DIGBY WELLS
ENVIRONMENTAL

Dagsoom Twyfelaar Coal Mining Project near Ermelo, Mpumalanga

Air Quality Impact Assessment

Project Number:

DAG5603

Prepared for:

Dagsoom Coal Mining (Pty) Ltd

October 2019

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I, Matthew Ojelede as duly authorised representative of Digby Wells and Associates (South Africa) (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (South Africa) (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (South Africa) (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Dagsoom Coal Mining (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the Air Quality Impact Assessment for the proposed Dagsoom Coal Mining Project, near Ermelo in the Mpumalanga Province.

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EXECUTIVE SUMMARY

Dagsoom Coal Mining (Pty) Ltd (hereinafter Dagsoom) propose to develop an underground coal mine, the Twyfelaar Coal Mine, near Ermelo in the Mpumalanga Province (the Project). Dagsoom intends to apply for a Mining Right in terms of the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) in compliance with the South African national environmental legislative framework.

An Air Quality Impact Assessment (AQIA) for Dagsoom Twyfelaar Coal Mine the Project and associated infrastructure (Block A) was initiated with the development of an emissions inventory for the operational phase. The construction and decommissioning phases will be short-term, with anticipated impacts considered negligible. Data from the emission inventory served as input parameters used in the dispersion model simulations to predict pollutants Ground Level Concentrations (GLC) for total suspended particulate (TSP), particulate matter with aerodynamic diameter less than 10 micron (PM_{10}), particulate matter with aerodynamic diameter less than 2.5 micron ($PM_{2.5}$), nitrogen dioxide (NO_2) and carbon monoxide(CO).

Model simulations of GLC of these pollutants were generated using the American Meteorological Society and United States Environmental Protection Agency (USEPA) Regulatory Model (AERMOD). AERMOD was configured for an analysis of a 20 km^2 study domain. Isopleths were generated for different averaging periods recommended by the regulatory authorities and compared with the South African standards to ascertain compliance.

A summary of the findings from the AQIA study is given below:

- The daily GLC of $PM_{2.5}$ predicted for the Project are below the South African standard of 40 µg/m^3 at the Project boundary and at sensitive receptors. However, a small footprint within the Project boundary will experience GLC above the standard. The annual GLC of $PM_{2.5}$ predicted for this Project are below the South African standard of 25 µg/m^3. Exceedances of the daily and annual limits will be confined to a smaller area within the Project boundary. At the selected sensitive receptors, predicted GLC will be lower than the South African standards for daily and annual limits. With mitigation measure in place, concentration within the Project boundary will be reduced to below regulatory standard.
- The PM_{10} 24-hr GLC were below the South African standard of 75 µg/m^3 outside the Project boundary and at sensitive receptors. The same applies to the predicted PM_{10} annual GLC, which were below the South African standard of 40 µg/m^3. Although there are areas with exceedances, these will be confined within the Project boundary.
- The dust deposition rates predicted confirmed that exceedances of the residential and non-residential limit values will occur, but areas with exceedance will be confined within the Project boundary. The predicted exposure levels at the sensitive receptors are below the residential limit of 600 mg/m^2/day and non-residential limit of 1200 mg/m^2/day.
- Model predictions show pockets of areas where the NO_2 1-hr limit value of 200 µg/m^3 are likely to be exceeded. However, this is expected to dissipate quickly once airborne. Isopleths showing the annual GLC could not be generated due to the very low

concentration predicted. The predicted NO_2 1-hr and annual GLC will be lower than the standards of 200 µg/m^3 and 40 µg/m^3 at the Project boundary and at sensitive receptors.

- Model predictions confirm that the CO 8-hr GLC will not exceed the South African standard of 10 mg/m^3 on site and at sensitive receptors. The predicted levels were so small and insignificant that the model did not return any isopleth. The maximum GLC predicted for this project was 0.1987 mg/m^3.

The AQIA impacts of the proposed Project was conducted using a predictive model to ascertain future pollutants' levels once the mine is in operation. Taking cognisance of the GLC, a risk matrix as used assess the nature, significance, extent, duration and probability of potentially significant impacts. The Project impacts are deemed "minor to negligible" based on the rating system. Despite the aforementioned, the mine should commit to mitigation interventions to curtail emissions from sources.

Some of the possible mitigation measures recommended include:

- Application of mitigation measures in line with Good International Industrial Practice Good International Industry Practice (GIIP), as detailed in the impact assessment section (i.e. use of dust suppressants / binders on haul roads and exposed areas, set maximum speed limits on haul roads and to have these limits enforced, rehabilitation of stockpiles to prevent wind erosion, enclosure of crushers, etc.); and
- Operation of ambient air quality monitoring network for particulates and gases to check the effectiveness of mitigation measures in place.

With the implementation of mitigation interventions proposed in this report, it will be possible that potential impacts can be further reduced to insignificance onsite, with subtle or no implications for offsite receptor locations.

ACRONYMS, ABBREVIATIONS AND DEFINITION

AERMOD	American Meteorological Society/United States Environmental Protection Agency Regulatory Model
AQIA	Air Quality Impact Assessment
CO	Carbon Monoxide
DEA	Department of Environmental Affairs
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
GLC	Ground Level Concentrations
NO_2	Nitrogen Dioxide
PM10	Particulate Matter with Aerodynamic Diameter less than 10 Micron
PM2.5	Particulate Matter with Aerodynamic Diameter less than 2.5 Micron
LOM	Life of Mine
MM5	Mesoscale model - Fifth generation
NO_2	Oxides of Nitrogen
OEL	Occupational Exposure Limit
PM_{10}	Particulate Matter less than 10 microns in diameter
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
ROM	Run of Mine
TSP	Total Suspended Particulates
tpa	Tonnes per annum
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Introduction

Dagsoom Coal Mining (Pty) Ltd (hereinafter Dagsoom) propose to develop an underground coal mine, the Twyfelaar Coal Mine, near Ermelo in the Mpumalanga Province (the Project). Dagsoom intends to apply for a Mining Right in terms of the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA).

Dagsoom appointed Digby Wells Environmental (hereinafter Digby Wells) to undertake the Environmental Impact Assessment (EIA) process for the Project. This report constitutes the specialist Air Quality Impact Assessment (AQIA) component, which was compiled to comply with the South African legal framework. The AQIA is not a health study, however, the ground level concentration (GLC) of pollutants predicted are used to determine future pollutants' levels, exposure levels at receptor locations, and potential health implications if regulatory standards are exceeded.

1.1 Project background and description

The Project is located approximately 32 km southeast of Ermelo and ~3 km west from the Project boundary to the edge of the town of Sheepmoor. The Project is situated within the Msukaligwa Local Municipality (MLM) of the Gert Sibande District Municipality (GSDM) in Mpumalanga Province.

Dagsoom intends to develop an underground coal mine using bord-and-pillar mining procedures, after the coal seam is accessed via an initial boxcut. Pillars of coal are left behind to support the roof as the coal is cut away with a continuous miner. The coal resource is sub-outcropping on the eastern and southern side of a hill located towards the northern extent of the Project area. This area constitutes 'Block A' and remains the focus of the current suite of specialist studies in support of the ESIA.

The Project plans a peak mining production rate of 34 000 tonnes per month (tpm), while the average run-of-mine (ROM) is 408 000 tonnes per annum (tpa) (Scorpion Mineral Processing, 2014). The Life-of-Mine (LoM) is four to five years.

Three options were identified as suitable for the Project[1] and are discussed briefly below. The first two options are based on a ROM throughput of 408 000 tpa. While the last option is based on a ROM throughput of 287 232 tpa:

1.1.1 Option 1

This option involves mining, stockpiling, hauling and selling ROM material to a local customer. A 100% yield is assumed as no processing follows the mining operations. The ROM product is hauled by road to the customer at a rate of 408 000 tpa. This option will likely encompass

[1] Scopion Mineral Processing (2014) Processing Report for the Dagsoom Coal Project, South Africa, C0085-00-REP-001

drilling and blasting operations. A ROM stockpile is required, as well as a product load-out facility.

1.1.2 Option 2

This option involves mining, stockpiling, crushing and selling to a local customer, possibly Eskom. .A 100% yield is assumed, and the ROM product is hauled to the customer at a rate of 408 000 tpa. A ROM stockpile is required, followed by a crushing and screening plant, as well as a product loadout facility.

1.1.3 Option 3

This option involves mining, stockpiling, crushing, screening, washing and selling an upgraded product for the export market. An 80% theoretical yield is assumed. Therefore, the production rate is 287 232 tpa of export quality coal. The ROM product is hauled to a train load-out station, from where the coal is transported to the Richards Bay Coal Terminal (RBCT) via the RBCT railway line. The capital cost requirements for this option are for the mining operations, which are likely to be drill and blast operations. A ROM stockpile is required, followed by a crushing and screening plant, a dense medium separation (DMS) plant, fine tailings and coarse discard facilities, as well as a product load-out facility.

The option presumed to have the worst air quality impact, Option two was chosen, with 100% yield (408 000tpa), ROM product, hauling on dirt road, crushing and screening, plant and loadout facility.

The various activities associated with the different phases of the Project are presented in Table 1-1. Activities with negligible implications on ambient air quality will not be assessed.

Table 1-1: Project Activities

Activity No.	Activity
Construction Phase	
1	Site clearance and topsoil removal.
2	Excavation and construction of surface infrastructure, including the plant, contractor's area, fuel bay, haul roads, PCD and storm water catchment dams, coal tip and conveyor belt, pipelines and clean water canals.
3	Loading, transportation, tipping and spreading during the construction of stockpiles, including topsoil, overburden and emergency coal stockpiles.
4	The establishment of the initial boxcut and decline.
Operational Phase	

Activity No.	Activity
5	Material handling and processes: Tipping from underground conveyor, coal removal by truck-and-front end loader
6	Hauling of ore and discards.
7	Crushing and screening
8	Operation and maintenance of the stockpiles, including topsoil, overburden and ROM coal stockpiles.
Decommissioning Phase	
9	Demolition and removal of all infrastructure, including transporting materials off site
10	Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring

1.2 Scope of Work

Based on the requirements of the Project, the air quality scope of work encompasses the following:

- Establishment of the site meteorology and ambient air quality;
- Assessment of the future air quality impacts and comparison against regulatory standards for compliance; and
- Recommendation of management measures, including mitigation and monitoring requirements.

2 Details of the Specialist

Matthew Ojelede is an air quality specialist at Digby Wells & Associates South Africa (Pty) Ltd, and Manager at the Department of Atmospheric Sciences and Noise. He holds' degrees in BSc Geology (Hons) from the University of Benin, Edo State, Nigeria; an MSc in Environmental Science from the University of the Witwatersrand and a PhD in Environmental Management from the University of Johannesburg. He is a member of the South African Council for Natural Scientific Professions (SACNASP), and the National Association for Clean Air (NACA). He has authored and co-authored research articles and conference papers in peer reviewed journals both local and international.

He has attended specialised courses in atmospheric dispersion modelling (AERMOD and CALPUFF).

3 Assumptions, Limitations and Exclusions

Assumptions, limitations and exclusions pertaining to the Project are discussed in Table 3-1

Table 3-1:Assumptions, Limitations and Exclusions

Assumption, Limitation or Exclusion	Consequence
No historical ambient air quality data for the Project area	The AQIA did not consider cumulative impacts due to lack of background air quality data
Electricity was solely from the national grid, while a 250KVA generator was used for emergency supply (Scorpion Mineral Processing, 2014)	Less particulate and gaseous emissions to the ambient environments
The point, area and volume source parameters assessed were limited to “Block A” only	The AQIA does not consider the extent of the mining right area or any activities that may take place outside of Block A
Uncertainty associated with dispersion models	Since mining activities were selected to demonstrate the worst-case scenario, model GLC may results over-estimating the magnitude
Location of the ventilation shaft	The only consequence is that the x;y coordinate of emission source is inaccurate. Other than that, emissions from this source is accounted for in the assessment

4 Relevant Legislation, Standards and Guidelines

4.1 South African Legislation and Regulation

The National Environmental Management Act, 1998 (Act No. 107 of 1998) (the NEMA) as amended provides the legislative framework for environmental management in South Africa. Principles from NEMA are relevant to air pollution and encompasses pollution avoidance or minimisation and legislative means for compliance and enforcement.

The prevailing legislation in the Republic of South Africa with regards to the Air Quality is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). NEM: AQA forms one of the many pieces of legislations that falls under the ambit of the NEMA.

NEM: AQA puts in place various measures for the prevention of pollution and national norms and standards for the regulation of air quality in South Africa. It also authorizes the Minister of Environmental Affairs to enforce its provisions through the issuance of policy documents and regulations. As in section 24G of NEMA, section 22A of NEM: AQA has a provision for administrative fine for contravention. In line with NEMAQA, the Department of Environmental Affairs (DEA) published the acceptable dust fallout limits for residential and non-residential areas 01 November 2013. The dust fallout standard is given in the Table 4-1 below.

Table 4-1: Dust Fall Standards (NEMAQA - NDCR, 2013)

Restriction Areas	Dust fall rate (mg/m²/day, 30-days average)	Permitted Frequency of exceeding dust fall rate
Residential Area	< 600	Two within a year, not sequential months
Non-Residential Area	< 1200	Two within a year, not sequential months

DEA has established National Ambient Air Quality Standards for PM_{10} and gases in Table 4-2 since December 2009 and $PM_{2.5}$, since June 2012 (GN 486: 2012) as in Table 4-3.

Table 4-2: National Ambient Air Quality Standards for Particulate Matter (PM_{10}) (2009)

Averaging Period	Limit Value (µg/m3)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
National Ambient Air Quality Standard for Sulphur Dioxide (SO_2)				
10 Minutes	500	191	526	Immediate
1 hour	350	134	88	Immediate
24 hours	125	48	4	Immediate
1 year	50	19	0	Immediate
The reference method for the analysis of SO_2 shall be ISO 6767.				
National Ambient Air Quality Standard for Nitrogen Dioxide (NO_2)				
1 hour	200	106	88	Immediate
1 year	40	21	0	Immediate
The reference method for the analysis of NO_2 shall be ISO 7996.				
National Ambient Air Quality Standard for Particulate Matter (PM_{10})				
24 hour	75		4	1 January 2015
1 year	40		0	1 January 2015
The reference method for the determination of the PM10 fraction of suspended particulate matter shall be EN 12341.				
National Ambient Air Quality Standard for Ozone (O_3)				
8 hours (running)	120 (61ppb)		11	Immediate
The reference method for the analysis of ozone shall be the UV photometric method as described in SANS 13964.				
National Ambient Air Quality Standard for Carbon Monoxide (CO) mg/m3				
1 hour	30	26 (ppm)	88	Immediate

Averaging Period	Limit Value (µg/m3)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
8 hour (calculated on 1 hourly averages)	10	8.7 (ppm)	11	Immediate
The reference method for analysis of CO shall be ISO 4224.				

According to the World Health Organization (WHO, 2000), guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating or reducing to minimum ambient levels of pollutants that are known or likely to be hazardous to human health and wellbeing. Once the guidelines are adopted as standards (which is the case with NEM: AQA), they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

The NEM:AQA Regulation Regarding Air Dispersion Modelling in Government Gazette 37804, Government Notice R 533, July 2014 informed the approach used in this assessment. Level 3 assessment was used, which required detailed meteorological geophysical and source input data to predict future emission levels from the Project.

With the Project being an underground operation, emissions will be expected from the ventilation shaft. The levels of criteria pollutants in the underground working environment published in by the Department of Mineral Resources, Mine Health and Safety Act, (Act No. 29 of 1996), as amended in Government Gazette No. 29276, Government Notice 989 in 2006 were used as input parameters in assessing the contribution from this source.

Table 4-3: National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$) (2012)

National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$)			
Averaging Period	**Limit Value (µg/m3)**	**Frequency of Exceedance**	**Compliance Date**
24 hours	40	0	1 January 2016 – 31 December 2029
24 hours	25	0	01 January 2030
1 year	20	0	1 January 2016 – 31 December 2029
1 year	15	0	01 January 2030
The reference method for the determination of PM2.5 fraction of suspended particulate matter shall be EN 14907.			

5 Baseline Environment

The Project's baseline environment is discussed in Section 5.1.1 below, focusing on the meteorology as there were no ambient air quality data to assess background pollutants' levels.

5.1.1 Receptors Assessment

The town of Sheepmoor is the main cluster of dwellings in the area and is residential in nature, with facilities such as schools and clinics. The site is rural, with isolated farm dwellings scattered around the Project area (white circle with black dots at the middle) in Figure 5-1. These sensitive receptors are locations where people work or reside, and may include "hospitals, schools, day-care facilities, elderly housing and convalescent facilities United States Environmental Protection Agency (USEPA) 2016. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants". Human settlements where involuntary exposure is likely to occur are not exempted. The different dwellings and their proximate distances from the Project infrastructure are depicted in Figure 5-1.

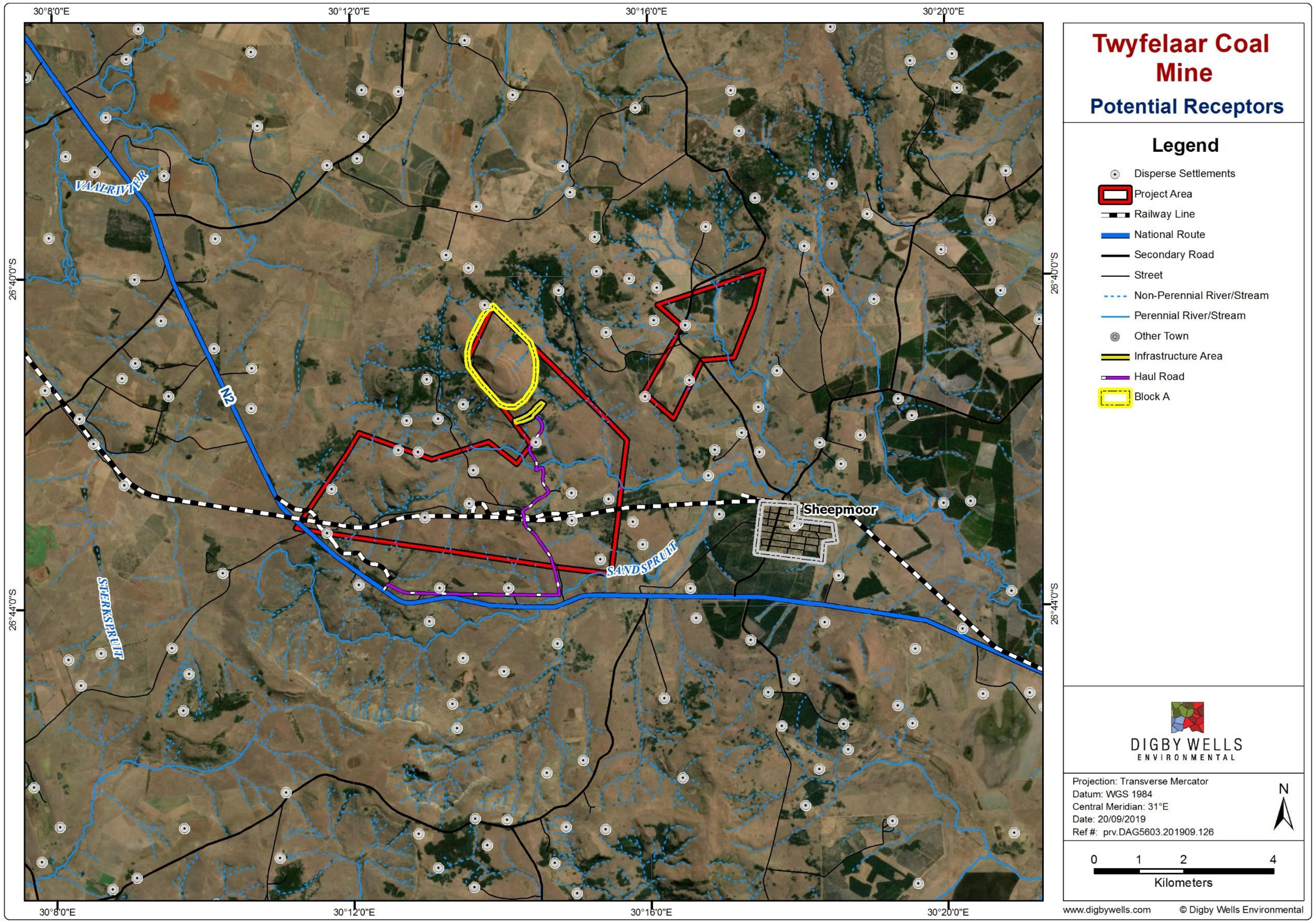

Figure 5-1: Project Area

5.1.2 General Description of Climate in South Africa

Ambient air quality in this region of South Africa is strongly influenced by regional atmospheric movements, together with local climatic and meteorological conditions. There are distinct summer and winter weather patterns that affect the dispersal of pollutants in the atmosphere. In summer, unstable atmospheric conditions result in mixing of the atmosphere and rapid dispersion of pollutants. Summer rainfall also aids in removing pollutants through wet deposition. Precipitation reduces wind erosion potential by increasing the moisture content of exposed surface materials–this represents an effective mechanism for suppressing wind-blown dust. Rain-days are defined as days experiencing 0.1 mm or more rainfall.

In contrast, winter is characterised by atmospheric stability caused by a persistent high-pressure system over South Africa. This dominant high-pressure system results in subsidence, causing clear skies and a pronounced temperature inversion over interior of South Africa. This inversion layer traps pollutants from near surface sources in the lower atmosphere, which results in reduced dispersion and poorer air quality. Preston-Whyte and Tyson (1988) described the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants.

Modelled meteorological data from Lakes Environmental (hereafter Lakes) for the period January 2016 to December 2018 (Lakes 2019) encompassing parameters such as temperature, relative humidity, wind speed and direction for the Project area are discussed (Table 5-1).

5.1.2.1 Temperature

The temperature per month for the Project site (3-year average) are presented in Table 5-1 and Figure 5-3. The data indicate that mean temperatures ranged between 8°C - 19°C. Ambient temperatures were higher during the summer months. The maximum temperatures (**in bold**) on the other hand ranged between 17°C - 31°C, depicted in Table 5-1.

5.1.2.2 Rainfall

The total monthly rainfall records (3 years average) are provided in Figure 5-2. Based on data for rainfall, the summer months (December – February) often receives much of the rains (i.e. >50%) with December and January being the peak rainfall months (Figure 5-2), followed by Spring with 31% and Autumn with 17%. While winter (June – August), received the least rainfall of 1.8% (Figure 5-2).

5.1.2.3 Relative Humidity

The relative humidity per month (3-year average) ranged between 70% and 78% throughout the whole year (Table 5-1 and Figure 5-3). Ravi et al., (2006)[2], investigated the effect of near

[2] Ravi S; Zobeck TM; Over TM; Okin GS; D'Odorico P (2006) On the effect of moisture bonding forces in air-dry soils on threshold frictional velocity of wind erosion. *Sedimentology, 53, 597-609*

surface air humidity on soil erodibility. Results show that the *threshold friction velocity* required for fine particulate matter to be airborne decreases with increasing values of relative humidity between about 40% and 65%, while above and below this range the threshold friction velocity increases with air humidity i.e. In air-dry soils (RH < 65%), the soils are too dry for the liquid-bridge bond to exist. However, with humidity conditions (RH > 65%) water condenses into liquid and form bridges between the soil grains and then the liquid-bridge bonding dominates, increasing the *threshold friction velocity*.

Table 5-1: Climate Statistics (Lakes 2019)

Parameters	3-year average												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Max Temp. (◦C)	18	18	18	15	11	9	8	11	15	15	18	19	15
	29	**28**	**26**	**25**	**19**	**17**	**17**	**21**	**25**	**28**	**28**	**30**	**24**
Total Mon. Rain (mm)	248	139	150	33	7	3	5	13	34	89	178	240	1140
Rel. Hum. (%)	75	78	74	74	74	74	75	71	73	73	70	72	73

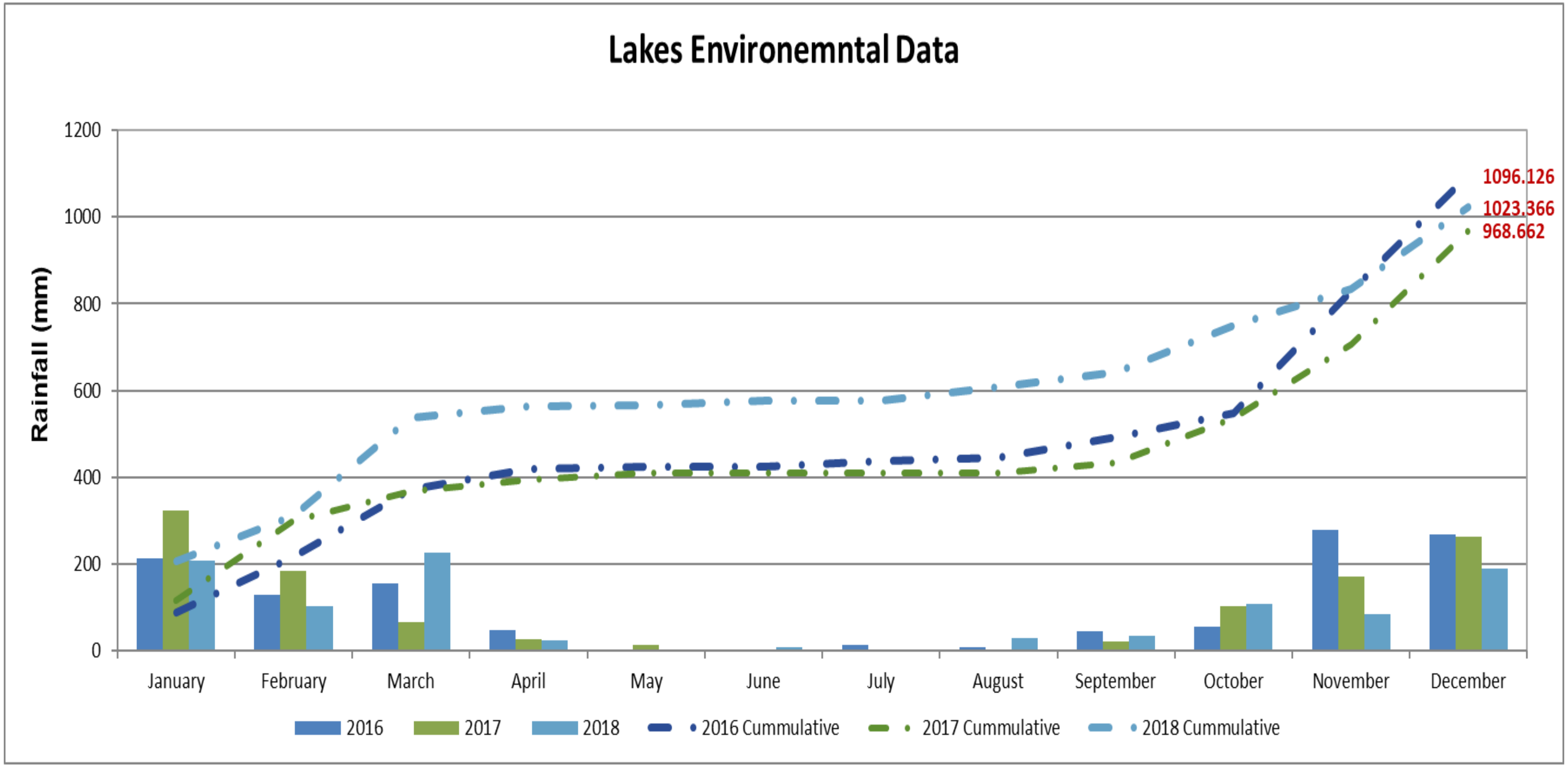

Figure 5-2: Rainfall (Lakes 2019)

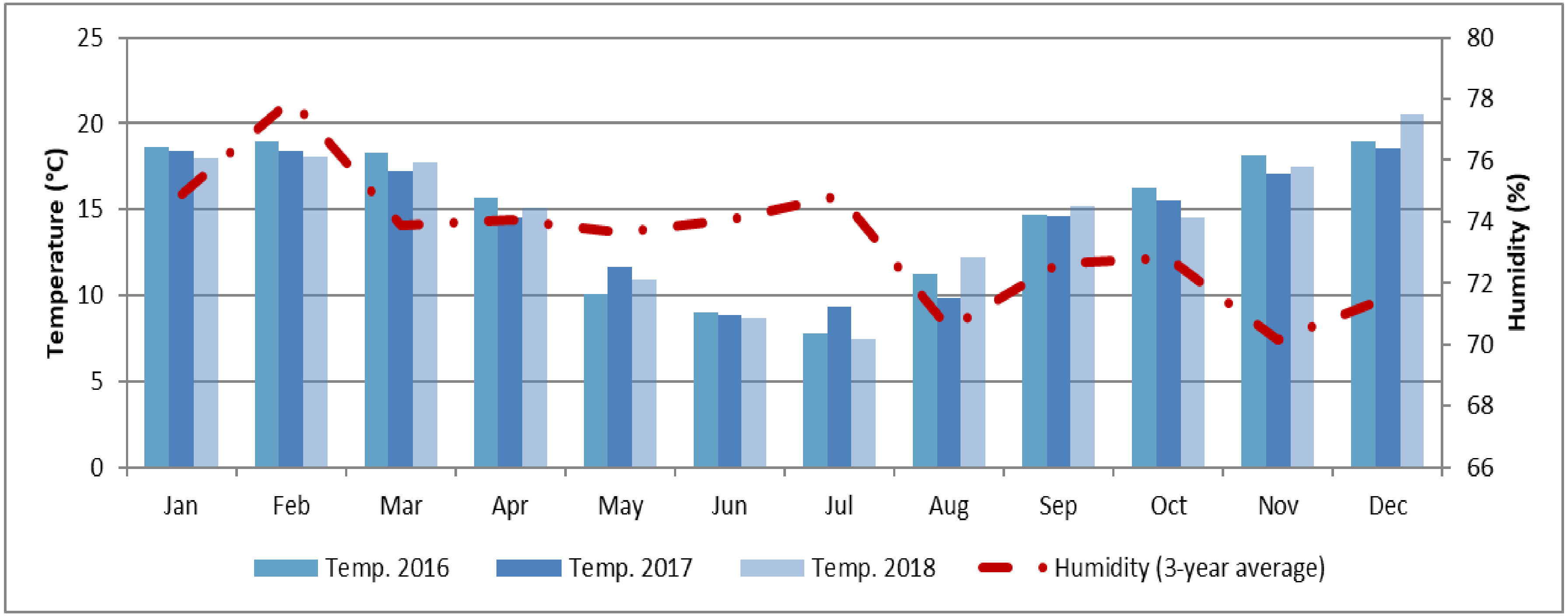

Figure 5-3: Mean Temperature and Relative Humidity (Lakes 2019)

5.1.2.4 Wind Speed

The wind rose for the period 2016 – 2018 is depicted in Figure 5-4. The dominant winds are blowing from the east (13%) and the west northeast (12%). However, the stronger winds, ≥ 5.4 m/s are concentrated more in the western sector. The average wind speed at the project site is 3.8 m/s and calm conditions (wind speeds <0.5 m/s) occurred for 2.3% of the time. The wind class frequency is shown in Figure 5-5.

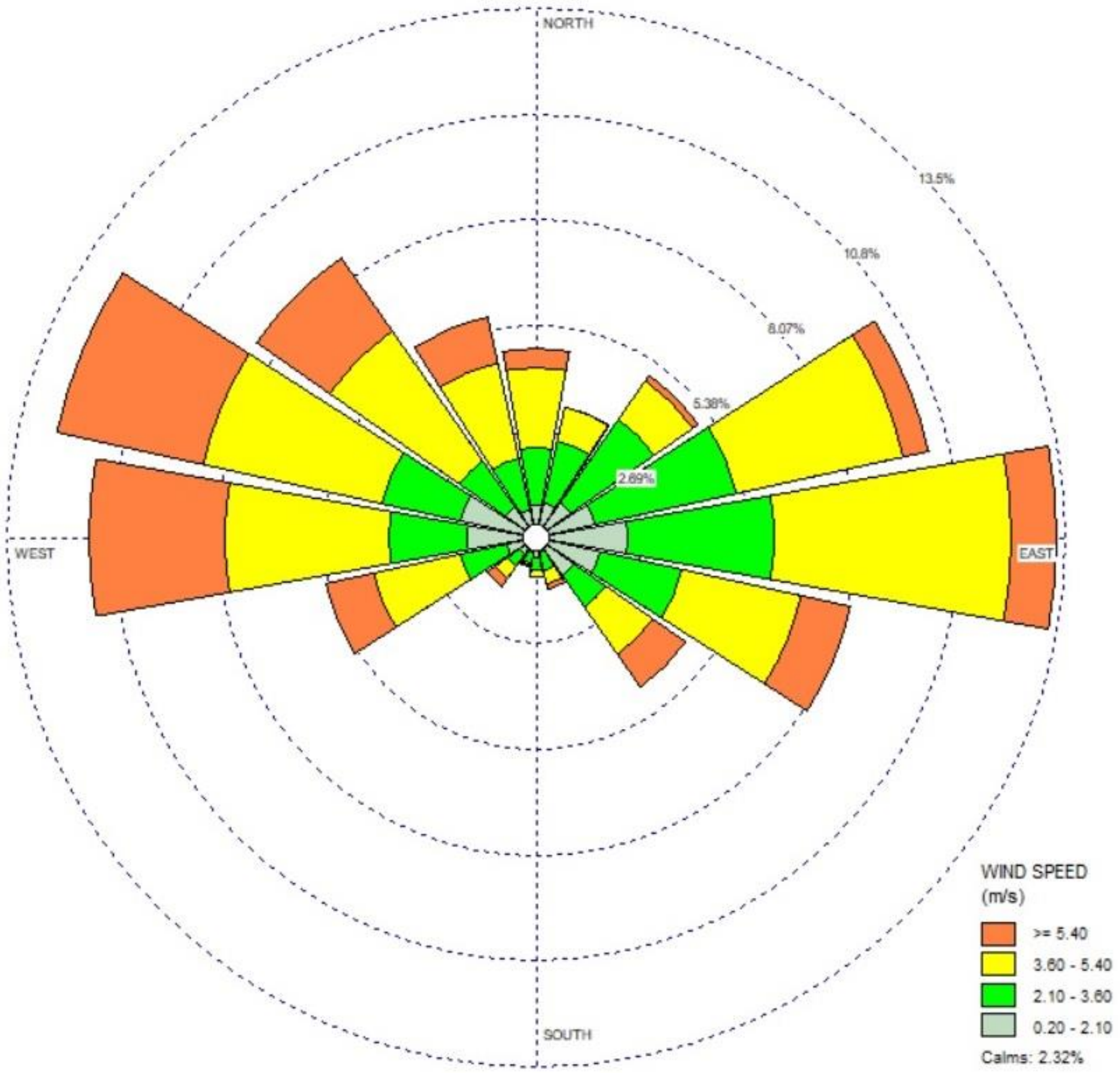

Figure 5-4: Surface wind rose (Lakes 2019)

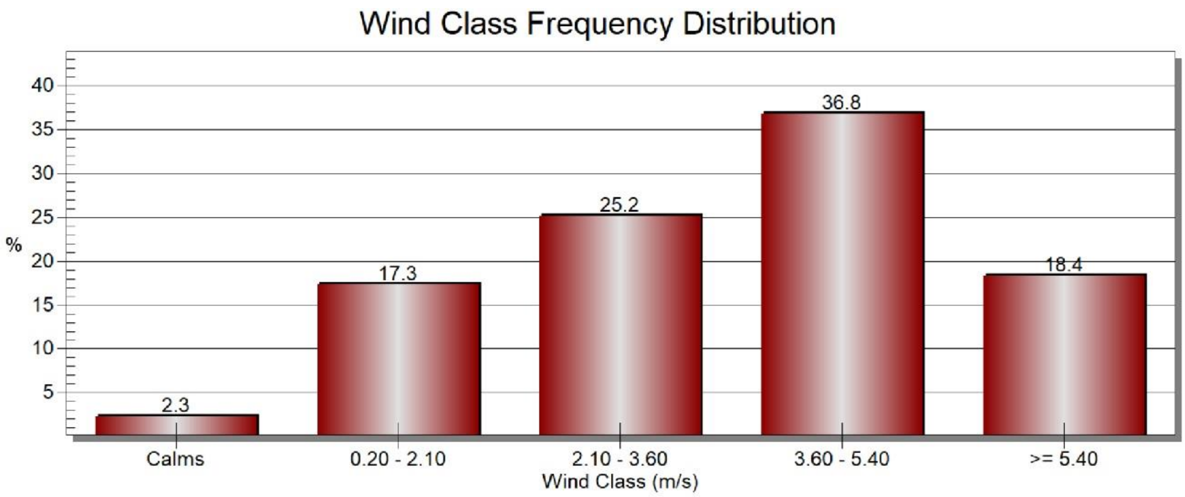

Figure 5-5: Wind Class Frequency (Lakes 2019)

5.1.3 Existing Air Quality

5.1.3.1 Fine Particulate Matter and Dust Fall

Dagsoom has not commenced the monitoring of fine particulate matter PM_{10} and $PM_{2.5}$. The same applies for dustfall, with aerodynamic diameter greater than 30 µm in the Project area. Monitoring of these criteria pollutants will ensure background levels are established prior to the commencement of mining.

5.1.3.1 Gaseous Pollutants

In addition to the above mentioned, data collection for the other criteria gaseous pollutants, such as SO_2, NO_2 and CO has not yet commenced in the Project area.

Monitoring of these pollutants prior to the commencement of mining is invaluable as this will represent a reference point to which future perturbations can be compared.

6 Methodology

The following section provides the methodology adopted to complete the AQIA. The construction and closure phases of the Project will be short-term, with negligible impacts anticipated. Therefore, these were not considered in detail in this assessment. The approach adopted to determine the future impacts from the operational phase is detailed below.

6.1 Assessment of Operational Impacts

The following section provides the methodology used to assess the operational impacts the Project will have on the air quality of the area.

6.1.1 Impact Assessment Approach

The methodology adopted in assessing the impacts from the proposed mining operation and related activities is provided in Figure 6-1.

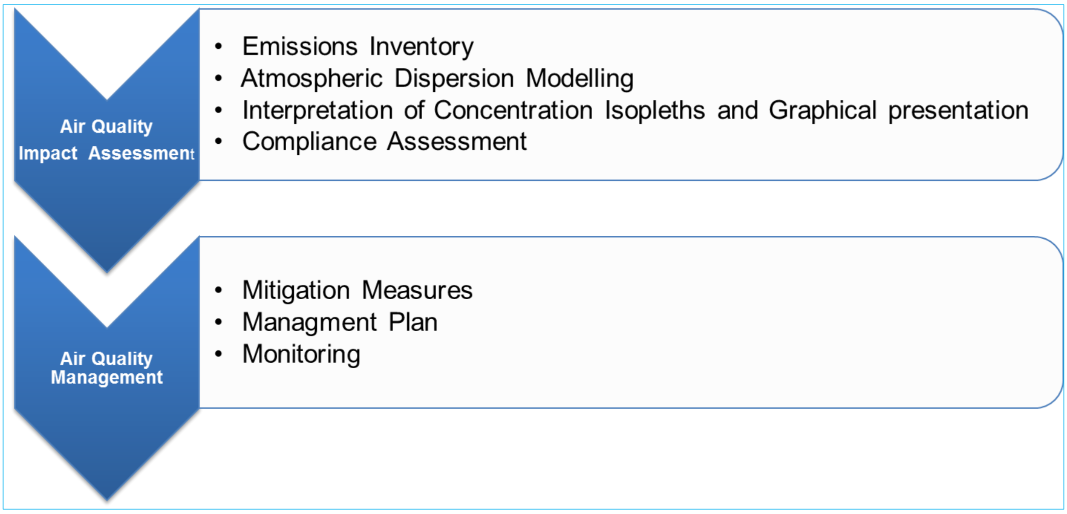

Figure 6-1: Air Quality Impact Assessment Methodology

In the impact assessment, tasks to be completed include the development of the emissions inventory, followed by model simulations to predict Ground Level Concentrations (GLC) of criteria pollutants. The findings of the impact assessment were used to assess compliance with regulations and informs the mitigation measures to be recommended and management plan, as well as monitoring requirements for the Project.

6.1.1.1 Emissions Inventory

The development of an emissions inventory forms the basis for any AQIA. Emission rates are typically obtained using actual sampling equipment at the point of emission or are estimated from mass and energy balances or emission factors which have been established at similar operations. Emission factors published by the USEPA in its AP-42 document "Compilation of Air Pollution Emission Factors" (USEPA, 1995; 1998; 2016) and Australian National Pollutant Inventory "Emission Estimation Technique (EET, 2012)" manuals were employed.

Quoting directly from the USEPA AP-42 (2016), …"*air pollutant emission factors are representative values that attempt to relate the quantity of a pollutant released to the ambient air with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages*".

The approach recommended in the USEPA (2006) was applied. The equations and parameters used in the calculations of the emissions expected from various sources within the proposed operation are discussed in detail in Table 6-1.

Table 6-1: Emission Factor Equations

Activity	Emission Equation	Source	Information assumed/provided
Materials handling (including conveying)	$EF_{TSP\,(kg/t)} = k_{TSP} \times 0.0016 \times \frac{\left(\frac{U_{(m/s)}}{2.2}\right)^{1.3}}{\left(\frac{M_{(\%)}}{2}\right)^{1.4}}$ Where, E = Emission factor (kg dust / t transferred) U = Mean wind speed (m/s) M = Material moisture content (%) The $PM_{2.5}$, PM_{10} and TSP fraction of the emission factor is 5.3%,0 35% and 0 74% respectively. An average wind speed of 3.8 m/s was used based on the Lakes Environmental data for the period 2016 – 2018.	US-EPA AP42 Section 13.2.4	<u>The moisture content of materials are as follows:</u> ROM:3.7% (Scorpion Mineral Processing, 2014); Discard Dump:3.0% (Assumed) Topsoil Stockpile: 6.9% (Assumed) The throughput of ore was 408,000 tpa Hours of operation were given as 24 hrs per day, 7 days per week.
Vehicle entrainment on unpaved surfaces	$EF_{(\frac{KG}{VKT})} = \frac{0.4536}{1.6093} * k * (\frac{s(\%)}{12}) a * (\frac{w(t))}{3}) b$ Where, E = particulate emission factor in grams per vehicle km travelled (g/VKT) k = basic emission factor for particle size range and units of interest s = road surface silt content (%) W = average weight (tonnes) of the vehicles travelling the road = 40 t side truck	US-EPA AP42 Section 13.2.2	In the absence of site-specific silt data, use was made of the default silt content: Mine Road: 6.9% Operational transport activities onsite include the transport of imported ore to the stockpile at the plant. Hours of operation were assumed as 24 hrs per day, 7 days per week.

Activity	Emission Equation	Source	Information assumed/provided
	The particle size multiplier (k) is given as 0.15 for $PM_{2.5}$ and 1.5 for PM_{10}, and as 4.9 for TSP The empirical constant (a) is given as 0.9 for $PM_{2.5}$ and PM_{10}, and 4.9 for TSP The empirical constant (b) is given as 0.45 for $PM_{2.5}$, PM_{10} and TSP		The capacity of the haul trucks to be used was given as 40 t side truck. The layout of the haul roads was assumed to be 25 m. The throughput of material was provided as 408,000 tpa, with a ratio of 1.0 mt to 2.5 mt of discard.
Crushing and screening	Primary: $E_{TSP} = 0.03 \text{ kg/t material processed}$ Secondary: $E_{TSP} = 0.01 \text{ kg/t material processed}$ Where, E = Default emission factor for low moisture content ore	NPI, 2012: Mining	The throughput of material was provided as 408,000 tpa ore. Hours of operation were given as 24 hrs per day, 7 days per week. Primary crushing and secondary crushing occurring at the plant.
Wind Erosion	$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right)$	USEPA, 1998	The silt contents of materials are as follows: Coal:4.0% (Assumed) Discard Dump: 3.0% (Assumed) Topsoil: 6.9% (Assumed)
Tipping	$E_{TSP} = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \times \left(\frac{M}{2}\right)^{-1.4}$ $E_{PM10} = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \times \left(\frac{M}{2}\right)^{-1.4}$	US-EPA AP42 Section 13.2.4	The silt contents of materials are as follows: Coal:4.0% (Assumed) Discard Dump: 3.0% (Assumed) U = mean wind speed in m/s M = moisture content in %
Generator	PM_{10}: 30.1 mg/Nm^3 NO_2: 4241 mg/Nm^3 CO: 703 mg/Nm3	CAT 250 KVA	Parameters applied: Exit temperature:469.7°C Exit Velocity: 16.3 m/s Release height: 10 m Volumetric flow rate: 38,8 m^3/s

Coal mine ventilation systems are always usually designed to maintain healthy and safe atmospheric working conditions underground, with adequate quantities of fresh air to the miners. In addition, to ensure that toxic, noxious, and explosive gases and dusts are diluted by fresh air and is subsequently expelled to the surface via the ventilation system. The parameters adopted for the ventilation shaft are indicated in Table 6-2 and Table 6-3, and emissions from the shaft were considered as point source.

Table 6-2: Parameters adopted for the Ventilation Shafts

Source	Diameter (m)	Release Height (m) (1)	Volumetric Flow rate (m^3/s)	Exit Velocity (m/s) (2)	Exit temperature (K) (3)
Up cast shaft	7	6	500.4	13	298

Table 6-3: MHSA OEL (2006)

Pollutant	Occupational Limit	Occupational Limit	Emissions Rate
	(ppm)	(mg/Nm^3)	(g/s)
CO	30	35	17.5
NO_2	3	5	2.5
SO_2	2	5	2.5
PM_{10}		10	5.0
$PM_{2.5}$		3	1.5

6.1.1.2 Air Quality Dispersion Modelling

Dispersion models compute ambient concentrations as a function of source configurations, emission rates and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in GLCs of pollutants arising from the emissions of various sources. All emission scenarios would be simulated using the USEPA's Preferred / Recommended Models: AERMOD modelling system.

AERMOD modelling system incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including both surface and elevated sources, and of simple or complex terrain.

The mesoscale model, known as MM5 (Fifth-Generation Penn State/NCAR Mesoscale Model) is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model designed to simulate or predict meso-scale atmospheric circulation. MM5 modelled meteorological data set for full three calendar years was obtained from Lakes Environmental in Canada. This dataset consists of surface and upper air meteorological data required to run the dispersion model.

There are two input data processors that are regulatory components of the AERMOD modelling system:

- AERMET, a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts; and

- AERMAP, a terrain data pre-processor that incorporates complex terrain using United States Geological Survey Digital Elevation Data.

6.1.1.3 Modelling Domain

The influence of the terrain will vary with the source height and position and the local meteorology. Table 6-4 gives an overview of meteorological parameters and basic setup options for the AERMOD model runs.

AERMOD's three models and required model inputs are described below:

- AERMET: calculates boundary layer parameters for input to AERMOD:
  - Model inputs: wind speed; wind direction; cover; ambient temperature; albedo; surface roughness; and Bowen ratio.
- AERMAP: calculates terrain heights and receptor grids for input to AERMOD:
  - Model inputs: DEM data [x,y,z]; design of receptor grid; and
  - Model outputs for AERMOD: [x,y,z] and hill height scale for each receptor.
- AERMOD: calculates temporally averaged air pollution concentrations at receptor locations for comparison to the relevant standard:

Table 6-4: Summary of Meteorological and AERMET Parameters Model inputs: source parameters (from permit application); boundary layer meteorology (from AERMET); and receptor data (from AERMAP).

Number of grids (spacing)	200 m
Number of grids points	121 x 121
Years of analysis	January 2016 to December 2018
Centre of analysis	Sheepmoor (26.704847 S; 30.247269 E)
Meteorological grid domain	20 km (east-west) x 20 km (south-north)
Station Base Elevation	1606 m
MM5-Processed Grid Cell (Grid Cell Centre)	26.704847 S; 30.247269 E
Anemometer Height	14 m
Sectors	The surrounding area land use type was grassland
Albedo	0.28 (generated with the AERMOD Model – when the land use types are specified)
Surface Roughness	0.0725
Bowen Ratio	0.75

Terrain Option	Flat

7 Dispersion Model Simulation Results

The model results consist of a graphical representation of GLC (in µg/m³) for the different pollutants, and dust deposition rates (Total Suspended Particulate – TSP) are presented in mg/m²/day. The daily averages were calculated as the 4th highest value (99th percentile). Annual averages were shown as the 1st highest value (100th percentile). The predicted daily, monthly and annual GLC for the modelled pollutants at selected receptors are provided in this report.

7.1 Isopleth Plots and Evaluation of Modelling Results

7.1.1 $PM_{2.5}$ Predicted GLC

The GLC of $PM_{2.5}$ predicted over a 24-hour averaging period for the operational phase returned simulation isopleths that are shown in Figure 7-1 ($PM_{2.5}$ daily) and Figure 7-2 ($PM_{2.5}$ annual).

The model simulations show the worst-case scenario (assuming no mitigation measures were put in place at the mine). The predicted exceedances of the 24-hour standard of 40 µg/m³ will occur within the Project boundary and not outside (Figure 7-1). The GLC at Hartebespruit and Sheepmoor, the nearest sensitive receptors will be lower than the standard (Table 7-1). The annual GLC of $PM_{2.5}$ predicted will not exceed standard outside the Project boundary. However, a small area within the mine boundary will experience exceedances of the annual limit (25 µg/m³) (Figure 7-2).

7.1.2 PM_{10} Predicted GLC

The 24-hour GLC of PM_{10} predicted for the proposed Dagsoom Mine operation returned simulation isopleths shown in Figure 7-3 (PM_{10} daily) and Figure 7-4 (PM_{10} annual).

Areas where exceedance of the South African 24-hour standard (75 µg/m³) occurred are concentrated within the mine boundary (Figure 7-3). The GLC at the nearest sensitive receptors were below the standard (Table 7-1). The predicted annual isopleth showed that only a small area within the mine will experience exceedances (Figure 7-4). This will fall under the Occupational Hygiene regulation. The annual GLC predicted at the selected sensitive receptors were all below the South African standard (Table 7-1).

7.1.3 TSP Predicted Impacts

The predicted dust deposition rates (represented as TSP), from the model simulation are shown in Figure 7-5 and Figure 7-6.

The predicted dust deposition rates confirm that the non-residential limit of 1,200 mg/m²/day will be exceeded at certain locations within the mine boundary. However, this is expected to disperse quickly outside the mine boundary with negligible impacts at the selected receptors. The predicted exposure levels at the sensitive receptors are reported in Table 7-1.

7.1.4 NO_2 Predicted Impacts

Model predictions confirm that the NOx (as NO_2) 1-hr GLC show areas with exceedances of the South African standard of 200 µg/m³ that occur within the mine boundary for most of the time (Figure 7-7). Although some areas outside the mine boundary will experience exceedances, this will dissipate quickly to negligible levels. The predicted annual levels were very low, as a result the model did not generate isopleths. Hence, the annual standard of 40 µg/m³, will not be exceeded on site and at offsite locations.

7.1.5 CO Predicted Impacts

Model predictions confirm that the CO 8-hr GLC will not exceed the South African standard of 10 mg/m³ on site and at offsite locations (sensitive receptors). Isopleths showing the GLC could not be generated due to the very low concentration predicted. Therefore, no map has been created for this pollutant.

The maximum predicted CO 8-hr GLC was 0.1987 µg/m³ and impacted of this pollutant is not anticipated for the Project.

Table 7-1: Predicted Concentrations of PM_{10}, $PM_{2.5}$ and Dust Deposition Rates at Selected Sensitive Receptors

Pollutants	Averaging Period	South Africa Air Quality Standard (µg/m³)	Predicted Ground Level Concentration (µg/m³)	
			Sheepmoor	Hartebespruit
PM_{10} (No Mitigation)	Daily	50(1)	17.12	1.12
	Annual	20(1)	0.68	0.12
$PM_{2.5}$ (No Mitigation)	Daily	25(1)	3.41	0.22
	Annual	10(1)	0.14	0.02
Dust Deposition Rates (mg/m²/day)				
Dust (No Mitigation)	Monthly	Residential (600(2)) Non-residential (1200(2))	26	30
Dust (With Mitigation)			7	11

1. South African National Ambient Air Quality Standards, 2009;2012
2. South African National Dust Control Regulation, 2013 (NDCS)

Table 7-2: Predicted Concentrations of NO_2, CO at Selected Sensitive Receptors

Pollutants	Averaging Period	South Africa Air Quality Standard (µg/m³)	Predicted Ground Level Concentration (µg/m³)	
			Sheepmoor	Hartebespruit
NO_2 (No Mitigation)	1 hour	200[(1)]	39.5	34.2
	1 year	40[(1)]	0.4	0.2
South Africa Air Quality Standard (mg/m³)				
CO (No mitigation)	8 hours	10[(2)]	Maximum value was 0.1987 mg/m³ (impact is considered negligible)	

1. South African National Ambient Air Quality Standards, 2009;2012

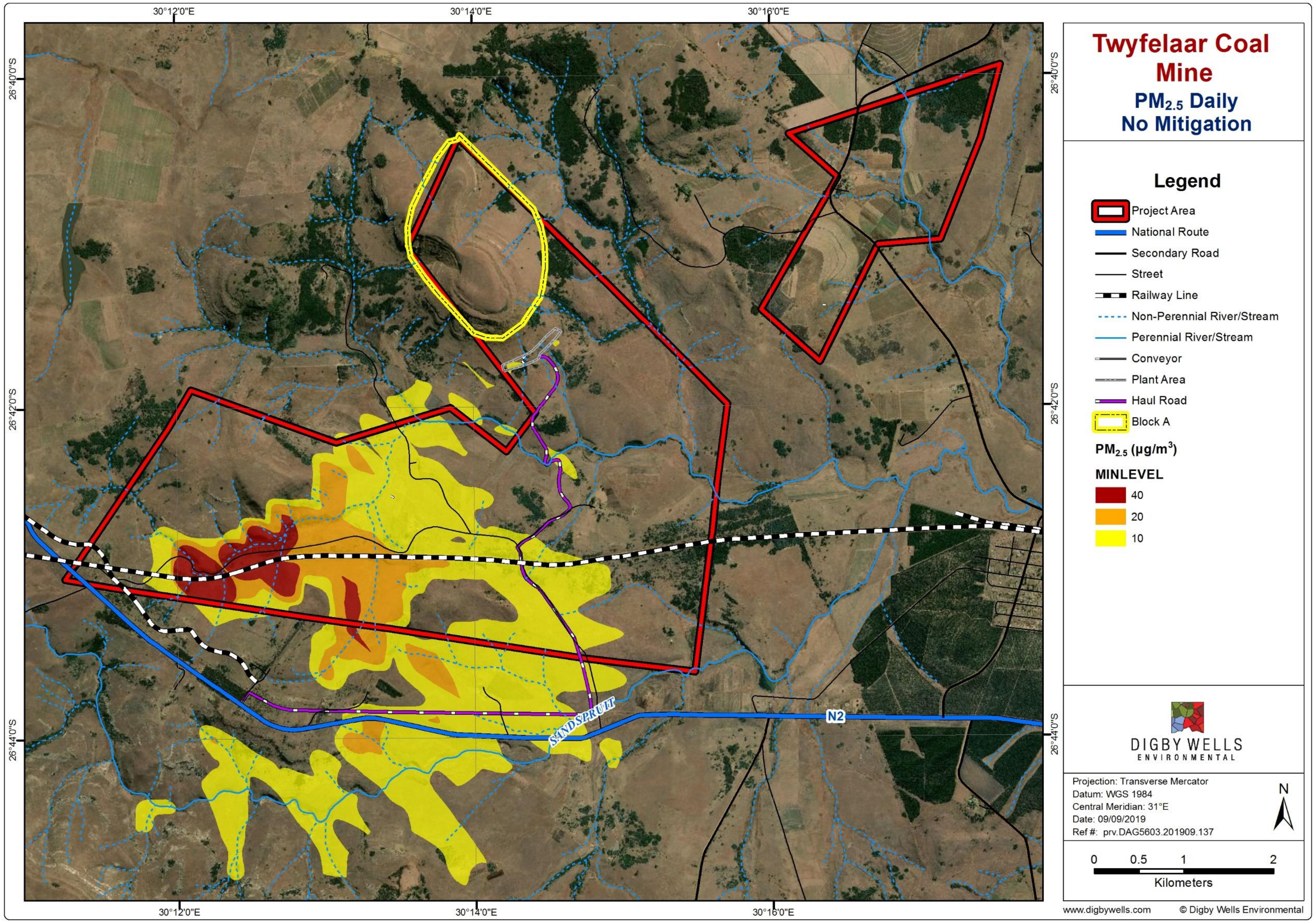

Figure 7-1: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ Concentrations ($\mu g/m^3$)

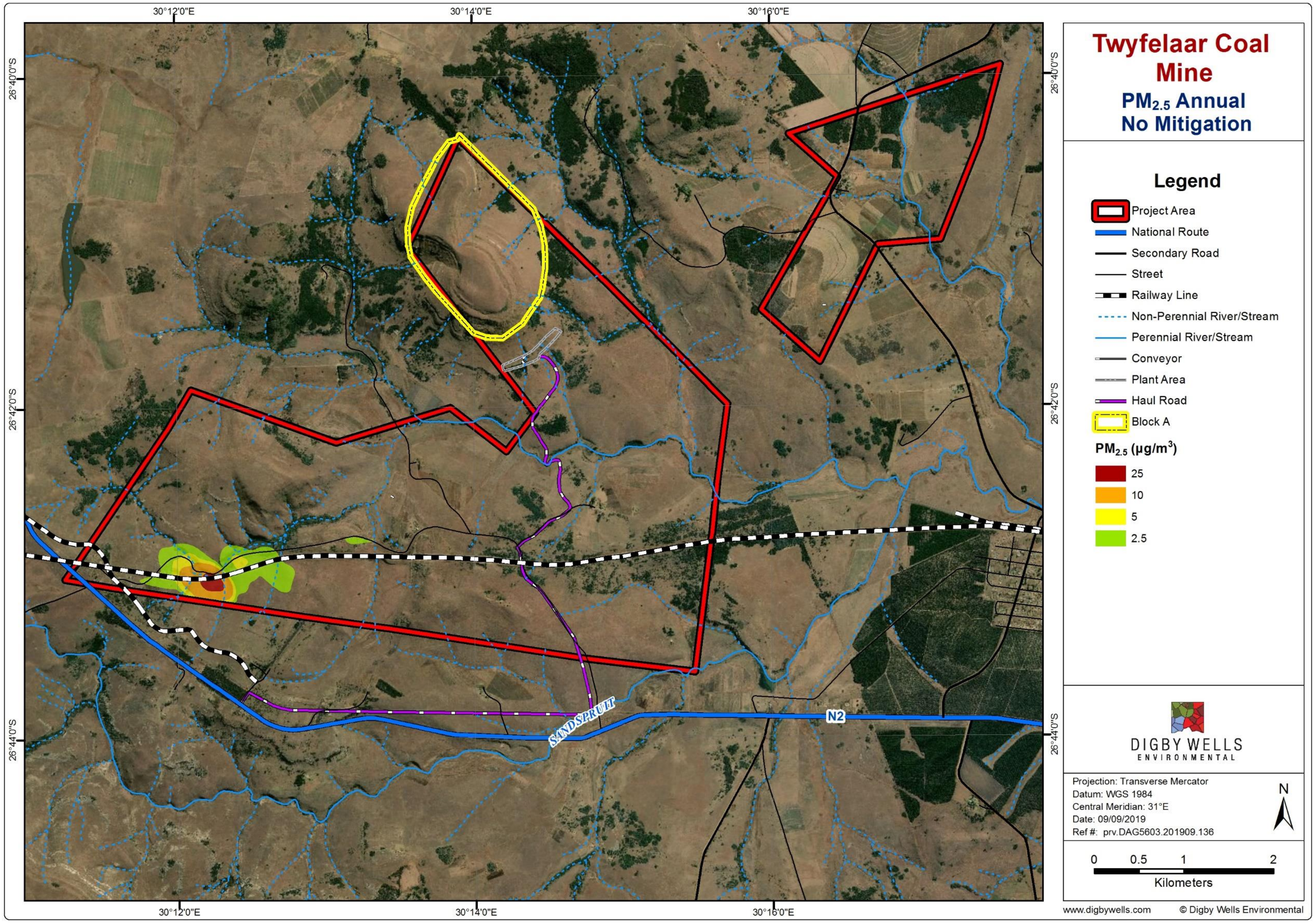

Figure 7-2: Predicted 1st highest (100th percentile) Annual PM2.5 Annual Concentrations (µg/m³)

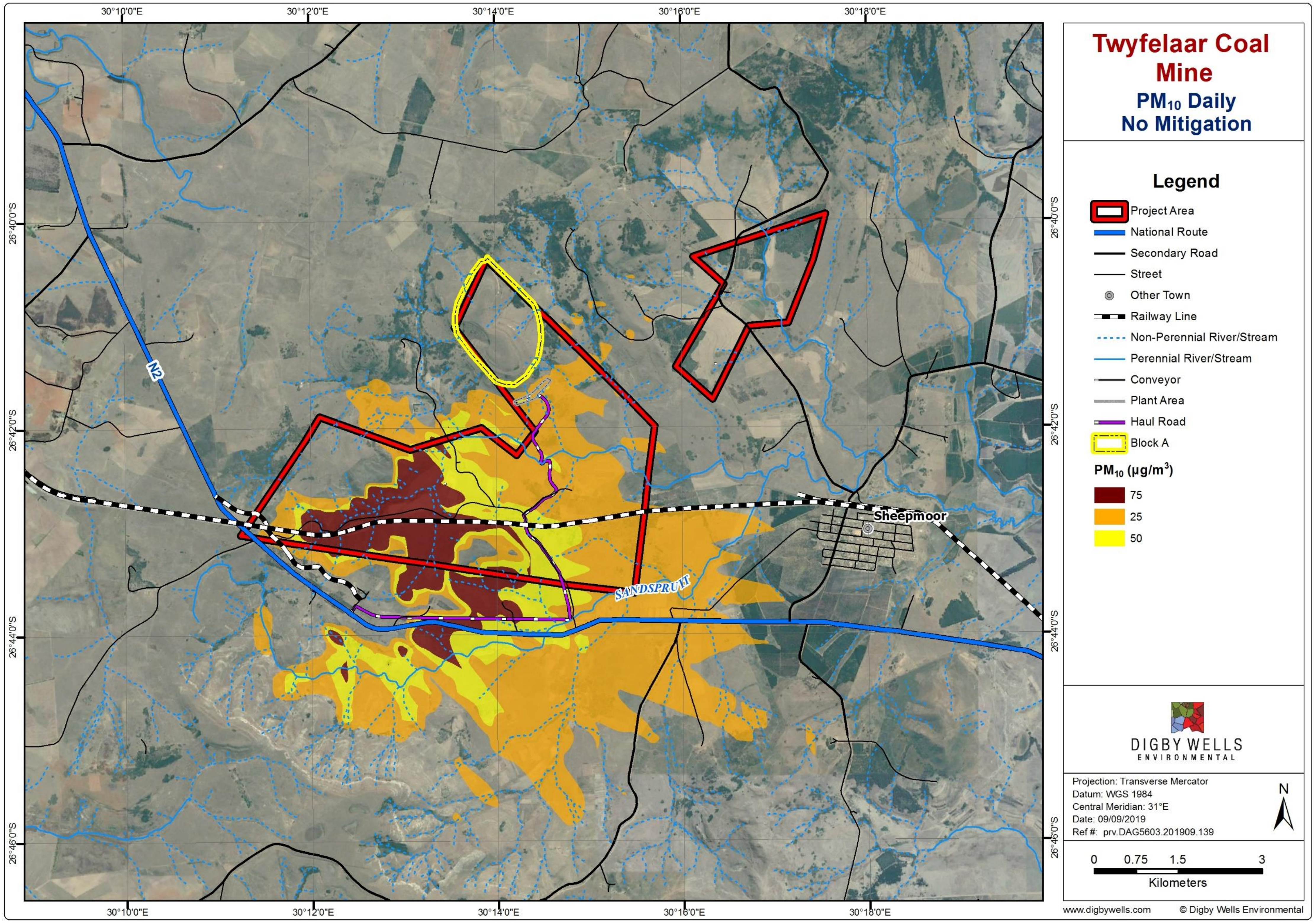

Figure 7-3: Predicted 4th highest (99th percentile) daily PM_{10} Concentrations (µg/m³)

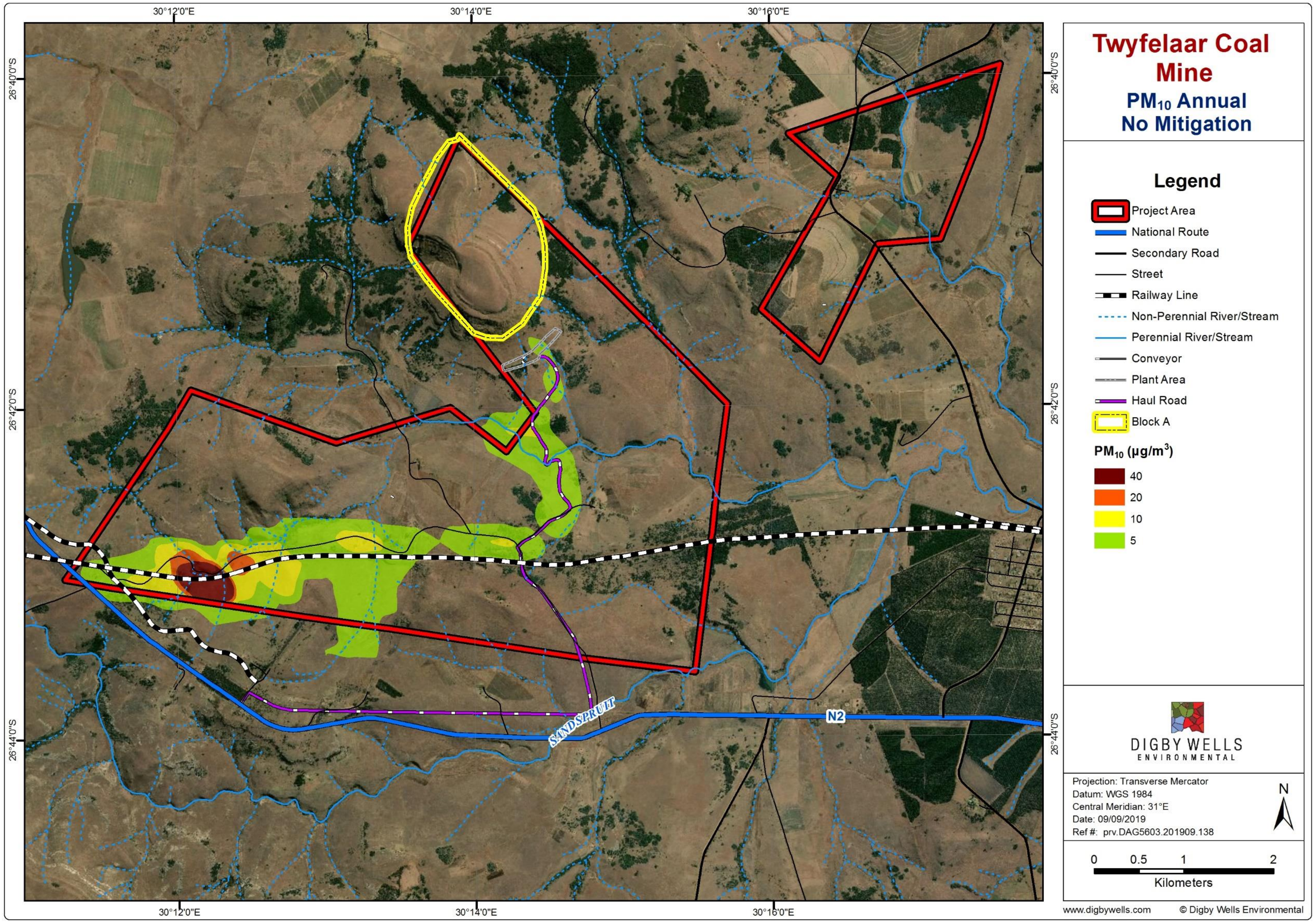

Figure 7-4: Predicted 1st highest (100th percentile) Annual PM_{10} Concentrations (µg/m^3)

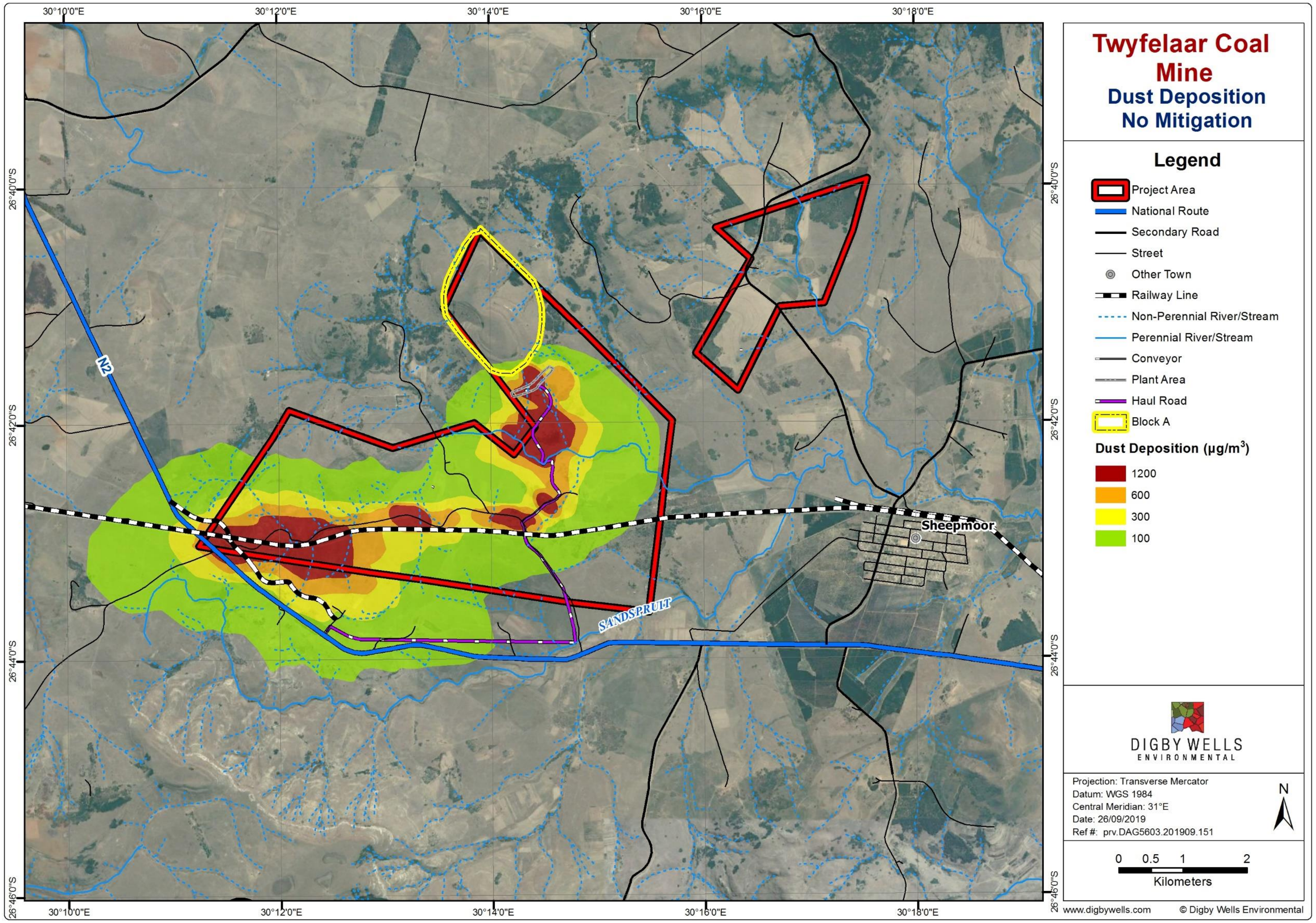

Figure 7-5: Predicted (100th percentile) Monthly TSP Deposition Rates (mg/m²/day) No Mitigation

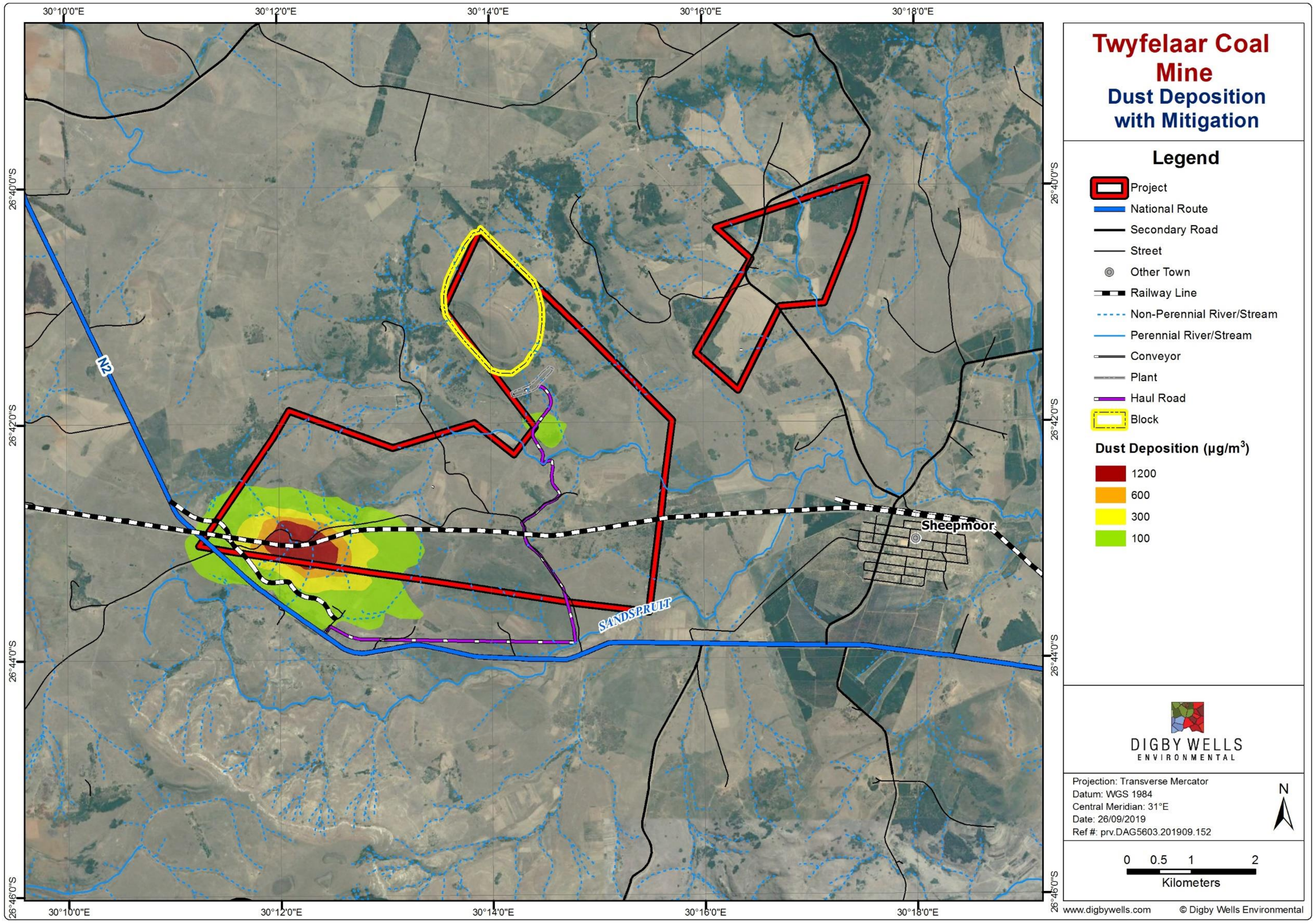

Figure 7-6: Predicted (100th percentile) Monthly TSP Deposition Rates ($mg/m^2/day$) With Mitigation

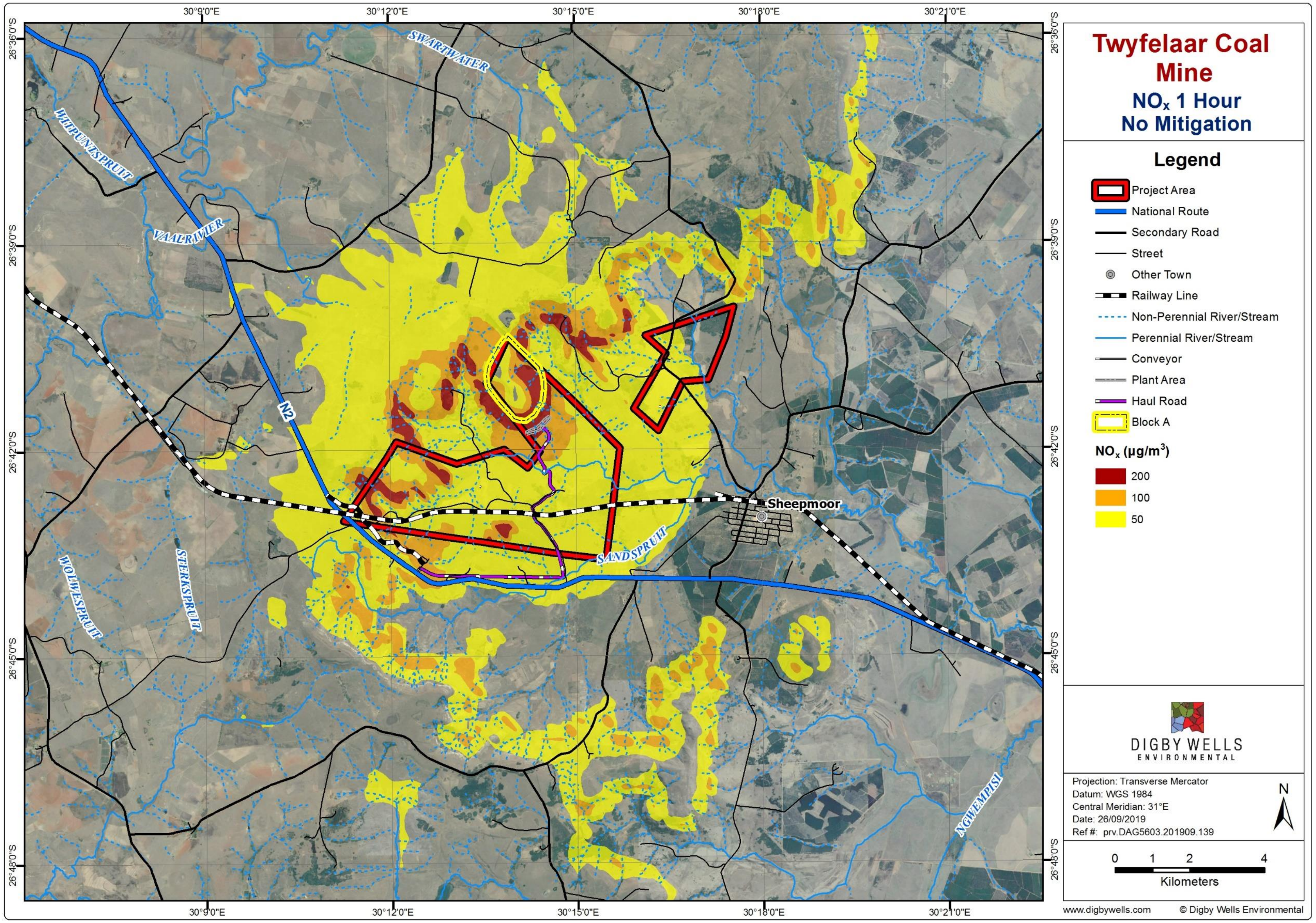

Figure 7-7: Predicted NO_2 1-hr Concentrations (µg/m³)

8 Discussions

The potential impacts predicted for the Project have been appraised using the predicted GLC of pollutants from emission sources, mainly without mitigation measures in place.

8.1 Findings

The results presented represent the worst-case scenario, i.e. without mitigation measures in place. The main findings of this air quality study are summarised as follows:

- The daily GLC of $PM_{2.5}$ predicted for the Project are below the South African standard of 40 µg/m³ at the Project boundary and at sensitive receptors. However, a small footprint within the Project boundary will experience GLC above the standard. The annual GLC of $PM_{2.5}$ predicted for this Project are below the South African standard of 25 µg/m³. Exceedances of the daily and annual limits will be confined to a smaller area within the Project boundary. At the selected sensitive receptors, predicted GLC will be lower than the South African standards for daily and annual limits. With mitigation measure in place, concentration within the Project boundary will be reduced to below regulatory standard.
- The PM_{10} 24-hr GLC were below the South African standard of 75 µg/m³ outside the mine boundary and at sensitive receptors. The same applies to the PM_{10} annual GLC, which were below the South African standard of 40 µg/m³. Although exceedances will occur, they are predicted to be confined within the mine boundary.
- The dust deposition rates predicted confirmed that exceedances of the residential and non-residential limit values will occur, but areas with exceedance will be confined within the mine boundary. The predicted exposure levels at the sensitive receptors are below the residential limit of 600 mg/m²/day and non-residential limit of 1200 mg/m²/day.
- Model predictions show pockets of areas where the NO_2 1-hr limit value of 200 µg/m³ will be exceeded. However, this is expected to dissipate quickly once airborne. Isopleths showing the annual GLC could not be generated due to the very low concentration predicted. The predicted NO_2 1-hr and annual GLC will be lower than the standards of 200 µg/m³ and 40 µg/m³ at the Project boundary and at sensitive receptors.
- Model predictions confirm that the CO 8-hr GLC will not exceed the South African standard of 10 mg/m³ on site and at sensitive receptors. The predicted levels were so small and insignificant that the model did not return any isopleth. The maximum GLC predicted for this project was 0.1987 mg/m³.

9 Impact Assessment Ranking

The potential impacts from the proposed Project have been assessed based on the severity predicted on-site and at sensitive receptor(s). This culminates in a significance rating which identifies the most important impacts that require mitigation and/or management.

Based on international guidelines and South African legislation, the following criteria were considered when examining potentially significant impacts:

- Nature of impacts (direct / indirect, positive / negative);
- Duration (short / medium / long-term, permanent (irreversible) / temporary (reversible), frequent / seldom);
- Extent (geographical area, size of affected population / habitat / species);
- Intensity (minimal, severe, replaceable / irreplaceable);
- Probability (high / medium / low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact / risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 9-1. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts. Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in the Environmental Management Plan Report (EMPr). The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 9-2, which is extracted from Table 9-1. The description of the significance ratings is discussed in Table 9-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 9-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 9-2: Probability/Consequence Matrix

Significance																																						
Probability 7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Consequence																																						

Table 9-3: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Substantial (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Major (positive)
36 to 72	An positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Major (negative)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Substantial (negative)

9.1 Potential Impacts

The sections below provide the description of the potential impacts during the construction, operation and decommissioning phases of the Project. The combine impact from a host of different sources during each phase is assessed, not individual activity.

9.1.1 Construction Phase

9.1.1.1 Impact Description

Construction of Project infrastructure will occur in phases and will be short-term in nature. Therefore, the associated impacts will be negligible. As part of the Construction Phase of the project, the following activities are identified that may impact on the ambient air quality of the area:

- Site clearing;
- Excavation; and
- Loading, transport, tipping and spreading of materials.

Activities associated with site clearing will result in the generation of fugitive dust comprising of TSP, PM_{10} and $PM_{2.5}$, especially from dirt roads and open surfaces which are traversed during the construction activities. Also, excavation, loading and tipping of construction material will lead to dust generation. Although gaseous emissions will be generated from off-road vehicles, emissions will disperse faster due to the duration and nature of each activity. The different activities will occur in phases, will be short-term and localised in nature, and will have low impacts on the ambient air quality.

The management objective is to ensure that emissions on-site and off-site locations are not in exceedance of the regulatory limits for the protection of the environment, human health and wellbeing. Mitigation measures will be implemented (Table 9-4) to ensure that emissions remain below limit values and in compliance with the relevant standards.

9.1.1.2 Impact Ratings

The potential impact from construction activities on air quality are provided in Table 9-4.

Table 9-4: Significance ratings for site clearing, excavation/transport, tipping and spreading of materials

Activity and Interaction: Site Clearing, Excavation / Transport, Tipping and Spreading of Materials			
Impact Description: Nuisance and reduction in ambient air quality			
Prior to Mitigation / Management			
Dimension	**Rating**	**Motivation**	**Significance**

Activity and Interaction: Site Clearing, Excavation / Transport, Tipping and Spreading of Materials			
Duration	Short-Term (2)	Impact will occur for the duration of the activity	(30) Negligible (negative)
Extent	Limited (2)	Exposure extent will be confined to the vicinity of the activity, but only to a limited degree	
Intensity	Minor (2)	Very little change to baseline environment	
Probability	Likely (5)	Impact may occur	
Nature	Negative		
Mitigation / Management Actions			
▪ Apply wetting agents, dust suppressant or binders on exposed areas (including excavated stockpiled material and on dirt roads); ▪ Enforce adherence to set vehicle speed limits; ▪ Conduct activities judiciously during windy days (≥5.4 m/s); and ▪ Minimise the drop heights when loading, offloading and tipping material.			
Post- Mitigation			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short-Term (2)	Impact will occur for the duration of the activity	(5) Negligible (negative)
Extent	Very limited (1)	Limited to specific activity	
Intensity	Low (1)	Impacts will be low after mitigation measures are applied	
Probability	Rare (2)	Conceivable, but only in extreme circumstances after mitigations are applied	
Nature	Negative		

9.1.2 Operational Phase

9.1.2.1 Impact Description

As part of the Operational Phase, impacts on the ambient air quality are anticipated from the following activities:

- Material handling processes;
- Hauling of ore and discard waste;
- Crushing and screening;

- Wind erosion from storage piles and exposed areas; and
- Generator sets.

The model predictions have showed that exceedance of the regulatory limits will occur over a smaller footprint within the Project boundary. Anticipated pollutants encompass particulate matter and gaseous pollutants through the release of TSP, PM_{10} and $PM_{2.5}$, NO_2, and CO, with the potential to increase background concentrations above usual. Mitigation measures will be implemented (Table 9-5), to ensure that emissions remain within limits and in compliance with the relevant standards.

9.1.2.2 Impact Ratings

The potential impact on air quality from operational activities is provided in Table 9-5.

Table 9-5: Significance Ratings for Material Handing, Hauling of Ore and Discard Waste, Crushing and Screening, Wind Erosion, and Generator Sets

<table>
<tr><td colspan="4">Activity and Interaction: Material Handing, Hauling of Ore and Discard Waste, Crushing and Screening, Wind Erosion, and Generator Sets</td></tr>
<tr><td colspan="4">Impact Description: Nuisance and potential health effects from exposure to fine particulate matter, gases and volatile</td></tr>
<tr><td colspan="4">Prior to Mitigation / Management</td></tr>
<tr><td>Dimension</td><td>Rating</td><td>Motivation</td><td>Significance</td></tr>
<tr><td>Duration</td><td>Project life (5)</td><td>Impact will occur for the project life</td><td rowspan="5">(44) Minor (negative)</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>Exposure extent will be local, as far as the Project boundary</td></tr>
<tr><td>Intensity</td><td>Discernible (3)</td><td>Discernible impact from emissions</td></tr>
<tr><td>Probability</td><td>Probable (4)</td><td>It is probable that impact will occur</td></tr>
<tr><td>Nature</td><td colspan="2">Negative</td></tr>
<tr><td colspan="4">Mitigation / Management Actions</td></tr>
<tr><td colspan="4">▪ Apply wetting agents, dust suppressant or binders on the dirt roads;
▪ Construct surfaces of haul roads from lateritic soils and avoid fine/colloidal (e.g. clays and silts) materials;
▪ Vegetate exposed areas as soon as practicably possible;
▪ Enclose the crusher, screens, transfer and discharge points and conveyors;
▪ The area of disturbance shall be kept to a minimum at all times and no unnecessary stripping must occur, especially on windy days (wind speed ≥ 5.4 m/s);
▪ Set maximum vehicle speed limits on site and enforce these limits;
▪ Ensure generators are operated at optimal conditions; and
▪ Minimise the drop heights when loading and unloading material onto trucks and at tipping points.</td></tr>
<tr><td colspan="4">Post- Mitigation</td></tr>
</table>

<table>
<tr><th colspan="4">Activity and Interaction: Material Handing, Hauling of Ore and Discard Waste, Crushing and Screening, Wind Erosion, and Generator Sets</th></tr>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td>Duration</td><td>Project life (5)</td><td>Impact will occur for the for the project life</td><td rowspan="5">(27) Negligible (negative)</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The impact footprint will be limited to a small footprint within the Project boundary after mitigation</td></tr>
<tr><td>Intensity</td><td>Minor (2)</td><td>Minor impact anticipated after mitigation measures are applied</td></tr>
<tr><td>Probability</td><td>Unlikely (3)</td><td>Impact is unlikely to occur after mitigations are applied.</td></tr>
<tr><td>Nature</td><td colspan="2">Negative</td></tr>
</table>

9.1.3 Decommissioning Phase

9.1.3.1 Impact Description

As part of the Decommissioning Phase the following activities have been identified that may impact on the ambient air quality of the study area; i.e. increasing the level of pollutants in the atmosphere (Table 9-6):

- Demolition and removal of all infrastructure, including transporting materials off site; and
- Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring.

Rehabilitation will be on-going and carried out concurrently with the day to day operation of the mine, while the final rehabilitation will occur after the end of the operational life. During this activity, transporting and handling of topsoil and capping material for the final rehabilitation will occur. The impacts on the local ambient air quality during the decommissioning phase will be lower than those associated with the construction phase due to efforts in rehabilitating the Project site concurrently. Any implication this phase may have on the ambient air quality of the area will be short-term, localised and negligible. Demolition and rehabilitation will be conducted in phases to minimise dust generation on site. Anticipated impacts will be short-term and negligible. Mitigation measures will be implemented (Table 9-6) to ensure that emissions remain below limit values and the mine remains in compliance with relevant standards.

9.1.3.2 Impact Ratings

The potential impact on air quality from decommissioning and rehabilitation activities is provided in Table 9-6.

Table 9-6: Significance Ratings for Rehabilitation

Activity and Interaction: Rehabilitation and Demolition of Infrastructure			
Impact Description: Demolition and the removal of infrastructure may result in fugitive dust emissions. Nuisance dust and possible health implications from exposure to airborne particulate matter			
Prior to mitigation/ management			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short term (2)	Impact will be short-term	(18) Negligible (negative)
Extent	Limited (2)	Airborne dust will be limited to site and immediate surroundings	
Intensity	Minor (2)	Minor, no significant change to baseline	
Probability	Probable (3)	Probable impacts will occur	
Nature	Negative		
Mitigation/ Management actions			
▪ Apply wetting agents, dust suppressant or binders on the exposed areas (including excavated material and roads); ▪ Enforce vehicle speed limits on site; ▪ Keep the area of disturbance to a minimum at all times; ▪ Minimise the drop heights when loading and unloading material onto trucks; ▪ Dismantling of infrastructure should be done in phases; and ▪ Implement routine maintenance, vegetation (and if required secondary-vegetation).			
Post- mitigation			
Dimension	**Rating**	**Motivation**	**Significance**
Duration	Short term (2)	Impact will be short-term	(4) Negligible (negative)
Extent	Very Limited (1)	Impacts will be very limited to the Project site	
Intensity	Minimal (-1)	Minimal impacts anticipated	
Probability	Highly unlikely (1)	It is unlikely that impacts will occur after mitigation	
Nature	Negative		

10 Environmental Management Plan

10.1 Most Significant Air Quality Impacts

This section lists the main aspects that are expected to more impact on ambient air quality due to the construction and operation of the Project (Table 10-1) based on model simulations.

Table 10-1: Most Significant Impacts

Operational Phase	
Aspects	**Potential Significant Impacts**
Emissions from dirt roads due to hauling of ore to the Rail-Terminal or to local market	*Nuisance effect and possible health implications from exposure to airborne dust*
Wind erosion of stockpiles	*Nuisance effect and possible health implications from exposure to airborne dust*

10.2 Summary of Mitigation and Management

Table 10-2 provides a summary of the activity, environmental aspects and impacts on the receiving environment. Information on the mitigation, relevant legal requirements, recommended management plans, timing of implementation, and roles / responsibilities of persons implementing the Environmental, Management Plan (EMP) are highlighted.

Table 10-2: Proposed Mitigation and Management Measures

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation	Standard to be Achieved/Objective
Construction of infrastructure	Reduction in the quality of ambient air due to generation of dust	Air Quality	Construction	▪ Apply wetting agents, dust suppressants and binders on exposed areas; ▪ Limit activity to non-windy days (with wind speed ≥ 5.4 m/s); ▪ Keep the area of disturbance to a minimum and avoid any unnecessary clearing, digging or scraping, especially on windy days; ▪ Construct surfaces of all access roads from lateritic soils and avoid fine/colloidal (e.g. clays and silts) materials; ▪ Minimise the drop heights when loading onto trucks and at tipping points; ▪ Monitor dust deposition rates and PM_{10} to ensure compliance with guidelines; and ▪ Set maximum speed limits and have these limits enforced.	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013.
Material handling, crushing and screening	Reduction in the quality of ambient air due to the generation of dust	Air Quality	Operation	▪ Apply wetting agents, dust suppressants and binders on exposed areas; ▪ Limit activity to non-windy days (with wind speed ≥ 5.4 m/s); ▪ Minimise the area of disturbance at all times and avoid any unnecessary clearing, digging or scraping, especially on windy days; ▪ Construct surfaces of mine and haul roads from lateritic soils and avoid fine/colloidal (e.g. clays and silts) materials; ▪ Minimise drop heights when loading onto trucks and at conveyor tipping points; ▪ Monitor dust deposition rates and PM_{10} to ensure compliance with regulations; and ▪ Set maximum speed limits and have these limits enforced.	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Listed Activities and Associated Minimum Emission Standard, 2013. ▪ National Atmospheric Emissions Reporting Regulation, 2015

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation	Standard to be Achieved/Objective
Generators	Reduction in the quality of ambient air due to gaseous emissions	Air Quality	Operation	▪ Use of low sulfur fuel; ▪ Operate the generators at optimal conditions	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004, 2004. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Listed Activities and Associated Minimum Emission Standard, 2013 ▪ National Atmospheric Emissions Reporting Regulation, 2015
▪ Demolition and removal of infrastructure ▪ Rehabilitation of project area	Reduction in the quality of ambient air due to generation of dust	Air Quality	Decommissioning	▪ Dismantling of infrastructure should be done in phases; ▪ Minimise drop heights when loading and offloading; ▪ Limit demolition activities to non-windy days (≥5.4 m/s); ▪ Apply wetting agents, dust suppressant and binders on dirt roads and exposed areas; and ▪ Rehabilitated landscape should be vegetated and monitored for vegetation establishment in line with the Rehabilitation and Closure Plan.	▪ South African National Environmental Management: Air Quality Act, Act.39 of 2004 – Air Quality Standard: 2009, 2012. ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Dust Control Regulation, 2013 ▪ National Environmental Management: Air Quality Act (Act.39 of 2004) – Listed Activities and Associated Minimum Emission Standard, 2013 ▪ National Atmospheric Emissions Reporting Regulation, 2015

11 Recommendations

The following recommendations based on the results presented in this report will be applied to this Project to ensure compliance with the regulatory standards:

- Administer mitigation measures as described in the impact assessment above (i.e. use of dust suppressants / binders on haul roads and exposed areas, set maximum speed limits on haul roads and have these limits enforced and enclosure of crushers;
- Commission an ambient air quality monitoring network and maintain this for the life of the Project, as data will provide useful information to management on the efficiency of the mitigation measures in place;
- The mine should start monitoring prior to the commencement of operation. This will ensure baseline data is available to which future perturbations can be compared.

12 Conclusion

This study was undertaken to understand the air quality impacts associated with the proposed Project. Pollutants quantified and evaluated in this assessment included TSP, PM_{10}, $PM_{2.5}$, NO_2 and CO respectively.

The modelling results (isopleths of GLC) presented in this report confirmed that impacts are mostly confined within the mine boundary, with negligible impacts for nearby receptors in the Project area. The exposure levels predicted at the nearby receptors were below the South African standards.

Although the findings from this study indicates minor to negligible impacts based on the isopleths of GLC predicted, management must ensure measures to mitigate and further reduce emissions and subsequent exposure concentrations on-site and at offsite receptor locations are part of the day-to-day practices on commencement of mining operation. This includes good housekeeping on the part of mine personnel to curtail emissions, adherence to best practice mitigation and management measures recommended in this report, and regularly review to assess the efficiency of mitigation measures in place to ensure compliance.

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