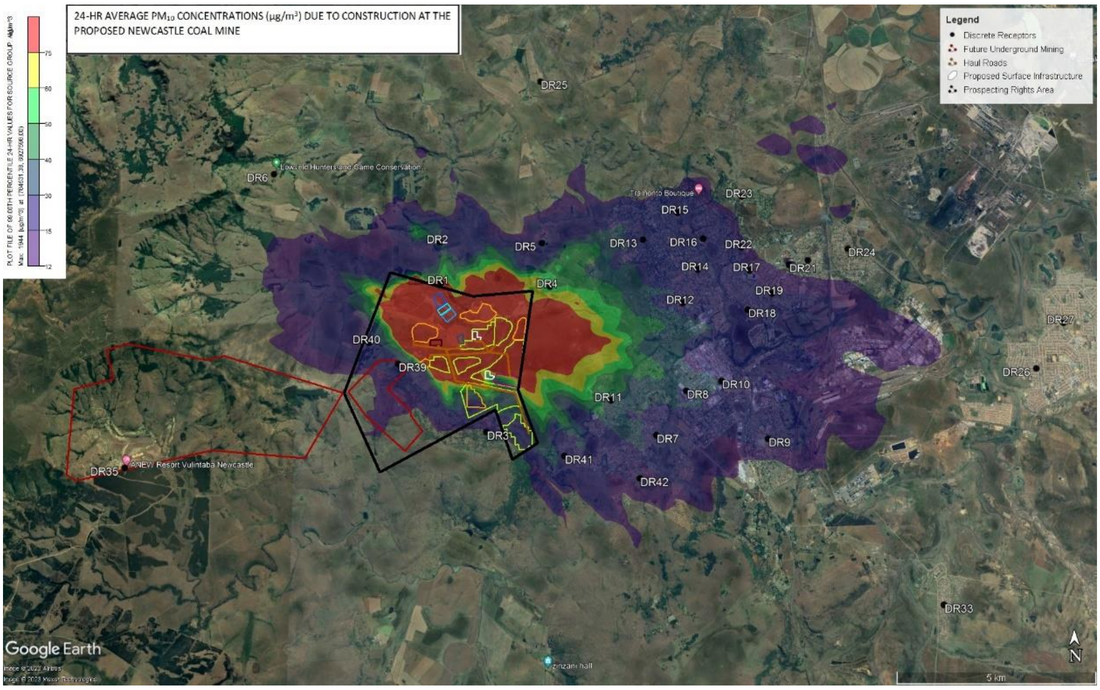


Figure 6-2: Predicted Daily Average PM_{10} Concentrations at the proposed mine - Construction Phase.

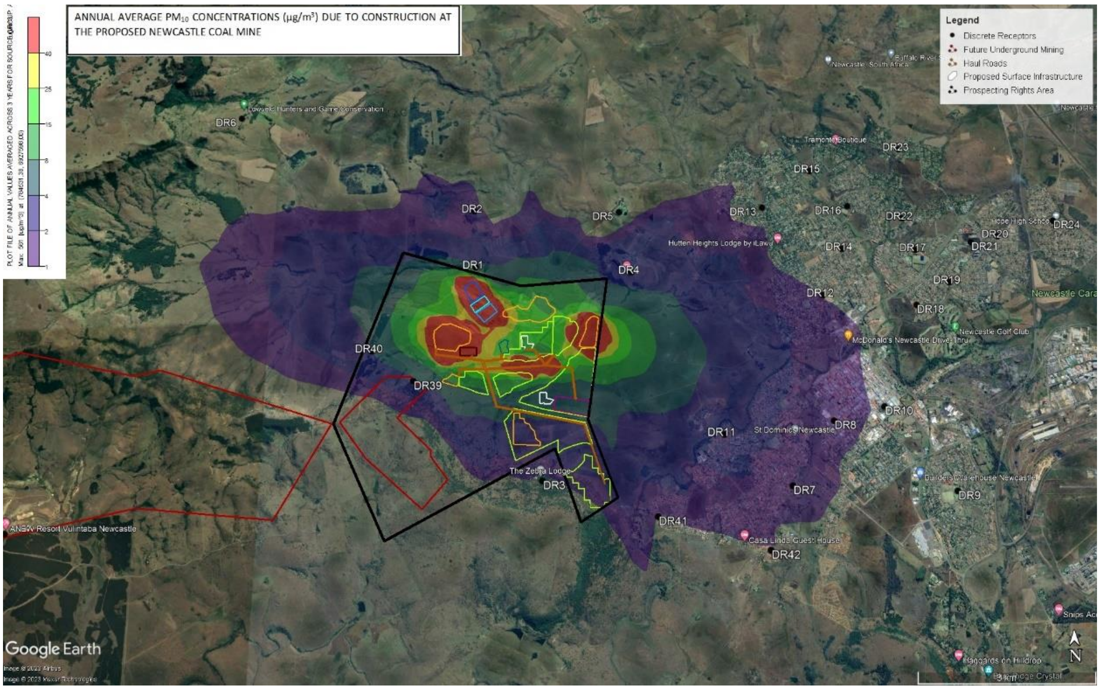


Figure 6-3: Predicted Annual Average PM$_{10}$ Concentrations at the proposed mine - Construction Phase.

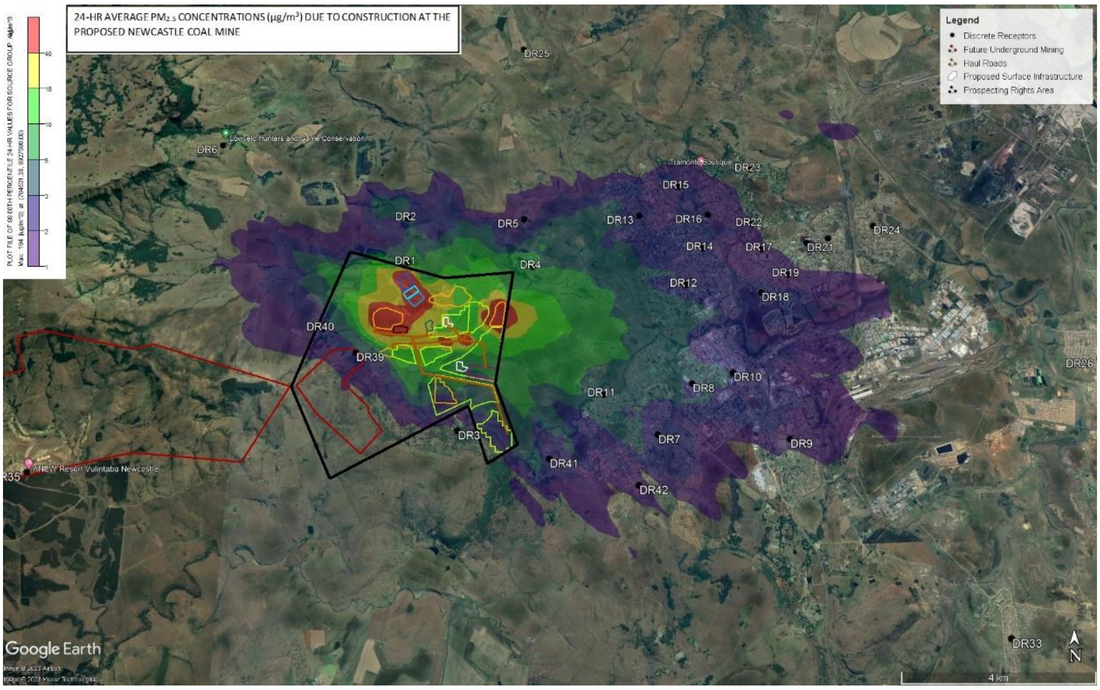


Figure 6-4: Predicted Daily Average PM$_{2.5}$ Concentrations at the proposed mine - Construction Phase.

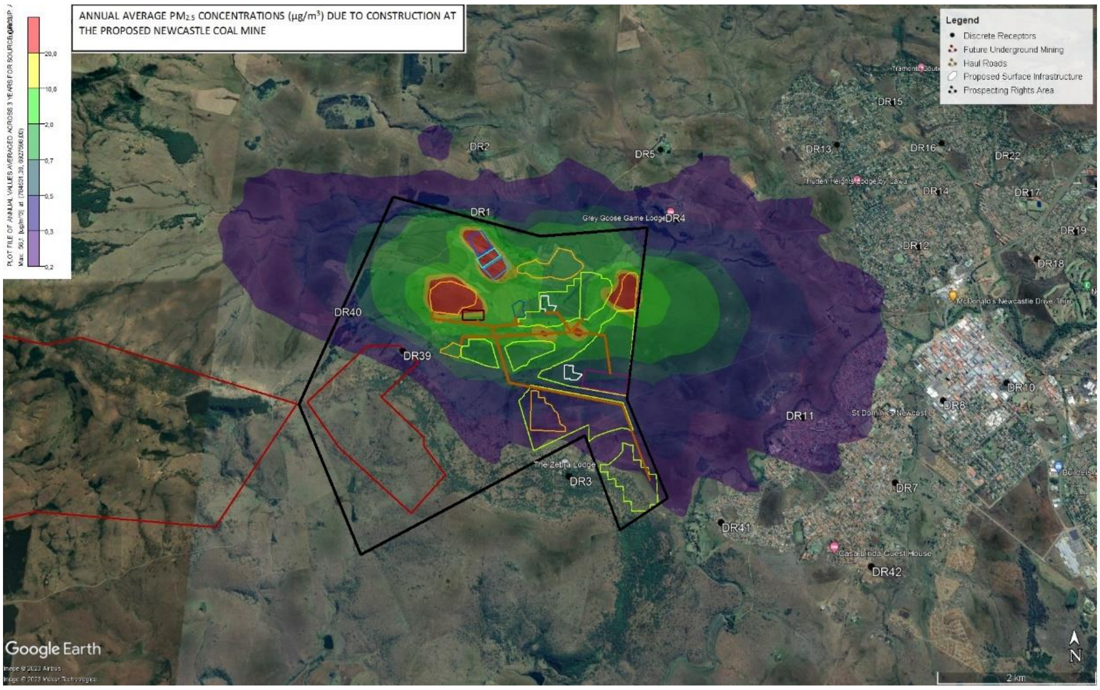


Figure 6-5: Predicted Annual Average PM$_{2.5}$ Concentrations at the proposed mine - Construction Phase.

6.3.2. *Operational Phase*

For the operational phase, 3 multi-pit mining options were considered in the assessment (i.e. Pits 1 to 3: located closest to the Newcastle area; Pits 2 to 6: maximum Pit combination proposed for Year 9; and Pits 5 & 6: to represent minimum pit combination, with one of the Pits (i.e. Pit 5) located nearest to receptors within the proposed mine boundary), since it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site.

The dispersion model output plots for dustfall rates, PM_{10} and $PM_{2.5}$ concentrations due to proposed surface mining activities associated with operations at the proposed mine, are given in Figure 6-6 to Figure 6-20, with dispersion towards the south-eastern and/or north-eastern quadrants also projected. Areas where exceedances of the ambient air quality standards are projected are indicated in red in the PM_{10} and $PM_{2.5}$ figures. For dustfall, areas of exceedance with the residential and non-residential area limits are indicated in yellow and red, respectively.

Predicted incremental dustfall rates and PM (PM_{10} and $PM_{2.5}$) concentrations are higher than those projected under the construction phase, but still comply with applicable standards over most of the project area modelled for dustfall, $PM_{2.5}$ and annual PM_{10}. While exceedances are projected outside the mine boundary for the same pollutants (dustfall, $PM_{2.5}$ and annual PM_{10}), they are mostly restricted to offsite areas located south-east and north-east of the proposed mine, within maximum radii of 2.3km, 3.7km and 2.6km for dustfall (Figure 6-6, Figure 6-11, & Figure 6-16), $PM_{2.5}$ (Figure 6-9 to Figure 6-10, Figure 6-14 to Figure 6-15, & Figure 6-19 to Figure 6-20) and annual PM_{10} (Figure 6-8, Figure 6-13, & Figure 6-18), respectively. Predicted incremental daily PM_{10} concentrations are relatively high, with exceedances of the daily standard extending from the mine boundary to offsite areas up to 10.7km towards the south-east and north-east (Figure 6-7, Figure 6-12, & Figure 6-17). However, it must be noted that all exceedances projected for the operational phase are without mitigation.

Among the three multi-pit mining options considered for the operational phase, the options involving 3 Pits and 5 Pits generally resulted in higher maximum predicted concentrations compared to the option involving 2 Pits, as seen in the isopleth plots. The spatial extent of exceedances projected outside the north-eastern and south-eastern proposed mine boundaries (without mitigation) is also indicated to be greater for the 3 Pit and 5 Pit options, and lesser for the 2 Pit option (Figure 6-6 to Figure 6-20). The offsite exceedances are projected within specific radii indicated below:

- 2 Pit option – 855m (for dustfall), 2.2km (for daily $PM_{2.5}$), 1.4km (for annual PM_{10}) and 7.3km (for daily PM_{10}), with annual $PM_{2.5}$ exceedances restricted to a small portion of the proposed eastern mine boundary.
- 5 Pit option – 2.3km (for dustfall), 850m (for annual $PM_{2.5}$), 3.6km (for daily $PM_{2.5}$), 2.3km (for annual PM_{10}), and 9.3km (for daily PM_{10}).
- 3 Pit option – 2.3km (for dustfall), 1.3km (for annual $PM_{2.5}$), 3.7km (for daily $PM_{2.5}$), 2.6km (for annual PM_{10}), and 10.7km (for daily PM_{10}).

Offsite areas/discrete receptors within the domain of projected exceedances for dustfall, $PM_{2.5}$ and $PM_{10,}$ include the following (Table 6-14):

Table 6-14: Discrete receptors located within the domain of projected exceedances for dustfall, $PM_{2.5}$ and PM_{10} (operational phase).

Discrete Receptor ID	Discrete Receptor Name	Multi-Pit Option		
		3-Pits	5-Pits	2-Pits
	Dustfall			
DR3	Dwellings (Zebra Lodge)		x	
DR41	Residential Area (Fernwood, Sunset View)		x	
	Daily $PM_{2.5}$			
DR7	Residential Area (Lennoxton)		x	
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	
DR41	Residential Area (Fernwood, Sunset View)	x	x	
	Annual $PM_{2.5}$			
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x		
DR41	Residential Area (Fernwood, Sunset View)	x	x	
	Daily PM_{10}			
DR1	Dwellings (farm workers'houses)	x	x	
DR3	Dwellings (Zebra Lodge)		x	
DR4	Dwellings (Game Goose Game Lodge)	x		x
DR7	Residential Area (Lennoxton)	x	x	x
DR8	Residential Area (Newcastle CBD & Newcastle Central)/Edu (unknown)	x	x	x
DR9	Residential Area (Arbor Park, Equarand,Vlam)	x	x	
DR10	Residential Area (Newcastle CBD)/Edu (unknown)	x	x	x
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	x
DR12	Residential Area (Hennenman)	x		x
DR14	Residential Area (Pioneer Park)	x		x
DR16	Educational Facility (unknown)	x		x
DR17	Educational Facility (Ferum High school)	x		x
DR18	Educational Facility (Majuba TVET College)	x	x	x
DR19	Residential Area (Barry Hertzog Park)	x		
DR20	Residential Area (Amajuba Park)	x		

DR21	Educational Facility (Amajuba School, Newcastle Training Centre, Majuba FETC)	x		
DR22	Residential Area (Sunnyridge)			x
DR24	Residential Area (Ncandu Park)/Edu (Hope High School)	x		
DR39	Dwellings (Thornhill Country Estate)			x
DR40	Dwellings (unknown)			x
DR41	Residential Area (Fernwood, Sunset View)	x	x	x
DR42	Residential Area (Sunset View, Fairleigh, Gandhi Park)	x	x	x
	Annual PM_{10}			
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	
DR41	Residential Area (Fernwood, Sunset View)		x	

Inside the mine boundary, exceedances of the standards are also observed for all three pollutants and are mostly localised near to the proposed surface mining activities (open pits, drilling, blasting, loading/offloading operations, haul routes, material stockpile areas, transfer points and proposed material stockpile/exposed areas) for dustfall and annual $PM_{2.5}$ (Figure 6-6, Figure 6-10 to Figure 6-11, & Figure 6-15 to Figure 6-16, & Figure 6-20), which contrasts with the larger spatial extent projected in PM_{10} (daily and annual) and daily $PM_{2.5}$ exceedances (Figure 6-7 to Figure 6-9, Figure 6-12 to Figure 6-14, & Figure 6-17 to Figure 6-19). However, it must be noted that all exceedances projected for the operational phase are without mitigation.

The maximum predicted incremental PM_{10} and $PM_{2.5}$ concentrations and dustfall rates at nearby sensitive receptors are given in Table 6-16 to Table 6-18 for the operational phase, while maximum predicted incremental concentrations at the boundary of the proposed mine are given in Table 6-20. Most discrete receptors (22 in total) downwind of the project site, i.e. within a 10.7km radius south-east and north-east of the proposed mine (mostly schools and residential areas in Newcastle) are indicated to be impacted by exceedances in daily PM_{10} concentrations for the 3, 5 and 2-multi-pit options and could thus be at high risk under the unmitigated scenario (Figure 6-7, Figure 6-12 & Figure 6-17; Table 6-14, and Table 6-16 to Table 6-18). The proposed mine should thus implement dust mitigation measures as far as possible to limit the impact of PM_{10} emissions on these receptors during the operational phase. On the other hand, only four receptors in total are indicated to be impacted by exceedances projected for dustfall, $PM_{2.5}$ and annual PM_{10} (Table 6-14).

Dust mitigation measures that can be implemented to reduce dustfall and PM emissions, including corresponding mitigation potentials, are provided in Section 7 of this AQIAr. Most of the mitigation measures have mitigation potentials/control efficiencies ranging between 25% and 75%, with only a few of the measures being 90 – 100% effective. Thus, the level of emission reduction at the proposed mine during the operational phase will depend on the choice of mitigation applied, depending on affordability and practicality.

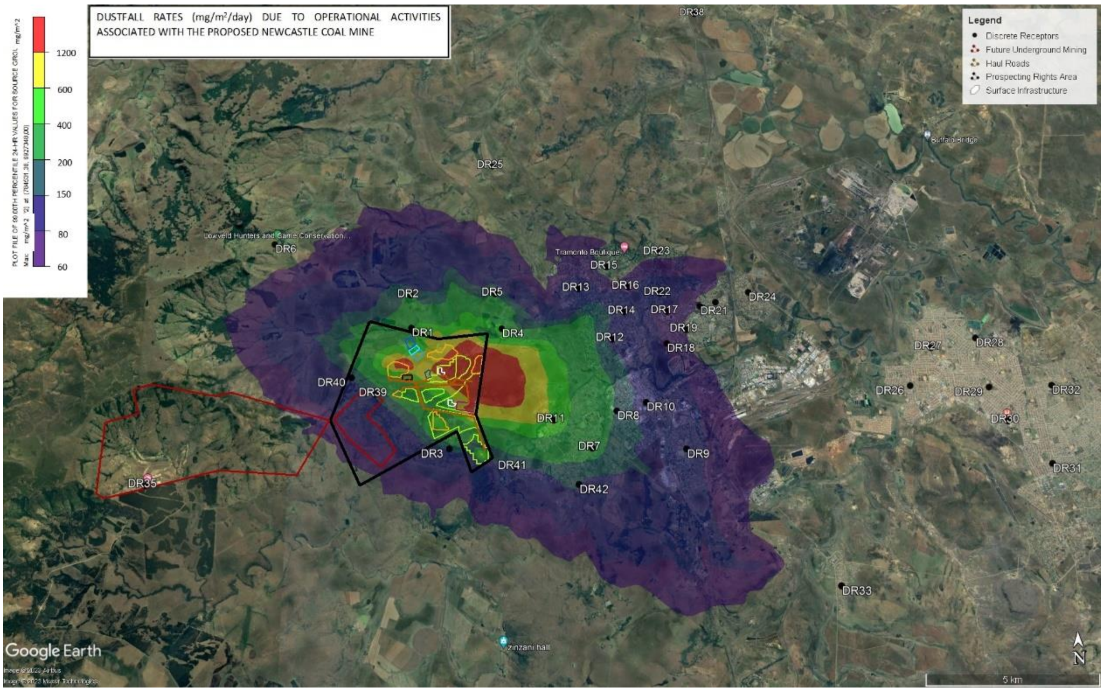


Figure 6-6: Predicted Dustfall Rates at the proposed mine - Operational Phase (3 Pit option).

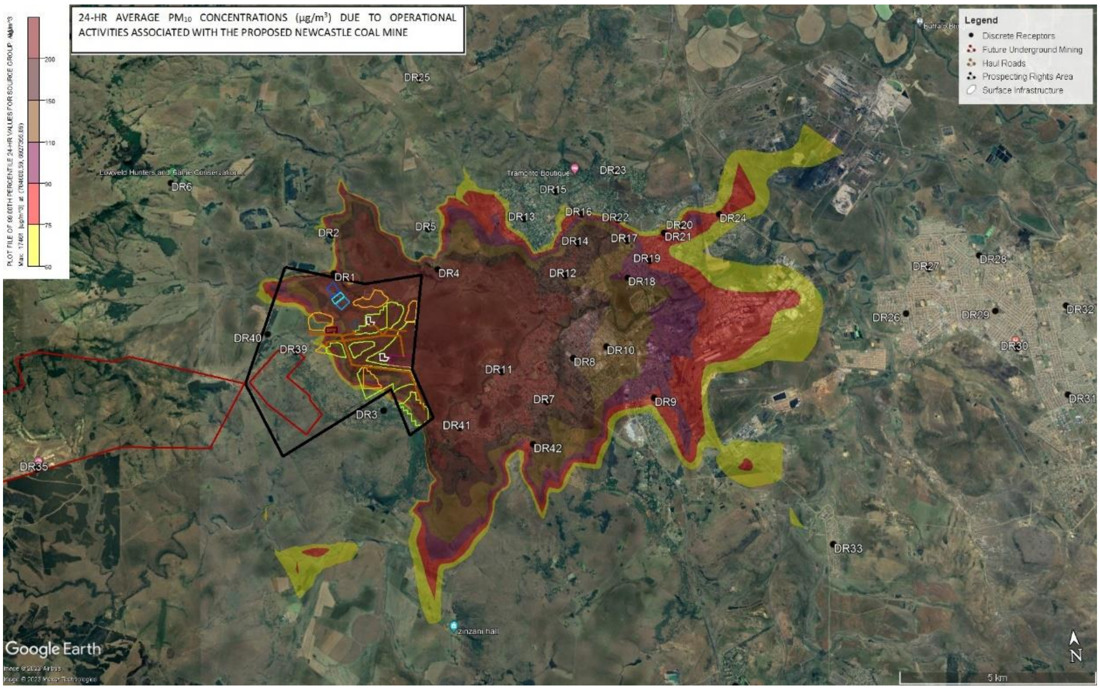


Figure 6-7: Predicted Daily Average PM_{10} Concentrations at the proposed mine - Operational Phase (3 Pit option).

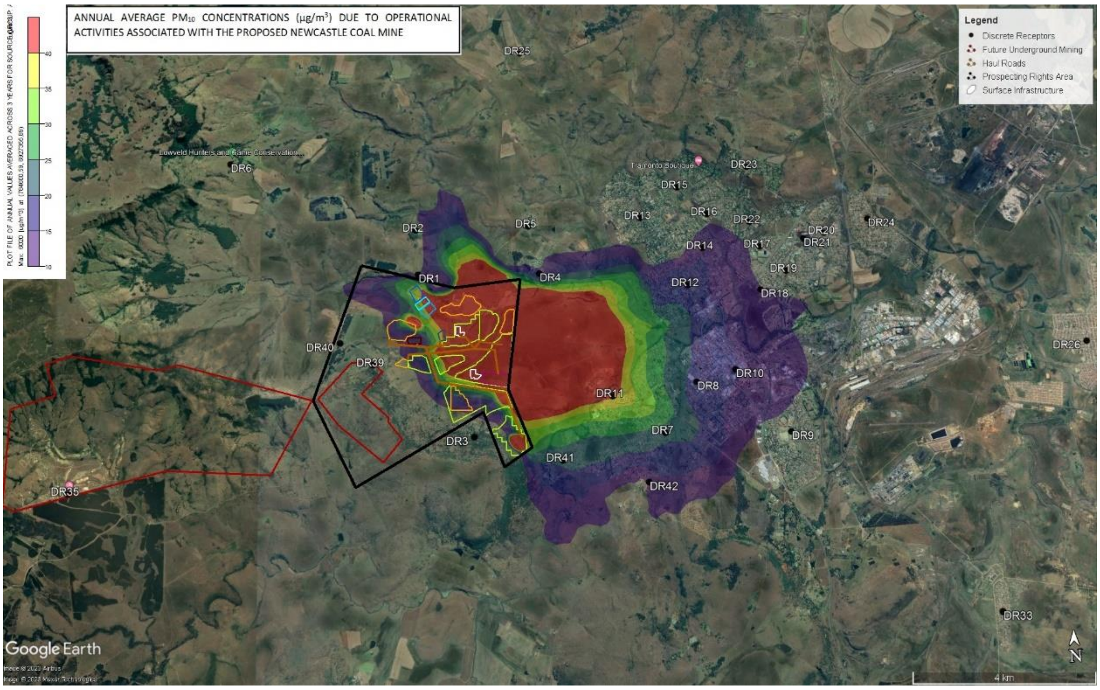


Figure 6-8: Predicted Annual Average PM_{10} Concentrations at the proposed mine - Operational Phase (3 Pit option).

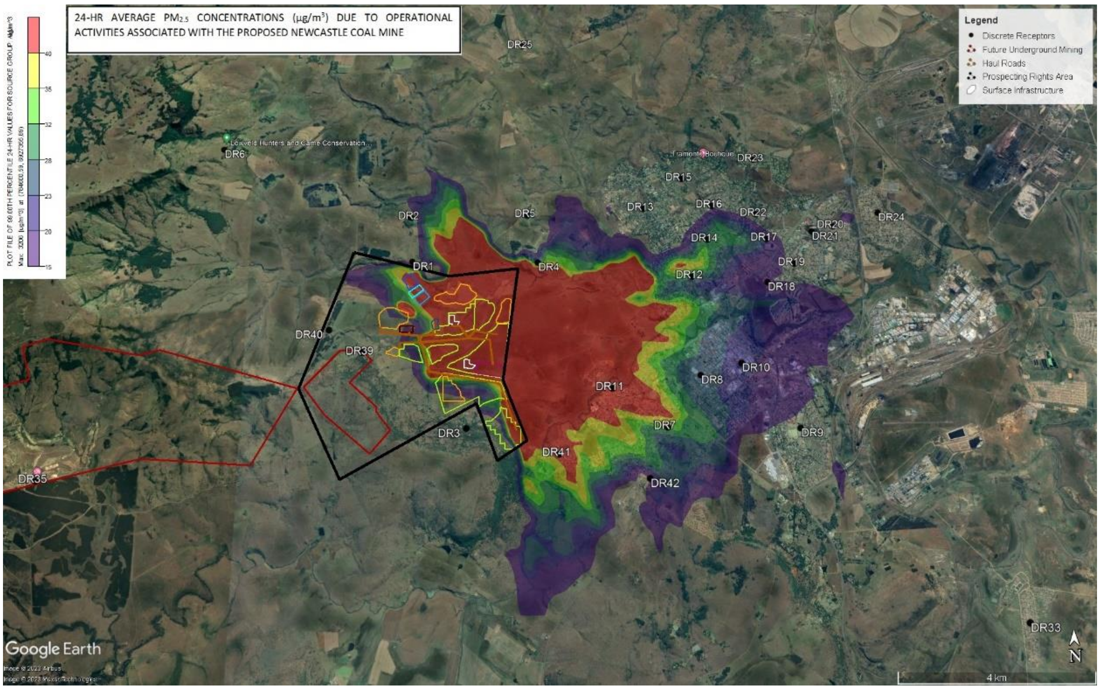


Figure 6-9: Predicted Daily Average $PM_{2.5}$ Concentrations at the proposed mine - Operational Phase (3 Pit option).

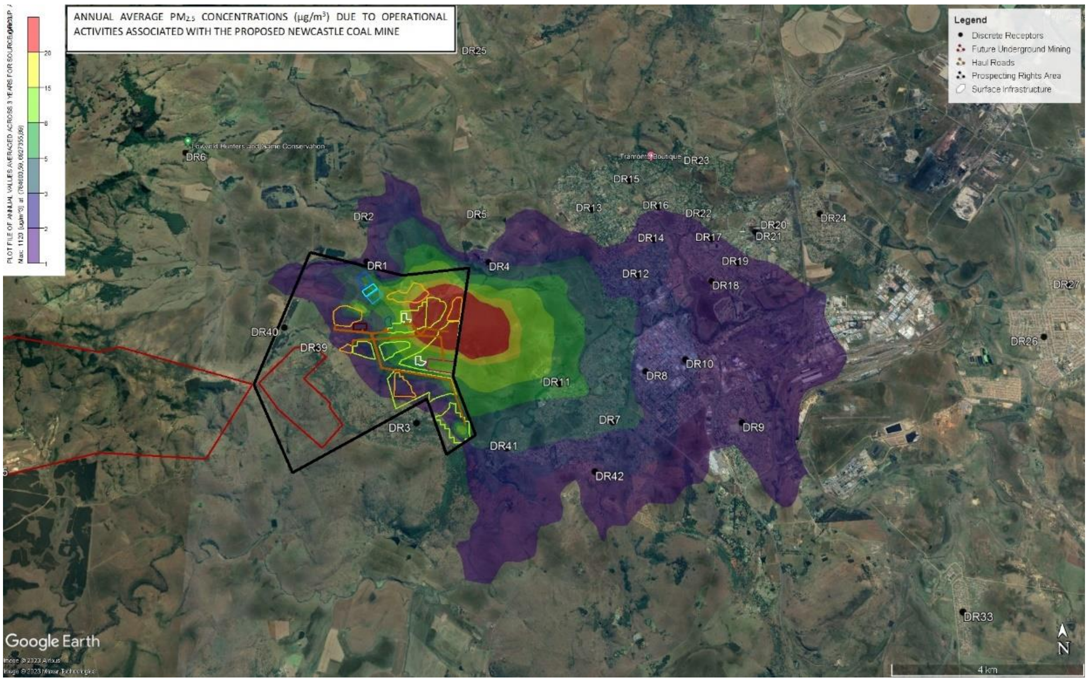


Figure 6-10: Predicted Annual Average $PM_{2.5}$ Concentrations at the proposed mine - Operational Phase (3 Pit option).

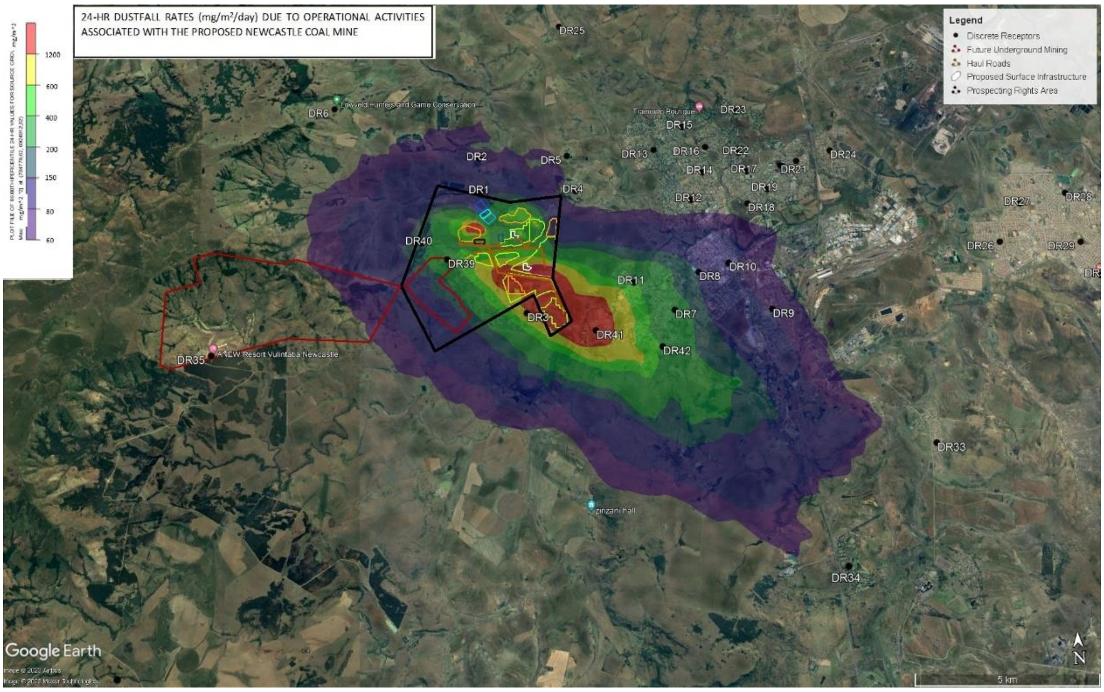


Figure 6-11: Predicted Dustfall Rates at the proposed mine - Operational Phase (5 Pit option).

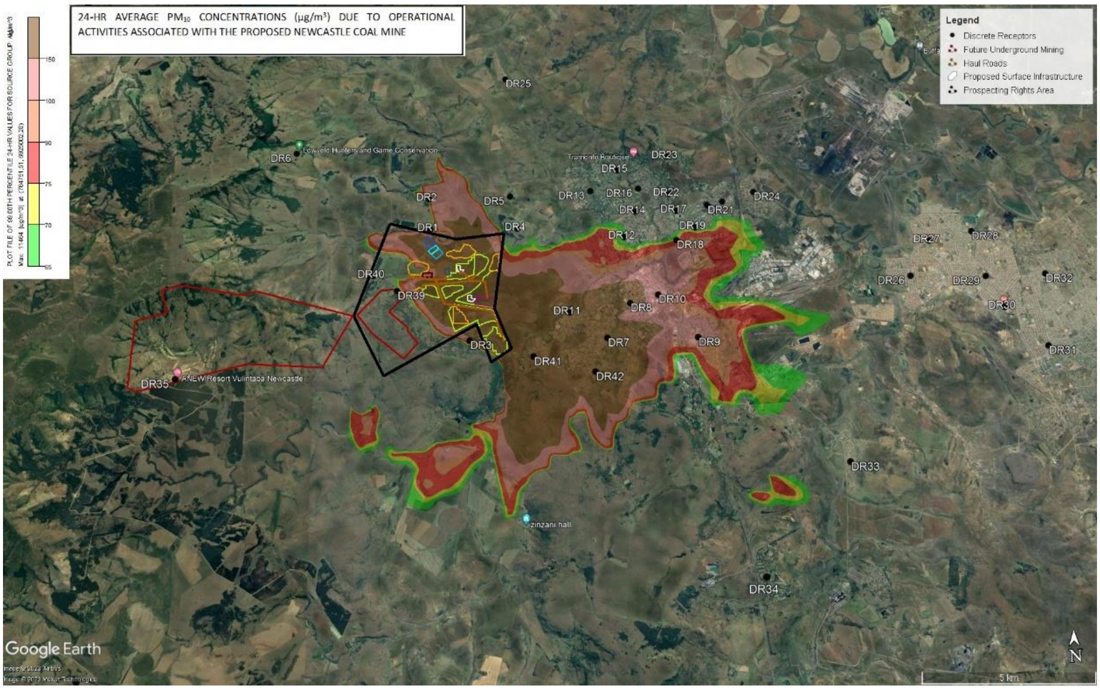


Figure 6-12: Predicted Daily Average PM_{10} Concentrations at the proposed mine - Operational Phase (5 Pit option).

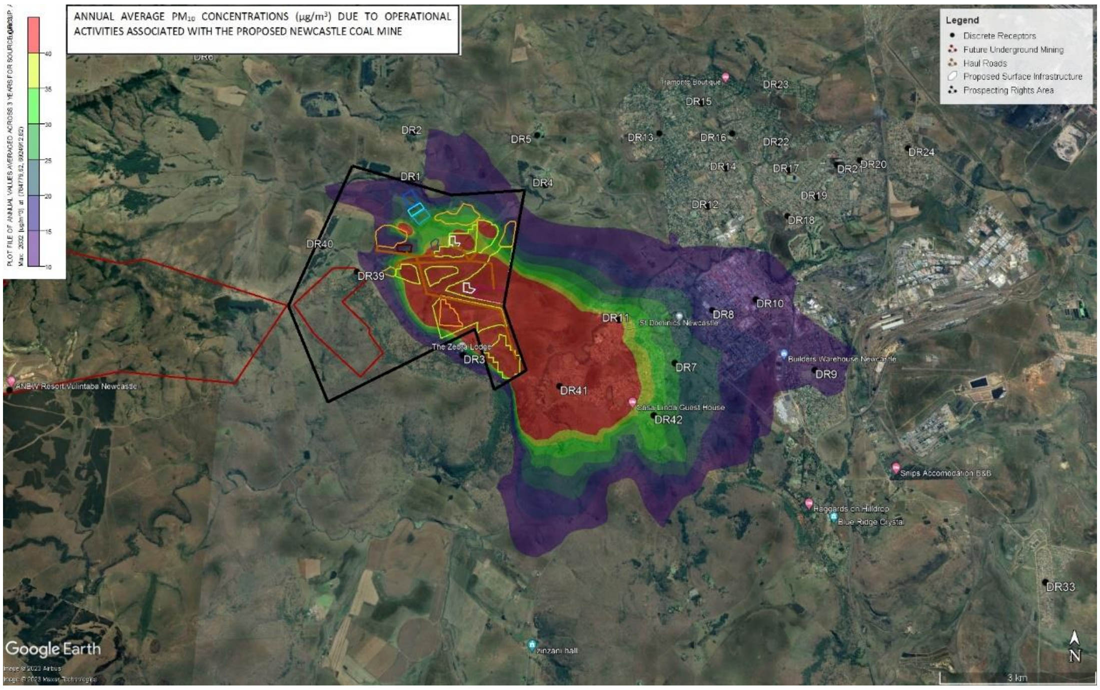


Figure 6-13: Predicted Annual Average PM_{10} Concentrations at the proposed mine - Operational Phase (5 Pit option).

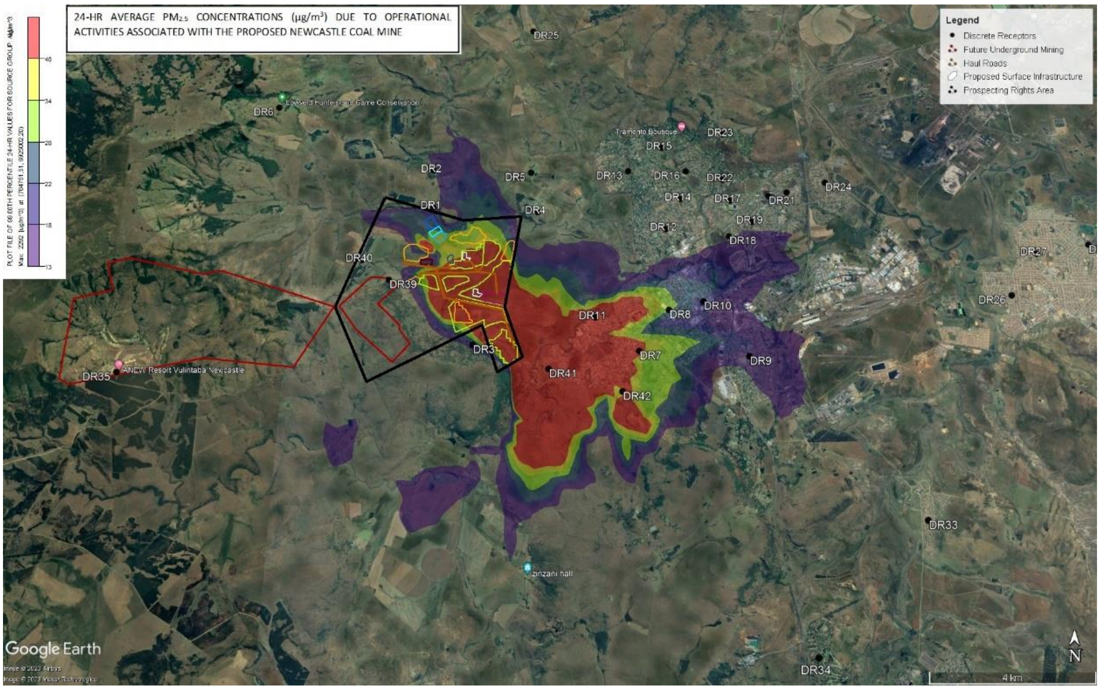


Figure 6-14: Predicted Daily Average $PM_{2.5}$ Concentrations at the proposed mine - Operational Phase (5 Pit option).

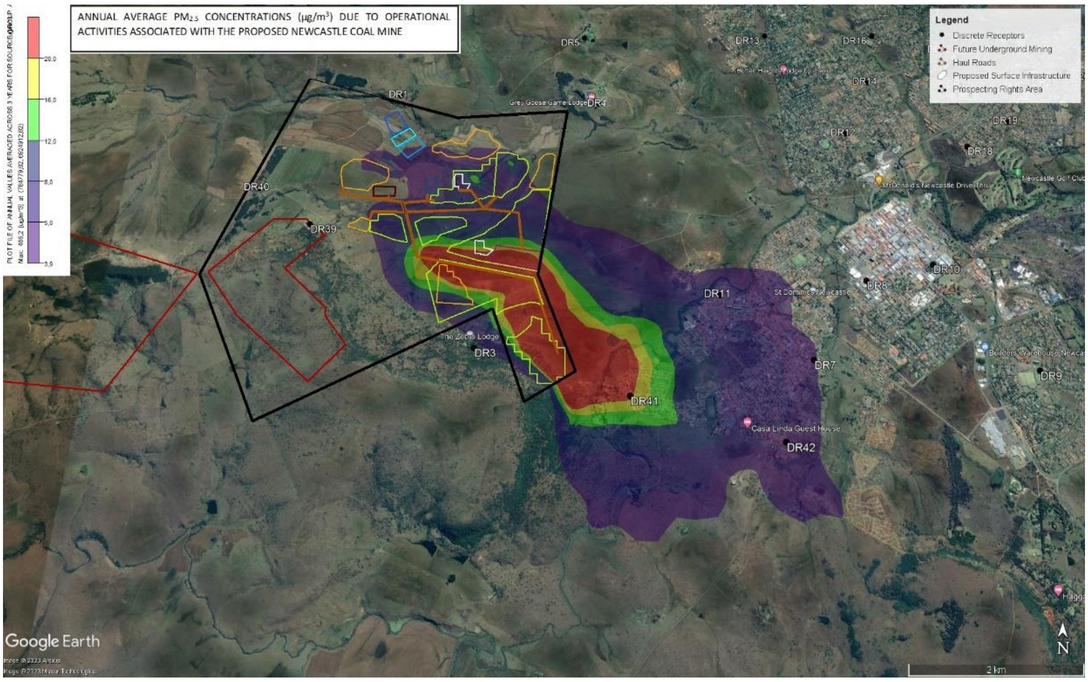


Figure 6-15: Predicted Annual Average $PM_{2.5}$ Concentrations at the proposed mine - Operational Phase (5 Pit option).

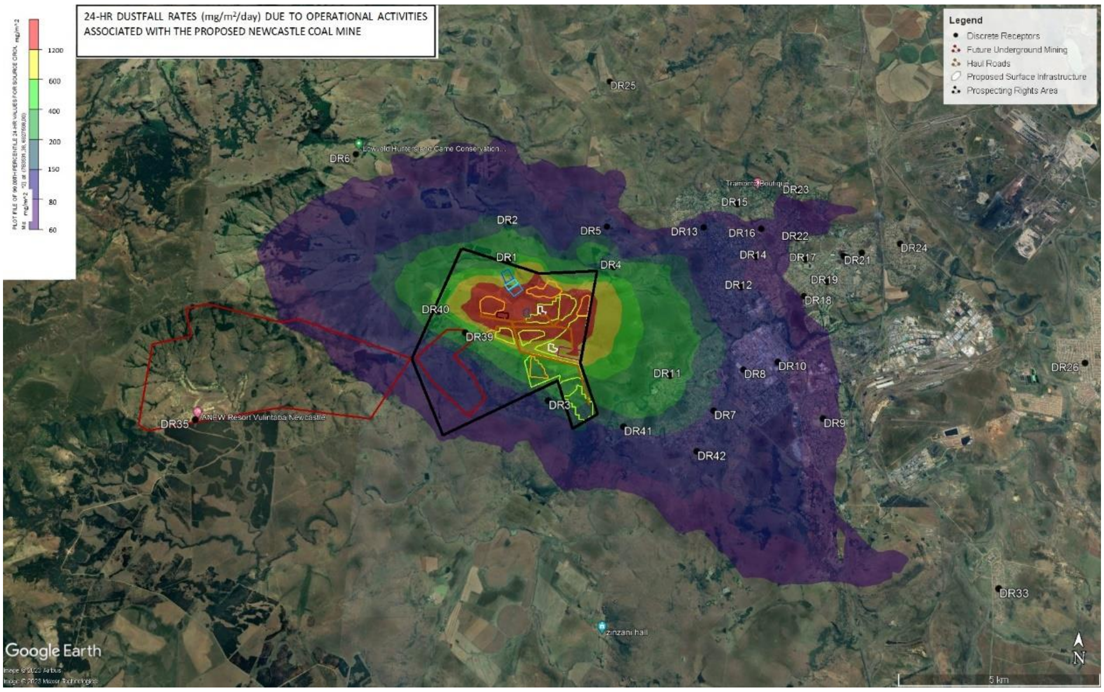


Figure 6-16: Predicted Dustfall Rates at the proposed mine - Operational Phase (2 Pit option).

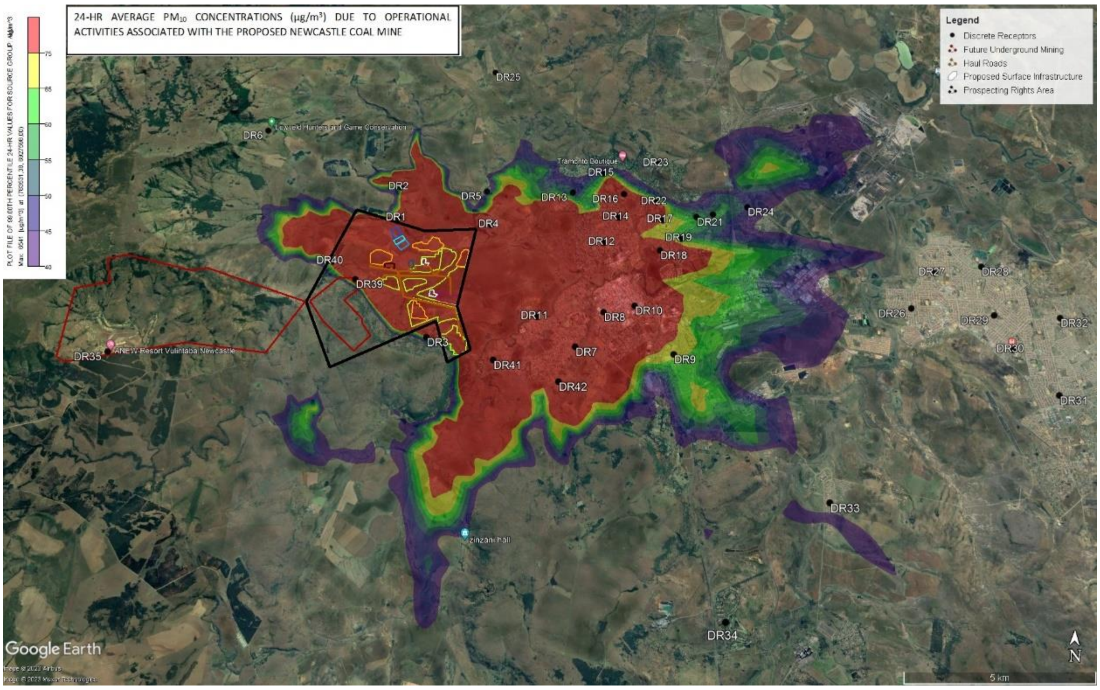


Figure 6-17: Predicted Daily Average PM_{10} Concentrations at the proposed mine - Operational Phase (2 Pit option).

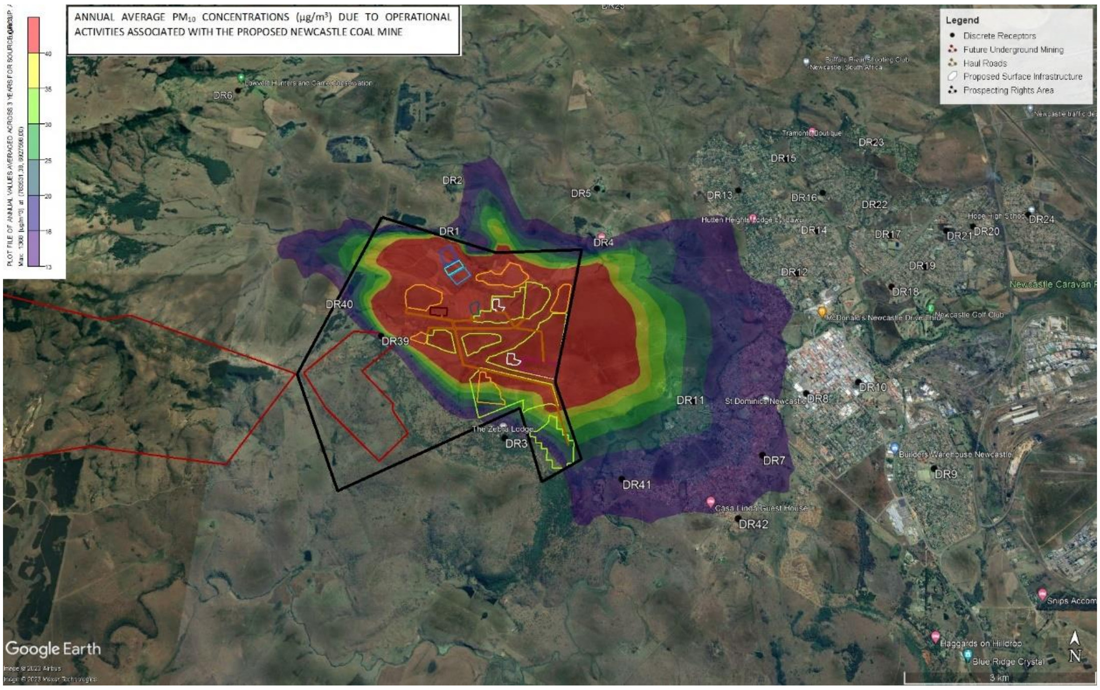


Figure 6-18: Predicted Annual Average PM_{10} Concentrations at the proposed mine - Operational Phase (2 Pit option).

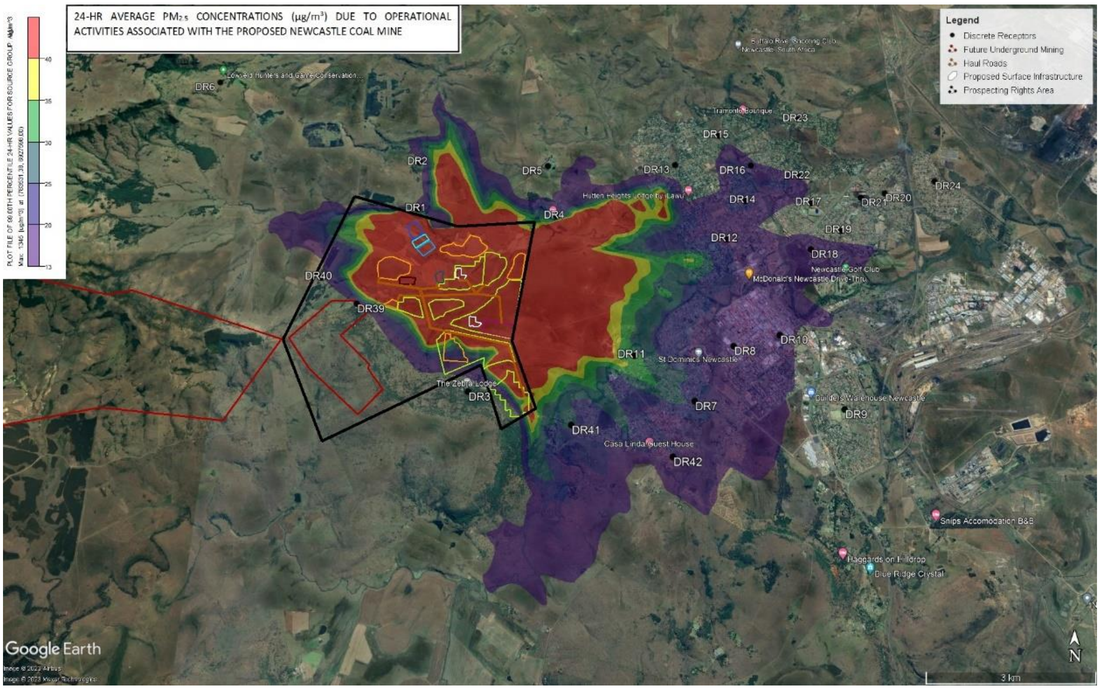


Figure 6-19: Predicted Daily Average $PM_{2.5}$ Concentrations at the proposed mine - Operational Phase (2 Pit Option).

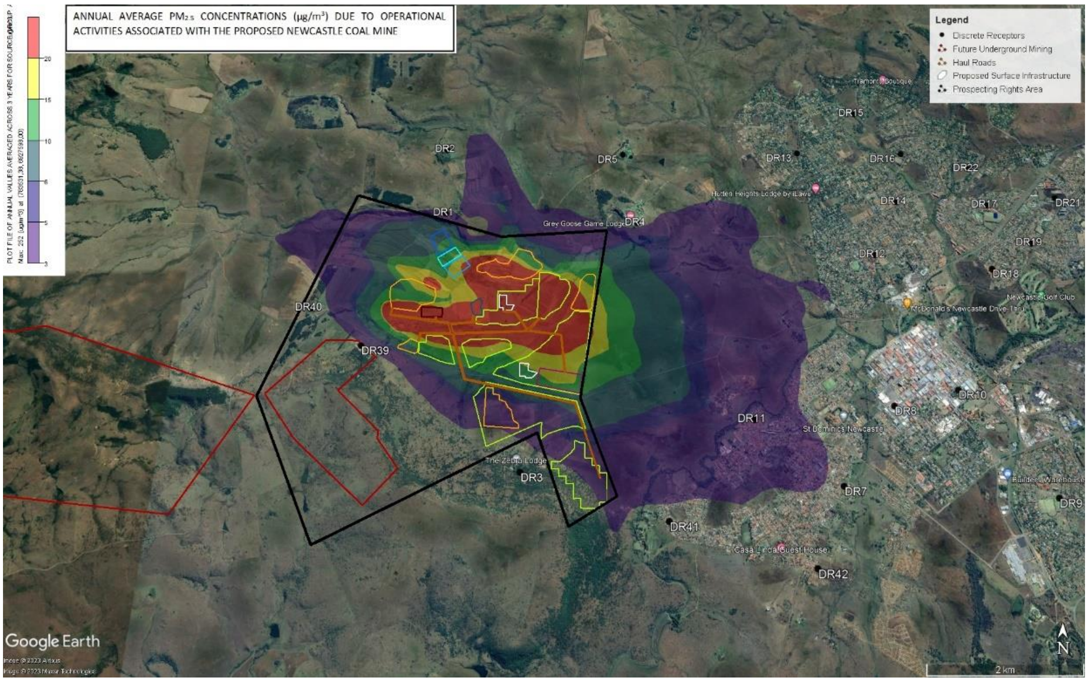


Figure 6-20: Predicted Annual Average $PM_{2.5}$ Concentrations at the proposed mine - Operational Phase (2 Pit option).

6.3.3. Maximum Predicted Incremental Concentrations

Maximum predicted incremental concentrations at nearby sensitive receptors (represented as discrete receptors) located within a 20km radius from the proposed mine are given in Table 6-15 to Table 6-18 for the construction and operational phases.

The discrete receptor points are located at the centre of residential areas (mostly dwellings), or near schools, hospitals, old age homes and cemeteries, in order to determine the maximum concentrations that could be expected near sensitive receptors. A spatial representation of the identified discrete receptors is shown below in Figure 6-21. The receptors were identified during a desktop study (please refer to section 2.4).

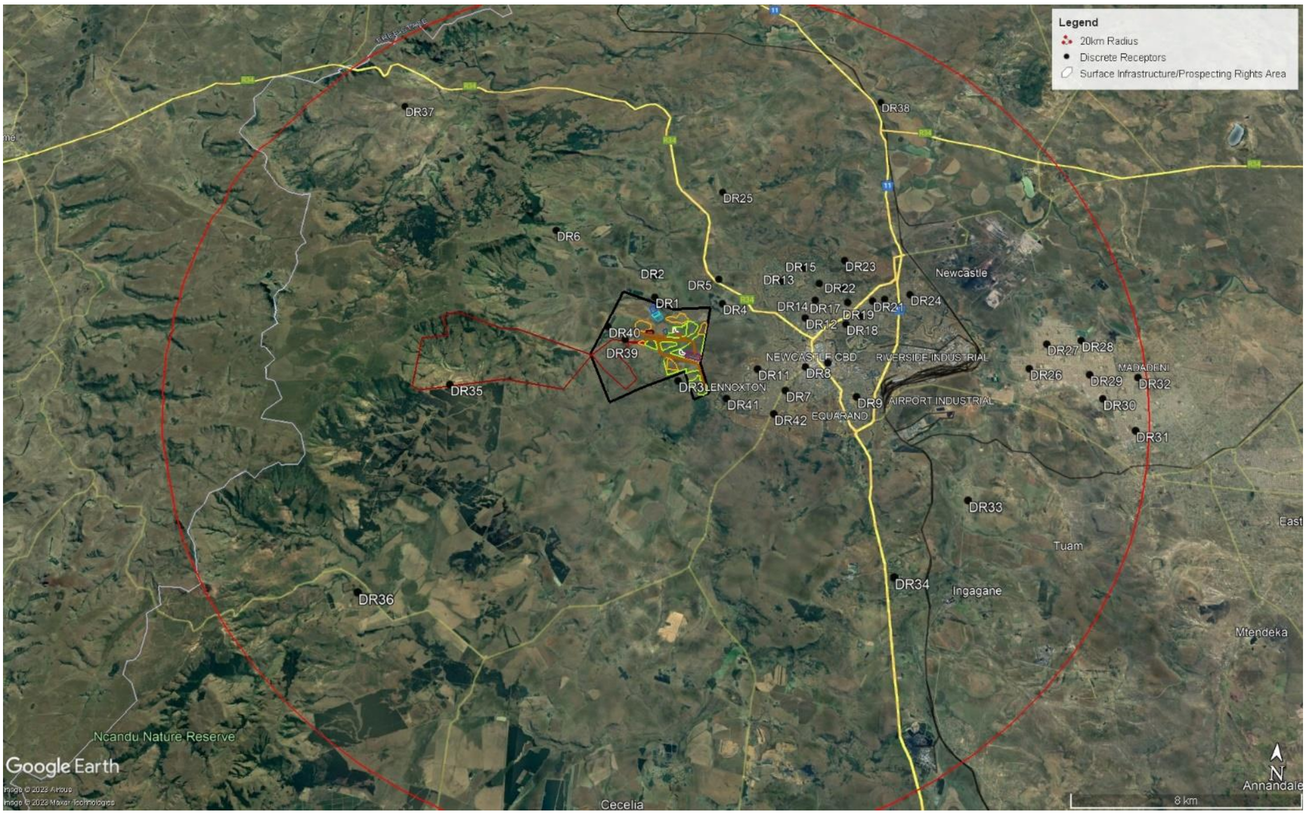


Figure 6-21: Spatial representation of discrete receptors included in dispersion model (<20km from the proposed mine).

Table 6-15: Maximum predicted incremental PM_{10}, $PM_{2.5}$ concentrations and Dustfall rates at nearby sensitive receptors, located within a 20km radius of the proposed mine – Construction Phase.

INCREMENTAL CONCENTRATIONS (µg/m³)								
Discrete Receptor	Dustfall (mg/m²/day)	PM_{10} (24H)	PM_{10} (Annual)	$PM_{2.5}$ (24H)	$PM_{2.5}$ (Annual)	UTM Co-ordinates (35S)		Elevation (m)
	Residential: 600mg/m²/day Non-residential: 1200 mg/m²/day	75	40	40	20	X (m)	Y (m)	
DR1	342.88	104.15	5.98	10.42	0.60	782442.1	6928970	1250.56
DR2	81.02	32.16	1.65	3.22	0.17	782434.9	6930067.78	1253.37
DR3	63.98	11.92	1.29	1.19	0.13	783561.82	6925041.31	1274.83
DR4	86.97	51.35	3.12	5.14	0.31	785313.48	6928794.24	1236.79
DR5	48.13	14.82	0.87	1.48	0.09	785137.37	6929974.04	1270.21
DR6	41.24	7.23	0.65	0.72	0.06	778012.03	6932060.14	1444.92
DR7	40.00	24.98	1.65	2.50	0.16	787941.07	6924827.49	1202.03
DR8	50.64	22.70	1.53	2.27	0.15	788777.85	6925946.72	1194.63
DR9	27.90	15.30	0.92	1.53	0.09	790829.59	6924650.99	1228.24
DR10	44.85	24.39	1.34	2.44	0.13	789709.51	6926174.29	1204.16
DR11	60.00	38.65	2.52	3.86	0.25	786807.37	6925757.52	1193.4
DR12	33.40	24.79	1.37	2.48	0.14	788806.17	6928259.37	1209.08
DR13	30.62	20.32	1.02	2.03	0.10	787830.29	6929991.45	1262.25
DR14	29.52	23.36	1.17	2.34	0.12	789245.17	6929139.14	1217.09
DR15	24.02	17.23	0.84	1.72	0.08	788790.78	6930698.04	1237.78
DR16	25.43	20.11	1.14	2.01	0.11	789433.87	6929973.84	1228.04
DR17	23.73	15.04	0.75	1.50	0.08	790617.38	6929082.33	1229.2
DR18	25.98	22.48	1.10	2.25	0.11	790510.11	6928029.03	1215.49
DR19	21.00	15.97	0.85	1.60	0.09	791173.65	6928442.4	1217.8
DR20	17.80	10.89	0.55	1.09	0.05	792191.9	6929307.48	1228.14
DR21	19.99	12.43	0.60	1.24	0.06	791675.11	6929205.78	1228.25
DR22	24.26	15.38	0.79	1.54	0.08	790439.09	6929708.12	1238.17
DR23	18.33	7.88	0.37	0.79	0.04	790533.39	6931098.39	1331.57
DR24	16.51	8.85	0.46	0.89	0.05	793278.43	6929587.32	1221.83
DR25	18.85	3.04	0.17	0.30	0.02	785227.47	6934471.13	1320.22
DR26	11.10	7.46	0.46	0.75	0.05	797870	6926369.98	1196.29
DR27	9.14	8.83	0.42	0.88	0.04	798951.47	6927591.98	1208.48
DR28	8.28	8.12	0.37	0.81	0.04	800171	6927906.77	1182.51
DR29	8.37	6.47	0.37	0.65	0.04	800608.19	6926313.7	1201.22
DR30	10.38	6.93	0.33	0.69	0.03	800792.27	6925242.94	1220.13
DR31	10.56	5.76	0.29	0.58	0.03	802472	6923921.17	1240.46
DR32	7.58	5.79	0.33	0.58	0.03	802379.96	6926130.13	1196.78
DR33	14.95	5.78	0.51	0.58	0.05	795015.52	6920367.02	1194.92
DR34	13.71	4.70	0.39	0.47	0.04	791975.67	6917147.11	1225.78
DR35	22.67	5.17	0.40	0.52	0.04	774292.01	6924413.17	1424.69
DR36	7.54	2.55	0.16	0.26	0.02	771915.11	6915654.76	1445.26
DR37	8.56	3.44	0.24	0.34	0.02	770508.55	6938527.89	1532.67
DR38	3.44	2.77	0.12	0.28	0.01	792525.93	6939969.82	1202.86
DR39	207.15	26.18	3.45	2.62	0.34	781298.04	6926872.78	1285.12
DR40	199.01	23.37	3.98	2.34	0.40	780548.85	6927445.81	1296.29

DR41	50.00	21.99	1.37	2.19	0.14	785551.54	6924369.38	1199.81
DR42	40.00	16.44	1.41	1.64	0.13	787465.28	6923744.41	1230.8

Table 6-16: Maximum predicted incremental PM_{10}, $PM_{2.5}$ concentrations and Dustfall rates at nearby sensitive receptors, located within a 20km radius of the proposed mine – Operational Phase (3-Pit Option).

INCREMENTAL CONCENTRATIONS (µg/m³)								
Discrete Receptor	Dustfall (mg/m²/day)	PM_{10} (24H)	PM_{10} (Annual)	$PM_{2.5}$ (24H)	$PM_{2.5}$ (Annual)	UTM Co-ordinates (35S)		Elevation (m)
	Residential: 600mg/m²/day Non-residential: 1200 mg/m²/day	75	40	40	20	X (m)	Y (m)	
3-Pit Option (Pits 1 – 3)								
DR1	406.95	86.07	11.04	13.71	1.57	782442.1	6928970	1250.56
DR2	203.06	47.30	5.76	7.48	0.82	782434.9	6930067.78	1253.37
DR3	156.14	18.35	2.46	2.86	0.34	783561.82	6925041.31	1274.83
DR4	470.39	202.63	13.55	30.28	1.97	785313.48	6928794.24	1236.79
DR5	191.24	25.02	2.38	3.66	0.32	785137.37	6929974.04	1270.21
DR6	47.10	5.56	0.67	0.83	0.10	778012.03	6932060.14	1444.92
DR7	221.13	230.75	22.81	31.84	3.32	787941.07	6924827.49	1202.03
DR8	189.61	147.57	18.54	22.42	2.66	788777.85	6925946.72	1194.63
DR9	103.52	83.39	8.37	13.53	1.20	790829.59	6924650.99	1228.24
DR10	123.21	139.28	15.44	22.00	2.23	789709.51	6926174.29	1204.16
DR11	521.00	366.44	41.11	60.46	6.10	786807.37	6925757.52	1193.4
DR12	134.26	170.39	17.63	28.08	2.53	788806.17	6928259.37	1209.08
DR13	100.52	28.47	2.38	4.66	0.34	787830.29	6929991.45	1262.25
DR14	106.82	202.69	14.37	31.05	2.14	789245.17	6929139.14	1217.09
DR15	50.47	45.81	2.62	6.91	0.37	788790.78	6930698.04	1237.78
DR16	71.79	96.13	6.96	14.99	1.01	789433.87	6929973.84	1228.04
DR17	74.47	127.52	8.15	20.55	1.21	790617.38	6929082.33	1229.2
DR18	75.92	109.80	10.59	16.58	1.51	790510.11	6928029.03	1215.49
DR19	59.57	85.24	7.86	13.24	1.10	791173.65	6928442.4	1217.8
DR20	48.27	79.72	6.03	12.55	0.88	792191.9	6929307.48	1228.14
DR21	53.68	92.92	6.66	14.83	0.98	791675.11	6929205.78	1228.25
DR22	83.64	64.05	5.10	10.31	0.74	790439.09	6929708.12	1238.17
DR23	56.50	5.40	0.60	0.84	0.08	790533.39	6931098.39	1331.57
DR24	36.85	78.51	5.67	11.15	0.83	793278.43	6929587.32	1221.83
DR25	26.27	5.11	0.43	0.79	0.06	785227.47	6934471.13	1320.22
DR26	20.97	35.16	3.45	5.45	0.49	797870	6926369.98	1196.29
DR27	15.05	43.43	3.51	6.90	0.51	798951.47	6927591.98	1208.48
DR28	13.35	34.69	2.76	5.47	0.40	800171	6927906.77	1182.51
DR29	15.21	24.03	2.60	3.64	0.37	800608.19	6926313.7	1201.22
DR30	17.23	35.42	2.66	5.30	0.38	800792.27	6925242.94	1220.13
DR31	16.06	24.53	1.86	3.69	0.27	802472	6923921.17	1240.46
DR32	12.78	20.66	2.18	3.19	0.31	802379.96	6926130.13	1196.78
DR33	34.06	56.28	4.77	8.77	0.69	795015.52	6920367.02	1194.92
DR34	27.53	36.80	2.58	5.70	0.37	791975.67	6917147.11	1225.78
DR35	24.16	3.21	0.36	0.50	0.05	774292.01	6924413.17	1424.69

DR36	7.71	1.20	0.12	0.19	0.02	771915.11	6915654.76	1445.26
DR37	10.57	1.83	0.23	0.27	0.03	770508.55	6938527.89	1532.67
DR38	5.48	10.09	0.75	1.60	0.10	792525.93	6939969.82	1202.86
DR39	160.92	19.62	3.33	3.11	0.47	781298.04	6926872.78	1285.12
DR40	148.50	26.95	3.80	3.73	0.52	780548.85	6927445.81	1296.29
DR41	146.91	259.80	21.51	43.03	3.06	785551.54	6924369.38	1199.81
DR42	158.84	95.04	10.37	15.55	1.47	787465.28	6923744.41	1230.8

Table 6-17: Maximum predicted incremental PM_{10}, $PM_{2.5}$ concentrations and Dustfall rates at nearby sensitive receptors, located within a 20km radius of the proposed mine – Operational Phase (5-Pit Option).

INCREMENTAL CONCENTRATIONS (µg/m³)								
Discrete Receptor	Dustfall (mg/m²/day)	PM_{10} (24H)	PM_{10} (Annual)	$PM_{2.5}$ (24H)	$PM_{2.5}$ (Annual)	UTM Co-ordinates (35S)		Elevation (m)
	Residential: 600mg/m²/day Non-residential: 1200 mg/m²/day	75	40	40	20	X (m)	Y (m)	
5-Pit Option (Pits 2 – 6)								
DR1	127.99	75.67	8.48	10.45	1.08	782442.1	6928970	1250.56
DR2	76.58	67.08	5.04	9.28	0.65	782434.9	6930067.78	1253.37
DR3	985.98	90.71	16.48	16.52	2.65	783561.82	6925041.31	1274.83
DR4	57.63	63.79	6.84	9.43	0.88	785313.48	6928794.24	1236.79
DR5	45.74	24.67	2.20	3.40	0.29	785137.37	6929974.04	1270.21
DR6	37.32	4.29	0.51	0.65	0.07	778012.03	6932060.14	1444.92
DR7	246.46	252.97	26.64	42.97	3.97	787941.07	6924827.49	1202.03
DR8	142.27	168.61	16.94	26.53	2.45	788777.85	6925946.72	1194.63
DR9	79.17	110.82	11.18	17.78	1.60	790829.59	6924650.99	1228.24
DR10	92.17	129.99	13.28	21.32	1.92	789709.51	6926174.29	1204.16
DR11	424.31	459.85	40.92	78.42	6.03	786807.37	6925757.52	1193.4
DR12	45.24	63.61	6.79	8.60	0.84	788806.17	6928259.37	1209.08
DR13	29.68	30.45	2.47	4.28	0.33	787830.29	6929991.45	1262.25
DR14	29.80	46.52	4.62	6.95	0.59	789245.17	6929139.14	1217.09
DR15	19.99	34.99	2.59	5.22	0.35	788790.78	6930698.04	1237.78
DR16	22.63	38.53	3.17	5.62	0.42	789433.87	6929973.84	1228.04
DR17	29.16	48.88	4.51	5.67	0.54	790617.38	6929082.33	1229.2
DR18	47.66	79.63	8.25	12.17	1.14	790510.11	6928029.03	1215.49
DR19	39.63	61.74	6.88	8.92	0.94	791173.65	6928442.4	1217.8
DR20	29.11	48.47	4.48	6.26	0.58	792191.9	6929307.48	1228.14
DR21	30.08	52.74	4.40	6.31	0.55	791675.11	6929205.78	1228.25
DR22	24.67	39.86	3.38	5.74	0.43	790439.09	6929708.12	1238.17
DR23	28.77	4.53	0.50	0.66	0.07	790533.39	6931098.39	1331.57
DR24	23.95	43.71	4.40	5.66	0.60	793278.43	6929587.32	1221.83
DR25	14.43	4.22	0.44	0.65	0.06	785227.47	6934471.13	1320.22
DR26	17.25	33.39	3.04	4.39	0.42	797870	6926369.98	1196.29
DR27	14.44	24.85	2.47	3.45	0.34	798951.47	6927591.98	1208.48
DR28	13.43	19.81	2.02	2.97	0.28	800171	6927906.77	1182.51
DR29	12.75	29.59	2.44	4.17	0.34	800608.19	6926313.7	1201.22
DR30	12.68	33.93	2.91	4.96	0.42	800792.27	6925242.94	1220.13

DR31	12.47	22.96	2.05	3.69	0.28	802472	6923921.17	1240.46
DR32	10.16	26.24	2.15	4.03	0.30	802379.96	6926130.13	1196.78
DR33	35.12	46.91	4.31	7.02	0.61	795015.52	6920367.02	1194.92
DR34	32.51	61.01	4.16	9.09	0.61	791975.67	6917147.11	1225.78
DR35	28.21	3.22	0.50	0.53	0.08	774292.01	6924413.17	1424.69
DR36	7.59	1.34	0.15	0.21	0.02	771915.11	6915654.76	1445.26
DR37	9.36	1.74	0.21	0.26	0.03	770508.55	6938527.89	1532.67
DR38	4.52	6.02	0.63	0.95	0.08	792525.93	6939969.82	1202.86
DR39	292.32	54.85	7.36	7.25	0.99	781298.04	6926872.78	1285.12
DR40	180.63	36.72	5.25	4.92	0.69	780548.85	6927445.81	1296.29
DR41	2656.26	936.45	124.31	176.01	20.81	785551.54	6924369.38	1199.81
DR42	381.23	226.59	29.48	38.69	4.28	787465.28	6923744.41	1230.8

Table 6-18: Maximum predicted incremental PM_{10}, $PM_{2.5}$ concentrations and Dustfall rates at nearby sensitive receptors, located within a 20km radius of the proposed mine – Operational Phase (2-Pit Option).

INCREMENTAL CONCENTRATIONS (µg/m³)								
Discrete Receptor	Dustfall (mg/m²/day)	PM_{10} (24H)	PM_{10} (Annual)	$PM_{2.5}$ (24H)	$PM_{2.5}$ (Annual)	UTM Co-ordinates (35S)		Elevation (m)
	Residential: 600mg/m²/day Non-residential: 1200 mg/m²/day	75	40	40	20	X (m)	Y (m)	
2-Pit Option (Pits 5 – 6)								
DR1	495.96	124.33	19.25	18.62	2.68	782442.1	6928970	1250.56
DR2	185.43	68.10	8.07	10.25	1.09	782434.9	6930067.78	1253.37
DR3	170.00	59.00	4.18	3.66	0.51	783561.82	6925041.31	1274.83
DR4	297.86	160.37	14.95	24.96	2.11	785313.48	6928794.24	1236.79
DR5	123.29	39.59	3.74	5.75	0.50	785137.37	6929974.04	1270.21
DR6	44.02	5.56	0.73	0.80	0.11	778012.03	6932060.14	1444.92
DR7	143.91	141.64	14.78	22.82	2.29	787941.07	6924827.49	1202.03
DR8	121.02	100.21	11.45	16.51	1.70	788777.85	6925946.72	1194.63
DR9	68.88	66.61	6.56	11.37	0.96	790829.59	6924650.99	1228.24
DR10	90.24	90.07	9.49	14.21	1.44	789709.51	6926174.29	1204.16
DR11	246.16	197.33	22.48	33.90	3.48	786807.37	6925757.52	1193.4
DR12	85.84	101.90	9.88	16.87	1.51	788806.17	6928259.37	1209.08
DR13	105.25	52.01	5.19	7.08	0.69	787830.29	6929991.45	1262.25
DR14	73.17	129.85	9.85	22.78	1.52	789245.17	6929139.14	1217.09
DR15	48.73	57.79	4.60	9.03	0.65	788790.78	6930698.04	1237.78
DR16	66.74	121.01	7.99	19.71	1.23	789433.87	6929973.84	1228.04
DR17	48.83	76.65	5.95	12.42	0.87	790617.38	6929082.33	1229.2
DR18	58.16	101.88	8.34	17.79	1.28	790510.11	6928029.03	1215.49
DR19	43.80	63.57	5.97	10.79	0.90	791173.65	6928442.4	1217.8
DR20	34.12	58.13	4.39	8.60	0.64	792191.9	6929307.48	1228.14
DR21	37.60	62.62	4.81	9.28	0.70	791675.11	6929205.78	1228.25
DR22	58.93	91.35	5.86	14.80	0.86	790439.09	6929708.12	1238.17
DR23	53.90	9.89	0.88	1.43	0.12	790533.39	6931098.39	1331.57
DR24	30.29	49.19	3.80	7.64	0.56	793278.43	6929587.32	1221.83
DR25	23.05	7.74	0.61	0.97	0.08	785227.47	6934471.13	1320.22
DR26	19.09	29.38	2.60	5.12	0.39	797870	6926369.98	1196.29

DR27	14.43	32.48	2.67	5.01	0.40	798951.47	6927591.98	1208.48
DR28	12.39	27.09	2.24	4.43	0.34	800171	6927906.77	1182.51
DR29	13.80	20.92	2.00	3.55	0.30	800608.19	6926313.7	1201.22
DR30	15.29	26.44	2.18	4.21	0.32	800792.27	6925242.94	1220.13
DR31	13.51	19.99	1.71	3.41	0.25	802472	6923921.17	1240.46
DR32	11.62	19.12	1.70	3.14	0.25	802379.96	6926130.13	1196.78
DR33	27.98	33.26	3.61	5.49	0.54	795015.52	6920367.02	1194.92
DR34	23.65	25.19	2.42	4.11	0.35	791975.67	6917147.11	1225.78
DR35	27.79	2.98	0.38	0.44	0.06	774292.01	6924413.17	1424.69
DR36	9.34	1.45	0.14	0.24	0.02	771915.11	6915654.76	1445.26
DR37	10.10	2.03	0.24	0.30	0.04	770508.55	6938527.89	1532.67
DR38	6.05	6.93	0.61	1.14	0.09	792525.93	6939969.82	1202.86
DR39	313.04	106.12	15.85	13.24	1.95	781298.04	6926872.78	1285.12
DR40	324.62	93.64	11.97	11.96	1.50	780548.85	6927445.81	1296.29
DR41	151.42	149.02	15.75	26.05	2.26	785551.54	6924369.38	1199.81
DR42	112.43	117.41	11.84	18.36	1.68	787465.28	6923744.41	1230.8

Maximum predicted incremental concentrations at the proposed mine boundary are given in Table 6-19 and Table 6-20 for the two modelled scenarios. As would be expected, exceedances of the limits are observed for dustfall rates, PM_{10} and $PM_{2.5}$ concentrations mostly along the south-eastern and north-eastern sections of the boundary, due to the influence of prevailing west-northwesterly and north-westerly winds and high topographical features north-west and west-southwest of the proposed mine, impacting on dispersion of pollutants towards the north-easterly and south-easterly directions.

Table 6-19: Summary of Predicted Maximum Modelled Incremental Concentrations at the boundary of the proposed mine – Construction Phase.

POLLUTANT	AVERAGING TIME	MAXIMUM MODELLED CONCENTRATION ($\mu g/m^3$) [3]	COMPLIANCE AIR QUALITY STANDARD ($\mu g/m^3$)
Proposed Newcastle Coal Mine			
Dustfall	Daily	>1 200	1200[1 & 2]
PM_{10}	Daily	>75	75
	Annual	>40	40
$PM_{2.5}$	Daily	105	40
	Annual	14.55	20

Notes:
1. Dustfall given in $mg/m^2/day$.
2. Non-residential area dustfall standard.
3. Along the north-eastern, south-eastern and eastern proposed mine boundaries.

Table 6-20: Summary of Predicted Maximum Modelled Incremental Concentrations at the boundary of the proposed mine – Operational Phase.

POLLUTANT	AVERAGING TIME	MAXIMUM MODELLED CONCENTRATION ($\mu g/m^3$) [3]	COMPLIANCE AIR QUALITY STANDARD ($\mu g/m^3$)
Proposed Newcastle Coal Mine			
Dustfall	Daily	>1200	1200[1 & 2]
PM_{10}	Daily	>75	75
	Annual	>40	40
$PM_{2.5}$	Daily	>40	40
	Annual	>20	20

Notes:
1. Dustfall given in $mg/m^2/day$.
2. Non-residential area dustfall standard.
3. Along the north-eastern, south-eastern and eastern proposed mine boundaries.

6.3.4. Cumulative Impacts

Emissions from sources need to be assessed in terms of the cumulative impacts in an area. The *Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014),* outlines the following for sources not influenced by background concentrations in isolated areas and non-priority areas:

- For annual averages, the highest predicted concentration (C_P) must be less than the NAAQS, no exceedances allowed;
- For short-term averages (24 hours or less), the 99th percentile concentrations must be less than the NAAQS. Whenever one year is modelled, the highest concentrations shall be considered.

The Newcastle Coal Mine is a proposed facility thus the modelled emissions do not yet contribute to background concentrations. Maximum predicted concentrations at nearby sensitive receptors (within 20km) of the proposed mine boundary are given in Table 6-15 to Table 6-18 above for the construction and operational phases of the proposed mine. Predicted dustfall rates, and $PM_{2.5}$ and PM_{10} concentrations decrease as you move further away from the emission source. Thus, cumulative impacts for these pollutants will be higher nearer to the planned area of construction and proposed mine/crushing and screening plant's operations.

6.3.5. Impact Analysis

The level of impact of surface mining activities associated with the proposed mine is assessed using the methodology in Table 6-21 and summarised in Table 6-22 and Table 6-23 for the construction and operational phases of the proposed mine, respectively. Based on the modelled emission sources, the overall impact is identified to result in low to medium and medium negative impacts during construction and operation, respectively, if strict mitigation measures are implemented.

Table 6-21: Description of Terms for the Impact Rating System.

<table>
<tr><td colspan="3">Extent = E (The area over which the proposed impact will be experienced).

5: International
4: National
3: Regional
2: Local
1: Site</td><td colspan="3">Reversibility = R (The degree to which the proposed impact can be reversed upon completion of the proposed development/ activity).

4: Irreversible
3: Barely Reversible
2: Partly Reversible
1: Completely Reversible</td></tr>
<tr><td colspan="6">Status of Impact
+: Positive (A benefit to the receiving environment)
N: Neutral (No cost or benefit to the receiving environment)
-: Negative (A cost to the receiving environment)</td></tr>
<tr><td colspan="3">Magnitude = M (The severity of the proposed development/activity).
5: Very high/ don’t know
4: High
3: Moderate
2: Low
1: Minor
0: Not applicable/none/negligible</td><td colspan="3">Duration = D (The timeframe for which the proposed impact will be experienced).
5: Permanent
4: Long-term (ceases with the operational life)
3: Medium-term (5-15 years)
2: Short-term (0-5 years)
1: Immediate
0: Not applicable/none/negligible</td></tr>
<tr><td colspan="3">Probability = P (The likelihood / degree of certainty of the proposed impact occurring).
5: Definite/don’t know
4: Highly probable
3: Medium probability
2: Low probability
1: Improbable</td><td colspan="3">Cumulative Effect = C (The impact of the proposed development/ activity on the environmental parameter being assessed when added to other existing or potential impacts).
4: High Cumulative Impact
3: Medium Cumulative Impact
2: Low Cumulative Impact
1: No Cumulative Impact
0: Not applicable</td></tr>
<tr><td colspan="3">Loss of Resources = L (The degree to which a given resource will be lost as a result of the proposed development / activity.)
4: Complete Loss of Resources
3: Intermediate Loss of Resources
2: Low loss of resources
1: No Loss of resources</td><td colspan="3"></td></tr>
<tr><td colspan="6">Significance will be determined through the Rayten methodology for determining significance. Significance will be determined through a synthesis of the assessed impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + loss of resources+ duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.</td></tr>
<tr><td colspan="2">Significance</td><td colspan="2">Environmental Significance Points</td><td colspan="2">Colour Code</td></tr>
<tr><td colspan="2">Low (negative)</td><td colspan="2">>-30</td><td colspan="2">L</td></tr>
<tr><td colspan="2">Medium (negative)</td><td colspan="2">-30 to -90</td><td colspan="2">M</td></tr>
<tr><td colspan="2">High (negative)</td><td colspan="2">>-90</td><td colspan="2">H</td></tr>
</table>

Table 6-22: Rating of Air Quality Impacts associated with mining activities at the proposed mine – Construction Phase.

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION										RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION									
			E	P	R	L	D	C	M	TOTAL	STATUS	SP		E	P	R	L	D	C	M	TOTAL	STATUS	SP
AREAS: 1. Proposed Mining Area																							
CONSTRUCTION PHASE ACTIVITIES: 1.Heavy construction activities (Pit 1, stockpile areas & storm water managemnet systems)																							
Air Quality: Construction Phase																							
Dustfall - 24H	1	1	2	4	3	2	2	3	2	32	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	2	2	1	14	-	L
PM10 - 24H	1	1	2	4	3	2	2	3	3	48	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	2	3	2	30	-	M
PM10 - annual	1	1	2	4	3	2	2	3	2	32	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	2	2	1	14	-	L
PM2.5 - 24H	1	1	2	4	3	2	2	3	2	32	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	2	2	1	14	-	L
PM2.5 annual	1	1	2	4	3	2	2	2	2	30	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	2	2	1	14	-	L

Table 6-23: Rating of Air Quality Impacts associated with mining activities at the proposed mine – Operation Phase.

Impacts associated with 3-Pit Option.

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION										RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION									
			E	P	R	L	D	C	M	TOTAL	STATUS	SP		E	P	R	L	D	C	M	TOTAL	STATUS	SP
AREAS: 1. Proposed Opencast Mining Area (3-Pit Option)																							
OPERATIONAL PHASE ACTIVITIES: 1. Material handling (Excavator loading activities, material transfer.) ; 2. Wind erosion exposed areas (stockpiles, open pits, exposed areas); 3. Vehicle dust entrainment on haul roads; 4. Truck loading & offloading operations; 5. Bulldozing activities; 6. Drilling & Blasting; 7. Crushing & Screening.																							
Air Quality: Operational Phase																							
Dustfall - 24H	1	1-6	2	4	3	3	3	4	3	57	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	2	32	-	M
PM10 - 24H	1	1-6	2	4	3	4	3	4	5	100	-	H	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	3	3	3	4	68	-	M
PM10 - annual	1	1-6	2	4	3	3	3	4	4	76	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	3	48	-	M
PM2.5 - 24H	1	1-6	2	4	3	3	3	4	4	76	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	3	48	-	M
PM2.5 annual	1	1-6	2	4	3	3	3	4	3	57	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	2	32	-	M

Impacts associated with 5-Pit Option

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION										RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION									
			E	P	R	L	D	C	M	TOTAL	STATUS	SP		E	P	R	L	D	C	M	TOTAL	STATUS	SP
AREAS: 1. Proposed Opencast Mining Area (5-Pit Option)																						
OPERATIONAL PHASE ACTIVITIES: 1. Material handling (Excavator loading activities, material transfer.) ; 2. Wind erosion exposed areas (stockpiles, open pits, exposed areas); 3. Vehicle dust entrainment on haul roads; 4. Truck loading & offloading operations; 5. Bulldozing activities; 6. Drilling & Blasting; 7. Crushing & Screening.																						
Air Quality: Operational Phase																						
Dustfall - 24H	1	1-6	2	4	3	3	3	4	3	57	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	2	32	-	M
PM10 - 24H	1	1-6	2	4	3	4	3	4	5	100	-	H	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	3	3	3	4	68	-	M
PM10 - annual	1	1-6	2	4	3	3	3	4	4	76	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	3	48	-	M
PM2.5 - 24H	1	1-6	2	4	3	3	3	4	4	76	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	3	48	-	M
PM2.5 annual	1	1-6	2	4	3	3	3	4	3	57	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	2	32	-	M

Impacts associated with 2-Pit Option

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION										RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION									
			E	P	R	L	D	C	M	TOTAL	STATUS	SP		E	P	R	L	D	C	M	TOTAL	STATUS	SP
AREAS: 1. Proposed Opencast Mining Area (2-Pit Option)																						
OPERATIONAL PHASE ACTIVITIES: 1. Material handling (Excavator loading activities, material transfer.) ; 2. Wind erosion exposed areas (stockpiles, open pits, exposed areas); 3. Vehicle dust entrainment on haul roads; 4. Truck loading & offloading operations; 5. Bulldozing activities; 6. Drilling & Blasting; 7. Crushing & Screening.																						
Air Quality: Operational Phase																						
Dustfall - 24H	1	1-6	2	4	3	2	3	3	2	34	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	2	2	30	-	M
PM10 - 24H	1	1-6	2	4	3	4	3	4	5	100	-	H	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	3	3	3	4	68	-	M
PM10 - annual	1	1-6	2	4	3	3	3	3	3	54	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	3	48	-	M
PM2.5 - 24H	1	1-6	2	4	3	3	3	3	3	54	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	3	3	48	-	M
PM2.5 annual	1	1-6	2	4	3	2	3	3	2	34	-	M	Dust mitigation measures (refer to section 7 of the AQIA report)	2	4	2	2	3	2	2	30	-	M

6.4. Assumptions, Limitations and Exclusions

The key assumptions, limitations and exclusions of the study are given below:

Assumptions

- Mining activity at the 7 pits of the proposed mine will occur in sequence (starting at Pit 1), as per the planned mining schedule, and not all seven pits will be open at any given time. However, given the variable coal qualities, it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site, to meet the required product qualities. Thus, 3 multi-pit mining options were considered in the assessment (i.e. Pits 1 to 3: located closest to the Newcastle area; Pits 2 to 6: maximum Pit combination proposed for Year 9; and Pits 5 & 6: to represent minimum pit combination, with one of the Pits (i.e. Pit 5) located nearest to receptors within the proposed mine boundary).
- Data/information provided by the client and used as input into the model were assumed to be accurate and complete at the time of modelling;
- Construction was assumed to occur during the day for 10 hours a day for 7 days a week, 365 days a year, based on information provided by the client.
- Construction will be done using a phased approach and was thus assumed to take place mainly over areas designated for surface infrastructure associated with Pit 1 (including the access roads, storm water management infrastructure, overburden dump areas, etc). Thus, a total of 8 different areas/sections were considered for the initial phase of construction.
- All mining activities and plant operations, except bulldozing, drilling, and blasting, were assumed to occur for 24 hours a day for 7 days a week;
- Drilling and blasting were both assumed to occur twice a week (based on operating hours at other similar coal mines) between 08:00 – 16:00 (i.e. for 8 hours a day) and 15:00 – 16:00 (i.e. for 1 hour a day), respectively;
- Bulldozing was assumed to occur for 16 hours a day for 7 days a week (based on operating hours at other similar coal mines);
- A total of 30 drill holes were estimated as information on the number of drill holes were not known at the time of modelling;
- Blasting area size was assumed to be 2 400m^2 (60m x 40m) as information on blast area size was not known at the time of modelling. This was based on blasting area size at a similar mine;
- Material throughputs were based on the information provided by the client and include:
    - A maximum annual production rate of 1,800,000 tonnes of coal from the opencast pits at the proposed mine;
    - A maximum annual production rate of ~19,980, 000 tonnes of overburden from the opencast pits at the proposed mine;
    - An hourly throughput of 205 tonnes of coal tipped into the mobile crushing and screening plant;
    - An hourly throughput of 205 tonnes of coal processed at the crushing and screening units; and
    - A maximum annual production rate of 1,500,000 tonnes of product coal from the crushing and screening plant.
- Mitigation measures that were considered in this study were limited to those confirmed by Minetek Resources and included:

  - water spraying (assumed) on the unpaved haul routes, assumed to achieve 40% control efficiency (i.e. routes from pit area to overburden and product stockpiles);
- The location, dimensions - including maximum heights for stockpile areas, and exact footprints for some of the modelled sources were assumed based on the information provided by client. Where information was not provided or was unknown, assumptions were made;
- Design capacities and models of equipment sources (trucks and excavators) were assumed based on information provided by the client; models and design capacities of bulldozers were assumed.

Limitations

- Detailed information for each emission source is required for input into the model, such as the dimensions, material throughputs, material characteristics and the exact locality of the sources. In some instances, not all these details are known. To account for the emissions, assumptions and estimates were made where necessary.
- The study is limited by the amount of detailed information that could be provided at the time of modelling.
- There was no ambient air quality monitoring data that could be used to determine baseline pollutant concentrations at the project site. Thus, the baseline air quality status at the project area could not be determined. The nearest AQMS to the proposed mine is located at the Newcastle station (~9km east-northeast of proposed mine). However, it appears to be malfunctioning as there was no data recorded over the past few years.

Exclusions

- Activities that are not associated with the project and occur outside the scope of the proposed mine were not included in the assessment. These may include any potential background emission sources. Background sources are excluded as detailed information for these is required for input into the model and is not readily available. Furthermore, the assessment focused on the impact of emissions attributable to emission source activities associated with the proposed mine, specifically.

7. MITIGATION MEASURES

Dust, which also contains the smaller PM_{10} and $PM_{2.5}$ particles, is the main pollutant of concern associated with activities that will be undertaken at the proposed mine. Activities associated with dust emissions are described in more detail in Section 6.1 and include heavy construction, wind erosion from proposed stockpiles and exposed areas, material handling operations, in-pit operations, hauling on unpaved routes, crushing, screening and miscellaneous transfer points.

It is recommended that dust mitigation measures be implemented during the construction and operational phases of the proposed mine. For the construction phase, mitigation measures that can be considered for implementation are described in more detail in Table 7-2 and include vegetative stabilisation, use of wind barriers, limiting the size of areas that need clearing and earth-moving management. For the operational phase, under which relatively high concentrations and dustfall rates are projected, a DMP should be implemented to reduce additional levels in background concentrations at the site.

Measures that can be considered for inclusion in the DMP include vehicle restrictions, reducing the height of material transfer at the crushing and screening plant, enclosure of material transfer points, water sprays during material handling operations, and the use rock armour at large stockpiles prone to wind erosion. Further, the DMP must be reviewed and updated on an annual basis. These measures and their efficiency for reduced dust emissions are summarised in Table 7-1. In addition, a summary of recommendations and monitoring requirements for the proposed mine (including the crushing and screening plant) for the operational phase is given in Table 7-3. It is further recommended that the proposed mine undertake monthly dustfall monitoring and continuous (daily) PM_{10} monitoring during the operational phase (due to the high dustfall rates and PM_{10} concentrations projected). Dustfall monitoring before operation is also recommended to determine baseline conditions.

The recommendations provided below in Table 7-1 and Table 7-3 are only briefly outlined within a general context and should be considered depending on affordability and feasibility.

Table 7-1: Common dust control measures for mining activity and associated control efficiencies (%) (taken from NPI, 2012).

SOURCE	RECOMMENDED CONTROL MEASURES	CONTROL EFFICIENCY (%)
Offloading trucks	Water sprays	70
Loading stockpiles	Variable height stacker	25
	Water sprays	50
	Telescopic chute with sprays	75
	Total enclosure	99
Unloading from stockpiles	Water Sprays	50
	Wind breaks	30
Loading to trains/rail wagons	Enclosure	70
	Enclosure and use of fabric filters	99
Miscellaneous transfer and conveying	Water sprays with chemicals	90
	Enclosure	70
	Enclosure and use of fabric filters	99
Hauling	Level 1 watering (2 litres/m^2/hr)	50
	Level 2 watering (>2 litres/m^2/hr)	75
	Sealed or salt encrusted roads	100
Wind erosion from stockpiles	Water sprays	50
	Wind breaks	30
	Total enclosure	99
	Rock armour and/or topsoil applied	30
Wind erosion	Primary rehabilitation	30
	Secondary rehabilitation	60
	Vegetation	40

	Re-vegetation	90
	Fully rehabilitated	100

In terms of ambient air quality monitoring, recommended dust bucket and PM_{10} monitoring locations are provided in Figure 7-1.

7.1. Recommendations for Dustfall and PM_{10} Monitoring

In terms of the Draft National Dust Control Regulations, monthly dustfall monitoring should be undertaken using the ASTM D1739-98 (reapproved 2017) method. This method prescribes that, for each region to be surveyed, a minimum of four (4) sampling sites shall be provided.

Therefore, the following recommendations are made:

- It is recommended that any dust buckets installed should have wind shields attached, in accordance with the specifications provided;
- Where possible and practical, dust buckets should not be installed within 20m of structures higher than 1m;
- The stand for the container should hold the top of the container at a height of 2m above ground;
- Prevailing winds are from the west-northwest and north-west, and the dispersion model output plots show dispersion towards the south-eastern and north-eastern quadrants. Therefore, it is recommended that:
    - At least one bucket be placed south-east and north-east of the proposed mining area to accommodate for these two (2) principal wind directions;
    - At least one bucket be placed east, north, south and west of the proposed mining area to accommodate for these four (4) principal wind directions;
    - At least one bucket be placed near DR39 (DJ Browning Farming - Craig Farm, Thornhill Country Estate), which is located inside the application area, to monitor dustfall rates at this receptor, depending on accessibility of monitoring sites.
    -

In terms of PM_{10} monitoring, it is recommended that a PM_{10} monitoring station be placed downwind of the proposed mining activities, east of the proposed mining area.

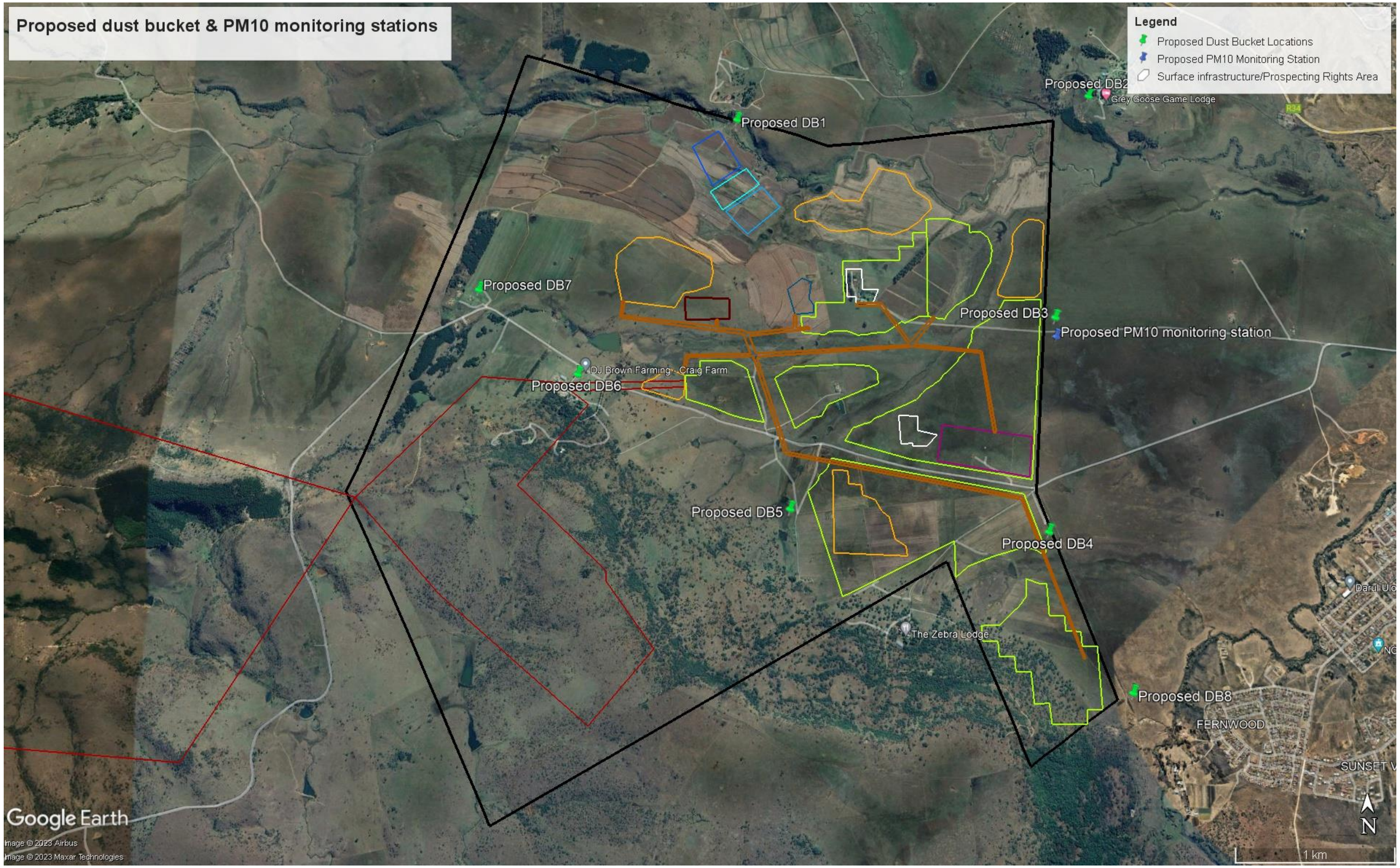


Figure 7-1: Proposed siting of dust buckets and PM_{10} monitoring stations for the proposed operations at Newcastle Coal Mine.

Table 7-2: Dust control measures for construction (Department of Environment and Conservation, 2011).

<table>
<tr><th>DUST CONTROL MEASURE</th><th>DESCRIPTION</th></tr>
<tr><td>Limit Cleared Areas</td><td>Before the commencement of any site works and during the operation, as much vegetation as possible should be retained, including patches and strips to minimise dust. Dust emissions can be controlled using the following procedures:
Before any site works commence, plan and locate the vegetation cover that needs to be retained;
Protect this vegetation by fencing or blocking off from the rest of the site operations;
In other areas, maintain the original vegetation cover for as long as possible;
Avoid clearing the entire site at once, instead clear areas as required in stages of the operation.
Retaining the original trees, shrubs and grasses is one of the most efficient and effective ways of minimising dust emissions. Even low or sparse vegetation can be very effective at dissipating wind velocity at the ground surface, where dust lift off occurs.</td></tr>
<tr><td>Vegetative Stabilisation</td><td>Vegetation is a very effective form of reducing dust emissions. The following procedures should be considered in minimising dust emissions:
Retain as much existing vegetation as possible;
If an area needs to be cleared, transplant established plants that must be disturbed to areas that need vegetation;
If existing vegetation must be removed and cannot be immediately transplanted elsewhere, remove and maintain them for replanting at project completion. If trees and plants must be removed and it is not possible for them to be replanted, consider chipping and using the material as mulch – the advantage is that reseeding of original vegetation can occur. Where possible, restore vegetation that is native to the area to maximise plant success and improve environmental conditions.</td></tr>
<tr><td>Timing of Development</td><td>Activities with high dust-causing potential, such as topsoil stripping, should not be carried out in sensitive areas during adverse wind conditions.</td></tr>
<tr><td>Wind Barriers</td><td>Having appropriate wind barriers can be an effective measure for the control of dust over short distances. Wind barriers provide protection against the movement and impact of dust on nearby land uses.

Wind barriers should be placed on site before commencement of works and when it is apparent that one is required during the phase of the operation. Consider the following options when placing barriers to prevent dust emissions:
Wind barriers are most effective when placed perpendicular to the direction of the prevailing wind, but will have little or no effect when the wind direction is parallel to the fence;
When choosing wind barriers, it has been observed that solid barriers provide significant reductions in wind velocity for relatively short leeward distances, whereas porous barriers provide smaller reductions in velocity for more extended distances;
Wind barriers should be at least 2 metres high;
The screening material should have a porosity of 50% or less.</td></tr>
</table>

Earth Moving Management	Earth-moving works have the potential to generate large amounts of dust. Planning earth-moving works particularly at the start of an operation can reduce dust emissions by limiting the time the site is exposed. Options for dust control can include the following: • Plan earth-moving works so that they are completed just prior to the time they are needed; • Observe weather conditions and do not commence or continue earth moving works if conditions are unsuitable e.g., under conditions of strong winds; • Pre-water areas to be disturbed.

Table 7-3: Summary of recommendations and monitoring requirements.

POLLUTANT	ACTIVITIES	MITIGATION MEASURE	MONITORING PROGRAM			
			MONITORING	TIMEFRAME (✓ = yes) (X = no)		
				Pre - operation	During - operation	Post – operation
Fugitive Dust – dustfall, PM_{10} & $PM_{2.5}$	Material handling operations; exposed areas, stockpiles/dumps, mining activity (excavators, etc.); truck loading and offloading operations; drilling, blasting, bulldozing and miscellaneous/conveyor transfer points.	The following dust mitigation measures can be considered at the proposed mine (including the crushing and screening plant) to reduce dust emissions associated with proposed coal mining activity: ▪ Reduce height of material transfer at the crushing and screening plant (e.g. miscellaneous/conveyor transfer points). ▪ Water sprays for material handling operations (e.g. wet material before conveying/transferring coal and while offloading trucks). ▪ Water sprays for drilling, blasting and bulldozing activities. ▪ Water sprays for stockpiles and material storage areas. ▪ Wind breaks at coal storage areas that are prone to dust emissions. ▪ Use of vegetation, topsoil and/or rock armour on large stockpiles and dumps that are prone to wind erosion.	Monthly dustfall monitoring and reporting as per the National Dust Control Regulations is required. As PM_{10} concentrations are predicted to be high for the operational phase, the proposed mine should undertake continuous (daily) PM_{10} monitoring upon commencement of mining operations.	✓ For dustfall (monthly) (required to determine baseline dustfall rates)	✓ For dustfall (monthly) & PM_{10} (daily)	X (not required if mining areas are fully rehabilitated)

		▪ Partial or full enclosure of conveyor/miscellaneous material transfer points. ▪ Regular cleaning and sweeping of plant areas to prevent the accumulation of dust on surfaces. ▪ Regular maintenance of plant equipment, including dust suppression equipment such as water sprays, to ensure the equipment is operating properly. ▪ Immediate clean-up of any material (i.e. coal, waste rock/overburden and topsoil) spillages. ▪ Conduct regular site inspections to ensure the dust mitigation measures are being implemented. Regular visual site inspections are recommended to assess whether further mitigation is required for any of the dust emission sources. A DMP must also be compiled and strictly implemented for the proposed mine for onsite activities during the operational phase. The DMP must include feasible and appropriate mitigation measures as described in Table 7-1 above for all key dust emission sources during the operational phase.				
Fugitive Dust – dustfall, PM_{10} & $PM_{2.5}$ **& Gases**	Vehicle dust entrainment, truck exhaust emissions and any other mining vehicle/equipment exhaust emissions	▪ Have clearly defined hauling routes/vehicle access areas. These areas should preferably be paved (e.g. using surface coating such as bitumen), where possible or treated for dust suppression. ▪ All main hauling roads should be treated for dust suppression (water spraying and chemical dust suppressants). ▪ Conduct regular cleaning/sweeping of paved road surfaces to prevent the accumulation of dust.	Monthly dustfall monitoring and reporting as per the National Dust Control Regulations is required. As PM_{10} concentrations are predicted to be high for the operational phase, the proposed mine should undertake continuous (daily) PM_{10}	✓ For dustfall (required to determine baseline dustfall rates)	✓ For dustfall & PM_{10}	X (not required if mining areas are fully rehabilitated)

		▪ Conduct regular maintenance and checks for haul road surfaces. ▪ Immediate clean-up of any spillage. ▪ All material that is being transported should be covered during transport (where possible). ▪ Control the number of trucks on the road, weight of trucks and the travelling speed. Implement strict vehicle speed limits (e.g. 20-40 km/h). ▪ Switch off engines whilst not in use; ▪ Establish a maintenance schedule to ensure proper maintenance of the trucks & mobile equipment; ▪ Conduct regular maintenance and quality checks (engines/tyres) for all heavy mobile equipment/trucks.	monitoring upon commencement of mining operations.			

7.2. Summary and Conclusions

Rayten Engineering Solutions (Pty) Ltd was appointed by Cabanga Environmental to compile an Air Quality Impact Assessment report (AQIAr) for the proposed Newcastle Coal Mine (hereafter referred to as “the proposed mine”, proposed by Minetek Resources (Pty) Ltd, and located approximately 5km west of the town of Newcastle, within the Amajuba District Municipality, in the KwaZulu-Natal (KZN) Province.

Mining at the proposed mine will comprise of an initial open pit mining component on the eastern portion, and a future underground mining component on the western portion of the Application Area. Opencast mining will be by means of conventional truck and shovel operations, with concurrent rehabilitation during the operational phase by means of the roll over method. Run of Mine (ROM) will be transported via trucks to in-pit ROM stockpiles, with the option of using conveyors also a considered alternative, and then processed at a mobile and in-pit crushing and screening plant, before being transported via haulage or conveyor to the product stockpile area. Product coal will either be sold or transported offsite (via road-trucks or via a proposed conveyor system) for further processing before being sold. The offsite processing will take place under toll-washing agreements with existing coal washing plants in the area. Environmental Authorisation (EA) is required for the proposed mining operations, with an Environmental Impact Assessment (EIA) process currently underway to obtain the EA. This AQIAr has been compiled as a supporting document for the EA application process for the proposed mine.

The main objective of the AQIA is to determine the potential impact of emissions associated with the operational activities at the proposed mine on ambient air quality in terms of dustfall, PM_{10} and $PM_{2.5}$.

As part of the AQIA, a baseline air quality assessment was undertaken to determine the following:

- the prevailing meteorological conditions at the site;
- baseline concentrations of key air pollutants of concern;
- identify existing sources of emissions; and
- identify key sensitive receptors surrounding the project site.

The land use immediately surrounding the proposed mine consists mostly of cultivated land, grassland, and forested land. Additionally, built-up areas, mines and quarries, barren land, waterbodies and wetlands occupy part of the land use within a 20km radius, but to a minimal extent. Barren land, waterbodies and wetlands are scattered in surrounding areas, while mines and quarries and built-up areas are in localised areas north-northeast to south-east of the proposed mine. The larger area surrounding the project site is classified as rural in nature. Few existing key sources of air pollution surrounding the proposed mine were identified during a desktop exercise and include:

- Agricultural activity (seasonal) and potential biomass burning (surrounding areas);
- Vehicle dust entrainment on unpaved roads (surrounding areas); and
- Planted forest/Plantations (mainly south-west and north-west of proposed mine).

MM5 meteorological data for the project area for the period 01 January 2020 – 31 December 2022 was used for input into the dispersion model and to determine prevailing meteorological conditions for the project site. Based on the prevailing wind fields for the period January 2020 to December 2022, emissions from activities at the proposed mine will likely be transported towards the south-easterly quadrant. Higher topographical features located north-west and west-southwest of the proposed mine could also enhance the dispersion of emissions impacting on nearby areas located south-east and north-east of the proposed mine, as evident in the dispersion model plots in Sections 6.3.1 and 6.3.2. Moderate to fast wind speeds observed during all the time periods, may result in effective dispersion and dilution of emissions from the proposed mining operations; however, higher winds speeds can also facilitate fugitive dust emissions from open exposed areas such as stockpiles and opencast areas. Removal of particulates via wet depositional processes would be evident during the warmer (wet) seasons (spring – early autumn), thus, lower ambient concentrations of dust could be expected during these seasons. Over the remainder of the year higher ambient concentrations of particulates could be expected.

The existing air quality situation is usually evaluated using available monitoring data from nearby government owned air quality monitoring stations (AQMS), which are accessible via the online South African Air Quality Information System (SAAQIS) portal. The nearest AQMS to the project site is located at the Newcastle station (-27.734167°S, 29.980139°E), located ~9km east-northeast of the proposed mine. However, there was no ambient air quality monitoring data available from the station as it appears to be malfunctioning, with no data recorded over the past few years. Thus, the baseline air quality status at the project area could not be determined. Moreover, dustfall data could not be provided in this AQIA report as there are no available dustfall networks operated near the project site, that could be determined.

The main conclusions of the AQIA for the project can be summarised as follows:

Dustfall, PM_{10} and $PM_{2.5}$ are key pollutants of concern associated with operations at the proposed mine and will be emitted from the following key sources:

Particulate Emissions:
- Construction activity;
- Drilling and blasting at the opencast pits;
- Bulldozing;
- Material handling operations (truck loading/offloading operations);
- Miscellaneous/conveyor transfer points;
- Crushing and screening;
- Wind erosion from exposed areas: the opencast pits, exposed surfaces and material stockpiles;
- Excavators (loading dump trucks at pit area, loading crusher at mobile plant, loading off-site haulage trucks; and
- Vehicle dust entrainment on unpaved roads.

Two scenarios were modelled in this assessment, i.e:
c) The **construction phase scenario**, where emissions associated with construction activity (e.g., establishment of access and haul roads, setting out material stockpile areas, construction of pollution control dams, etc) due to the development of infrastructure associated with the proposed mine, were modelled.
d) The **actual operating scenario**, where emissions from surface mining activities associated with operations at the proposed mine were modelled. This scenario represents the potential impacts if the proposed mine were emitting under normal operating conditions and considered 3 multi-pit

mining options (i.e. i.e. Pits 1 to 3: located closest to the Newcastle area; Pits 2 to 6: maximum Pit combination proposed for Year 9; and Pits 5 & 6: to represent minimum pit combination, with one of the Pits (i.e. Pit 5) located nearest to receptors within the proposed mine boundary), since it is likely that more than one pit will have to be open simultaneously, to allow for blending of different coal qualities on site.

Both scenarios were modelled without mitigation since limited information on planned mitigation measures was known at the time of modelling. This also represents the worst-case scenario.

Based on the dispersion model output plots for the construction phase, predicted incremental dustfall rates, PM_{10} and $PM_{2.5}$ concentrations are moderately high but mostly in compliance with the applicable limits over the project area (i.e. area within the 20km x 20km modelling domain), especially for dustfall, $PM_{2.5}$ and annual PM_{10}, for which predicted concentrations at offsite locations in nearby surrounding areas are only projected to exceed the applicable limits just outside the eastern mine boundary, but within a maximum radius of 300m. Inside the proposed mine boundary, predicted concentrations for the same pollutants fall well below the standards, except at localised areas near the planned areas of construction activity where exceedances are observed. For daily PM_{10}, while predicted incremental concentrations fall below the daily standard of 75 $\mu g/m^3$ over most of the project area, higher concentrations, including exceedances of the standards are projected over a wider area inside the mine boundary, and at offsite locations north-east and south-east of the proposed mine, within a maximum radius of 2.3km. It is noted that all exceedances predicted under the construction phase are without mitigation.

For the operational phase, predicted incremental dustfall rates and PM (PM_{10} and $PM_{2.5}$) concentrations are higher than those projected under the construction phase, but still comply with applicable standards over most of the project area modelled for dustfall, $PM_{2.5}$ and annual PM_{10}. While exceedances are projected outside the mine boundary for the same pollutants (dustfall, $PM_{2.5}$ and annual PM_{10}), they are mostly restricted to offsite areas located south-east and north-east of the proposed mine, within maximum radii of 2.3km, 3.7km and 2.6km for dustfall, $PM_{2.5}$, and annual PM_{10}, respectively. Predicted incremental daily PM_{10} concentrations are relatively high, with exceedances of the daily standard extending from the mine boundary to offsite areas up to 10.7km towards the south-east and north-east. All exceedances predicted under the operational phase are without mitigation. Inside the proposed mine boundary, exceedances of the standards are also observed for the modelled pollutants and are mostly localised near to the proposed surface mining activities (open pits, drilling, blasting, loading/offloading operations, haul routes, material stockpile areas, transfer points and proposed material stockpile/exposed areas) for dustfall and annual $PM_{2.5}$, which contrasts with the larger spatial extent projected in PM_{10} (daily and annual) and daily $PM_{2.5}$ exceedances. However, it should be noted that the projected exceedances are without mitigation.

Among the three multi-pit mining options considered for the operational phase, the options involving 3 Pits and 5 Pits generally resulted in higher maximum predicted concentrations compared to the option involving 2 Pits, as seen in the isopleth plots in Section 6.3.2 . The spatial extent of exceedances projected outside the north-eastern and south-eastern proposed mine boundaries (without mitigation) is also indicated to be greater for the 3 Pit and 5 Pit options, and lesser for the 2 Pit option. The offsite exceedances are projected within specific radii indicated below:

- 2 Pit option – 855m (for dustfall), 2.2km (for daily $PM_{2.5}$), 1.4km (for annual PM_{10}) and 7.3km (for daily PM_{10}), with annual $PM_{2.5}$ exceedances restricted to a small portion of the proposed eastern mine boundary.
- 5 Pit option – 2.3km (for dustfall), 850m (for annual $PM_{2.5}$), 3.6km (for daily $PM_{2.5}$), 2.3km (for annual PM_{10}), and 9.3km (for daily PM_{10}).
- 3 Pit option – 2.3km (for dustfall), 1.3km (for annual $PM_{2.5}$), 3.7km (for daily $PM_{2.5}$), 2.6km (for annual PM_{10}), and 10.7km (for daily PM_{10}).

Nearby sensitive receptors located within a 20km radius from the proposed mine boundary are not indicated to be impacted by the projected exceedances under the construction phase, since predicted concentrations mostly fall below the dustfall and PM standards, except at DR1 (dwellings just outside the northern mine boundary) where an exceedance of the daily PM_{10} standard is projected. Under the operational phase, several discrete receptors downwind of the project site, i.e. within a 10.7km radius south-east and north-east of the proposed mine (mostly schools and residential areas in Newcastle) are indicated to be mostly impacted by predicted exceedances in daily PM_{10} concentrations, and could thus be at high risk under the unmitigated scenario. Receptors located south-west and north-west of the proposed mine are likely to experience low concentrations of all modelled pollutants.

As dust, which also contains the smaller PM_{10} and $PM_{2.5}$ particles, is the key pollutant of concern associated with activities at the proposed mine, it is recommended that dust mitigation measures be implemented. For the construction phase, mitigation measures that can be considered for implementation are described in more detail in Section 7 of this report and include vegetative stabilisation, use of wind barriers, limiting the size of areas that need clearing and earth-moving management. For the operational phase, under which relatively high concentrations and dustfall rates are projected (i.e. without mitigation), a dust management plan (DMP) should be implemented to reduce additional levels in background concentrations at the site. Measures that can be considered for inclusion in the DMP include vehicle restrictions, reducing the height of material transfer at the crushing and screening plant, enclosure of material transfer points, water sprays during material handling operations, and the use rock armour at large stockpiles prone to wind erosion (refer to Section 7 of report). Further, the DMP must be reviewed and updated on an annual basis. It is further recommended that the proposed mine undertake monthly dustfall monitoring and continuous (daily) PM_{10} monitoring during the operational phase. Dustfall monitoring before commencement of operations is also recommended to determine baseline conditions.

In conclusion, the dispersion modelling results (i.e. without mitigation) indicate relatively high daily dustfall rates and PM (PM_{10} and $PM_{2.5}$) concentrations for the operational phase of the proposed mine, with exceedances of the applicable standards at offsite locations projected towards the north-east and south-east, within maximum radii of 2.3km, 3.7km and 10.7km for dustfall, $PM_{2.5}$ and PM_{10}, respectively. In contrast, comparatively lower incremental dustfall rates, and PM concentrations are projected for the construction phase. However, exceedances are still projected at offsite locations just outside the eastern mine boundary within a 300m radius (for dustfall, $PM_{2.5}$ and annual PM_{10}), as well as outside the north-eastern and south-eastern mine boundaries for daily PM_{10}. Discrete receptors located south-east and north-east of the proposed mine are indicated to be most impacted by emissions from the proposed mine. Furthermore, a total of 22 receptors are projected to fall within the domain of projected exceedances for daily PM_{10}, while only four receptors are indicated to be impacted by exceedances projected for dustfall, $PM_{2.5}$ and annual PM_{10} for the different multi-pit options considered in this assessment (Table E1).

Table E1: Discrete receptors located within the domain of projected exceedances for dustfall, $PM_{2.5}$ and PM_{10} (operational phase).

Discrete Receptor ID	Discrete Receptor Name	Multi-Pit Option		
		3-Pits	5-Pits	2-Pits
	Dustfall			
DR3	Dwellings (Zebra Lodge)		x	
DR41	Residential Area (Fernwood, Sunset View)		x	
	Daily $PM_{2.5}$			
DR7	Residential Area (Lennoxton)		x	
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	
DR41	Residential Area (Fernwood, Sunset View)	x	x	
	Annual $PM_{2.5}$			
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x		
DR41	Residential Area (Fernwood, Sunset View)	x	x	
	Daily PM_{10}			
DR1	Dwellings (farm workers'houses)	x	x	
DR3	Dwellings (Zebra Lodge)		x	
DR4	Dwellings (Game Goose Game Lodge)	x		x
DR7	Residential Area (Lennoxton)	x	x	x
DR8	Residential Area (Newcastle CBD & Newcastle Central)/Edu (unknown)	x	x	x
DR9	Residential Area (Arbor Park, Equarand,Vlam)	x	x	
DR10	Residential Area (Newcastle CBD)/Edu (unknown)	x	x	x
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	x
DR12	Residential Area (Hennenman)	x		x
DR14	Residential Area (Pioneer Park)	x		x
DR16	Educational Facility (unknown)	x		x
DR17	Educational Facility (Ferum High school)	x		x
DR18	Educational Facility (Majuba TVET College)	x	x	x
DR19	Residential Area (Barry Hertzog Park)	x		

DR20	Residential Area (Amajuba Park)	x		
DR21	Educational Facility (Amajuba School, Newcastle Training Centre, Majuba FETC)	x		
DR22	Residential Area (Sunnyridge)			x
DR24	Residential Area (Ncandu Park)/Edu (Hope High School)	x		
DR39	Dwellings (Thornhill Country Estate)			x
DR40	Dwellings (unknown)			x
DR41	Residential Area (Fernwood, Sunset View)	x	x	x
DR42	Residential Area (Sunset View, Fairleigh, Gandhi Park)	x	x	x
	Annual PM_{10}			
DR11	Residential Area (Sury Avile)/Edu (St Dominics)	x	x	
DR41	Residential Area (Fernwood, Sunset View)		x	

Should the proposed development go ahead, the implementation of dust mitigation measures summarised above (and detailed in Section 7 of this report) during construction and operation of the proposed mine is advised, to reduce dust emissions from proposed key emission sources as far as possible, and to reduce the impact on nearby sensitive receptors. Most of the mitigation measures have mitigation potentials/control efficiencies ranging between 25% and 75%, with only a few of the measures being 90 – 100% effective. Thus, should the dispersion model be run again with mitigation, it is likely that lesser concentrations will be predicted. However, the level of emission reduction will depend on the choice of mitigation. But it is noted that mitigation measures will help reduce the impacts at the receptor points.

The proposed development is projected to result in **low to medium and medium negative air quality impacts during construction and operation, respectively, after the implementation of mitigation measures.**

8. REFERENCES

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APPENDIX A

AIR DISPERSION MODELLING CHECKLIST

Table A1: Information Required in Air Dispersion Modelling Report.

Information Required in Plan of Study Report				
Description	**Included (Y/N)**	**Section**	**Page no.**	**Comments**
1. Facility and Modellers Information				
Project Identification Information				
Applicant details	Y	1.1	1	
Facility Identification	Y	1.1	1	
Physical address of facility	Y	1.1	1	Co-ordinates provided
AEL number	N			No AEL required
EIA reference	Y			KZN30/5/1/2/2/10122
Modelling contractors	Y	1.1	1	
Project Background				
Objectives of Baseline Assessment	Y	1.3	4	Terms of reference provided
Process description	Y	1.2	2	
Project Location				
Site layout plan	Y	1.2	3	
Regional map	Y	2	7-10	
Adjacent area map	Y	2	7-10	
Surrounding land use map	Y	2	7-10	
Elevation data (DEM)	Y	2	7-10	
2. Emission Characterisation				
Proposed emissions & source parameters				
All identifiable emissions listed	Y	6.1	31-44	
Parameters for each operating scenario	Y	6.1	31-44	
Proposed emissions calculations	Y	6.1	31-44	
3. Meteorological Data				
Surface Data				
Source of data	Y	5.1	17-18	
Seasonal wind roses	Y	5.1	21	
3-year representative data	Y	5.1	19	
Program used to process data	Y	5.1	17-18	
Description of station	Y	5.1	17-18	
Period of record	Y	5.1	17-18	
Spatial representativeness	Y	5.1	17-18	

Data complies with Code of Practice	Y	5.1	17-18	
Upper Air Data				
Source of data	Y	5.1	17-18	
4. Ambient Impact Analysis and Ambient Levels				
Standard Levels				
National Ambient Air Quality Standards	Y	3.3	12-13	
Background Concentrations				
Background values specified	N			No data
5. Modelling Procedures				
Proposed Model				
Assessment level proposed	Y	6.2.2	45-46	
Dispersion model to be used	Y	6.2.2	45-46	
Supporting models to be used	Y	6.2.2	45-46	
Version of models to be used	Y	6.2.2	45-46	
Proposed Emissions to be Modelled				
Pollutants specified	Y	6.2.2	45-46	
Scenarios to be modelled	Y	6.2.2	45-46	
Conversion factor utilized	N			Not used
Proposed Settings				
Settings to be utilized	Y	6.2.2	45-46	
Terrain settings	Y	6.2.2	45-46	
Land characteristics	Y	6.2.2	45-46	
Grid Receptors				
Property line resolution	Y	6.2.2	45-46	
Fine grid resolution	Y	6.2.2	45-46	
Medium grid resolution	Y	6.2.2	45-46	
Large grid resolution	Y	6.2.2	45-46	
6. Ambient Impact Results Documentation				
Tables of Modelling Results				
Pollutant	Y	6.3.3	65-71	
Averaging time	Y	6.3.3	65-71	
Operating scenario	Y	6.3.3	65-71	
Maximum modelled concentration	Y	6.3.3	65-71	
Receptor location	Y	6.3.3	65-71	
Receptor elevation	Y	6.3.3	65-71	
Date of maximum impact	N			
Name of output e-files	Y	Appendix B	94	
Source Impact Area Figures				
UTM co-ordinates	Y	6.3.1 - 6.3.2	47-64	

Modelled facility	Y	6.3.1 - 6.3.2	47-64	
Topography features	Y	2.3	5 & 9	
Isopleths	Y	6.3.1 - 6.3.2	47-64	
Value of maximum impact	Y	6.3.1 - 6.3.2	47-64	
Value of maximum cumulative impact	N			Proposed site, modelled concentrations do not yet contribute to background concentrations
7. Ambient Impact Supporting Documentation				
Electronic Files				
Electronic files can be provided upon request				
Input & output files for models	Y	Appendix B	97	name of files specified. Soft copies can be provided upon request
Input & output files for pre-processors	Y	Appendix B	97	name of files specified. Soft copies can be provided upon request
Input & output files for post-processors	Y	Appendix B	97	name of files specified. Soft copies can be provided upon request
Digital terrain files	Y			
Plot files	Y	Appendix B	97	name of files specified. Soft copies can be provided upon request
Final report	Y			

APPENDIX B

OUTPUT E-FILES

Table B1: List of output e-files used.

Summary of electronic modelling files				
Output File Number	Output File Name	Description	Date Created	Model
Construction Phase				
1	Newcastle_TSP_Construction	Dispersion modelling E-file for dustfall associated with proposed construction activities	May 2023	AERMOD
2	Newcastle_PM$_{10}$_Construction	Dispersion modelling E-file for PM_{10} associated with proposed construction activities	May 2023	AERMOD
3	Newcastle_PM$_{2.5}$_Construction	Dispersion modelling E-file for $PM_{2.5}$ associated with proposed construction activities	May 2023	AERMOD
Other				
1	Newcastle_TSP_Op	Dispersion modelling E-file for dustfall associated with proposed operational activities	August 2023	AERMOD
2	Newcastle_PM$_{10}$_Op	Dispersion modelling E-file for PM_{10} associated with proposed operational activities	August 2023	AERMOD
3	Newcastle_PM$_{2.5}$_Op	Dispersion modelling E-file for $PM_{2.5}$ associated with proposed operational activities	August 2023	AERMOD
Other				
4	Newcastle_MET	AERMET meteorological data file used for input into AERMOD	May 2023	AERMET

Note: an electronic copy of the modelling files can be provided upon request.

APPENDIX C

SUMMARY OF SOURCE PARAMETERS

Construction Phase

			Dimensions			Coordinates		
Source N	Source ID	Source Description	Length X (m)	Length Y (m)	Release Heights (m	X (m)	Y (m)	Elevation (m)
1	PAREA1	Overburden Dump 1 prep	120	40	0,5	multiple	multiple	1207,18
2	PAREA2	Overburden Dump 1+6 prep	60	40	0,5	multiple	multiple	1281,33
3	ARLN1	haul road 1	60	40		multiple	multiple	
6	ARLN2	haul road 2	240	80		multiple	multiple	
9	PAREA3	Pollution Control Dam	multiple	multiple	0,5	multiple	multiple	1233,93
10	PAREA4	Balancing Dam	multiple	multiple	0,5	multiple	multiple	1225,05
11	PAREA5	Future PCD	multiple	multiple	0,5	multiple	multiple	1235,95
12	AREA1	pre-stripping (Pit 1 prep)	multiple	multiple	0,5	multiple	multiple	1211,40

Operational Phase

			Dimensions			Coordinates		
Source Number	Source ID	Source Description	Length X (m)	Length Y (m)	Release Heights (	X (m)	Y (m)	Elevation (m)
1	OPIT1	Open Pit 1	120	40	13,6	multiple	multiple	1212,010
2	AREA1	drilling	60	40	0,5	multiple	multiple	1213,810
3	AREA2	blasting	60	40	10	multiple	multiple	1212,430
4	AREA3	exposed area (Pit 1)	240	80	0	multiple	multiple	1214,080
5	OPIT2	Open Pit 2	120	40	19,1	multiple	multiple	1235,880
6	AREA4	exposed area (Pit 2)	240	80	0	multiple	multiple	1233,760
7	OPIT3	Open Pit 3	120	40	14,6	multiple	multiple	1222,200
8	AREA5	exposed area (Pit 3)	240	80	0	multiple	multiple	1239,280
9	PAREA1	Overburden Dump 1	multiple	multiple	11,75	multiple	multiple	1207,180
10	PAREA2	Overburden Dump 2 (1+6)	multiple	multiple	17,15	multiple	multiple	1281,330
11	PAREA3	Overburden Dump 3	multiple	multiple	12,9	multiple	multiple	1244,800
12	PAREA4	Product Stockpile	multiple	multiple	2,5	multiple	multiple	1227,700
13	AREA6	dump truck 1 (offload ROM)	10,53	6,49	5,16	784555,60	6927390,87	1212,18
14	AREA7	dump truck 2 (offload ROM)	10,53	6,49	5,16	784556,52	6927371,71	1212,76
15	AREA8	dump truck 1 (offload overburden)	10,53	6,49	5,16	784652,12	6927975,40	1200,94
16	AREA9	dump truck 2 (offload overburden)	10,53	6,49	5,16	784633,00	6927992,39	1200,91
17	AREA10	dump truck 3 (offload overburden)	10,53	6,49	5,16	784608,57	6928000,89	1200,97
18	AREA11	dump truck 4 (offload overburden)	10,53	6,49	5,16	784579,90	6928001,95	1201,23
19	AREA12	dump truck 5 (offload overburden)	10,53	6,49	5,16	784543,78	6928001,95	1201,08
20	AREA13	dump truck 6 (offload overburden)	10,53	6,49	5,16	784509,79	6927992,39	1200,63
21	AREA14	dump truck 7 (offload overburden)	10,53	6,49	5,16	784486,43	6927972,21	1200,35
22	AREA15	dump truck 8 (offload overburden)	10,53	6,49	5,16	784460,94	6927947,78	1200,91
23	AREA16	dump truck 1 (offload crushed coal)	10,53	6,49	5,16	784227,26	6926503,27	1222,87
24	AREA17	dump truck 2 (offload crushed coal)	10,53	6,49	5,16	784149,97	6926513,52	1223,63
25	AREA18	excavator 1 at pit void (load dump truck with ROM)	10,53	6,49	5,17	784562,57	6927354,72	1213,15
26	AREA19	excavator 2 at pit void (load dump truck with ROM)	10,53	6,49	5,17	784549,48	6927354,04	1213,42
27	AREA20	excavator 1 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784531,74	6927354,31	1213,25
28	AREA21	excavator 2 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784512,64	6927354,04	1213,08
29	AREA22	excavator 3 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784491,09	6927353,49	1212,89
30	AREA23	excavator 4 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784467,48	6927352,67	1212,67
31	AREA24	excavator 5 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784461,35	6927403,15	1211,38
32	AREA25	excavator 6 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784485,49	6927402,74	1211,65
33	AREA26	excavator 7 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784505,27	6927402,60	1211,72
34	AREA27	excavator 8 at pit void (load dump truck with overburden)	10,53	6,49	5,17	784527,78	6927402,74	1211,78
35	AREA28	excavator 1 - in pit (load ROM onto primary crusher)	2,8	1,9	3,5	784549,60	6927382,58	1212,49
36	AREA29	excavator 1 (load product onto off-site trucks)	10,89	3,43	3,75	784204,12	6926222,80	1229,12
37	VOL1	load screening unit (ROM)	2	2	4	784540,57	6927383,20	1212,42
38	VOL2	load secondary crusher (ROM)	2	2	3,7	784530,53	6927383,20	1212,37
39	VOL3	load feeder (crushed coal)	2	2	2	784520,27	6927383,20	1212,31
40	VOL4	load dump truck/conveyor (crushed coal)	2	2	5,17	784509,96	6927383,26	1212,26
41	AREA30	primary crusher (in-pit)	2,8	1,9	3,5	784544,76	6927378,35	1212,60
42	AREA31	screening unit (in-pit)	2	2	4	784534,17	6927377,80	1212,55
43	AREA32	secondary crusher (in-pit)	2,5	1,4	3,7	784524,35	6927377,58	1212,50
44	AREA33	x1 bulldozer (stripping vegetation)	60	40	2,12	784477,96	6927131,89	1215,04
45	AREA34	x1 bulldozer (stripping topsoil)	60	40	2,12	784386,40	6927129,47	1215,00
46	AREA35	x1 bulldozer (dozing overburden at pit area)	15	10	2,12	784363,78	6927360,62	1209,73
47	AREA36	x1 bulldozer at overburden stockpile (shaping)	3,9	3,2	2,12	782146,71	6927890,43	1259,64
48	AREA37	x1 bulldozer at overburden stockpile (shaping)	3,9	3,2	2,12	784367,57	6927713,44	1205,23
49	AREA38	x1 bulldozer at ROM stockpile (shaping)	3,9	3,2	2,12	784568,94	6927383,51	1212,24
50	SLINE1	haul road 1 (from pit to OD Dump)	*	*	*	multiple	multiple	*
51	SLINE2	haul road 2 (from pit to product stockpile)	*	*	*	multiple	multiple	*
52	OPIT4	Open Pit D1	120	40	12,05	multiple	multiple	1229,19
53	AREA39	exposed area (Pit D1)	240	80	0	multiple	multiple	1232,45
54	OPIT5	Open Pit 4	120	40	15,2	multiple	multiple	1208,32
55	AREA40	exposed area (Pit 4)	240	80	0	multiple	multiple	1211,01
56	OPIT6	Open Pit 5	120	40	25,45	multiple	multiple	1241,33
57	AREA41	exposed area (Pit 5)	240	80	0	multiple	multiple	1243,59
58	OPIT7	Open Pit 6	120	40	26,75	multiple	multiple	1219,68
59	AREA 42	exposed area (Pit 6)	240	80	0	multiple	multiple	1221,52
60	PAREA5	Overburden Dump 4+6	multiple	multiple	13,35	multiple	multiple	1217,82
61	PAREA6	Overburden Dump 5	multiple	multiple	11,68	multiple	multiple	1259,34