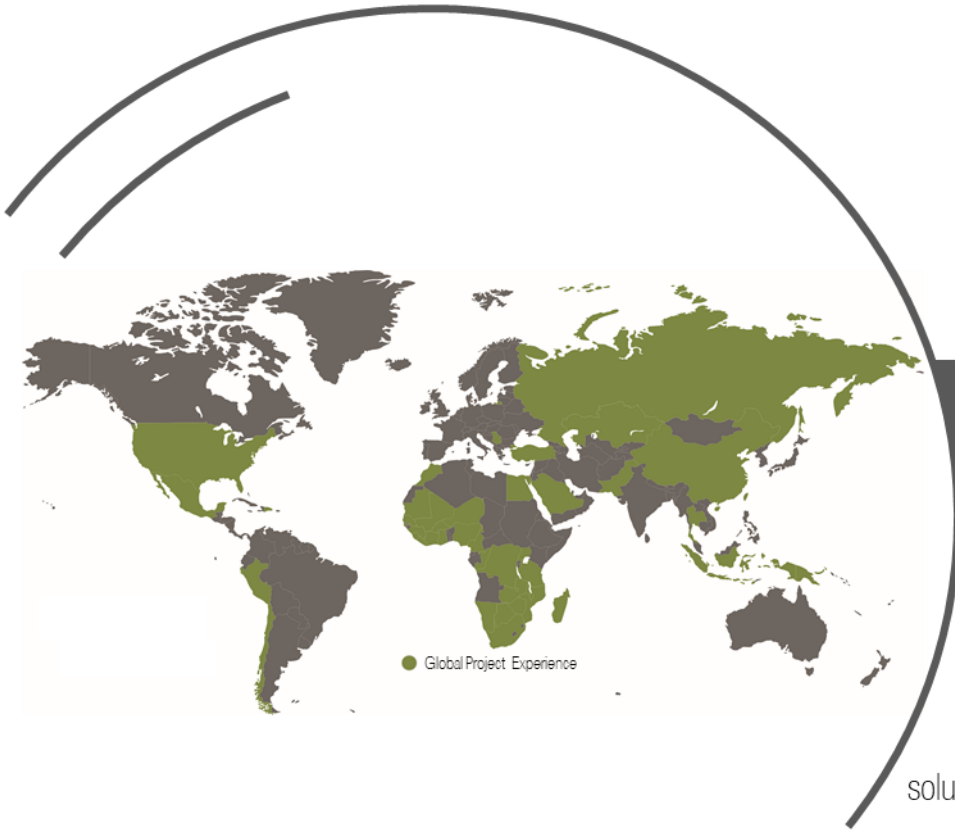

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Mining of the Middeldrift Resources within the existing New Clydesdale Colliery Mining Right, Magisterial District of Nkangala, Mpumalanga

Air Quality Impact Assessment

Prepared for:
Universal Coal NCC

Project Number:
UCD6587

June 2021

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This document has been prepared by Digby Wells Environmental.

Report Type:	Air Quality Impact Assessment
Project Name:	Mining of the Middeldrift Resources within the existing New Clydesdale Colliery Mining Right, Magisterial District of Nkangala, Mpumalanga
Project Code:	UCD6587

Name	Responsibility	Signature	Date
Matthew Ojelede Pr.Sci.Nat.	Report Compiler		June 2021
Stephen Burton	Reviewer		June 2021
Njabulo Mzilikazi	Project Manager		June 2021

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DETAILS AND DECLARATION OF THE SPECIALIST

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Brief Background of Specialist

Matthew has broad knowledge in the "*Atmospheric Sciences*" field, with more than 15 years of experience in academia and industry combined. He has garnered practical field experiences in setting up, monitoring, and decommissioning ambient air quality units and stations, encompassing real-time particulate monitor – AQ-Mesh®, Grimm Aerosol monitor®, Met-One E-Sampler®, radiello® passive/diffusive samplers for environmental monitoring, indoor and outdoor air monitoring, industrial air quality (IAQ), personal sampling and breathing zone assessment.

He is currently registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (Reg. No. 116980/18) and is a member of the National Association for Clean Air. He has authored and co-authored research articles and conference papers in peer-reviewed journals both locally and internationally.

Full name:	Matthew Ojelede
Title/Position:	Air Quality Specialist
Qualification(s):	BSc (Hon); MSc; PhD
Experience (years):	16 Years
Registration(s):	National Association for Clean Air (NACA) International Association for Impact Assessment South Africa (IAIAsa) South African Council for Natural Scientific Professions (SACNASP)

I, Matthew Ojelede, declare that: –

- I act as the independent specialist in this application;
- I will 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 declare that there are no circumstances that may compromise my objectivity in performing such work;
    - I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the 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; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

June 2021

Date

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge and information at the time of compilation. Digby Wells employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

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Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

EXECUTIVE SUMMARY

Universal Coal Development (IV) Pty Ltd (hereafter Universal Coal) operates the New Clydesdale Colliery (NCC), an integrated thermal coal mine located in the Witbank coalfield, approximately 149 km east from Johannesburg, in the Nkangala Magisterial District of Mpumalanga, South Africa. The mine comprises both underground and open-pit resources. Universal Coal had identified coal resources north of this existing NCC within their Mining Right Area (**MR Ref. No. MP30/5/1/2/2/492MR)** and as such is proposing to extend the proposed North Opencast Pit to the Middeldrift Resources (defined as the project area).

This Air Quality Impact Assessment (AQIA) forms part of the suite of specialist studies required for the Environmental Regulatory Process for the Middeldrift Resources within the existing New Clydesdale Colliery Mining Right. A total of 12.23 million tonnes (Mt) of coal have been identified. The total Life of Mine (LoM) of the Middeldrift Resource is approximately 12 years.

The dustfall rates measured in the proposed project area from a network of four monitoring locations, designated as non-residential, recorded just two exceedances at DR-003. The latter was non-compliant as these exceedances occurred in sequential months (August 2020 and September 2020). In general, more than 97th percentile of the dustfall records measured were below the limit values of 1 200 mg/m^2/d.

Potential emissions from the operational phase of the Project were assessed. Model simulations of Ground Level Concentration (GLC) of criteria pollutants were generated, for different averaging periods as recommended by the regulatory authorities and compared with the South African standards to ascertain compliance.

The findings of this air quality study are summarised as follows:

- The areas where the exceedance of the 24-hour standard of 40 µg/m^3 will occur are confined within the project area and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard. The predicted annual GLC of $PM_{2.5}$ did not exceed the regulatory standard 40 µg/m^3 within the Project area and at the selected receptors;
- The areas where the 24-hour standard of 75 µg/m^3 are likely to be exceeded are within the Project area and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard. The predicted annual isopleth showed that areas where exceedance will occur are confined to within the Project area; and
- The predicted dustfall rates confirmed that exceedances of the non-residential limit of 1,200 mg/m^2/d will occur. However, these exceedances will be mostly within the Project area. With mitigation or without mitigation measures in place, the operational phase of the project will not result in the exceedance of the non-residential limit at the selected sensitive receptors.

The impacts of the proposed Project were evaluated using a risk matrix that considers the nature, significance, extent, duration, and probability of impacts occurring. Based on this rating system, impacts on the surrounding receptors from the operational phase are deemed “minor negative” without mitigation. However, with mitigation, the impacts rating score was reduced to almost half but the rating remained “minor”. Although anticipated emissions from the operational phase activities are not likely to influence receptors outside the Project area, it is recommended that the mitigation and management intervention measures be adhered to on commencement of operation.

For emphasis, the possible mitigation measures and management intervention measures recommended include, but are not limited to:

- Application of dust suppressants on haul roads and exposed areas, setting maximum speed limits on haul roads and to have these limits enforced, and application of mitigation technology at the Coal Handling Processing Plant (CHPP); and
- Operation of ambient air quality monitoring network to amass valuable site-specific data needed to assess the effectiveness of mitigation measures put in place during operation.

Once Universal Coal implements the recommended mitigation measures outlined in this report, associated emissions can be contained to below standards, ensuring compliance with regulatory requirements.

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LIST OF ACRONYMS, ABBREVIATIONS AND DEFINITION

AERMOD	American Meteorological Society/United States Environmental Protection Agency Regulatory Model
AQIA	Air Quality Impact Assessment
CHPP	coal handling and processing plant
DEA	Department of Environmental Affairs
DMRE	Department of Mineral Resources and Energy
EMPr	Environmental Management Plan Report
GLC	Ground Level Concentrations
LOM	Life of Mine
MM5	Mesoscale model - Fifth generation
MR	Mining Right
NCC	New Clydesdale Colliery
NDCR	National Dust Control Regulations
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEMAQA	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
PM_{10}	Particulate Matter less than 10 microns in diameter
$PM_{2.5}$	Particulate Matter with Aerodynamic Diameter less than 2.5 Micron
ROM	Run of Mine
SAAELIP	South African Atmospheric Emission Licensing & Inventory Portal
Mtpa	Tonnes per annum
TSP	Total Suspended Particulates
USEPA	The United States Environmental Protection Agency
WBG	World Bank Group
WHO	World Health Organisation

CONTENT OF THIS REPORT IN ACCORDANCE WITH THE REGULATION GNR982 OF 2014, APPENDIX 6 (AS AMENDED)

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	iii iv Section 3
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Iii, iv
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 2
cA	And indication of the quality and age of the base data used for the specialist report;	Section 6
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7 and Section 9.4
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Section 6
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternatives;	N/A
(g)	an identification of any areas to be avoided, including buffers;	N/A
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4

Legal Requirement		Section in Report
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 7
(k)	any mitigation measures for inclusion in the EMPr;	Section 10
(l)	any conditions/aspects for inclusion in the environmental authorisation;	Section 14
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 11
(n)	a reasoned opinion (Environmental Impact Statement) -	Section 14
	whether the proposed activity, activities or portions thereof should be authorised; and	Section 14
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	N/A
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 12
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 12
(q)	any other information requested by the competent authority.	N/A

1. Introduction

Universal Coal Development (IV) Pty Ltd (hereafter Universal Coal) operates the New Clydesdale Colliery (NCC), an integrated thermal coal mine located in the Witbank coalfield, approximately 149 km east from Johannesburg, in the Kriel district of Mpumalanga, South Africa. The mine comprises both underground and open-pit resources. Universal Coal had identified coal resources north of this existing NCC within their Mining Right Area (**MR Ref. No. MP30/5/1/2/2/492MR)** and as such is proposing to extend the proposed North Opencast Pit to the Middeldrift Resources (defined as Project area).

This Air Quality Impact Assessment (AQIA) forms part of a suite of specialist studies required for the Environmental Regulatory Process for the Middeldrift Resources within the existing NCC Mining Right.

1.1. Project Background and Description

The property is located within the Emalahleni Local Municipality and the Nkangala Magisterial District and is approximately 9 km north of Kriel in the Mpumalanga Province. The Middeldrift resources lie North of the NCC Diepspruit Mining Area (an underground mining operation) and Universal Coal is the holder of the Mineral Rights (MR). The project area is a greenfield area. The intention is to exploit the resources through opencast mining methodologies.

The proposed new activities at Middeldrift to be authorised will entail:

- Mining of a pan;
- Construction of a bridge over the Steenkoolspruit to access the Middeldrift resources;
- Diversion of the provincial road which runs through the area of the Middeldrift site; and
- Construction of a new road (linked to the diversion) (approximately 4 km long).

The construction, operation and decommissioning phases of the Project shall comprise the activities in Table 1-1. These Project activities will be used for the impact assessment.

Table 1-1: Project Activities

Project Phase	Project Activity
Construction Phase	Site/vegetation clearance
	Contractors laydown yard
	Access and haul road construction
	Topsoil stockpiling
Operational Phase	Open-pit establishment
	Removal of rock (blasting)
	Stockpiling (i.e. soils) establishment and operation

Project Phase	Project Activity
	Operation of the open pit workings
Decommissioning Phase	Rehabilitation – rehabilitation mainly consists of spreading of the preserved subsoil and topsoil, profiling of the land and re-vegetation
	Post-closure monitoring and rehabilitation

1.2. Mining

In the existing NCC area, the strip ratios are favourable for opencast mining. The Middeldrift Resource also has favourable strip ratios for opencast mining operations; however, Middeldrift is separated from the existing NCC opencast areas by a river. To protect this water course, it is intended that the Middeldrift Resource be mined as a separate opencast operation once the existing NCC areas have been mined out. This will require the diversion of the district road around the north of the opencast pit to continue with mining. For the mining at Middeldrift to progress through the district road, it requires wayleave applications, decommissioning of the existing road (D1651) and construction of a new road around the opencast pit. Option 1 is based on the possibility of the wayleaves and diversion not being approved, while Option 2 assumes that the road diversion will be permitted. See Figure 1-1 and Figure 1-2 for the respective options. A bridge over the Steenkoolspruit will be constructed to gain access to Middeldrift.

A total of 12.23 million tonnes per annum (Mtpa) of coal have been identified. The total Life of Mine (LOM) of the Middeldrift Resource is approximately 12 years (Department of Mineral Resources and Energy (DMRE) MP30/5/1/2/2/492MR – Application dated January 2021).

From the Middeldrift area, the coal will be transported to NCC by truck via haul road. Run of Mine will be washed at the existing NCC coal handling and processing plant (CHPP).

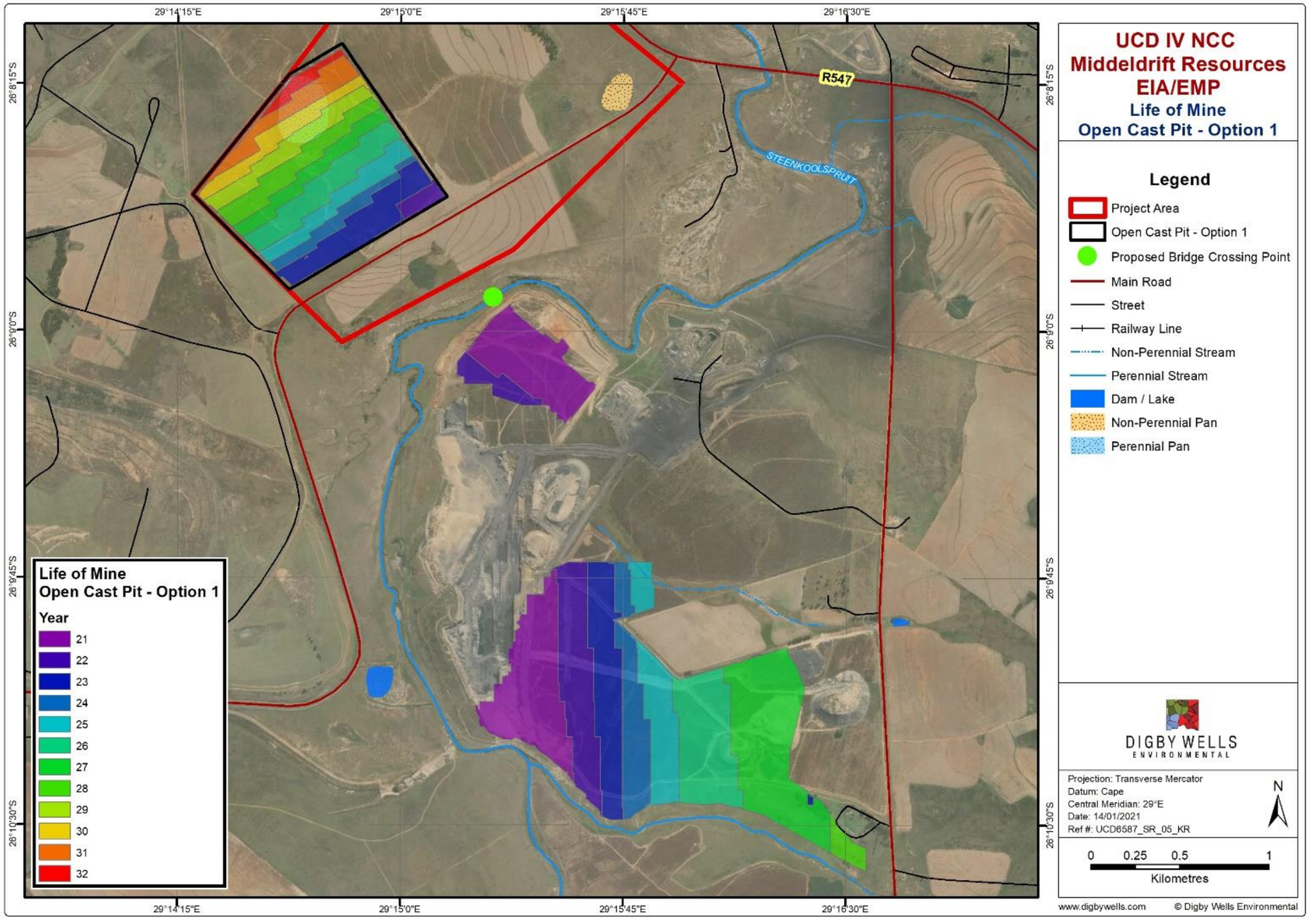


Figure 1-1 Progression of Mining Option 1

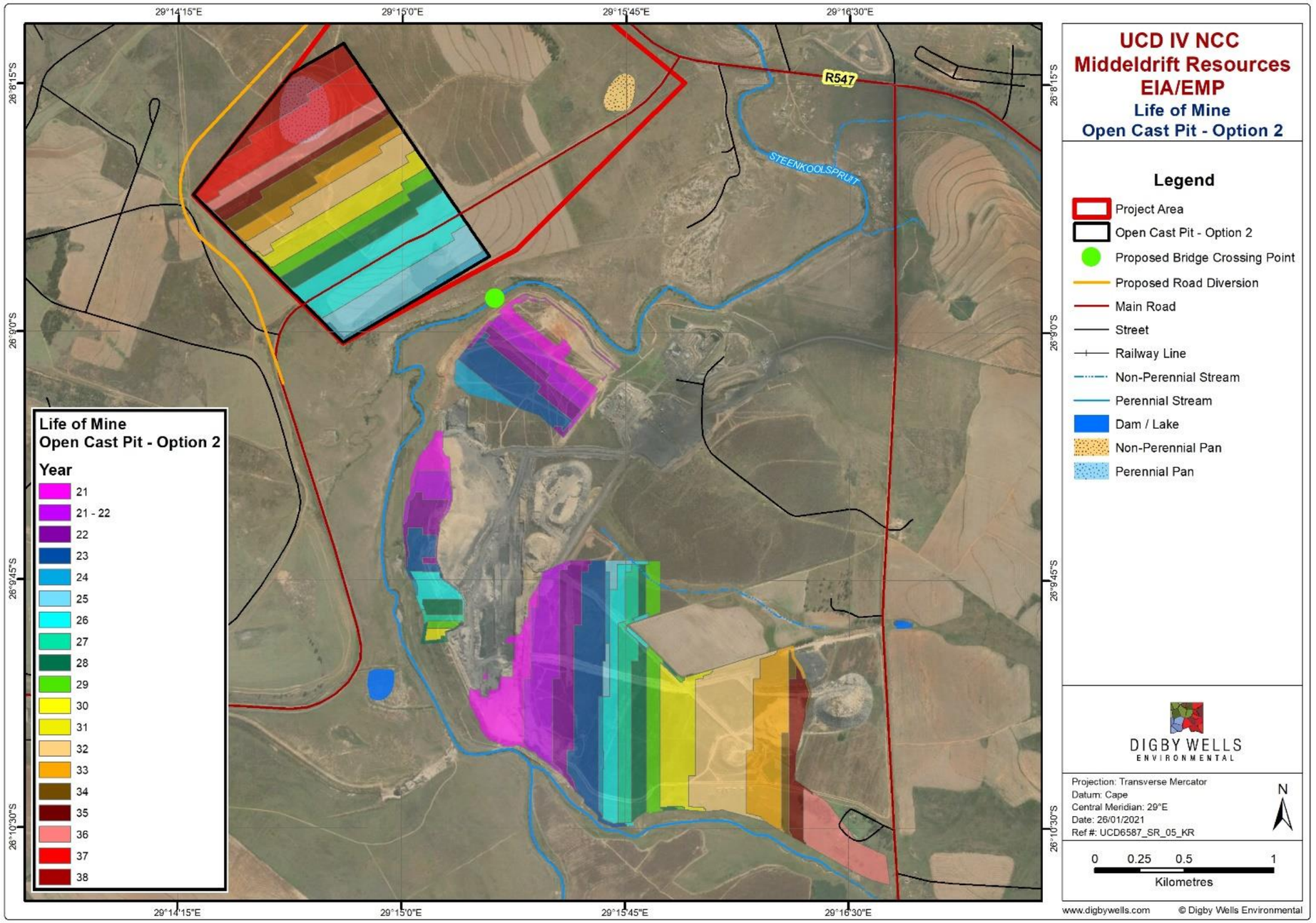


Figure 1-2: Progression of Mining Option 2

2. Scope of Work

This AQIA aimed to complete an air dispersion modelling assessment to predict the future implications of mining on the ambient air quality and exposure scenarios for nearby sensitive receptors as a result of Universal Coal's extraction of the Middeldrift Resource.

Based on the above mentioned, the air quality Scope of Work (SoW) encompasses the following:

- Establishment of the site meteorology and existing background air quality;
- Assessment of the future air quality impacts of the proposed Project on ambient air quality based on the extraction of the Middeldrift Resource and comparison of results against the regulatory standards for compliance; and
- Recommendation of management measures, including mitigation and monitoring requirements.

3. Details of the Specialist

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

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

4. Assumptions, Limitations and Exclusions

Assumptions, limitations, and exclusions pertaining to this Project are discussed in Table 4-1.

Table 4-1:Assumptions, Limitations and Exclusions

Assumption, Limitation, or Exclusion	Consequence
Two open pit options are currently being proposed. Option 2 envisaged as the worst-case scenario was chosen for assessment	This option will have more impacts on the ambient air quality due to the extended footprint
The uncertainty associated with dispersion models	Since mining activities were selected to demonstrate the worst-case scenario, the predicted model may have resulted in an overestimation

5. Relevant Legislation, Standards, and Guidelines

The legislation, regulation, and guidelines considered in this air quality report are tabulated and discussed briefly in Table 5-1. The applicable standards in terms of compliance are discussed in Section 5.1 below.

Table 5-1: Applicable Legislation, Regulations, Guidelines, and By-Laws

Legislation, Regulation, Guideline, or By-Law	Applicability
National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as Amended The NEMA is the statutory framework to enforce Section 24 of the Constitution of the Republic of South Africa …(Section 24: ***the right to a healthy environment and the right to have the environment protected).*** The NEMA is intended to promote co-operative governance and ensure that the rights of people are upheld, but also recognising the necessity of economic development.	Principles from NEMA are relevant to air pollution, Section 24(4) b(i) … "the investigation and assessment of the potential impacts of activities that require authorisation or permission.", and Section 24(7).
National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) The prevailing legislation in the Republic of South Africa with regards to the Air Quality field is the National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM: AQA). According to the Act, the Department of Environmental Affairs (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of NEM: AQA. A fundamental aspect of the new approach to air quality regulation, as reflected in the NEM: AQA is the establishment of National Ambient Air Quality Standards (NAAQS). These standards provide the goals for air quality management plans and also provide the benchmark by which the effectiveness of these management plans is measured. The NEM: AQA provides for the identification of priority pollutants and the setting of ambient standards with respect to these pollutants.	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.
NEM:AQA National Dust Control Regulation 2013 (GN No. 827 of 2013) The Minister of Water and Environmental Affairs, released on 01 November 2013 the National Dust Control Regulation, in terms of Section 53, read with Section 32 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)(NEM:AQA). In the published	The purpose of these Regulations is to prescribe general measures for the control of dust in all areas.

Legislation, Regulation, Guideline, or By-Law	Applicability
National Dust Control Regulations, terms like target, action, and alert thresholds were omitted. Another notable observation was the reduction of the permissible frequency of exceedance from three to two incidences within a year. The standard adopted a more stringent approach than previously and would require dedicated mitigation plans now that it is in force.	
Mine Health and Safety Act, 1996 (Act No. 29 of 1996) as amended GN R 989 of 5 October 2006 The limit states the occupational exposure values for airborne pollutants with respect to occupational hygiene.	The purpose of these Regulations is to prescribe general measures for the control of airborne pollutants in the workplace environment.

5.1. Applicable South African Standard

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, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified 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 NEMA as amended provides a legislative framework for environmental management in South Africa. The principles in NEMA are relevant to air pollution, Section 24(4) b(i) … "*the investigation and* assessment of the potential impacts of activities that require authorisation or permission.", and Section 24(7) *(a) Investigation of the environment likely to be significantly affected by the proposed activity …; (b) investigation of the potential impact including cumulative effects,…; (c) investigation of mitigation measures to keep adverse impacts to a minimum*.

NEM: AQA is the prevailing legislation in the Republic of South Africa with regards to air quality. NEM: AQA forms one of the many pieces of legislation 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 fines for contraventions.

In line with NEM: AQA, the Department of Environmental Affairs (DEA) has established National Ambient Air Quality Standards for particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) - (GN R 1210 of 24 December 2009) in Table 5-2. In 2012,

standards for particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) - (GN R 486 of 29 June 2012) were promulgated (Table 5-3).

Table 5-2: National Ambient Air Quality Standards for Particulate Matter (PM_{10}) (2009)

National Ambient Air Quality Standard for Particulate Matter (PM_{10})			
Averaging Period	**Limit Value (µg/m³)**	**Frequency of Exceedance**	**Compliance Date**
24 hours	75	4	1 January 2015
1 year	40	0	1 January 2015
The reference method for the determination of the PM_{10} fraction of suspended particulate matter shall be EN 12341.			

Table 5-3: National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$) (2012)

National Ambient Air Quality Standards for Particulate Matter (PM2.5)			
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 $PM_{2.5}$ fraction of suspended particulate matter shall be EN 14907.			

The DEA published National Dust Control Regulations (NDCR) which is the acceptable dustfall limits (particulate matter with an aerodynamic diameter less than 45 µm - considered as Total Suspended Particulate (TSP)) as described by the World Bank Group (WBG, 1998). The NDCR specifies the limits for residential and non-residential areas (GN R 827 of 1 November 2013). The dust fallout standard is given in Table 5-4 below.

Table 5-4: Dust Fall Standards (NDCR, 2013)

Restriction Areas	**Dustfall 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

6. Methodology

The methodology adopted in this AQIA study encompasses two components, an environmental baseline assessment and an environmental impact assessment. The baseline component characterises, mainly, the meteorology and ambient air quality of the project area. The second component involves the use of a computational air dispersion model to predict potential emissions associated with the proposed amendments and the degree of impact on the receiving environment.

6.1. Baseline Assessment

The baseline assessment examines the site and immediate surroundings, the sensitive receptors likely to be impacted, the meteorology and the exiting background air quality of the project area.

6.2. Project Area

The Middeldrift Resource is located approximately (~) 120 kilometres (km) east of Johannesburg, 30 km south of eMalahleni (Witbank), and ~ 9 km north of Kriel, in the Mpumalanga Province. The project area is within the Emalahleni Local Municipality and the Nkangala Magisterial District in the Mpumalanga Province.

In the immediate vicnity, several farm homesteads with animal husbandry and mechanised crop farming (i.e. maize) are observed, coupled with mining activities these represent the dominant land-use types (Google Earth® Pro V.7.3 (June 6, 2021)).

The directly and indirectly affected farms are mainly the Hartbeestfontein 39 IS, Kromfontein 30 IS, Middeldrift 42 IS and Roodepoort 40 IS.

Figure 6-1 shows the Project area, surrounding sensitive receptor and dust monitoring locations. According to the USEPA (2016), a sensitive receptor encompasses but is not limited to "*hospitals, schools, daycare facilities, elderly housing, and convalescent facilities. The aforementioned are locations where the occupants are more susceptible to airborne pollutants" if exposed*.

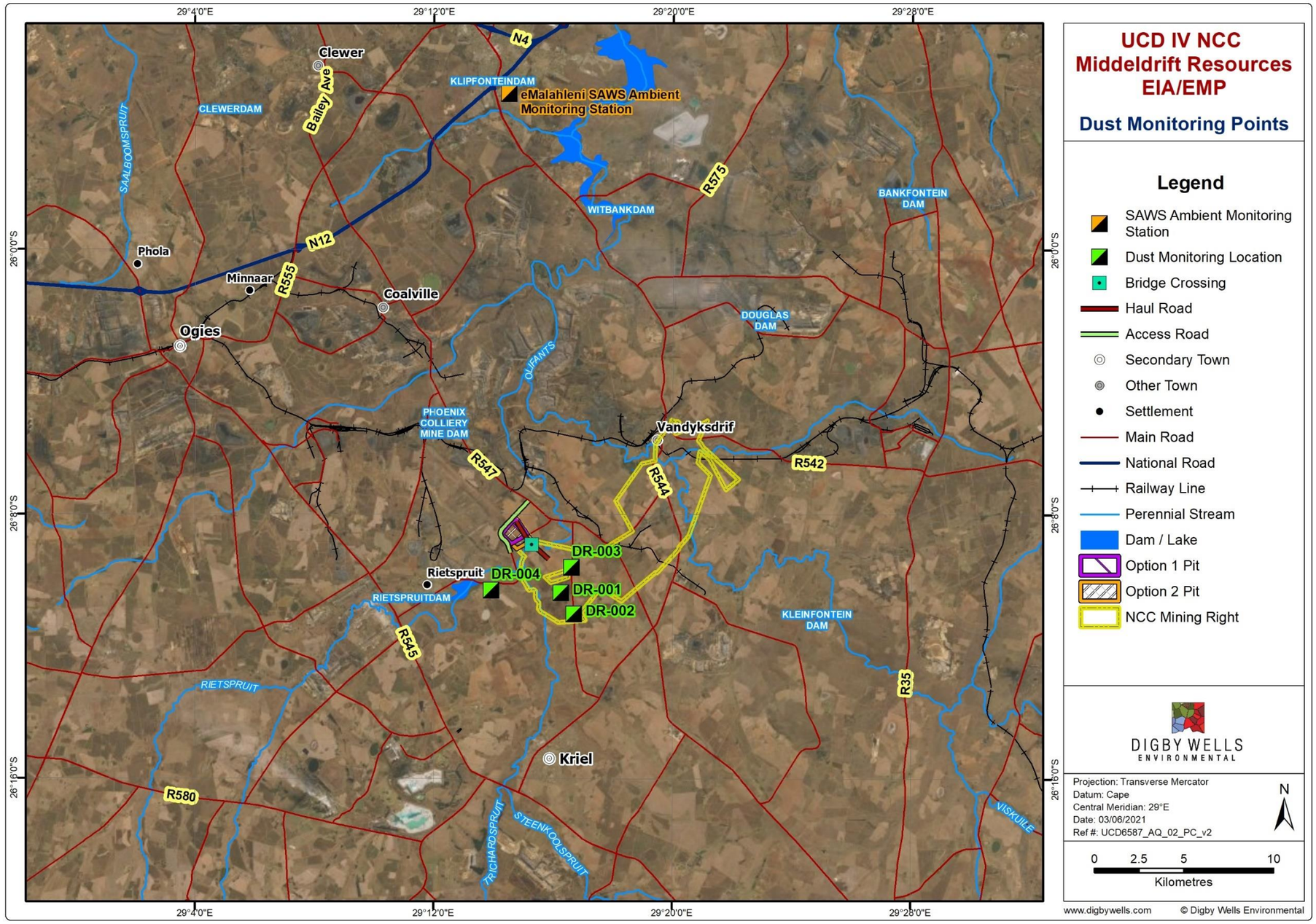


Figure 6-1: Project area Showing Surrounding Receptors and Dust Monitoring Locations

6.3. General Description of Climate in the Project Area

Site-specific mesoscale model (MM5) modelled meteorological data set for three years (2017-2019) obtained from Lakes Environmental Software was used to assess the prevailing weather conditions. The Pennsylvania State University / National Centre for Atmospheric Research (PSU/NCAR) MM5 is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model, which was designed to simulate or predict mesoscale atmospheric circulation. Meteorological data for a point in the proposed project area 18 km east southeast of Delmas (26.139658 S, 29.251925 E) was obtained. Data availability was 100%.

The meteorological data assessed encompasses temperature, relative humidity, wind speed, and direction, and are discussed below (Table 6-1).

6.3.1.1. Temperature

The monthly temperature (three-year average) is presented in Table 6-1 and Figure 6-2. The data indicate that the monthly temperature maximum varied between 18°C - 30°C, and the minimum between -0.2°C - 12°C. Ambient temperatures were observed to be higher during the summer months.

6.3.1.2. Relative Humidity

The relative humidity records (three-year average) ranged between 61% and 73% (Table 6-1 and Figure 6-3). Ravi et al., (2006)[1], investigated the effect of near-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 forms bridges between the soil grains and then the liquid-bridge bonding dominates, increasing the threshold friction velocity.

6.3.1.3. Rainfall

The total monthly rainfall records (three-years average) are provided in Table 6-1 and Figure 6-3. Based on the rainfall data, the summer months (December – February) received much of the rains (i.e. >66%), followed by Spring with 22% and Autumn with 11%. While winter (June – August), received less than 1% of rainfall.

[1] 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*

Table 6-1: Climate Statistics

Parameters		Three-year average												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temp. (◦C)	Max	29.7	28.1	27.5	25.8	20.4	17.9	18.0	21.4	25.3	28.2	28.6	30.4	25.1
	Min	8.5	11.6	10.3	7.3	3.2	0.2	-0.2	1.5	3.0	4.3	7.3	10.9	5.7
Rel. Hum. (%)		70	73	71	65	64	61	64	64	76	75	76	64	69
Total Mon. Rain (mm)		189	168	71	12	2	0	0	8	29	54	90	173	794

(Source: Lakes Environmental)

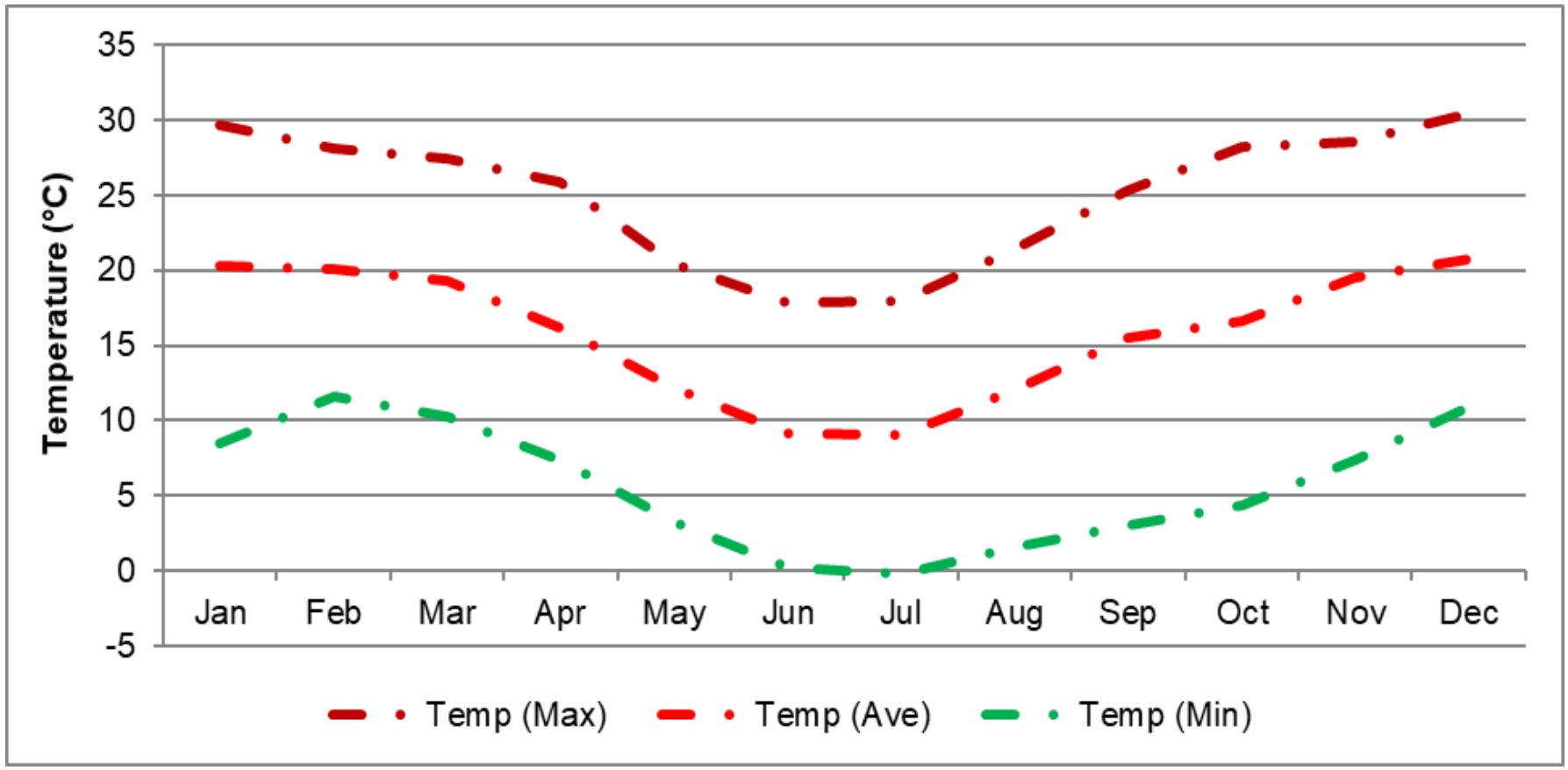


Figure 6-2: Temperature and Relative Humidity

(Source: Lakes Environmental)

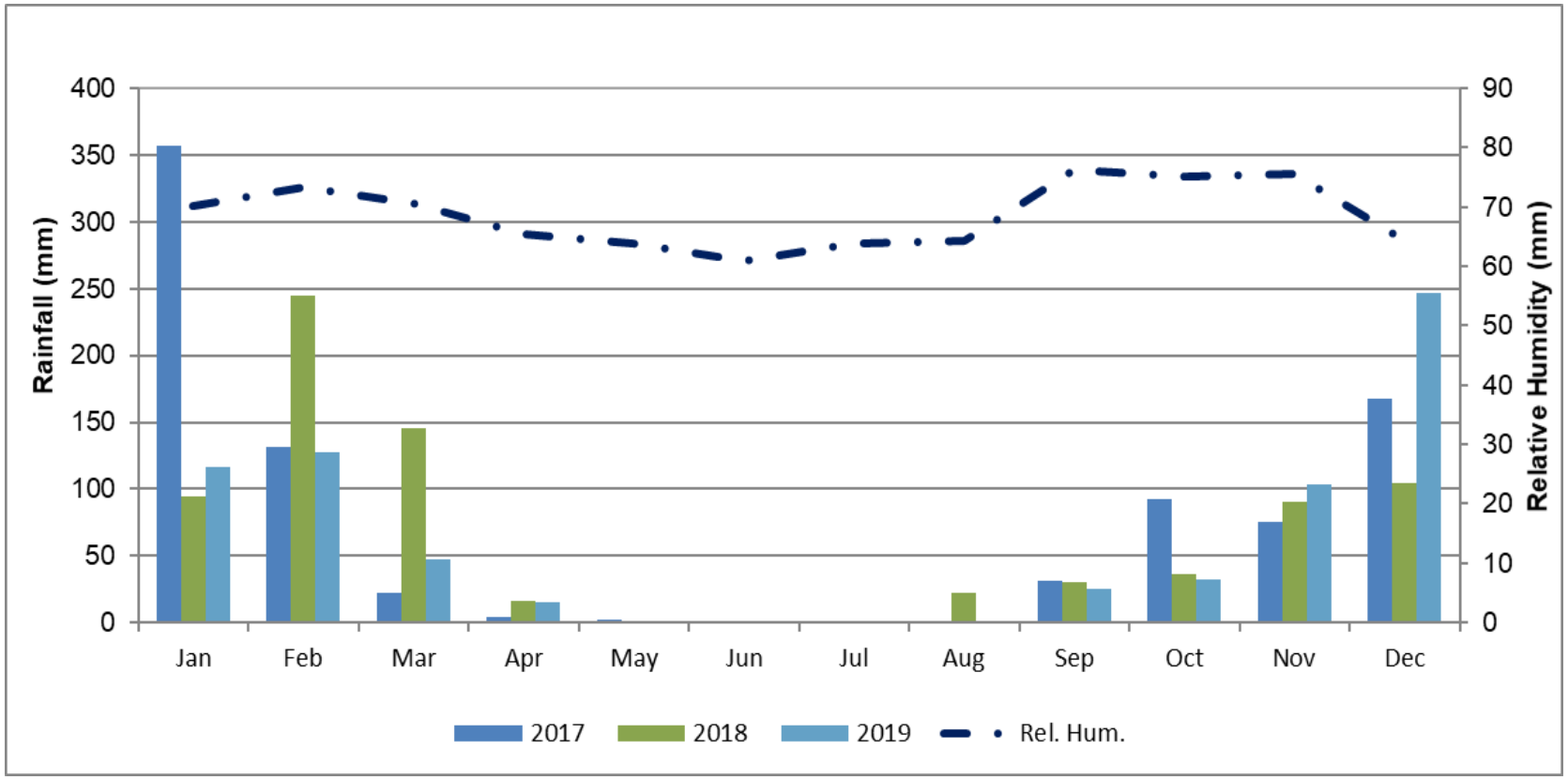


Figure 6-3: Rainfall and Relative Humidity

(Source: Lakes Environmental)

6.3.1.4. Wind Speed

Wind roses comprise 16 spokes which represent the directions from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence. The figure given at the bottom of the legend described the frequency with which calms conditions (wind speed below 0.5 m/s) occur.

Hourly meteorological data was analysed and used to understand the prevailing wind patterns in the project area. Data was used to assess the wind speed and wind direction regime on site. The diurnal, seasonal and periodic wind roses for the project area is depicted in (Figure 6-5).

The prevailing winds are from the northeast (10.5%) and north northwest (9.1%) respectively. Secondary contributions are from the northwest (8.4%) and east northeast (8.7%).

The average wind speed in the Project area is 3.1 m/s and calm conditions (<0.5 m/s) occurred for approximately 5.2% of the time. Wind speed capable of causing wind erosion i.e. ≥5.4 m/s occurred for about 6.7% of the time (Figure 6-4). This equates to approximately 25 days in a year.

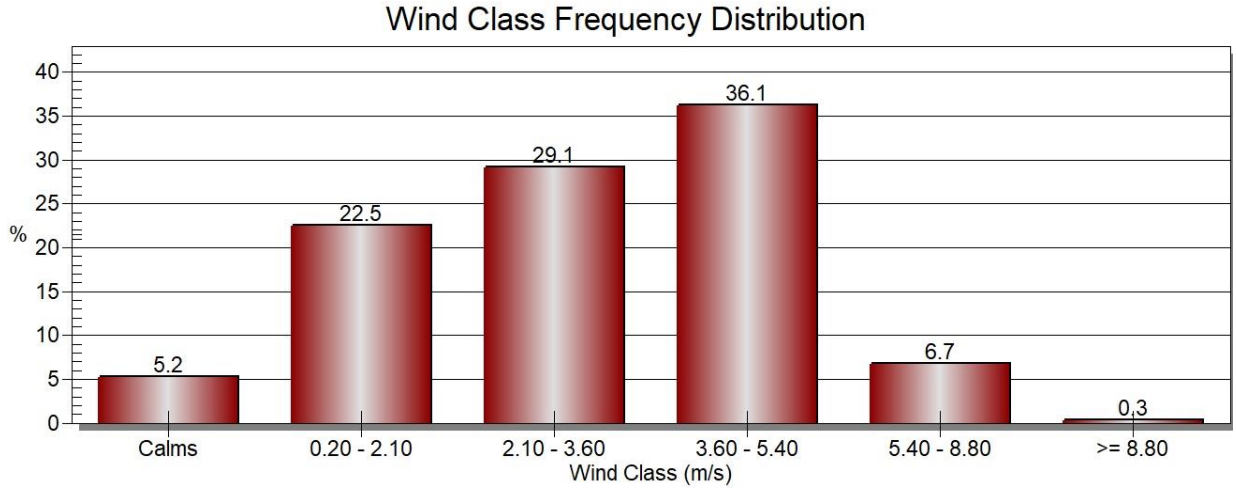
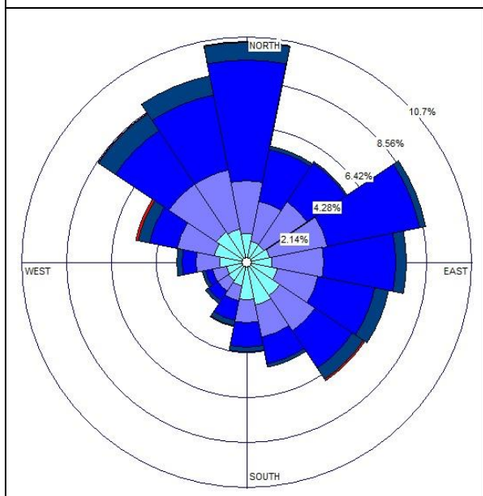
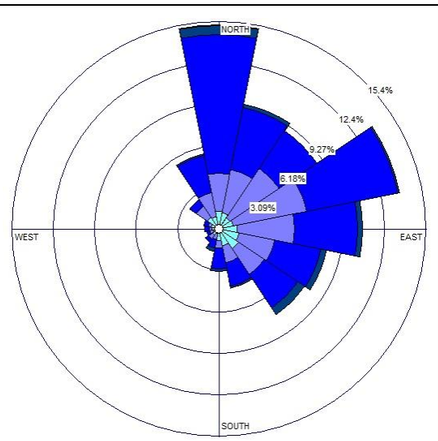
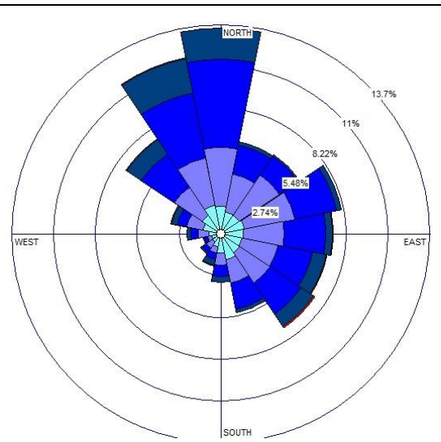
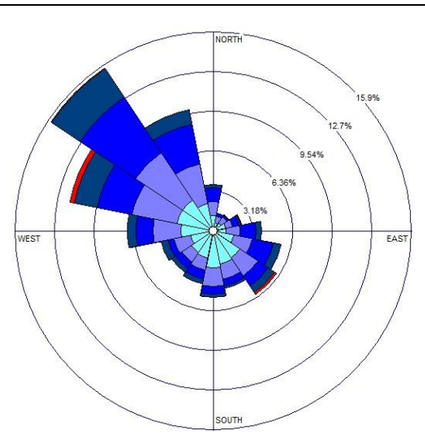
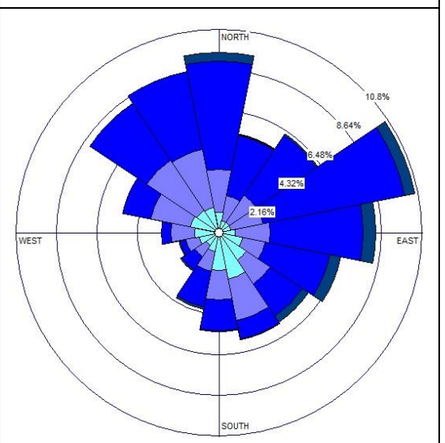


Figure 6-4: Wind Class Frequency

(Source: Lakes Environmental)

s

<table>
<tr><td>AERMET- Ready MM5</td><td colspan="4">Diurnal</td></tr>
<tr><td>January 2017 – December 2019</td><td>Night</td><td>Morning</td><td>Afternoon</td><td>Evening</td></tr>
<tr><td rowspan="2"> 
</td><td> 
</td><td> 
</td><td> 
</td><td> 
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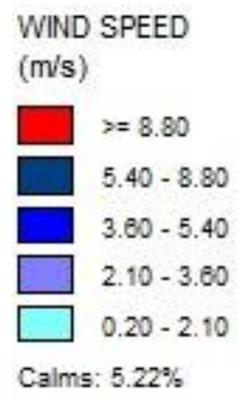
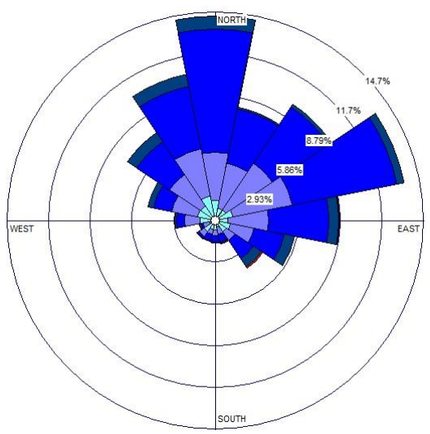
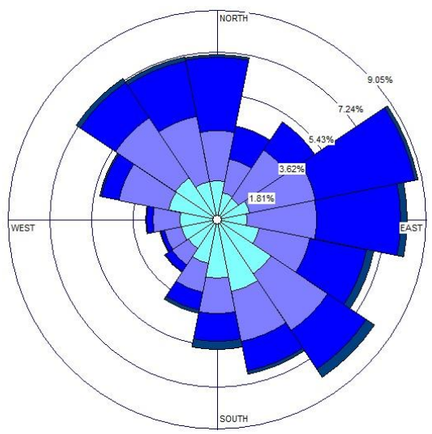
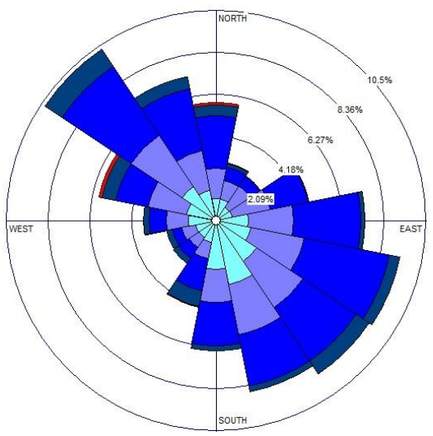
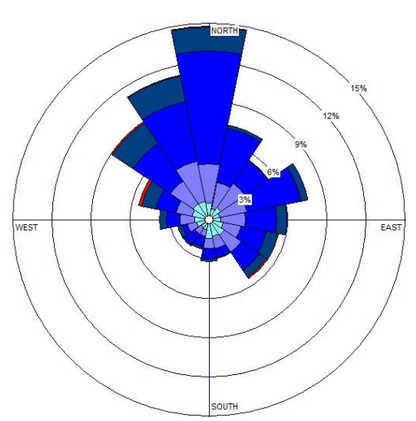
<tr><td rowspan="2"> 
</td><td>Summer</td><td>Autumn</td><td>Winter</td><td>Spring</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td><td> 
</td></tr>
</table>

Figure 6-5: Diurnal and Seasonal Wind Roses

(Source: Lakes Environmental)

6.3.2. Assessment of Existing Air Quality

Ambient air quality records measured onsite, south of the Middeldrift Resource footprint was used to assess the background scenario in this report. This is limited to dustfall measurements only, with no site-specific records for particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$) and gases, such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO).

The dustfall network has four monitoring locations labelled DR 001 to DR 004. The meaning of the acronym DR was not specified in any of the dust monitoring reports issued by Rayten Environmental and Engineering Consultants (Figure 6-1). The dustfall measurements were conducted following the ASTM D1739 (Reapproved 2017), "Standard Test Method for Collection and Measurement of Dust fallout (Settleable Particulate Matter)", 2019.

6.3.2.1. Dustfall

Data from a network of four dust monitoring locations operated by Rayten Engineering Solutions (Pty) Ltd (hereafter referred to as "Rayten") was used to assess the background scenario. These sites were designated as DR-001, DR-002, DR-003, and DR-004, and classified as non-residential. The data covered the period from January 2019 to October 2020 (Figure 6-6 and Figure 6-7).

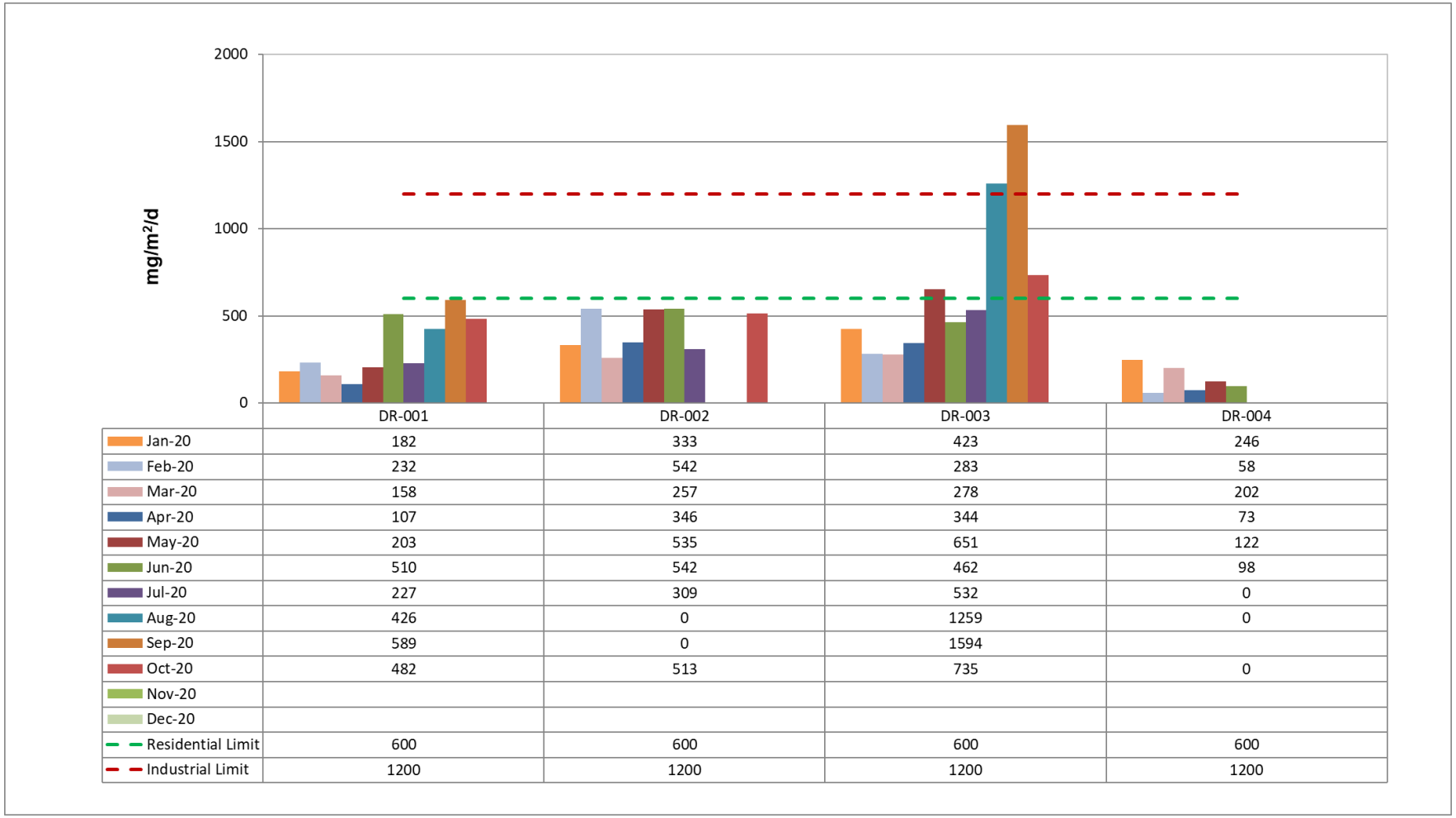
The dustfall rates were compared with the South African *Dust standards* (GN R 827 of 1 November 2013) for compliance. A summary of the results is presented below:

- With the sites classified as non-residential, no exceedance of the non-residential limit of 1 200 mg/m^2/d was recorded in 2019; and
- In 2020, site DR-003 recorded two exceedances of the non-residential limit in sequential months – August and September 2020. It was assumed that a localised dust-generating event resulted in the exceedances measured since the other sites were below the limit value.

Considering the distance of the monitoring locations from the project area, it is recommended that additional monitoring sites be commissioned once mining of the Middeldrift Resource commences.

	DR-001	DR-002	DR-003	DR-004
Jan-19	62	158	430	117
Feb-19	146	0	336	183
Mar-19	96	0	259	169
Apr-19	92	0	245	322
May-19	114	201	228	96
Jun-19	191	395	583	205
Jul-19	486	116	437	148
Aug-19	770	0	536	193
Sep-19	646	0	822	316
Sep-19	646	0	822	316
Oct-19	613	989	853	362
Nov-19	519	566	833	412
Dec-19	332	660	174	223
Residential Limit	600	600	600	600
Industrial Limit	1200	1200	1200	1200

Figure 6-6: Dustfall Measurements (Rayten, 2019)



	DR-001	DR-002	DR-003	DR-004
Jan-20	182	333	423	246
Feb-20	232	542	283	58
Mar-20	158	257	278	202
Apr-20	107	346	344	73
May-20	203	535	651	122
Jun-20	510	542	462	98
Jul-20	227	309	532	0
Aug-20	426	0	1259	0
Sep-20	589	0	1594	
Oct-20	482	513	735	0
Nov-20				
Dec-20				
Residential Limit	600	600	600	600
Industrial Limit	1200	1200	1200	1200

Figure 6-7: Dustfall Measurements (Rayten, 2020)

6.4. Air Quality Impact Assessment

The NEM: AQA regulation regarding Air Dispersion Modelling (GN R 533 of 11 July 2014) informed the assessment approach adopted. A Level 3 assessment was used, which required detailed meteorological geophysical and source input data.

6.4.1. Impact Assessment Approach

The approach used to determine the future impacts from the operational phase of the Project and related activities is provided in Figure 6-8.

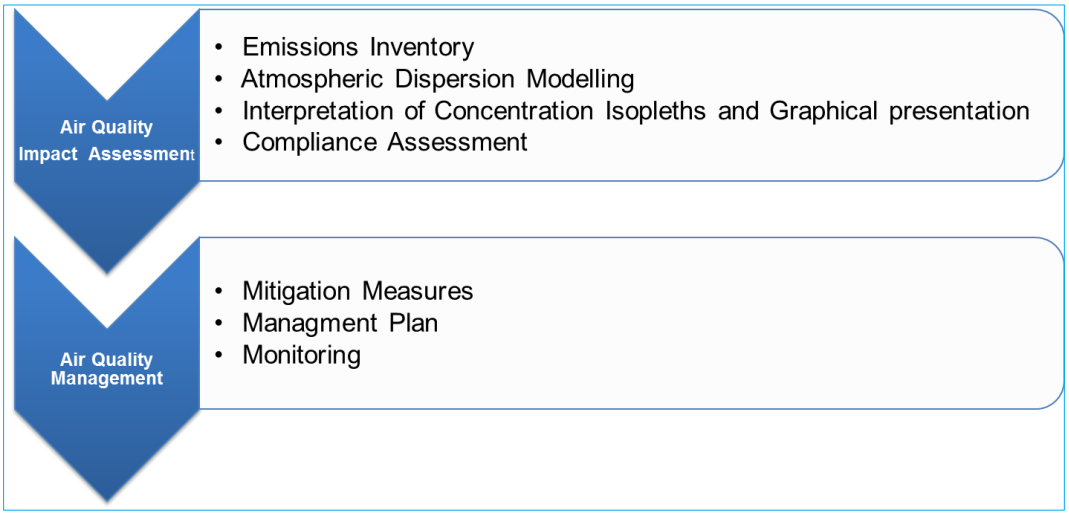


Figure 6-8: Air Quality Impact Assessment Approach

During the impact assessment, tasks completed includes the assessment of material data from the mine, development of an emissions inventory, followed by model simulations to predict Ground Level Concentration (GLC) of criteria pollutants. The model outputs were used to assess compliance with regulatory standards and inform the mitigation and management measures recommended, as well as monitoring requirements to assess the efficiency of the mitigation measures.

6.4.1.1. Emissions Inventory

The development of an emissions inventory forms the basis for any conceptual model. 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 that have been established at similar operations. The latter was followed, employing emission factors published by the USEPA in its *AP-42* "Compilation of Air Pollution Emission Factors" (USEPA, 1995; 1998; 2016) and Australian National Pollutant Inventory (*NPi*) "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 the pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. Such factors facilitate the 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 equations and parameters used in the calculations of the emissions anticipated from the various sources within the mine during operation are discussed in Table 6-2.

Table 6-2: 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 KTSP:0.74; KPM10:0.35 respectively. An average wind speed of 3.1 m/s was used based on the Lakes Environmental data for the period 2017 – 2019.	US-EPA AP42 Section 13.2.4	The moisture content of the materials are as follows: Ore: 4.5% 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 The particle size multiplier (k) is given as 0.15 for PM2.5 and 1.5 for PM10, and as 4.9 for TSP	US-EPA AP42 Section 13.2.2	Default silt content: Mine Road: 4.6% Hours of operation were assumed as 24 hrs per day, 7 days per week. The layout of the haul roads was assumed to be 20 m wide.

Activity	Emission Equation	Source	Information assumed/provided
	The empirical constant (a) is given as 0.9 for PM2.5 and PM10, and 4.9 for TSP The empirical constant (b) is given as 0.45 for PM2.5, PM10, and TSP		
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	Silt content: 6.9% (Assumed)
Drilling	$0.59 \frac{kg}{hole}$	NPI 1999	
Blasting	$0.000014(A)^{1.5}$	USEPA, 1998	Blasting two times a week (Assumed)
Crusher	Primar High moisture (TSP:0.01; PM10:0.004) Low moisture (TSP:0.2; PM10:0.02) Secondary High moisture (TSP:0.03; PM10:0.012) Low moisture (TSP:0.6; PM10:No data)	NPI EET Manual for Mining (NPI, 2012)	Low moisture content was assumed (≤ 4%)
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: Topsoil: 6.9% (Assumed) U = mean wind speed in m/s: 3.17 m/s M = moisture content (4 %) Coal: ≤ 4% moisture Overburden: ≤ 2.2% moisture
Processing Plant Dryer Exhaust	PM_{10}: mg/Nm^3 $PM_{2.5}$: mg/Nm^3		Parameters applied: Exit temperature:425.4°C Exit Velocity: 2.5 m/s Release height: 10 m Volumetric flow rate: 38,8 m^3/s

6.4.1.2. Air Quality Dispersion Modelling and Data Requirements

6.4.1.2.1. Meteorological Data Requirements

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.

An American Meteorological Society/United States Environmental Protection Agency Regulatory Model (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.

Three years' worth of MM5 modelled meteorological data were obtained from Lakes. This dataset consists of surface and upper air meteorological data required to run the dispersion model.

6.4.1.2.2. Modelling Domain

The AERMAP terrain pre-processor requires the user to define a modelling domain. The modelling domain is defined as the area that contains all the receptors and sources being modelled with a buffer, to accommodate any significant terrain elevations.

The influence of the terrain will vary with the source height and position and the local meteorology. Table 6-3 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: Digital elevation model 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:
  - Model inputs: source parameters (from permit application); boundary layer meteorology (from AERMET); and receptor data (from AERMAP).

Table 6-3: Summary of Meteorological and AERMET Parameters

Number of grids (spacing)	200 m
Number of grids points	121 x 121

Years of analysis	January 2017 to December 2019
Centre of analysis	Reedstream Park (26.139658 S; 29.251925 E)
Meteorological grid domain	20 km (east-west) x 20 km (south-north)
Station Base Elevation	1562 m
MM5-Processed Grid Cell (Grid Cell Centre)	26.139658 S; 29.251925 E
Anemometer Height	13 m
Sectors	The surrounding area land use type was cultivated
Albedo	0,33
Surface Roughness	0,27
Bowen Ratio	4,8
Terrain Option	Flat

6.4.1.3. Impact Assessment Ranking

Based on the predicted GLC of various pollutants and the spread across the mining landscape, the impact assessment ranking methodology in Appendix A was applied in rating the impacts of the project on the surrounding air quality.

7. Findings and Discussion

7.1. Baseline Results

The meteorology of the project area was assessed with three years' worth of data. The prevailing winds are from the northeast (10.5%) and north northwest (9.1%) respectively. Secondary contributions are from the northwest (8.4%) and east northeast (8.7%).

The average wind speed at the project area is 3.1 m/s and calm conditions (<0.5 m/s) occurred for some 5.2% of the time. Wind speed capable of causing wind erosion i.e. ≥5.4 m/s occurred for about 6.7% of the time (Figure 6-4). This equates to about 25 days in a year. Based on the statistics, twelve days in spring, seven days in winter, six days in summer, and two days in autumn experienced wind speed greater than 5.4 m/s.

The dustfall rates measured in the proposed project area from a network of four monitoring locations, designated as non-residential, recorded just two exceedances at DR-003. The latter was non-compliant as these exceedances occurred in sequential months (August 2020 and September 2020). In general, more than 97th percentile of the dustfall records measured were below the limit values of 1 200 mg/m^2/d.

7.2. Dispersion Model Simulation Results

The model results consist of a graphical presentation of GLC (in a unit of µg/m^3) for the different pollutants, and for dust deposition rates (mg/m^2/d). The daily averages were calculated as the 4th highest value (99th percentile). Annual averages were shown as the 1st highest value (100th percentile).

7.3. Isopleth Plots and Evaluation of Results

This section details the results from the dispersion model that was conducted for particulate matter emissions associated with $PM_{2.5}$, PM_{10} and dustfall from this project.

7.3.1. Predicted GLC of $PM_{2.5}$

The predicted GLC of $PM_{2.5}$ 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). The areas where the exceedance of the 24-hour standard of 40 µg/m³ will occur are confined within the Project area (Figure 7-1), and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard (see Table 7-1). The predicted annual GLC of $PM_{2.5}$ did not exceed the regulatory standard 40 µg/m³ within the Project area and at the selected receptors (Figure 6-1).

7.3.2. Predicted GLC of PM_{10}

The predicted GLC of PM_{10} over a 24-hour averaging period returned simulation isopleths shown in Figure 7-3 (PM_{10} daily) and Figure 7-4 (PM_{10} annual).

The areas where the 24-hour standard of 75 µg/m³ are likely to be exceeded are within the Project area and along the haul road. This can be seen in Figure 7-3 below. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard (see Table 7-1). The predicted annual isopleth showed that areas where exceedance will occur are confined to within the Project area (Figure 7-4).

7.3.3. Predicted Dustfall Rates

The predicted dustfall rates are shown in Figure 7-5 (with mitigation and without mitigation). The predicted dustfall rates confirmed that exceedances of the non-residential limit of 1,200 mg/m^2/d will occur. However, these exceedances will be mostly within the Project area. With mitigation or without mitigation measures in place, the operational phase of the project will not result in the exceedance of the non-residential limit at the selected sensitive receptors (Figure 6-1).

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)			
			DR-001	DR-002	DR-003	DR-004
$PM_{2.5}$ (No Mitigation)	Daily	40(1)	2.1	1.5	1.9	4.7
	Annual	20(1)	0.19	0.10	0.14	0.45
PM_{10} (No Mitigation)	Daily	75(1)	13.5	9.3	12.5	27.1
	Annual	40(1)	1.2	0.7	0.9	2.9
Dust Deposition Rates (mg/m²/day)						
Dust (No Mitigation)	Monthly	Non-residential (1200(2))	142	70	257	106
Dust (With Mitigation)			38	19	69	29

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

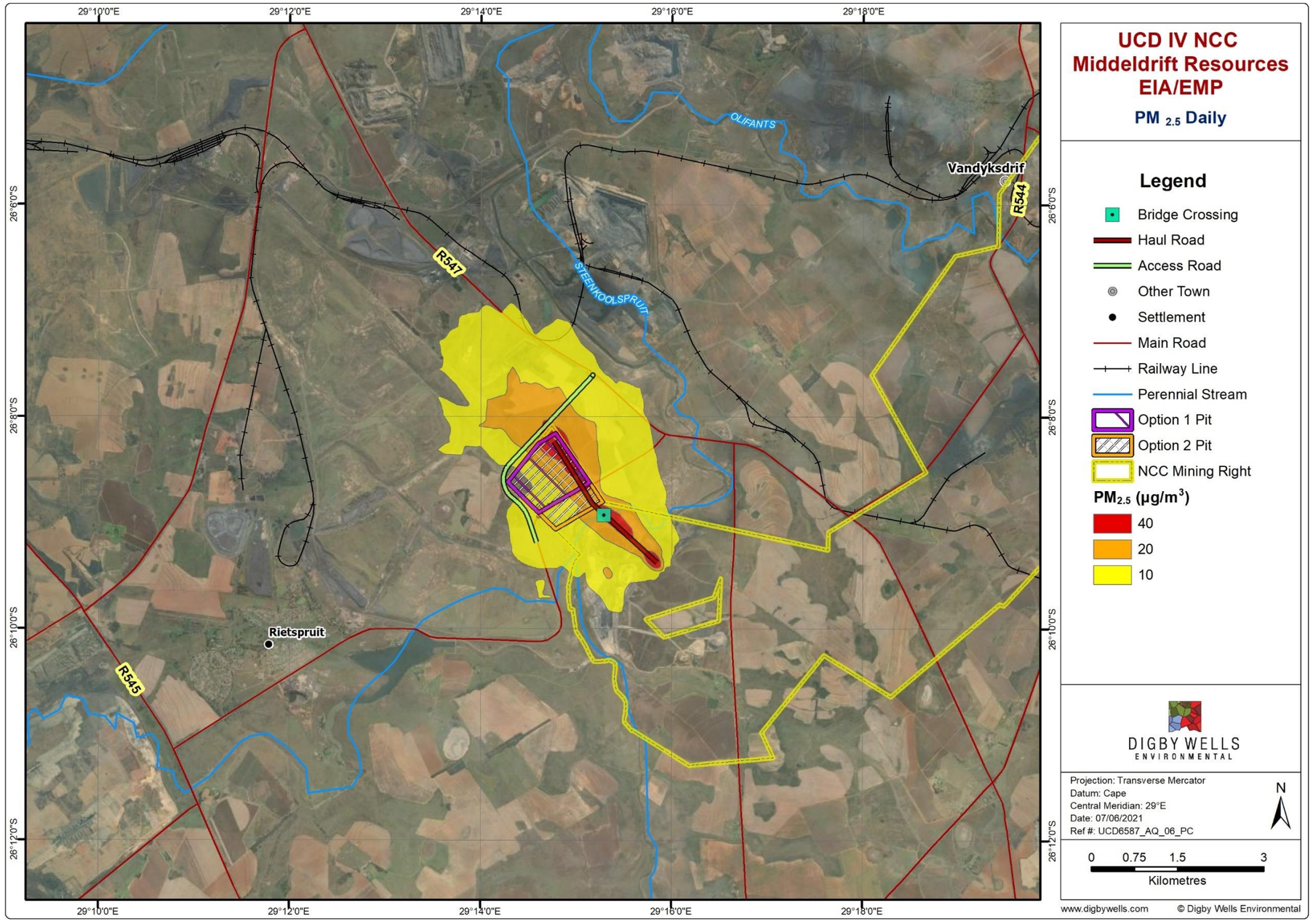


Figure 7-1: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ Concentrations (µg/m³)

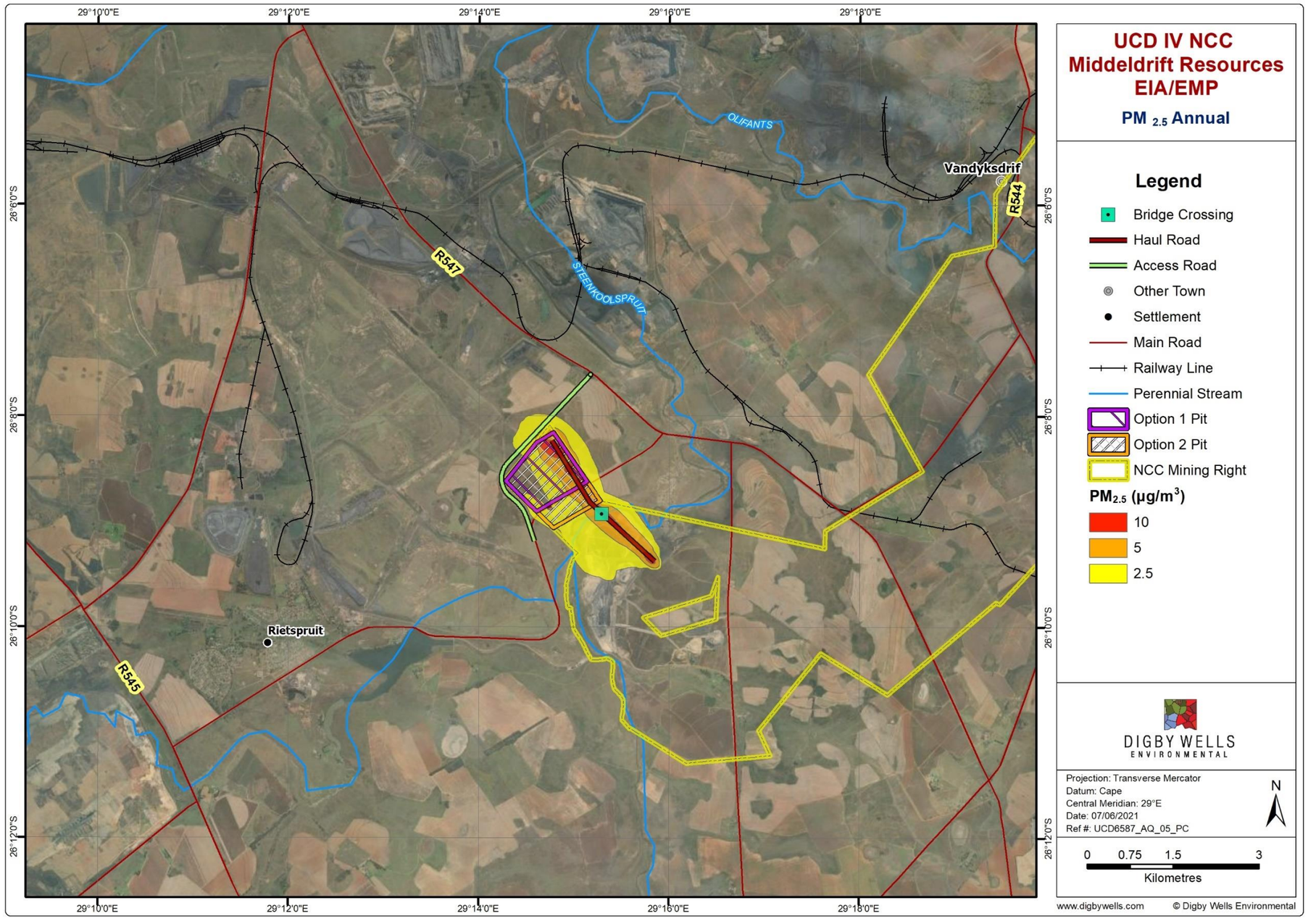


Figure 7-2: Predicted 1st highest (100th percentile) Annual PM2.5 Annual Concentrations (µg/m³)

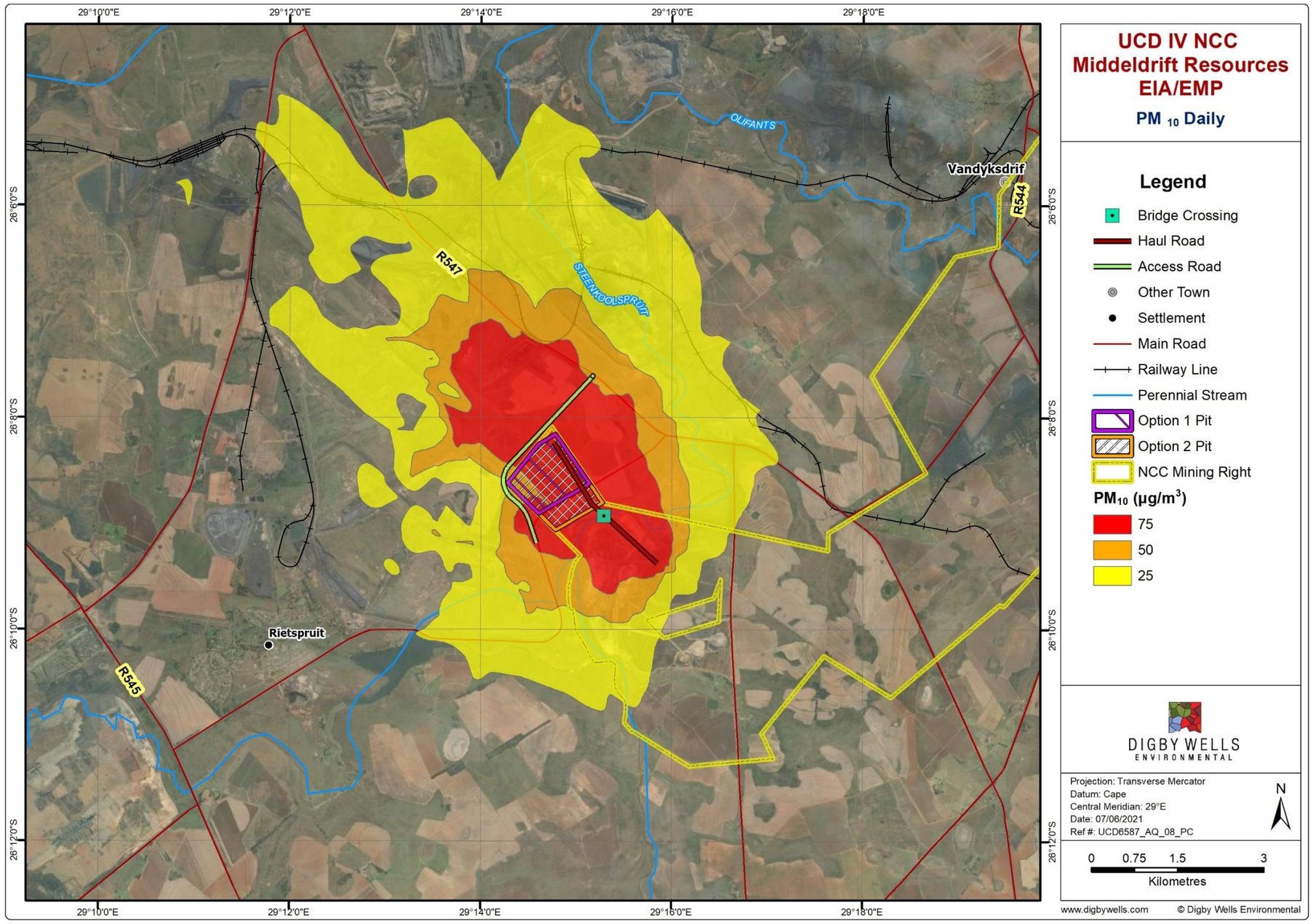


Figure 7-3: Predicted 4th highest (99th percentile) daily PM_{10} Concentrations (µg/m³)

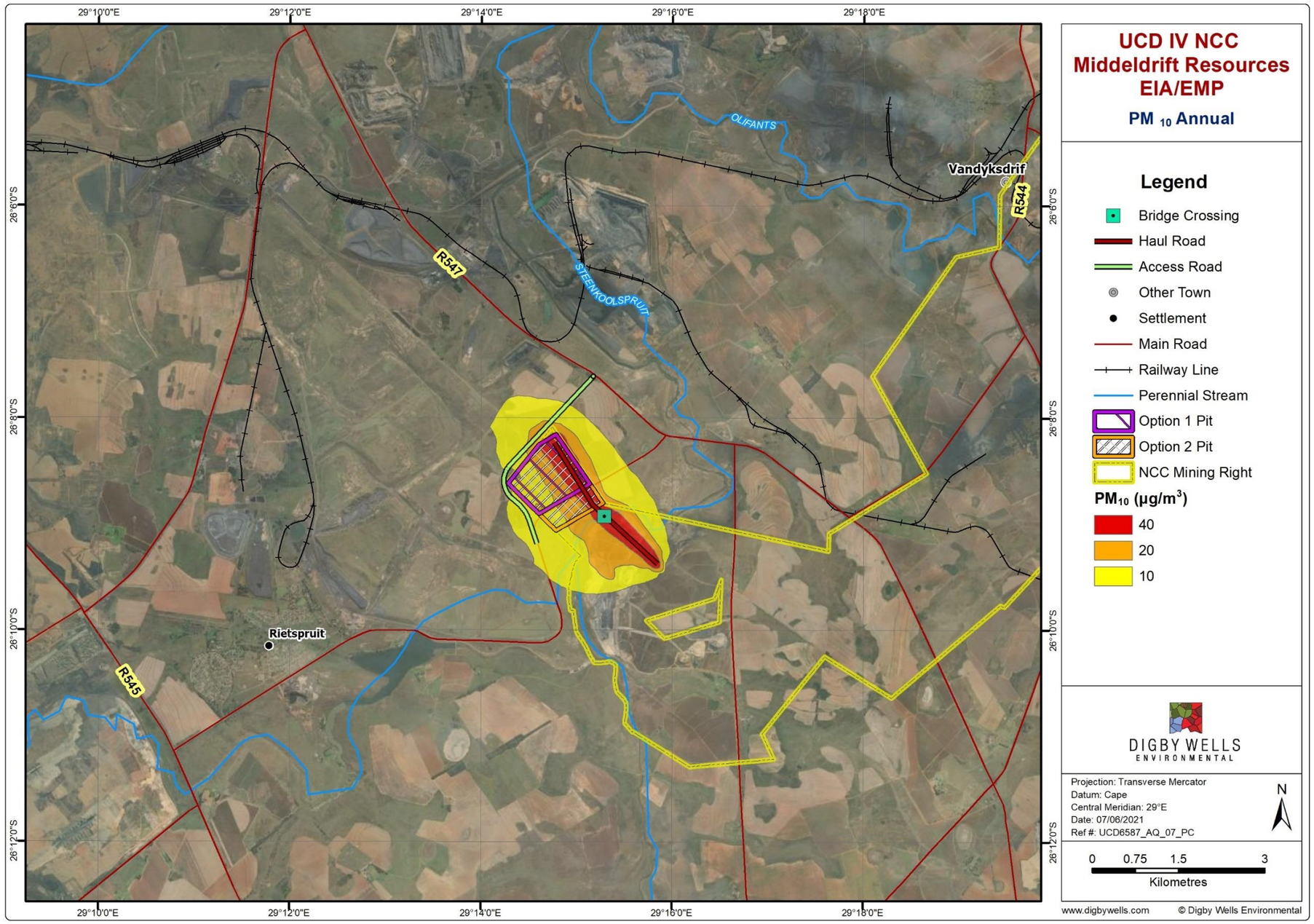


Figure 7-4: Predicted 1st highest (100th percentile) Annual PM_{10} Concentrations (µg/m³)

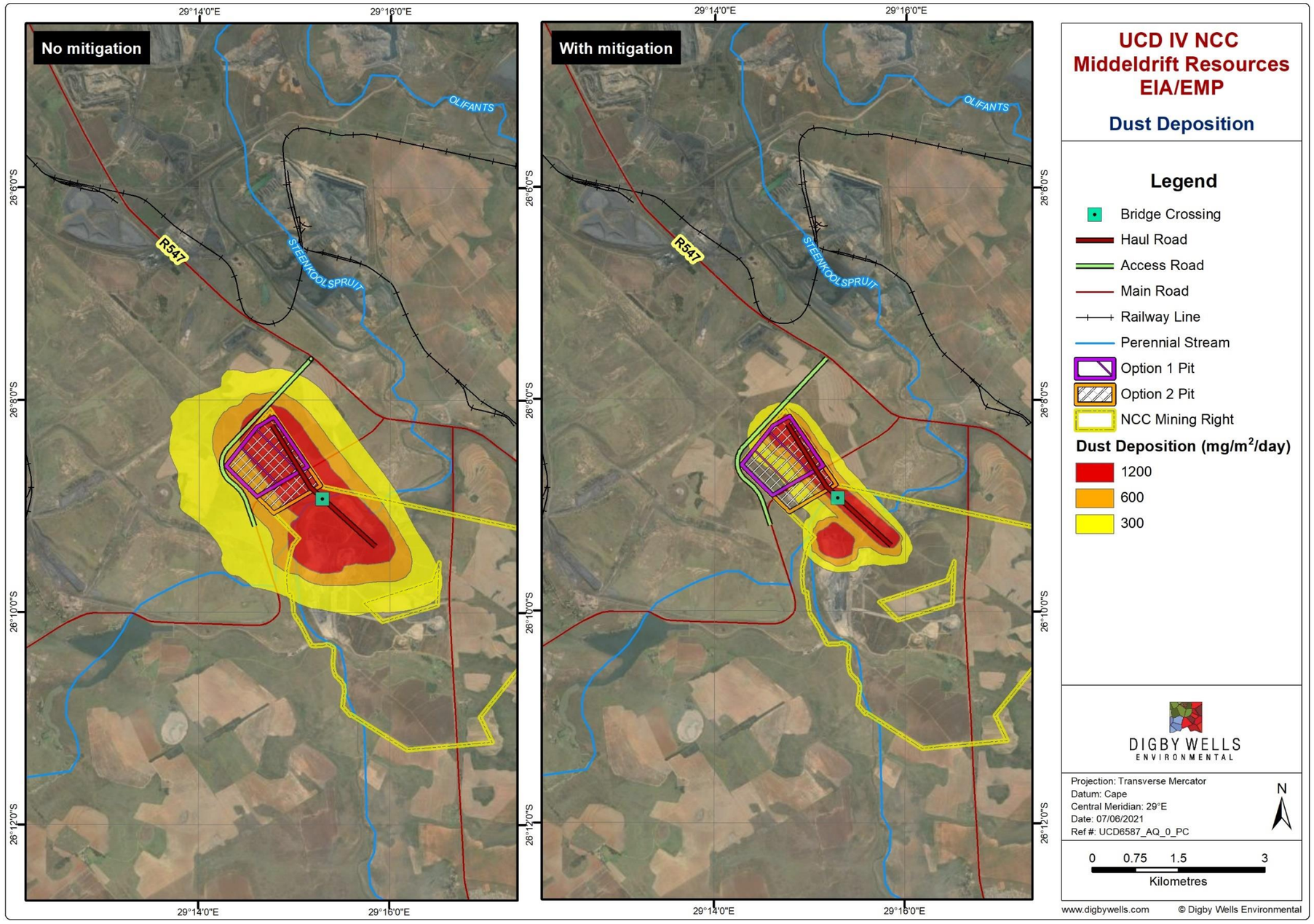


Figure 7-5: Predicted (100th percentile) Monthly TSP Deposition Rates (mg/m²/day) With and Without Mitigation

8. Discussions

The predicted GLC for the operational phase and associated Project risks have been appraised.

8.1. Findings

The findings presented here represent the worst-case scenario, i.e. Option 2 and without mitigation measures factored into the model runs, except for the dust deposition rates. The findings of this air quality study are summarised as follows:

- The areas where the exceedance of the 24-hour standard of 40 µg/m³ will occur are confined within the project area and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard. The predicted annual GLC of $PM_{2.5}$ did not exceed the regulatory standard 40 µg/m³ project area and at the selected receptors;
- The areas where the 24-hour standard of 75 µg/m³ are likely to be exceeded are within the project area and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard. The predicted annual isopleth showed that areas, where exceedance will occur, are confined to within the project area; and
- The predicted dustfall rates confirmed that exceedances of the non-residential limit of 1,200 mg/m^2/d will occur. However, these exceedances will be mostly within the project area. With mitigation or without mitigation measures in place, the operational phase of the project will not result in the exceedance of the non-residential limit at the selected sensitive receptors.

9. Impact Assessment Ranking

The impact assessment ranking methodology in Appendix A was applied in rating the implications of the different phases of the Project on the ambient air quality of the area.

9.1. Construction Phase

Activities during the Construction Phase that may have potential implications on the ambient air quality in the project area and surroundings i.e. increasing pollutant levels in the atmosphere are indicated in Table 9-1.

Table 9-1: Interactions and Impacts of Activity

Interaction	Impact
Site/vegetation clearance	• Generation of dust • Increased particulate matter load in the atmosphere leading to poor air quality • Soiling of surfaces due to dustfall
Access and haul road construction	
Topsoil Stockpiling	

9.1.1. Impact Description

The Construction Phase activities will occur in phases and will be short-term in nature. Therefore, the anticipated impacts will be negligible.

Site clearance, construction of access and haul roads and topsoil stockpiling activities will result in the generation of fugitive dust comprising of TSP, $PM_{10,}$ and $PM_{2.5}$. Excavation, loading, and offloading of construction material during this phase will result in the entrainment of dust. These activities will occur in phases, will be short-term and localised in nature, and will have low impacts on the ambient air quality.

9.1.1.1. Management Objectives

The management objective is to ensure that emissions on-site and at 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 to ensure that emissions remain below limit values and in compliance with the relevant standards.

9.1.1.2. Management Actions

- Air quality monitoring at upwind, onsite, downwind locations and at sensitive receptors; and
- Application of dust suppressants e.g. Dust-A-Side on haul roads and exposed areas to suppress dust from being airborne.

9.1.1.3. Impact Ratings

The construction phase activities will require similar mitigation measures to contain emissions to the atmosphere, hence these activities are grouped for the rating (Table 9-2).

Table 9-2: Significance Ratings for Site Clearing, Construction of Haul Road and Topsoil Stockpiling

Activity and Interaction: Site Clearing, Construction of Haul Roads and Topsoil Stockpiling			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Reduction in ambient air quality			
Prior to mitigation/ management			
Duration	Short term (1)	Dust will be generated for the duration of each activity in the construction phase	Negligible (negative) – 20
Extent	Limited (2)	Limited to the project area and immediate surroundings.	
Intensity	Minor (2)	Minor implications on the surrounding air quality	
Probability	Probable (4)	Probable that generated dust may impact ambient air quality.	
Nature	Negative		
Mitigation/ Management actions			
• Limit activity to non-windy days (wind speed less than 5.4 m/s); • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • Application of dust suppressant on the haul roads and exposed areas; • Set maximum speed limits on haul roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • Rehabilitation of disturbed land to allow for vegetation growth.			
Post- mitigation			
Duration	Short term (1)	Dust will be generated for the duration of each activity in the construction phase	Negligible (negative) – 12
Extent	Very Limited (1)	After mitigation measures are implemented, It is expected that the dust generated will be limited to isolated parts of the site.	
Intensity	Minimal (1)	Generated dust will have negligible impacts on the ambient air quality after mitigation	
Probability	Probable (4)	Probable that the impact on ambient air quality will occur.	
Nature	Negative		

9.2. Operational Phase

The Operational Phase activities that will be conducted with implications on the ambient air quality of the Project site and surroundings i.e. increasing emission to the ambient atmosphere are indicated in Table 9-3.

Table 9-3: Interactions and Impacts of Activity

Interaction	Impact
Open-pit development	• Generation of dust • Increased particulate matter load in the atmosphere leading to poor air quality • Soiling of surfaces due to dustfall
Removal of rock (blasting)	
Stockpiling of topsoil	
Use of haul road	
Operation of the plant	

9.2.1. Impact Description

The open-pit development, blasting and hauling of materials from the pit to the Run of Mine (ROM), dump and the Universal Coal NCC plant (for screening and crusher circuit) will result in the emission of particulate matter to the atmosphere.

9.2.1.1. Management Objectives

The management objective is to ensure that emissions on-site and at 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 to ensure that emissions remain below limit values and in compliance with the relevant standards.

9.2.1.2. Management Actions

- Air quality monitoring at upwind, onsite and downwind locations; and
- Application of dust suppressants e.g. Dust-A-Side on haul roads and exposed areas to ensure compliance.

9.2.1.3. Impact Ratings

The operational phase activities will require similar mitigation measures to contains emissions from sources to the atmosphere, hence these are grouped for the rating (Table 9-4).

Table 9-4: Significance Ratings for Development of the Pit, Removal of Rock, Stockpiling of Topsoil, Use of Haul Road, and Operation of the Plant

Activity and Interaction: Establishment of Open Pit, Removal of Rock, Stockpiling of Topsoil, Use of Haul Road and Operation of the Plant			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Dust generation and reduction in ambient air quality			
Prior to mitigation/ management			
Duration	Project life (5)	Dust will be generated for the project life	Minor (negative) – 60
Extent	Local (3)	Airborne dust will extend the development site	
Intensity	Very Serious (3)	Serious impact on ambient air quality	
Probability	Almost certain (6)	It is almost certain that the impact will occur.	
Nature	Negative		
Mitigation/ Management actions			
• Limit activity to non-windy days (wind speed less than 5.4 m/s); • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • Application of dust suppressant on the haul roads and exposed areas; • Set maximum speed limits on haul roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • The enclosure of the screening and crushing circuit			
Post- mitigation			
Duration	Project life (5)	Dust will be generated for the project life	Minor (negative) – 36
Extent	Limited (2)	Airborne dust will be limited to the project area and its immediate surrounding after mitigation.	
Intensity	Minor (2)	Minor impacts anticipated after mitigation	
Probability	Probable (4)	Probable that impact will occur after mitigation.	
Nature	Negative		

9.3. Decommissioning Phase

Activities during the Decommissioning Phase that may have potential impacts on the ambient air quality in the project area and surroundings are indicated in Table 9-5.

Table 9-5: Interactions and Impacts of Activity

Interaction	Impact
Demolition and removal of infrastructure	• Generation of dust • Increased particulate matter load in the atmosphere leading to poor air quality • Soiling of surfaces due to dustfall
Rehabilitation (spreading of the preserved subsoil and topsoil, profiling of the land and re-vegetation)	
Post-closure monitoring and rehabilitation	

9.3.1. Impact Description

The dismantling of mine infrastructure and rehabilitation activities which will include spreading of subsoil and topsoil, profiling, and re-vegetation of the project area will involve the use of heavy machinery and vehicles similar to those used in the construction phase. This will result in the release of fugitive emissions, such as TSP, $PM_{10,}$ and $PM_{2.5}$.

9.3.1.1. Management Objectives

The management objective is to ensure that emissions on-site and at 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 to ensure that emissions remain below limit values and in compliance with the relevant standards.

9.3.1.2. Management Actions

- Air quality monitoring at upwind, onsite and downwind locations; and
- Application of dust suppressants e.g. Dust-A-Side on haul roads and exposed areas to ensure compliance.

9.3.1.3. Impact Ratings

The decommissioning phase activities will require similar mitigation measures to those employed during the construction phase. The impact rating for this phase is discussed in Table 9-6.

Table 9-6: Significance Ratings for Demolition and Removal of Infrastructure and Rehabilitation of the Project area

Activity and Interaction: Demolition and Removal of Infrastructure and Rehabilitation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Dust generation and reduction in ambient air quality			
Prior to mitigation/ management			
Duration	Medium-term (3)	Dust will be generated in the medium term for the duration of each activity in the decommissioning phase	Negligible (negative) – 28
Extent	Limited (2)	Limited to the project area and immediate surroundings.	
Intensity	Minor (2)	Minor effect on surrounding air quality	
Probability	Probable (4)	Probable that generated dust may impact ambient air quality.	
Nature	Negative		
Mitigation/ Management actions			
• Limit activity to non-windy days (wind speed less than 5.4 m/s); • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • Application of dust suppressant on the haul roads and exposed areas; • Set maximum speed limits on haul roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • Rehabilitation of disturbed land to allow for vegetation growth.			
Post- mitigation			
Duration	Medium-term (3)	Dust will be generated in the medium term for the duration of each activity in the decommissioning phase	Negligible (negative) – 20
Extent	Very Limited (1)	After mitigation measures are implemented, It is expected that the dust generated will be limited to isolated parts of the site.	
Intensity	Minimal (1)	Generated dust will have minimal impacts on the ambient air quality after mitigation	
Probability	Probable (4)	Probable that an impact on ambient air quality will occur.	
Nature	Negative		

9.4. Cumulative Impacts

Historical dustfall records for the proposed project area are available for sensitive receptor sites DR-001 to DR-004 were used to evaluate cumulative impacts. The averages over the twenty-two months period at DR-001 (142 mg/m^2/d), DR-002 (70 mg/m^2/d), DR-003 (257 mg/m^2/d) and DR-004 (106 mg/m^2/d) were taken as the background to which the model predicted dust deposition rates from the same locations were added (**model prediction + the background**). The final cumulative levels were lower than the limit value of 1 200 mg/m^2/d as depicted in Table 9-7. So the operational phase of the Project will not result in non-compliant impacts at the designated receptors.

Table 9-7: Comparison of Modelled to Baseline Data

Pollutants	Averaging Period	Location	Regulatory Limit	Dust Deposition Rates (mg/m^2/d)		
				Model (No-Mitigation)	Background	Total
Dustfall	Monthly	DR-001	1200 mg/m^2/d (Non-Res. Limit)	142	327	**469**
		DR-002		70	294	**364**
		DR-003		257	559	**816**
		DR-004		106	169	**275**

9.5. Unplanned and Low Risk Events

Table 9-8 highlights some likely unplanned events related to this Project. This was based on expert knowledge drawn from the related industry. Data on the type of incidents and frequency will assist in establishing the nature, risk type, geographic spread, and appropriate mitigation measures to curtail impacts in the event of an occurrence.

Table 9-8: Unplanned Events and Associated Mitigation Measures

Unplanned Risk	Mitigation Measures
Extreme wind erosion event	Adequate cover and care for storage facilities which will serve as protection during an unplanned event – dust storm episode Exposed areas prone to erosions should be avoided or minimised at all times

10. Environmental Management Plan

Table 10-1 provides a summary of the proposed project activities, environmental aspects, and impacts on the receiving environment. Information on the mitigation measures, mitigation type, timing of implementation of the Environmental Management Plan (EMP) are specified.

Table 10-1: Environmental Management Plan

Activity	Potential Impacts	Aspects Affected	Phase	Mitigation Measures	Mitigation Type	Time period for implementation
• Site clearing; • Access and haul road construction; and • Topsoil stockpiling.	Poor air quality due to the generation of dust	Air Quality	Construction	• As far as possible, ilmit activity to non-windy days (wind speed less than 5.4 m/s); • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • Application of dust suppressant on the haul roads and exposed areas; • Set maximum speed limits on haul roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • Rehabilitation of disturbed land to allow for vegetation growth.	• Control through the implementation of an air quality management plan; • Dust control measures; and • Ambient air quality monitoring	On commencement of the construction phase and for the duration of the phase
• Open-pit development; • Removal of rocks; • Stockpiling of topsoil; • Use of haul road; and • Operation of the plant.	Poor air quality due to the generation of dust	Air Quality	Operation	• As far as possible, limit activity to non-windy days (wind speed less than 5.4 m/s); • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • Application of dust suppressant on the haul roads and exposed areas; • Set maximum speed limits on haul roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • The enclosure of the screening and crushing circuit	• Control through the implementation of an air quality management plan; • Dust control equipment; and • Ambient air quality monitoring.	Measurements must commence before the start of the operation phase and for the LOM.

Activity	Potential Impacts	Aspects Affected	Phase	Mitigation Measures	Mitigation Type	Time period for implementation
• Dismantling and removal of infrastructure • Rehabilitation of the project area • Post-closure monitoring and rehabilitation	Poor air quality due to the generation of dust	Air Quality	Decommissioning	• Limit activity to non-windy days (wind speed less than 5.4 m/s); • The area of disturbance must be kept to a minimum at all times and no unnecessary clearing, digging or scraping must occur, especially on windy days; • Application of dust suppressant on the haul roads and exposed areas; • Set maximum speed limits on haul roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • Rehabilitation of disturbed land to allow for vegetation growth.	• Control through the implementation of an air quality management plan; • Dust control measure; and • Ambient air quality monitoring	On commencement of the decommissioning phase and for the duration of the phase

11. Monitoring Programme

It is recommended that the historic dustfall monitoring network (DR-001 to DR-004) be maintained to ensure the regular collection of baseline data for the LOM. In addition, five dustfall monitoring sites can be commissioned. Table 11-1 shows the method and the frequency of monitoring, as the dispersion model do not justify setting up a real-time monitor to assess fine particulate component – PM_{10} and $PM_{2.5}$.

Table 11-1: Recommended Monitoring Plan

Monitoring Element	Comment	Frequency	Responsibility
Fine particulate matter monitoring (i.e. PM_{10} and $PM_{2.5}$); Dustfall monitoring	The reference method for the determination of $PM_{2.5}$ fraction (EN 14907); The reference method for the determination of PM_{10} fraction (EN 12341); Dustfall monitoring in accordance with the American Standard Test Method ASTM 1739-98 in SANS1137:2019	• Continuous for $PM_{2.5}$ and PM_{10}; • Monthly for dustfall	A designated Environmental Officer (EO) onsite to collect ambient air quality data and submit it to an independent consultant for interpretation and reporting. The reports are submitted to the South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP) in accordance with the National Atmospheric Emission Reporting Regulations (GN R 283 of 2 April 2015)

12. Stakeholder Engagement Comments Received

In terms of comments related to the potential impacts from the Project on air quality, nothing has been received from Interested and Affected Parties (I&APs). If, in future, concerns are raised, these concerns will be documented in line with the prescribed regulatory requirements.

13. Recommendations

Based on the results presented in this report, the following recommendations should be applied once operation commences:

- Revamp the dustfall monitoring network to include additional five dust monitoring locations for the LOM;
- Designate a qualified person to act as the EO to oversee implementation of mitigation measures and assess the efficiency of such measures regularly;
- Ensure air quality information is incorporated into the environmental management information system and submit annual reports to the South African Atmospheric Emission Licensing & Inventory Portal (SAAELIP), as required by law;

- Establish codes of practice for good housekeeping concerning dust management and mitigation, including regular appropriate restrictions on vehicle movements and speeds;
- Use of mitigation equipment at the CHPP; and
- Monitor the air quality management measures and information to ensure that adopted mitigation measures are sufficient to achieve current air quality standards at the project area and nearby receptors.

14. Reasoned Opinion Whether Project Should Proceed

The historical dustfall rates measured in the proposed project area was used to understand the baseline air quality scenario. In general, more than 97th percentile of the dustfall rates measured were below the non-residential limit values.

Based on the model predictions, the areas where exceedances are likely to occur will be confined within the project area. As depicted with the dust deposition isopleths, the predicted impacts can be minimised with adequate mitigation measures factored into the daily operations once mining commences.

Overall, assuming the dustfall status quo established with the historical records are not altered significantly, the model results show cumulative impacts will not result in exceedance impacts at the selected sensitive receptors. With appropriate mitigation measures and management measures in place, it is anticipated that mining of the Middeldrift Resources will not result in non-compliance at the sensitive receptors. The air quality specialist will recommend that the application be approved, provided the recommended mitigation measures are implemented.

15. Conclusion

The meteorology of the project area was assessed with three years' worth of data. The prevailing winds are from the northeast (10.5%) and north northwest (9.1%) respectively. Secondary contributions are from the northwest (8.4%) and east northeast (8.7%).

The average wind speed at the project area is 3.1 m/s and calm conditions (<0.5 m/s) occurred for some 5.2% of the time. Wind speed capable of causing wind erosion i.e. ≥5.4 m/s occurred for about 6.7% of the time (Figure 6-4). This equates to about 25 days in a year. Based on the statistics, twelve days in spring, seven days in winter, six days in summer, and two days in autumn experienced wind speed greater than 5.4 m/s.

The dustfall rates measured in the proposed project area from a network of four monitoring locations, designated as non-residential, recorded just two exceedances at DR-003. The latter was non-compliant as these exceedances occurred in sequential months (August 2020 and September 2020). In general, more than 97th percentile of the dustfall records measured were below the limit values of 1 200 mg/m^2/d.

Potential emissions from the operational phase of the Project were assessed. Model simulations of GLC of criteria pollutants were generated, for different averaging periods as

recommended by the regulatory authorities and compared with the South African standards to ascertain compliance.

The findings of this air quality study are summarised as follows:

- The areas where exceedance of the 24-hour standard of 40 µg/m³ will occur are confined within the project area, and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard. The predicted annual GLC of $PM_{2.5}$ did not exceed the regulatory standard 40 µg/m³ within the project area and at the selected receptors.
- The areas where the 24-hour standard of 75 µg/m³ are likely to be exceeded are within the project area and along the haul road. The predicted GLCs at the sensitive receptors (DR-001 to DR-004) were lower than the daily standard. The predicted annual isopleth showed that areas where exceedance will occur are confined to within the project area.
- The predicted dustfall rates confirmed that exceedances of the non-residential limit of 1,200 mg/m^2/d will occur. However, these exceedances will be mostly within the project area. With mitigation or without mitigation measures in place, the operational phase of the project will not result in the exceedance of the non-residential limit at the selected sensitive receptors.

The impacts of the proposed Project were evaluated using a risk matrix that considers the nature, significance, extent, duration, and probability of impacts occurring. Based on this rating system, impacts on the surrounding receptors from the operational phase are deemed “minor negative” without mitigation. However, with mitigation, the impacts rating score was reduced to almost half but the rating remained “minor”. Although anticipated emissions from the operational phase activities are not likely to influence receptors outside the project area, it is recommended that the mitigation and management intervention measures be adhered to on commencement of operation.

For emphasis, the possible mitigation measures and management intervention measures recommended include, but are not limited to:

- Application of dust suppressants on haul roads and exposed areas, setting maximum speed limits on haul roads and to have these limits enforced, and application of mitigation technology CHPP; and
- Operation of ambient air quality monitoring network to amass valuable site-specific data needed to assess the effectiveness of mitigation measures put in place during operation.

Once the mine implements the recommended mitigation measures outlined in this report, associated emissions can be contained to below standards, ensuring compliance with regulatory requirements.

16. References

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Appendix A: 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 16-1. 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 16-2, which is extracted from Table 16-1. The description of the significance ratings is discussed in Table 16-3.

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 16-1: 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 16-2: Probability/Consequence Matrix

Probability	Significance																																						
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 16-3: 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)