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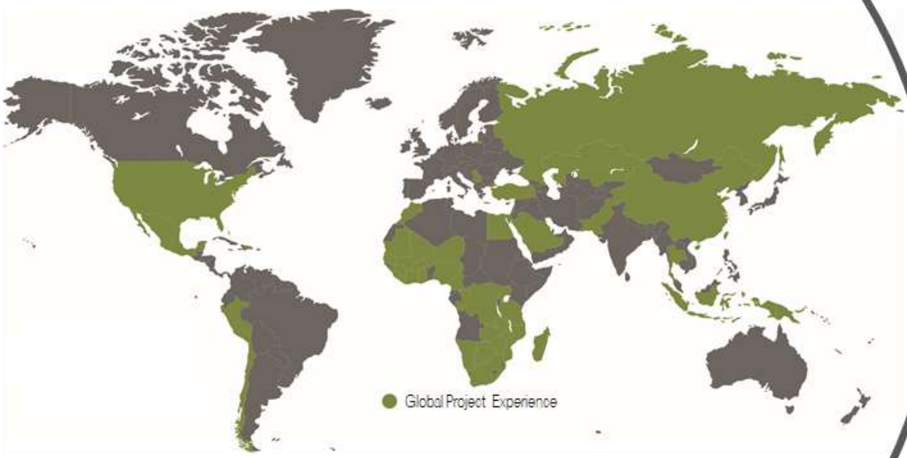

Providing innovative and sustainable solutions throughout the resources sector

Arnot South Environmental Authorisation and Water Use Licence

Air Quality Impact Assessment

Prepared for:
Exxaro Coal Mpumalanga (Pty) Ltd

Project Number:
UCD6802

August 2021

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This document has been prepared by Digby Wells Environmental.

Report Type:	Air Quality Impact Assessment
Project Name:	Arnot South Environmental Authorisation and Water Use Licence
Project Code:	UCD6802

Name	**Responsibility**	**Signature**	**Date**
Matthew Ojelede Pr.Sci.Nat.	Report Compiler		August 2021
Stephen Burton	Reviewer		August 2021

DETAILS AND DECLARATION OF THE SPECIALIST

Digby Wells and Associates (South Africa) (Pty) Ltd.

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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.

July 2021

Signature of the Specialist *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

Exxaro Coal Mpumalanga (Pty) Ltd (Exxaro) was the holder of a Prospecting Right (PR), reference MP 30/5/1/1/2360 PR for a proposed underground mine, referred to as Arnot South, situated 10km east of the town of Hendrina within the Nkangala District Municipality (NDM). The PR included farm portions, Weltevreden 174 IS, Mooiplaats 165 IS, Vlakfontein 166 IS, as well as Schoonoord 164 IS. The PR, authorised by the Department of Mineral Resources and Energy (DMRE), lapsed on 10 September 2020. The Mining Right Application (MRA) and Mine Works Programme (MWP) were submitted to the DMRE before the PR expiring, and issued reference number MP 30/5/1/2/2/10292 MR.

The process is being undertaken as per the requirements stipulated in the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA). Exxaro is initiating the required Integrated Environmental Authorisation (EA) and Water Use Licence Application (IWULA) processes to comply with the following requirements:

To this end, Digby Wells Environmental (hereinafter Digby Wells) was appointed as the independent Environmental Assessment Practitioner (EAP) to complete the Environmental Impact Assessment (EIA) in support of the Environmental Authorisation (EA) application.

This Air Quality Impact Assessment (AQIA) forms part of a suite of specialist studies required in support of the EA. The planned life-of-mine (LoM) is one year for the construction phase, followed by a 17-year operational phase.

This Air Quality Impact Assessment (AQIA) was set out to establish the future perturbation on ambient air quality from the proposed project's operational phase. For this AQIA, a holistic approach was adopted by considering all air emission sources associated with underground mining, with the focus on the worst-case scenario (i.e. without mitigation measures in place). The latter may have resulted in the model over-predicting future potential impacts.

In terms of baseline, the meteorology of the project area was assessed with three years' worth of data. The monthly temperature average varied between 10°C - 20°C. Ambient temperatures were observed to be higher during the summer months. The total monthly rainfall records show the summer months received much of the rains (>66%), followed by Spring with 24% and Autumn with 10%. While winter received the least rainfall (less than 1%). The annual total rainfall is 629 mm. The relative humidity records ranged between 62% and 73%.

The wind rose shows the prevailing winds are from the east northeast (15.7%) and west-northwest (10.3%). Secondary contributions are from the northwest (9.8%) and northwest (9.8%). The average wind speed was at 3.2 m/s and calm conditions occurred for some 3.6% of the time. High wind speed ≥5.4 m/s occurred for about 9.3% of the time. This equates to about 34 days of high wind speed each year. Based on the statistics, 14 days in spring experience high wind speed, nine days in winter, eight days in summer, and three days in autumn.

The ambient concentrations of particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) and those with aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) measured

during the one year were below the South African Ambient Air Quality Standards for most of the time, except for a day or two with exceedances. The concentration of sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) were generally below the limit values.

A summary of the predicted GLC is given below:

- For this assessment, the maximum GLC of $PM_{2.5}$ predicted was 29.6 µg/m³. This was below the daily limit value of 40 µg/m³. The GLC at the sensitive receptors (SR1) and SR2 were lower than the daily standard. The predicted annual GLC will not exceed the regulatory limit value of 40 µg/m³ onsite and at selected receptors.
- For PM_{10}, the daily limit value of 75 µg/m³ is likely to be exceeded along the dirt road from the plant to the edge of the western boundary (dirt road that runs south to the R38 route). The predicted daily GLC at the nearest sensitive receptors SR1 and SR2 were lower than the daily limit. The predicted annual GLC showed that exceedances will occur along the dirt road to the edge of the western boundary without mitigation in place. The predicted annual GLC at the nearest sensitive receptors SR1 and SR2 were below the annual limit value.
- The predicted dustfall rates confirmed that the non-residential limit of 1,200 mg/m²/d will be exceeded onsite and along the dirt road leading to the western boundary. However, these exceedances will be confined within the project boundary. With mitigation in place, the areas with exceedance shrunk significantly. The predicted dustfall rates at the selected receptors without and with mitigation were lower than the limit.
- For gases, the model predictions confirmed that the SO_2 24-hr GLC will be very low and unlikely to exceed the limit of 200 µg/m³. The predicted NO_2 1-hr GLC showed exceedances of the South African standard of 200 µg/m³ onsite and beyond the western boundary. Being a gas, this pollutant will dissipate quickly to negligible levels further away from the project area. The NO_2 predicted annual levels were very low, and hence, could not be plotted. The model simulations predicted CO 1-hr and CO 8-hr GLCs that were below the South African standard of 30 mg/m³ and 10 mg/m³ onsite and at the surrounding sensitive receptors. During the operational phase, the occurrences of CO exceedances are not anticipated due to the low GLC predicted.

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 were reduced to “negligible negative”. Since anticipated emissions from the operational phase activities are likely to have minimal impacts on receptors outside the Project boundary, with adequate mitigation and management intervention measures in place, such impacts can be minimised significantly.

Some of the mitigation measures and management intervention measures recommended are repeated and they include:

- Application of dust suppressants/binders 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 vent shaft; and
- Operation of ambient air quality monitoring network to collect valuable data needed to assess the effectiveness of mitigation measures put in place during operation.

Once the mine implements the recommendations outlined in this report, emissions from the mining operation can be reduced to levels below the ambient air quality standards, thus, 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
DEA	Department of Environmental Affairs
EMPr	Environmental Management Plan Report
GLC	Ground Level Concentrations
LoM	Life of Mine
MM5	Mesoscale model - Fifth generation
NDCR	National Dust Control Regulations
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
tpa	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-	iii
	(i) the specialist who prepared the report; and	iv
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 3
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	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
(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

Exxaro Coal Mpumalanga (Pty) Ltd (Exxaro) was the holder of a Prospecting Right (PR), reference MP 30/5/1/1/2360 PR for a proposed underground mine, referred to as Arnot South, situated 10 km east of the town of Hendrina within the Nkangala District Municipality (NDM). The PR included farm portions, Weltevreden 174 IS, Mooiplaats 165 IS, Vlakfontein 166 IS, as well as Schoonoord 164 IS. The PR, authorised by the Department of Mineral Resources and Energy (DMRE), lapsed on 10 September 2020. The Mining Right Application (MRA) and Mine Works programme (MWP) were submitted to the DMRE before the PR expiring, and issued reference number MP 30/5/1/2/2/10292 MR.

The process is being undertaken as per the requirements stipulated in the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA). Exxaro is initiating the required Integrated Environmental Authorisation (EA) and Water Use Licence Application (IWULA) processes to comply with the following requirements:

- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- National Environmental Management: Waste Act, 2008 (Act No. 56 of 2008) (NEM: WA); and
- National Water Act, 1998 (Act No. 36 of 1998) (NWA).

This EA and IWULA require a suite of specialist studies in support of the Environmental Regulatory Process for the proposed Arnot South Mining Right, including an Air Quality Impact Assessment (AQIA).

1.1. Project Background and Description

The Arnot South Prospecting Area is approximately 10 km east of Hendrina, 25 km west of Carolina, and 50 km southeast of Middelburg. The Project is near two of Eskom's power stations, namely Hendrina and Arnot. There are five farm homesteads situated within the planned underground mining area, and a small watercourse runs in a northeast direction across the northern half of the mining area. The land is currently mainly used for game farming.

As stated in the MWP provided, the No. 2 Seam is the only economically viable seam to mine. The depth of the Seam varies between 10 m to 100 m below the surface. The depth of the Seam varies between 10 m to 100 m below the surface (Figure 1-1).

The initial underground mine has an estimated life of Mine (LoM) of 17 years, producing 2.4 million ROM tonnes per annum (tpa). This mining right application is for 30 years. The current exploration drilling allowed for the identification of an underground mining area. Depending on the markets for the S2 and S4 coal, the estimated ROM coal is 32,912,300 tonnes that would allow an additional mining period of 13.7 years at annual ROM coal production of 2,400,000 tonnes per annum. The total estimated production life of Arnot South is 30 years.

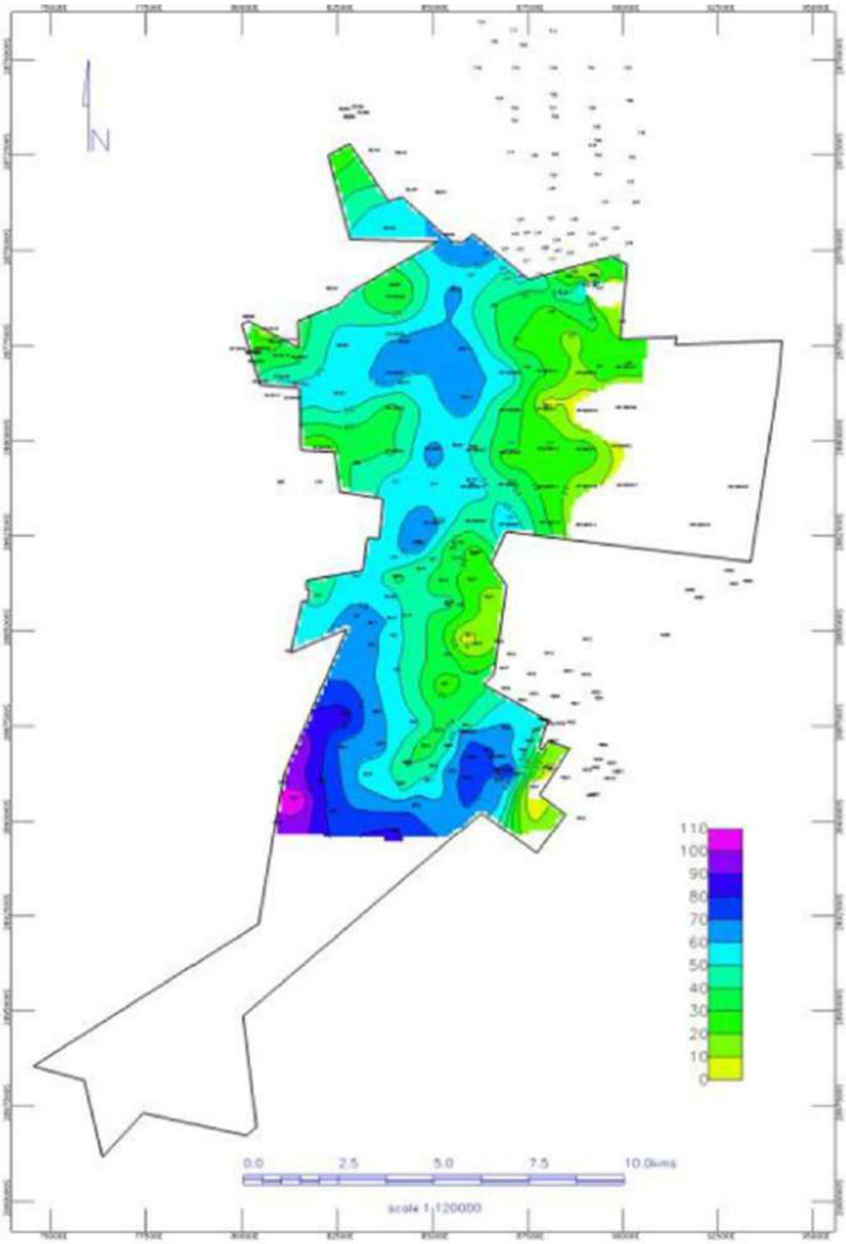

Figure 1-1: Seam Elevation (Source: Arnot South Mining Works Programme, 2020)

1.2. Mining

The mining of the initial reserve shall be by utilising underground Continuous Miner (CM) on the board and pillar (B&P) layout method due to the reserves being deep. Mining shall commence in the south-eastern end of the block from where the underground mining shall develop northwest.

A box cut, located in the southeast has been designed and shall allow access to the S2 underground workings. An eight- degree (°) ramp, 8.0 m wide, shall give access into the box cut and to the underground entrance portals. The inclination of the ramp shall allow rubber-wheeled equipment to travel up and down the ramp unassisted. The basis of the selected position of the box cut is on the most practical underground mining layout with the least conveyor belt transfer points.

All the necessary mine infrastructure for the Project area shall be established on the MP 30/5/1/1/2/360 PR area and shall be placed on the farm Weltevreden 174 IS on the southern part of the mining layout area.

1.3. Infrastructure

1.3.1. Approved Infrastructure

The infrastructure footprint, the physical location of the different infrastructures can be seen in greater detail within the proposed Arnot South Mining Right Boundary in Figure 1-2.

The Project list of activities for the construction, operation, and decommissioning phases are depicted in Table 1-1 below. This detailed list of project activities will be used for impact assessment.

Table 1-1: Project Activities

Phase	Activity
Construction	Removal of vegetation/topsoil for the establishment of mining and linear infrastructure
	Diesel storage and explosives magazine
	Construction of additional infrastructure, and ventilation fans (Noise generation/ increased noise level)
	Construction of access road and haul roads
	Stockpiling of soils, rock dump, and discard dump establishment.
Operational	Ventilation fans and infrastructure area containing stockpile areas
	Underground blasting
	Maintenance of haul roads, pipelines, machinery, water, effluent, and stormwater management infrastructure and stockpile areas.
	Removal of rock(blasting)

Phase	Activity
	Concurrent rehabilitation as mining progresses
Decommissioning	Demolition and removal of infrastructure
	Post-closure monitoring and rehabilitation
	Closure of the underground mine

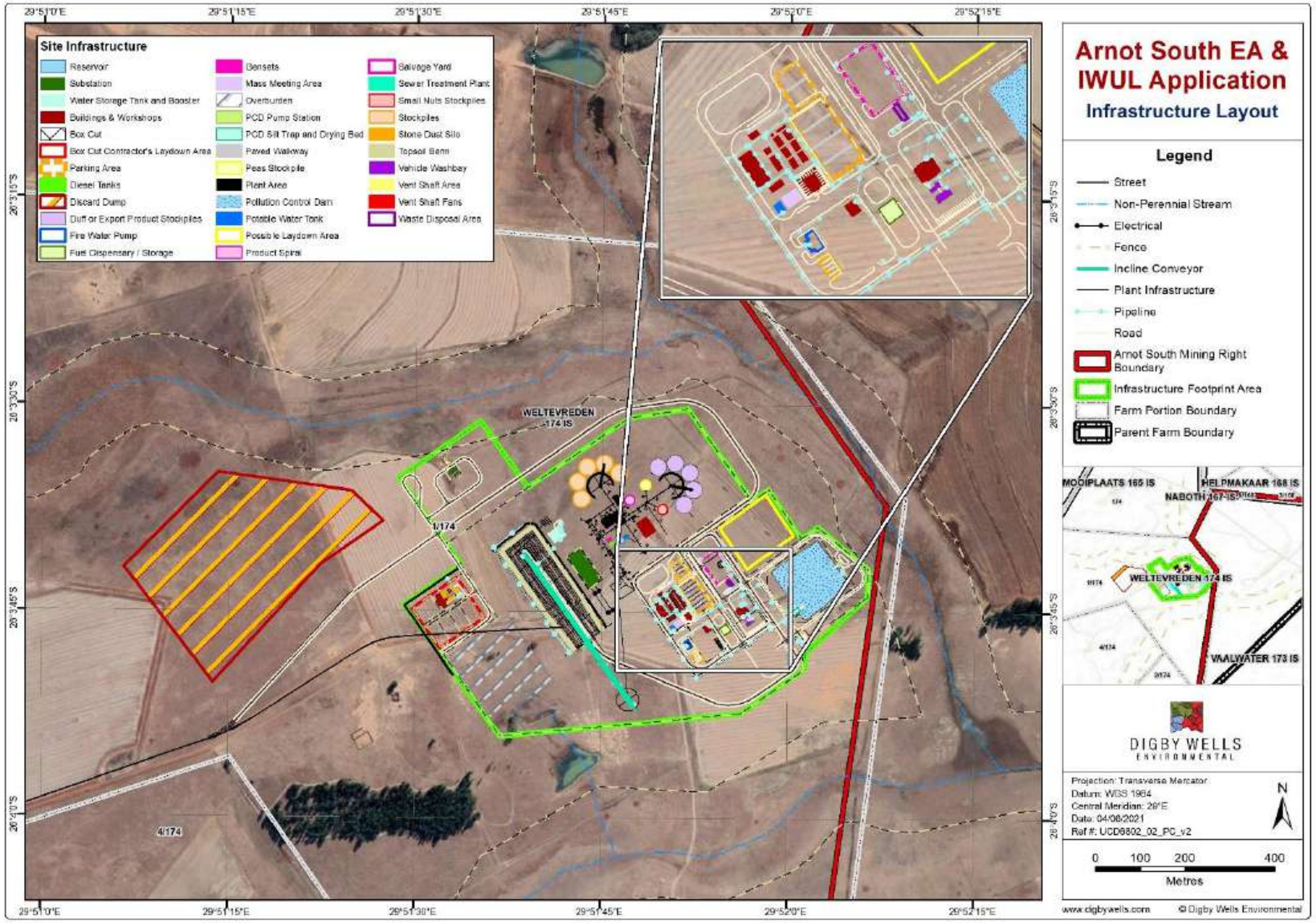

Figure 1-2: Arnot South Infrastructural Footprint

2. Scope of Work

The 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. 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 mining activities and comparison of predicted 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
Ambient air quality scenario	Air quality data is not site-specific. The air quality data from the South African Weather Service (SAWS) Station in Hendrina was used to assess the background scenario. Site scenarios are not anticipated to be worse.
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) 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 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 provides a legislative framework for environmental management in South Africa. The principles of 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).

The NEM: AQA is the prevailing legislation in the Republic of South Africa with regards to Air Quality, and forms one of the many pieces of legislation that falls under the ambit of the NEMA. The 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 (now known as the Department of Forestry, Fisheries and Environment) for contraventions. In line with NEM: AQA, the Department of Environmental Affairs (DEA) published National Dust Control Regulations (NDCR), the acceptable dustfall (particulate matter with an aerodynamic diameter less than 45 µm (considered as Total Suspended Particulate (TSP) as described by the World Bank Group (WBG) (WBG, 1998) limits for residential and non-residential areas (GN R 827 of 1 November 2013). The dust fallout standard is given in Table 5-2 below.

Table 5-2: 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

The DEA has established National Ambient Air Quality Standards for particulate matter with an aerodynamic diameter less than 10 microns (PM_{10}) in Table 5-3 and particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) since June 2012 (GN R 486 of 29 June 2012) as in Table 5-4.

Table 5-3: 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 5-4: 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.			

Table 5-5, Table 5-6, and Table 5-7 show the established limit values for gaseous pollutants SO_2, NO_2 and CO.

Table 5-5: National Ambient Air Quality Standards as of 24 December 2009

National Ambient Air Quality Standard for Sulphur Dioxide (SO_2)				
AVERAGING PERIOD	**LIMIT VALUE (µg/m³)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
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.				

Table 5-6: National Ambient Air Quality Standards as of 24 December 2009

National Ambient Air Quality Standard for Nitrogen Dioxide (NO_2)				
AVERAGING PERIOD	**LIMIT VALUE (µg/m³)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
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.				

Table 5-7: National Ambient Air Quality Standards as of 24 December 2009

National Ambient Air Quality Standard for Carbon Monoxide (CO)				
AVERAGING PERIOD	**LIMIT VALUE (mg/m³)**	**LIMIT VALUE (ppm)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 hour	30	26	88	Immediate
8 hour	10	8.7	11	Immediate
The reference method for analysis of CO shall be ISO 4224.				

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 area. The second component involves the use of a computational air dispersion model to predict potential emissions associated with the proposed underground mining activities and the degree of impact on the receiving environment.

6.1. Baseline Assessment

The baseline characterisation encompasses a detailed description of the meteorology of the study area, surrounding receptors likely to be impacted, and the existing air quality scenario.

6.2. Project Area

The Arnot South prospecting area is situated~ 10 km east of the town of Hendrina, 25 km west of Carolina, and 50 km southeast of Middelburg in the Mpumalanga Province, South Africa.

The Project is close to two of Eskom's operating power stations: Hendrina (25 km west of Project boundary) and Arnot (5.0 km north of project boundary) as depicted in Figure 6-1.

There are five farm homesteads situated within the planned underground mining area and a small watercourse that runs in a northeast direction across the northern half of the mining area. The land is currently mainly used for game farming. The target area for mining lies mainly on the farms Weltevreden 174 IS, Mooiplaats 165 IS, Vlakfontein 166 IS, and Schoonoord 164 IS.

Figure 6-1 shows the project boundary, surrounding sensitive receptor, and historical dust monitoring points (in Google Earth® Imagery). 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*.

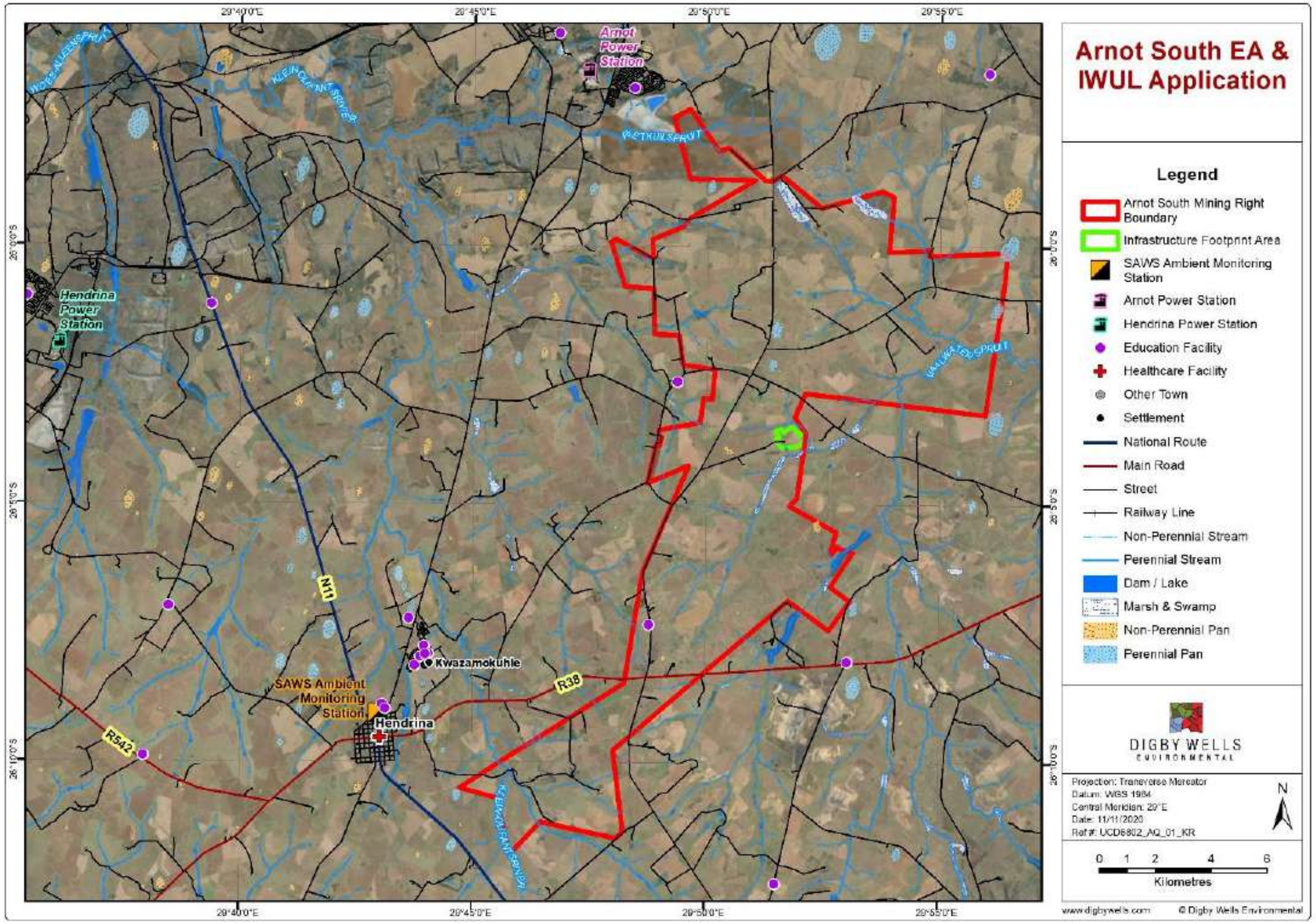

Figure 6-1: Arnot Mining Right Boundary and Surrounding Sensitive Receptors

6.3. General Description of Climate in the Project Area

Existing site-specific MM5 modelled meteorological data set for the full three calendar years (2017-2019) obtained from the Lakes Environmental Software was used to assess the prevailing weather conditions. The Pennsylvania State University / National Centre for Atmospheric Research (PSU/NCAR) mesoscale model (known as MM5) is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model, which was designed to simulate or predict mesoscale atmospheric circulation. This data has been tested extensively and is extremely accurate.

Modelled meteorological data was obtained for a point (26.085153°S, 29.841547°E) in the proposed project area 14 km northeast of Hendrina. Data availability was 100%.

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.

Meteorological parameters such as temperature, relative humidity, wind speed, and direction for the Project area were assessed (Table 6-1).

6.3.1.1. Temperature

The monthly temperature records for the project site (3-year average) are presented in Table 6-1 and Figure 6-3. The data indicate that the monthly temperature average varied between 10°C- 20°C. Ambient temperatures were observed to be higher during the summer months.

6.3.1.2. Rainfall

The total monthly rainfall records (3-years average) are provided in Table 6-1 and Figure 6-2. Based on the rainfall data, the summer months (December – February) received much of the rains (i.e >66%) with December and January being the peak rainfall months (Figure 6-2), followed by Spring with 24% and Autumn with 10%. While winter (June – August), received the least rainfall (less than 1%). The annual total rainfall is 629 mm.

6.3.1.3. Relative Humidity

The relative humidity records (3-year average) ranged between 62% 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

[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*

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*.

Table 6-1: Climate Statistics

Parameters	3-year average												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Temp. (◦C)	18	20	19	18	15	13	10	10	12	14	17	18	15
Total Mon. Rain (mm)	127	119	62	6	2	1	0	7	27	43	80	155	629
Rel. Hum. (%)	67	73	69	68	73	71	72	68	67	65	62	65	68

(Source: Lakes Environmental - 2017-2019l)

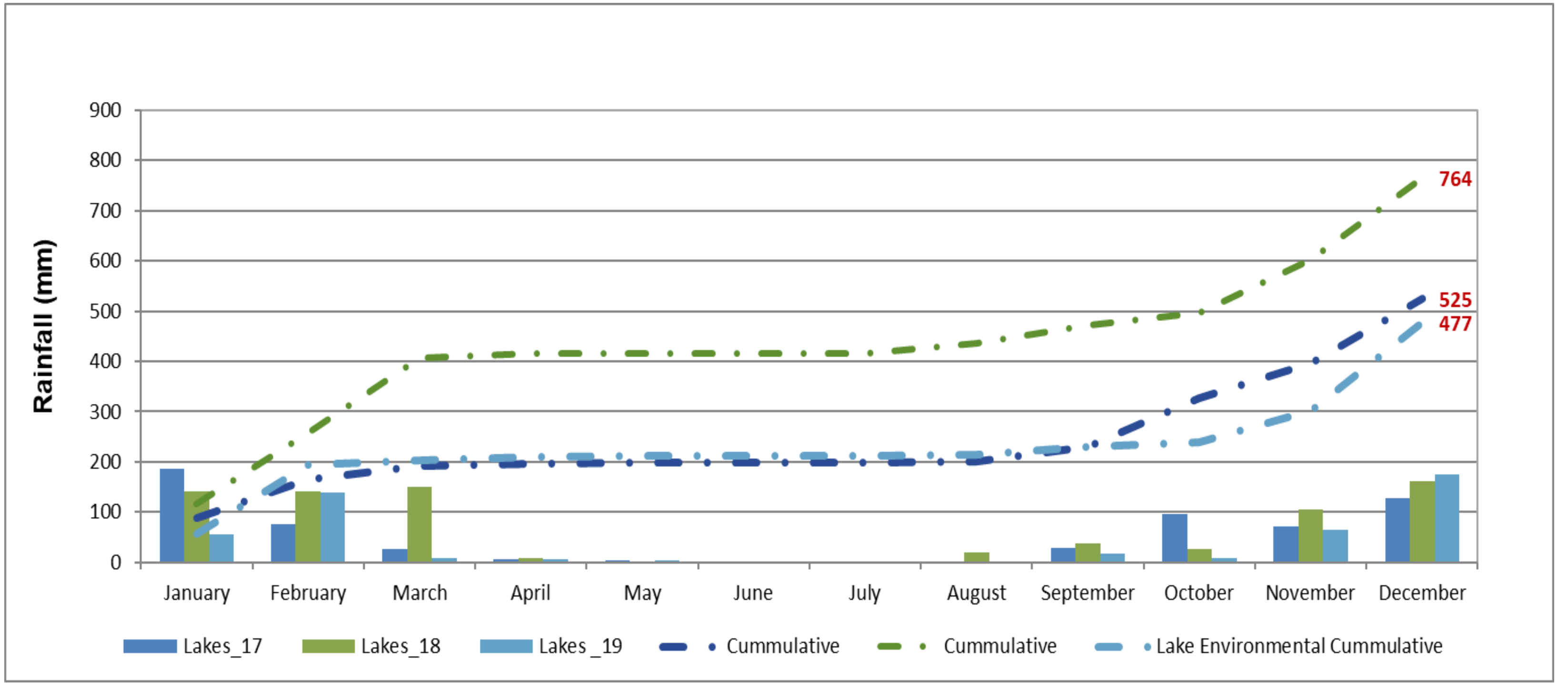

Figure 6-2: Rainfall

(Source: Lakes Environnemental - 2017-2019)

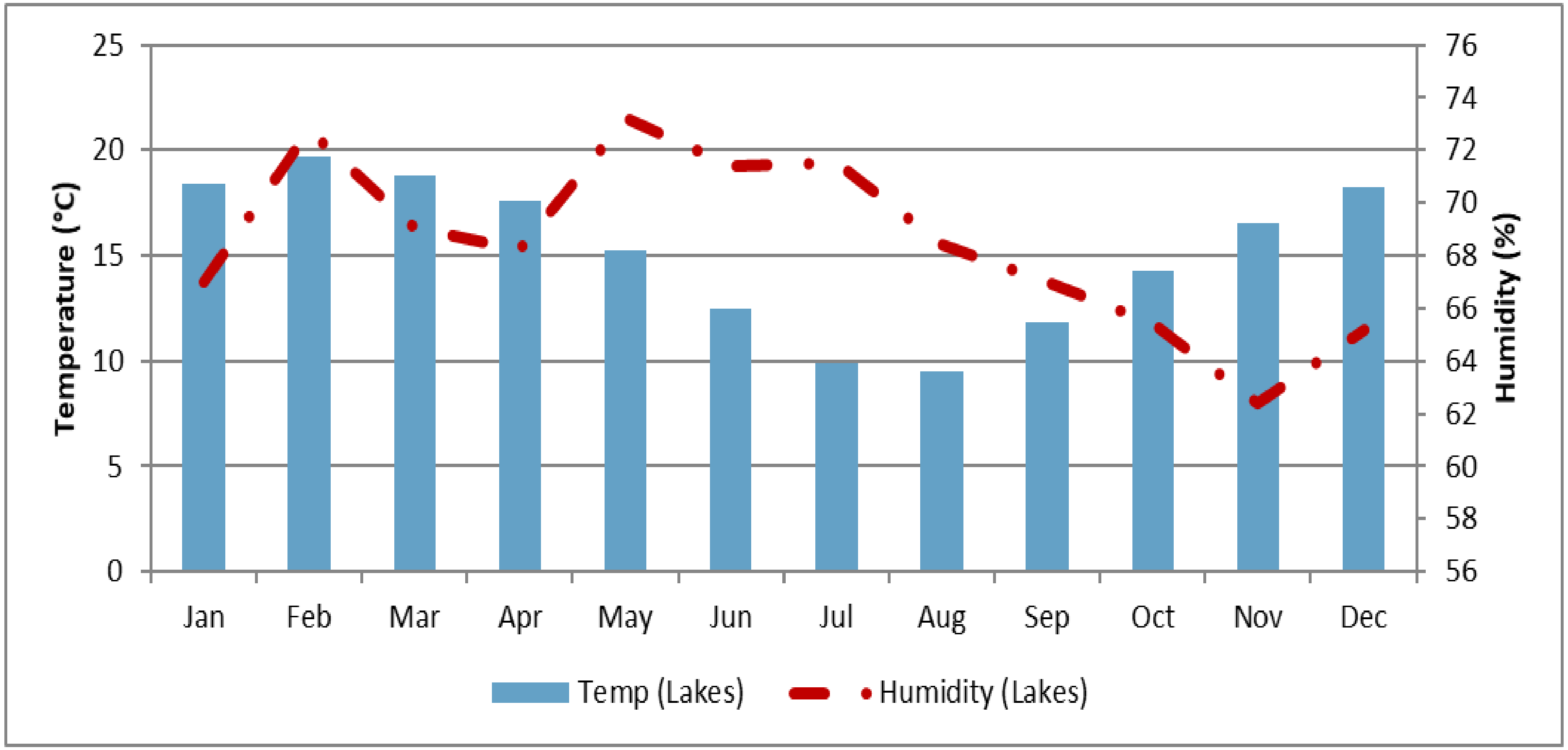

Figure 6-3: Monthly Temperature and Humidity

(Source: Lakes Environmental - 2017-2019)

6.3.1.4. Wind Speed

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 wind rose for the project area is depicted in (Figure 6-4). The prevailing winds are from the east northeast (15.7%) and west-northwest (10.3%). Secondary contributions are from the northwest (9.8%) and northwest (9.8%). The seasonal variability in wind speed patterns is shown in Figure 6-5.

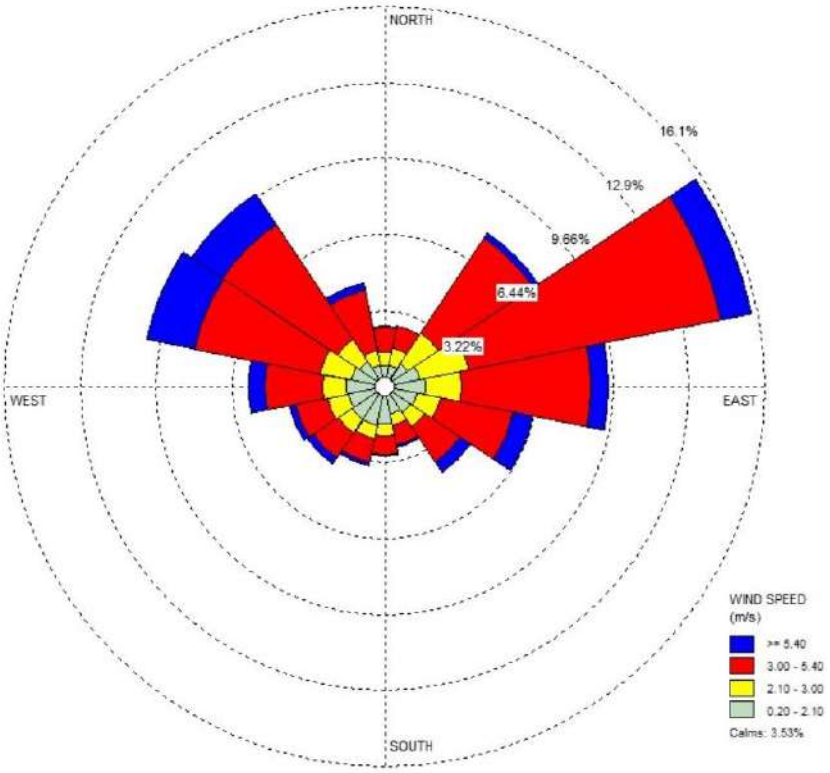

Figure 6-4: Surface Wind Rose

(Source: Lakes Environmental)

The average wind speed at the project site is 3.2 m/s and calm conditions (<0.5 m/s) occurred for some 3.6% of the time. Wind speed capable of causing wind erosion i.e ≥5.4 m/s occurred for about 9.3% of the time (Figure 6-6). This equates to about 34 days of high wind speed each year. Based on the statistics, 14 days in spring experience wind speed greater than 5.4 m/s, nine days in winter, eight days in summer, and three days in autumn. The wind class frequency is depicted in Figure 6-6.

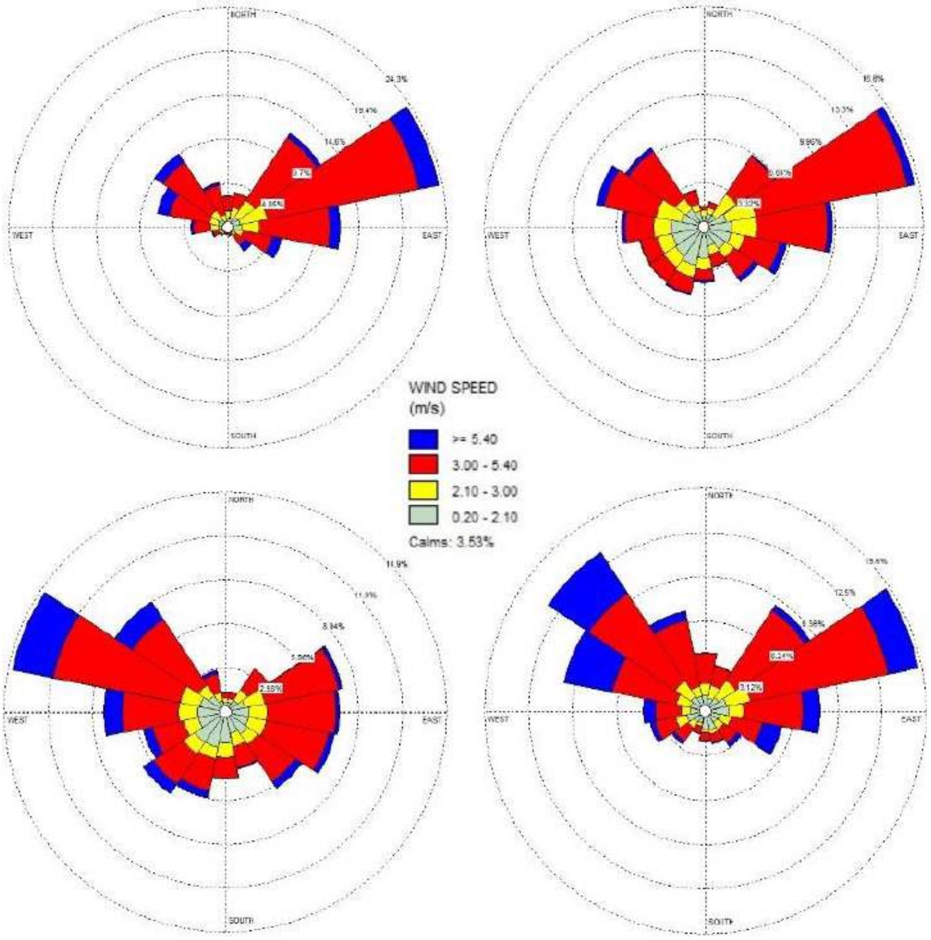

Figure 6-5: Seasonal Wind Roses

(Source: Lakes Environmental - 2017-2019)

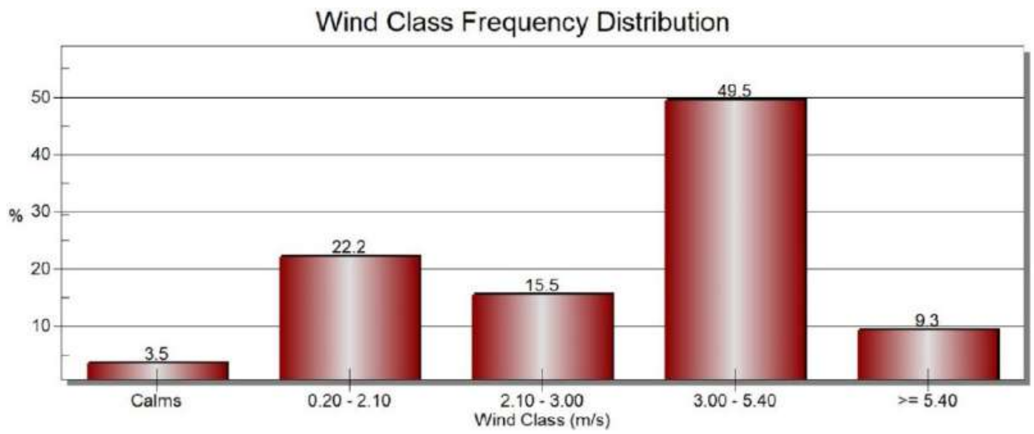

Figure 6-6: Wind Class Frequency.

(Source: Lakes Environmental 2017-2019)

6.3.2. Assessment of Existing Air Quality

Ambient air quality records measured by the South African Weather Service (SAWS) station at KwaZamokuhle High School, Ackerman Street, KwaZamokuhle Township in Hendrina, about 18 km southwest from the project site was used to assess background scenario. The PM_{10} and $PM_{2.5}$ and gases, such as SO_2, NO_2, and CO. Data covering the period, October 2019 to November 2020 was assessed.

6.3.3. Fine Particulate Matter

The ambient $PM_{2.5}$ and PM_{10} levels measured during the one-year period are presented. The daily concentrations of $PM_{2.5}$ and PM_{10} measured at the SAWS station in Hendrina are generally below the South African ambient air quality standards (red dotted line) of 40 µg/m^3 and 75 µg/m^3, respectively, except for a day or two with exceedances.

The $PM_{2.5}$ standard was exceeded on 26 June 2020, 22 July 2020, 10 and 11 October 2020 with ambient concentrations of 41 µg/m^3, 41 µg/m^3, 61 µg/m^{3,} and 120 µg/m^3 measured. For $PM_{2.5}$ daily, the 90th percentile was below 24 µg/m^3. The highest $PM_{2.5}$ concentration recorded during the period was 120 µg/m^3.

For PM_{10} daily, the ambient levels were most of the time below the PM_{10} standard, except for the exceedance that was observed on 11 October 2020, which correlates with the day and time the $PM_{2.5}$ standard was exceeded. The 90th percentile of measured data was at 44 µg/m^3, and the highest PM_{10} concentration KwaZamokuhleHigh School observed over the one year was at 134 µg/m^3. It was likely that a dust-generating event was conducted in the area on that day leading to the high levels of particulates measured.

The ambient air quality results collected are summarised in Table 6-2.

Table 6-2: Summary of the Ambient Air Quality Records Measured at SAWS Station in Hendrina Mpumalanga

Pollutant	Averaging period	SA Standard	Ambient Level below 90th Percentile	Highest Ambient Level Measured on-site	Exceedance of the Standard
$PM_{2.5}$	24 hours	40 µg/m^3 (2)	24	120	4
PM_{10}	24 hours	75 µg/m^3 (1)	44	134	1
CO	8 hours	26 ppm (1)	0.6	1.3	0
NO_2	1 hour	106 ppb (1)	16	234	1
SO_2	24 hours	48 ppb (1)	13	29	0

(1) South African Standard, Government Notice 1210, Government Gazette 32816
(2) South African Standard, Government Notice 486, Government Gazette 35463

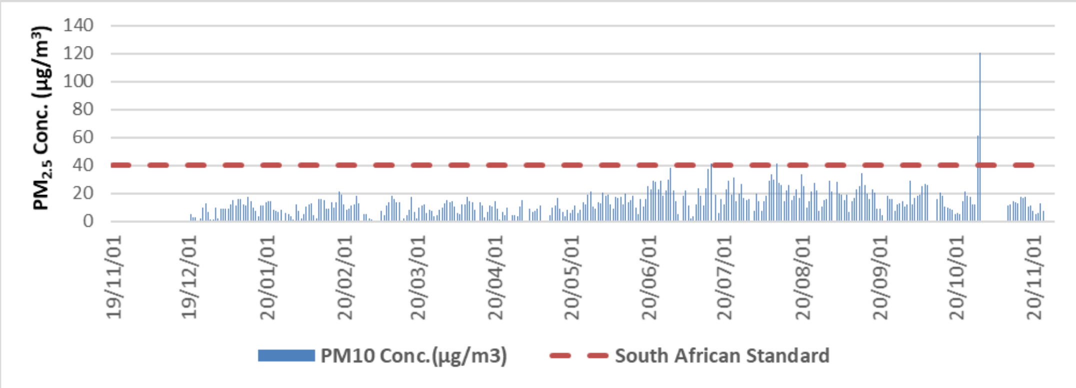

Figure 6-7: Background $PM_{2.5}$ Levels

(SAWS: Ambient Air Quality Station – Oct 2020 – Nov 2020)

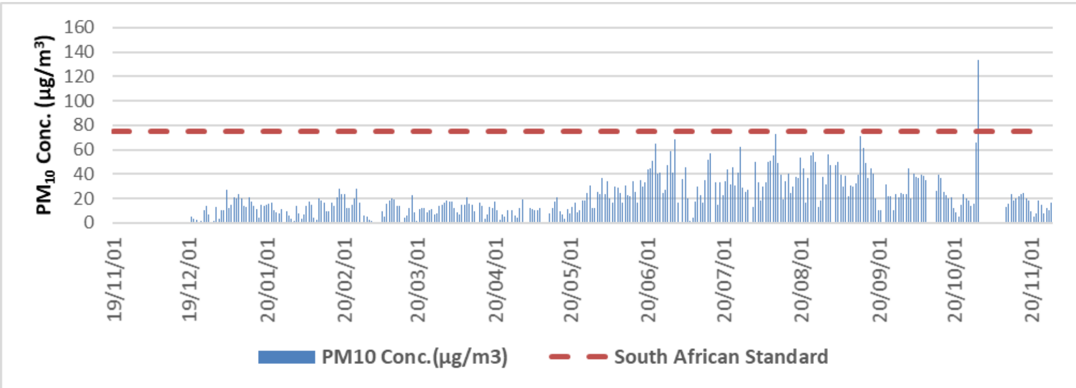

Figure 6-8: Background PM_{10} Levels

(SAWS: Ambient Air Quality Station – Oct 2020 – Nov 2020)

6.3.4. Gaseous Pollutants

The gaseous pollutant data from the SAWS ambient air quality station such as SO_2, NO_2 and CO are discussed below. The daily SO_2 concentrations measured at the SAWS station in Hendrina were low (the 90th percentile of the daily SO_2 levels was 13 ppb). The maximum daily concentration over the one-year record considered was 29 ppb. No exceedance of the South African standard of 48 ppb was recorded.

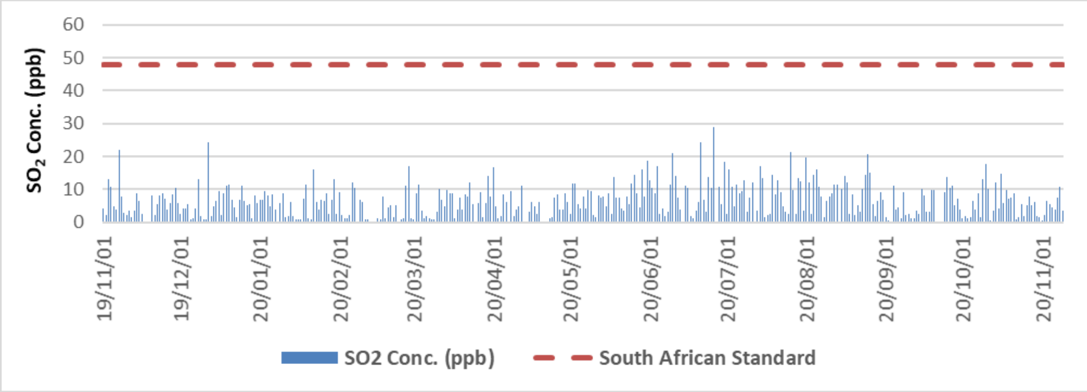

Figure 6-9: Background SO_2 Levels

(SAWS: Ambient Air Quality Station – Oct 2020 – Nov 2020)

The daily NO_2 concentrations measured at the SAWS station in Hendrina were low (the 90th percentile of the daily NO_2 levels was 16 ppb). The maximum daily concentration over the one-year record considered was 234 ppb. One exceedance of the South African standard of 106 ppb was measured on 8 November 2020.

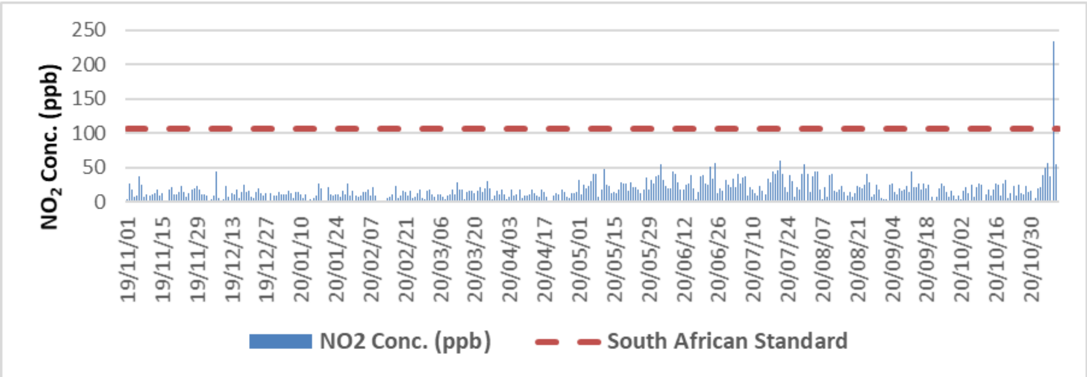

Figure 6-10: Background NO_2 Levels

(SAWS: Ambient Air Quality Station – Oct 2020 – Nov 2020)

Data was not available for 87% of the survey period. Ambient CO data were available for 13% of the time. The 8-hourly CO concentrations measured at the SAWS station in Hendrina were low (the 90th percentile of CO levels measured was 0.6 ppm). The maximum concentration measured over the period was 1.3 ppm. No exceedance of the South African standard of 26 ppm was observed.

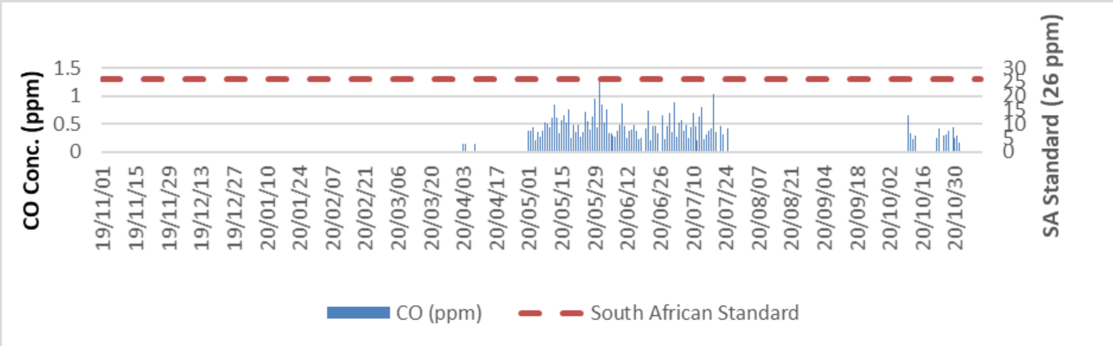

Figure 6-11: Background CO Levels

(SAWS: Ambient Air Quality Station – Oct 2020 – Nov 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 which was 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 6-12.

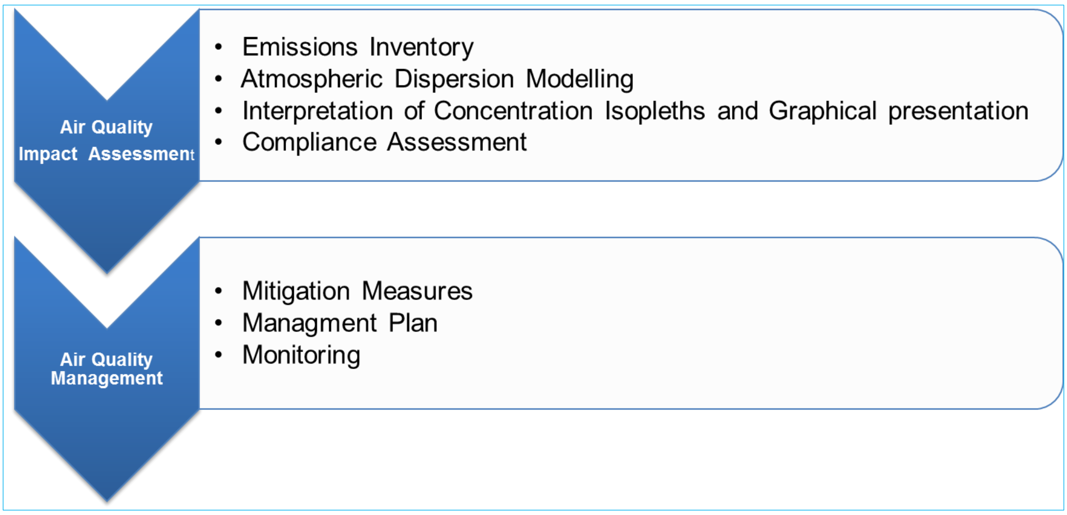

Figure 6-12: Air Quality Impact Assessment Methodology

During the impact assessment, tasks completed included the 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 air quality 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 average 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 6-3.

Table 6-3: 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,	US-EPA AP42 Section 13.2.2	Default silt content: Mine Road: 8.6%

Activity	Emission Equation	Source	Information assumed/provided
	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 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		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.
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)
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)	
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: 3.2 m/s M = moisture content (4.5 %)

Coal mine ventilation systems are usually designed to maintain healthy and safe atmospheric working conditions underground. The afore-mentioned, help provide fresh air to the miners, to ensure that toxic, noxious, and explosive gases and dusts from the mining activities are diluted by fresh air and are subsequently expelled to the surface via the ventilation system. The parameters adopted for the ventilation shaft and associated emissions rates are indicated in Table 6-4 and Table 6-5, and emissions from the shaft were considered as a point source.

Table 6-4: 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	3	6	92	13	298

Table 6-5: MHSA OEL (2006)

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

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 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 (2017 – 2019) 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 6-6 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 6-6: Summary of Meteorological and AERMET Parameters

Number of grids (spacing)	100 m, 200 m
Number of grids points	121 x 121
Years of analysis	January 2017 to December 2019
Centre of analysis	Carolina (26.085153 S; 29.841547 E)
Meteorological grid domain	20 km (east-west) x 20 km (south-north)
Station Base Elevation	1625 m
MM5-Processed Grid Cell (Grid Cell Centre)	26.085153°S; 29.841547°E
Anemometer Height	14 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 of airborne emissions across the mining landscape, the 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 (2017-2019). The monthly temperature average varied between 10°C - 20°C. Ambient temperatures were observed to be higher during the summer months. The total monthly rainfall records show the summer months received much of the rains (>66%), followed by Spring with 24% and Autumn with 10%. While winter received the least rainfall (less than 1%). The annual total rainfall is 629 mm. The relative humidity records ranged between 62% and 73%.

The wind rose shows the prevailing winds are from the east northeast (15.7%) and west-northwest (10.3%). Secondary contributions are from the northwest (9.8%) and northwest (9.8%). The average wind speed was at 3.2 m/s and calm conditions occurred for some 3.6% of the time. High wind speed ≥5.4 m/s occurred for about 9.3% of the time. This equates to about 34 days of high wind speed each year. Based on the statistics, 14 days in spring experience high wind speed, nine days in winter, eight days in summer, and three days in autumn.

The ambient concentrations of $PM_{2.5}$ and PM_{10} measured during the one year were below the South African 24-hours standards for most of the time, except for a day or two with exceedances. The 24hours concentration of SO_2, the 1-hour NO_2 and the 1-hour CO levels were generally below the limit values.

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

7.3.1. Predicted Concentration 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 model simulation did not return areas with exceedances of the 24-hour standard (40 µg/m^3) as depicted in Figure 7-1. The maximum GLC predicted was 29.6 µg/m^3. The predicted GLC at the sensitive receptors (SR1) and SR2 were lower than the daily standard (Table 7-1). The annual GLC of $PM_{2.5}$ predicted will not exceed the regulatory standard onsite and at selected receptors ((Table 7-1).

7.3.2. Predicted Concentration 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 predicted to be exceeded are along the dirt road from the plant to the edge of the western boundary (dirt road that runs south to R38). This can be seen in Figure 7-3 below. The predicted daily GLC at the nearest sensitive receptors SR1 and SR2 were lower than the daily standard (Table 7-1). The predicted annual isopleth showed that exceedances will occur along the dirt road to the edge of the western boundary without mitigation (Figure 7-4). The predicted annual GLC at the nearest sensitive receptors SR1 and SR2 were below the annual standard.

7.3.3. Predicted Dustfall Rates

The predicted dustfall rates are shown in Figure 7-5 (without mitigation and with mitigation). The predicted dustfall rates confirmed that the non-residential limit of 1,200 mg/m²/d will be exceeded onsite and along the dirt road leading to the western boundary. The exceedances will be confined within the project area. With mitigation in place, the areas with exceedance shrunk onsite and along the dirt road. The predicted dustfall rates at the selected receptors without and with mitigation were lower than the limit (Table 7-1).

7.3.4. Predicted Concentrations of SO_2

Model predictions confirm that the SOx (as SO_2) 24-hr GLC will be very low and unlikely to exceed the South African standard of 200 µg/m³ (Figure 6-9 and Table 7-2).

7.3.5. Predicted Concentrations of NO_2

The predicted NOx (as NO_2) 1-hr GLC shows exceedances of the South African standard of 200 µg/m³ onsite and outside and beyond the western boundary (Figure 7-8). Being a gas, this pollutant will dissipate quickly to negligible levels further away from the project area. The NOx (annual) concentrations were very low (see Table 7-2), hence could not be plotted.

7.3.6. Predicted Concentrations of CO

Model simulations returned predicted CO 1-hr and CO 8-hr GLCs that were below the South African standard of 30 mg/m³ and 10 mg/m³ onsite and at the surrounding sensitive receptors (see Table 7-2). During the operational phase, the exceedance of the regulatory limit is not anticipated due to the low GLC predicted.

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)	
			SR1	SR2
$PM_{2.5}$ (No Mitigation)	Daily	40[(1)]	3.9	2.7
	Annual	20[(1)]	0.2	0.3
PM_{10} (No Mitigation)	Daily	75[(1)]	25	10
	Annual	40[(1)]	1.5	0.9
Dust Deposition Rates (mg/m²/day)				
Dust (No Mitigation)	Monthly	Residential (600[(2)]) Non-residential (1200[(2)])	37	60
Dust (With Mitigation)			18	42

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

Table 7-2: Predicted Concentrations of SO_2, NO_2, CO at Selected Sensitive Receptors

Pollutants	Averaging Period	South Africa Air Quality Standard (µg/m³)	Predicted Ground Level Concentration (µg/m³)	
			SR1	SR2
SO_2 (No Mitigation)	Daily	125(1)	2.5	1
NO_2 (No Mitigation)	1 hour	200(1)	222	103
	Annual	40(1)	0.2	0.3
South Africa Air Quality Standard (mg/m³)				
CO (No mitigation)	1 hours	30(2)	0.2	0.08
	8 hours	10(2)	0.04	0.02

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

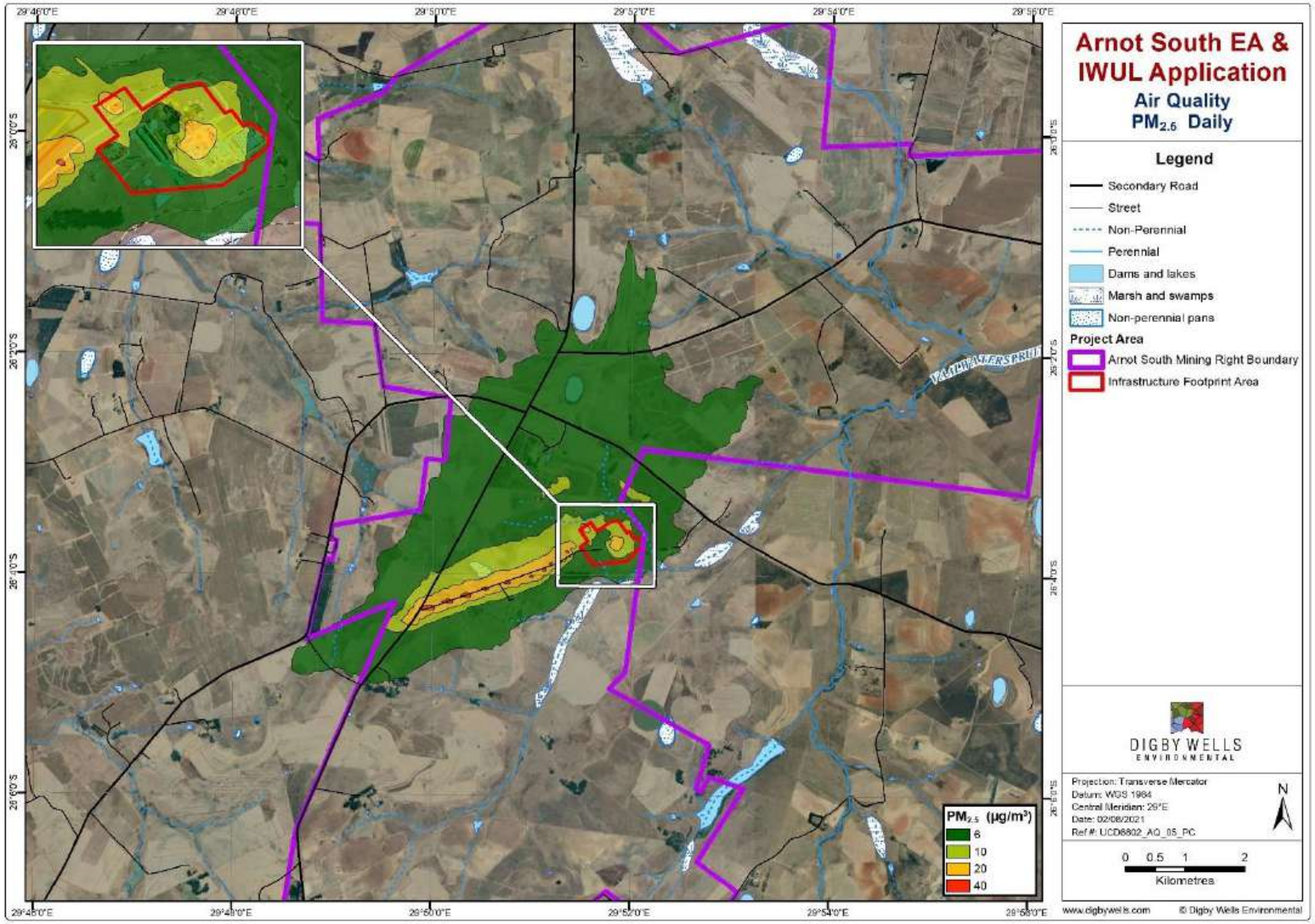

Figure 7-1: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ Concentrations (µg/m³)

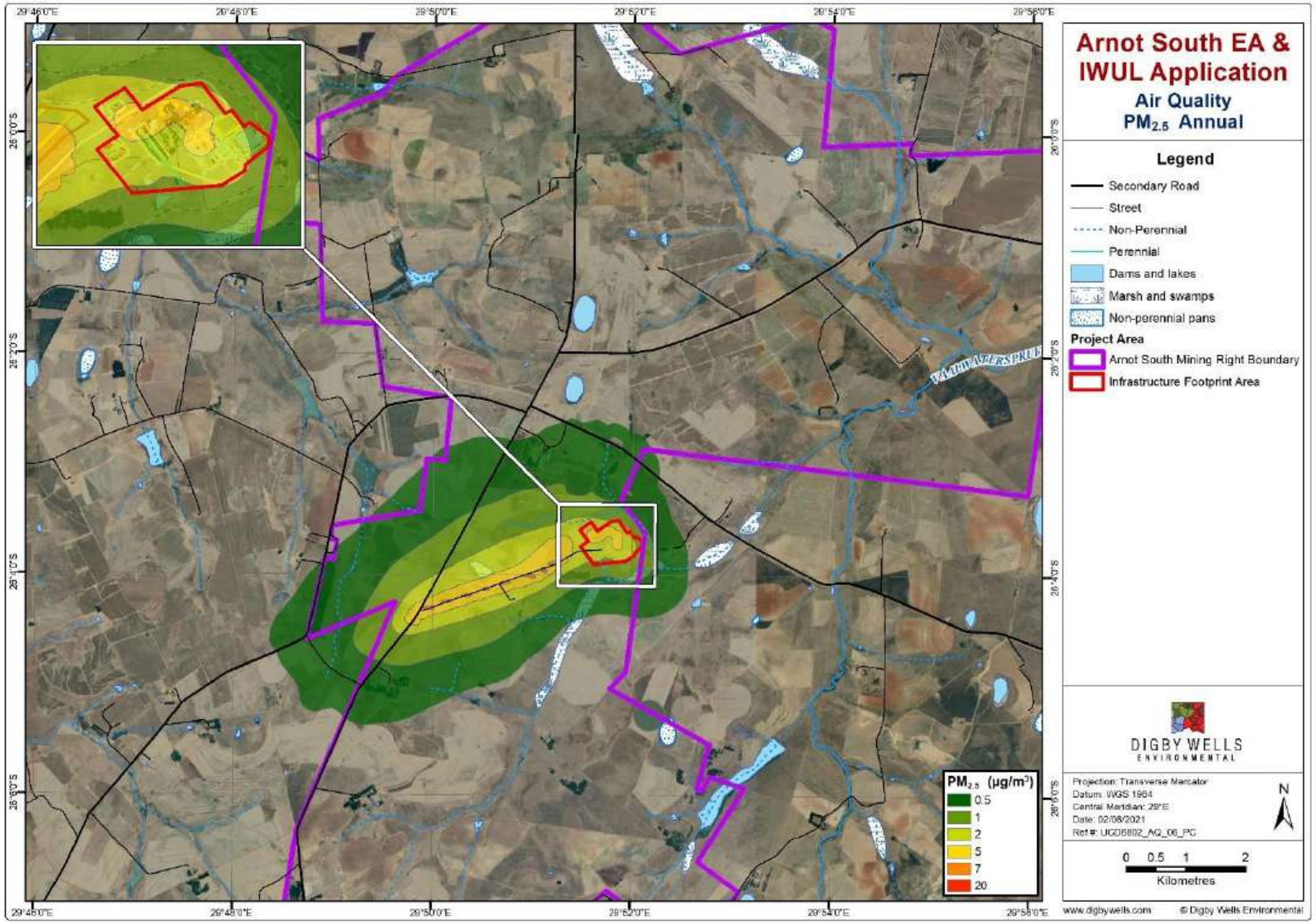

Figure 7-2: Predicted 1st highest (100th percentile) Annual PM2.5 Annual Concentrations (µg/m³)

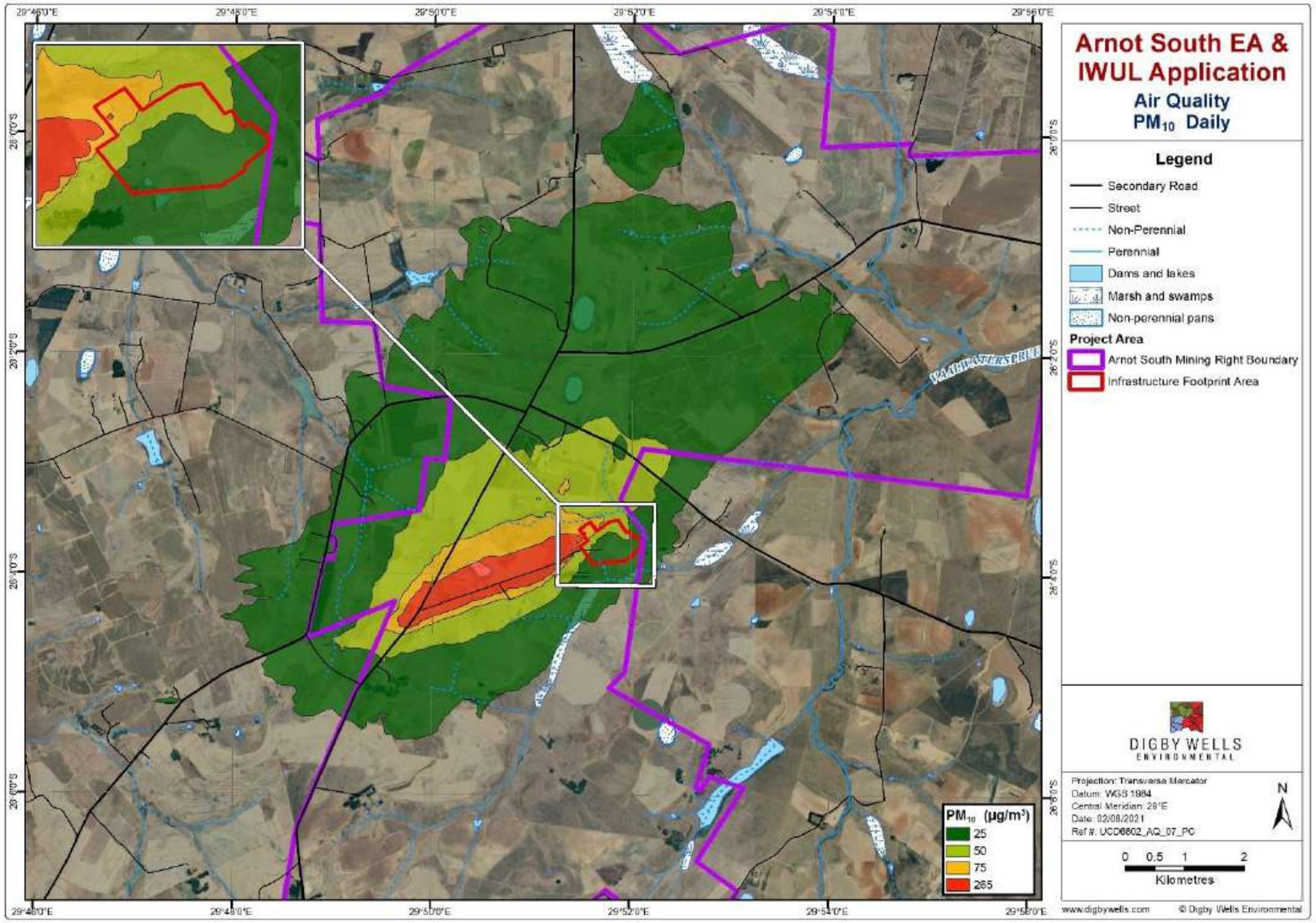

Figure 7-3: Predicted 4th highest (99th percentile) daily PM_{10} Concentrations (µg/m³)

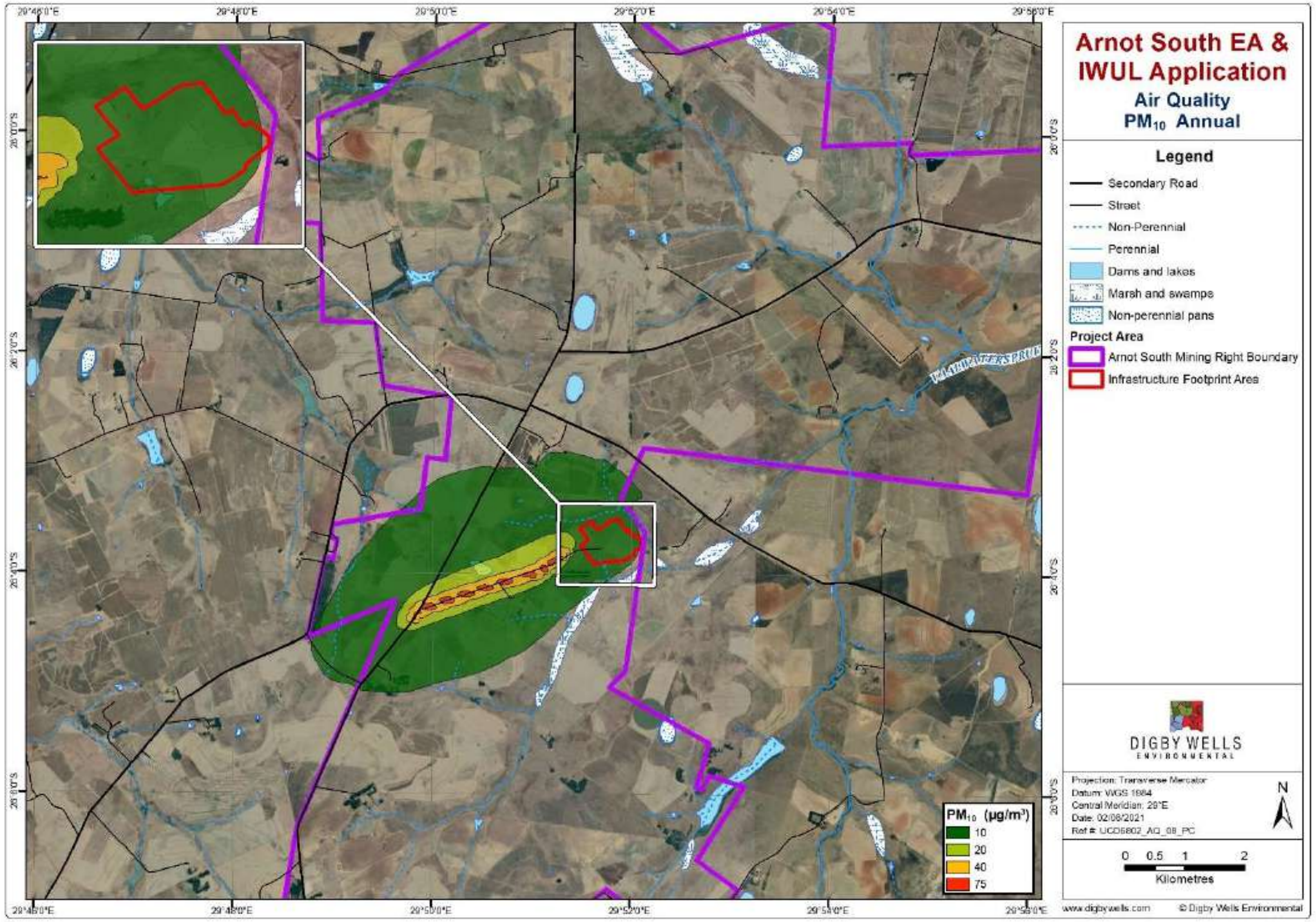

Figure 7-4: Predicted 1st highest (100th percentile) Annual PM_{10} Concentrations (µg/m³)

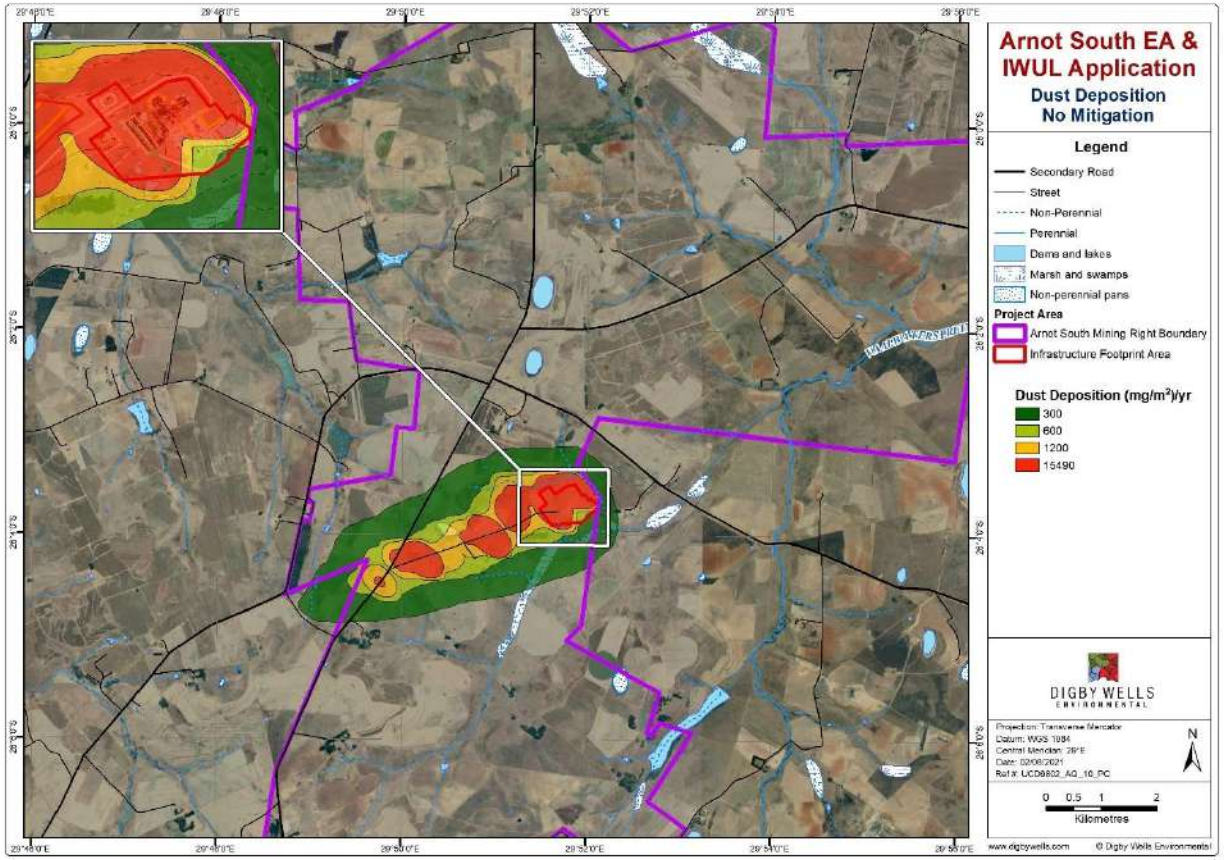

Figure 7-5: Predicted (100th percentile) Monthly Dust Deposition Rates (mg/m²/day) No Mitigation

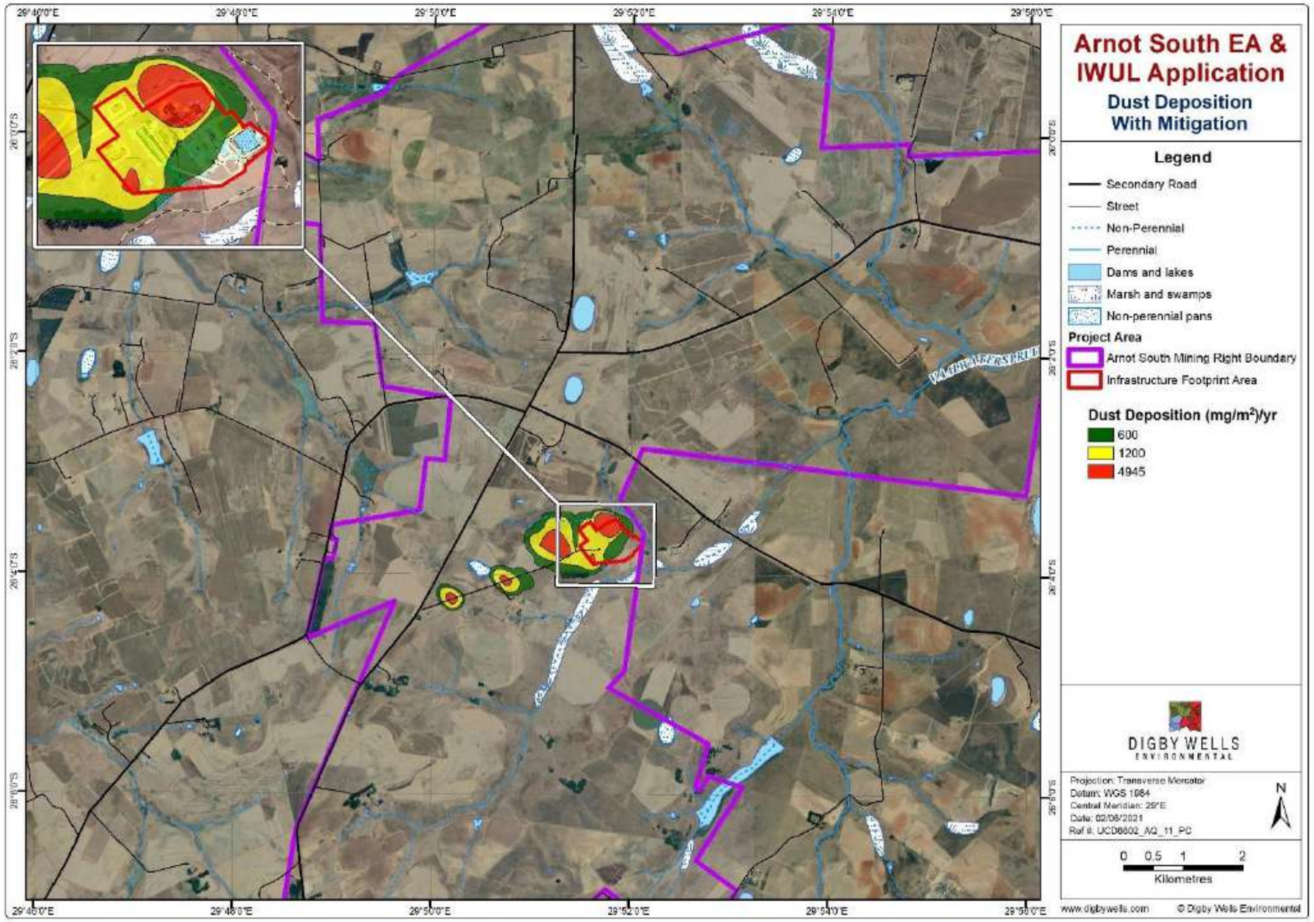

Figure 7-6: Predicted (100th percentile) Monthly Dust Deposition Rates (mg/m²/day) With Mitigation

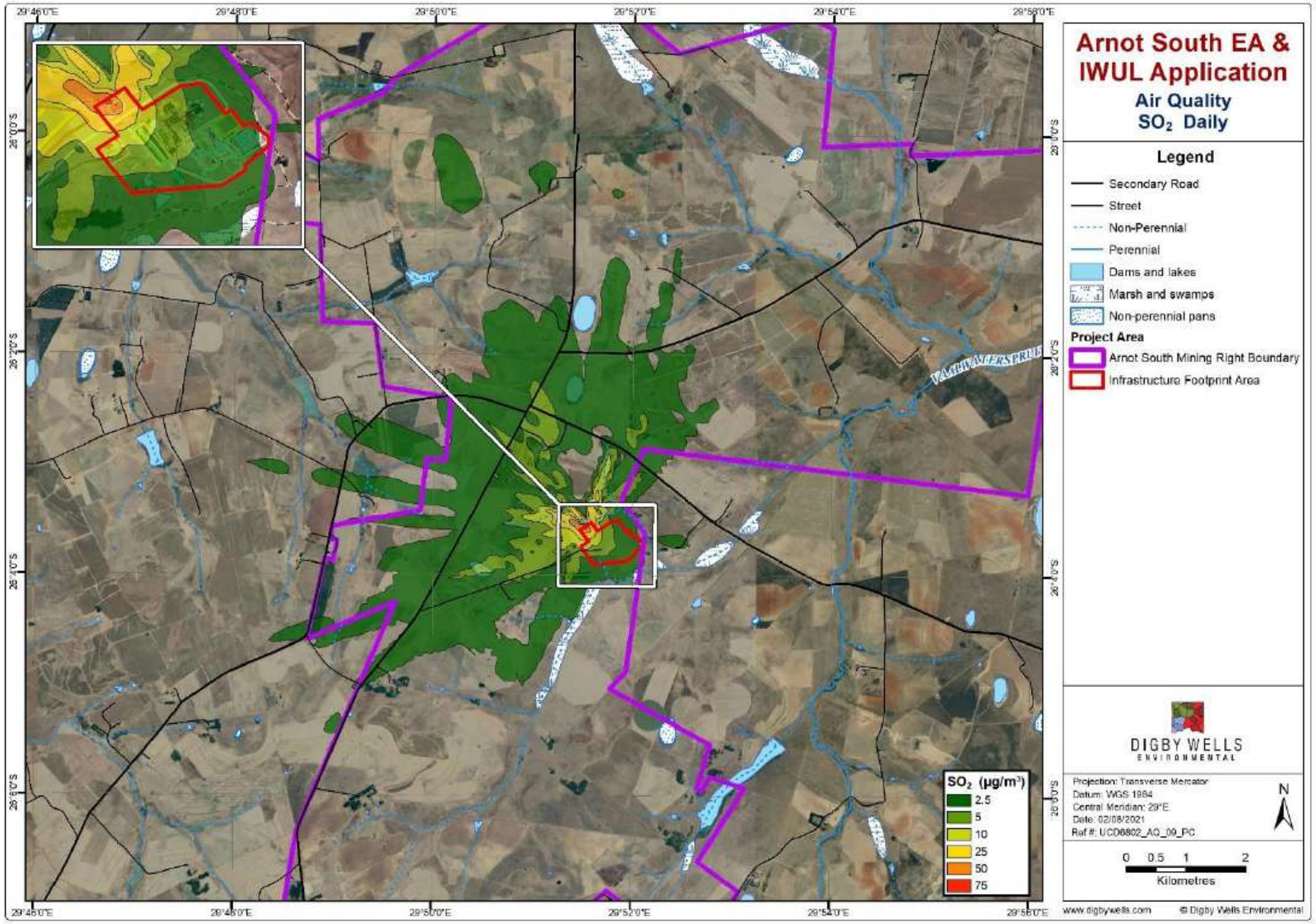

Figure 7-7: Predicted 24-hours SO_2 Ground Level Concentration ($\mu g/m^3$)

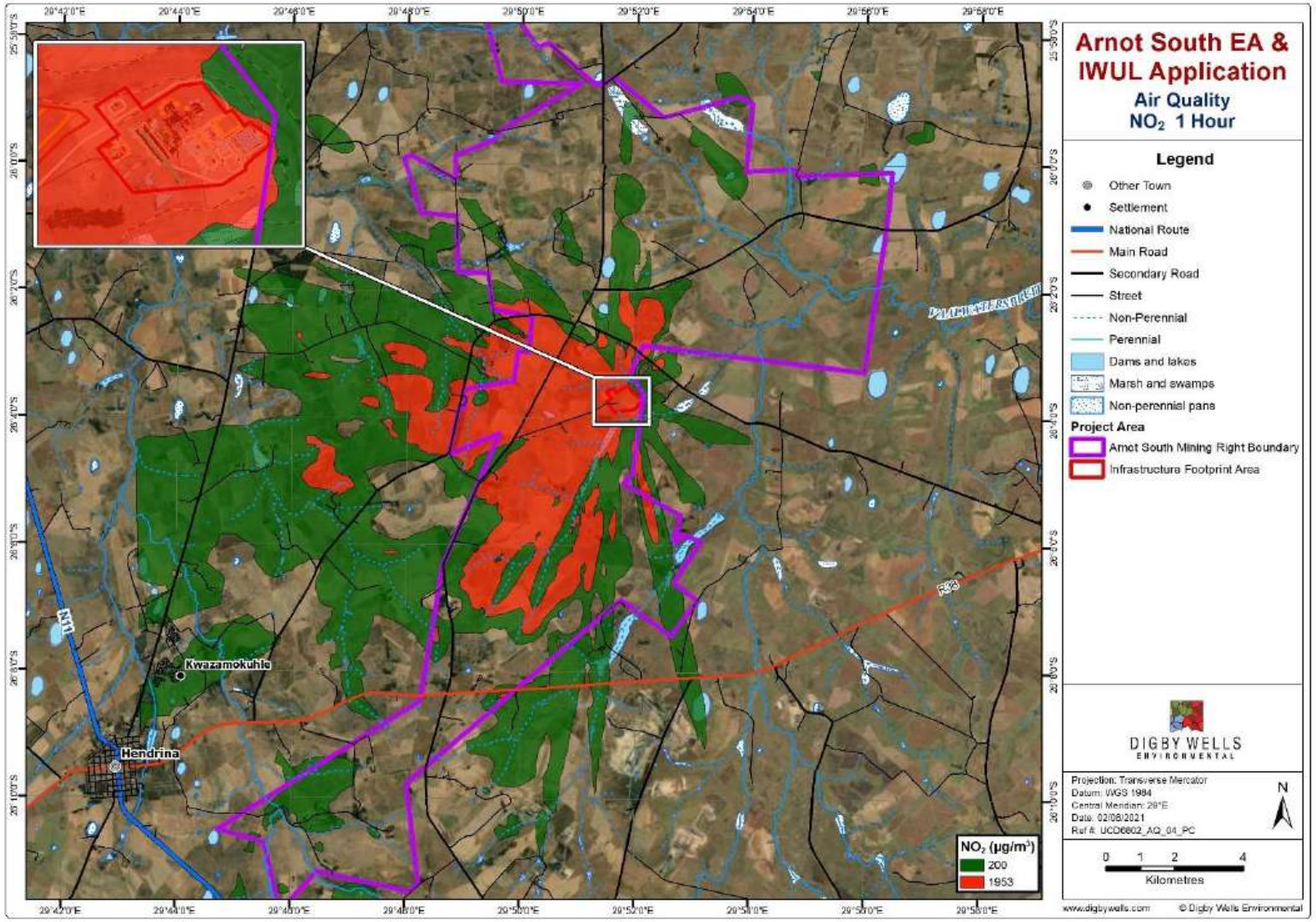

Figure 7-8: Predicted 1-hour Ground Level Concentration (µg/m^3)

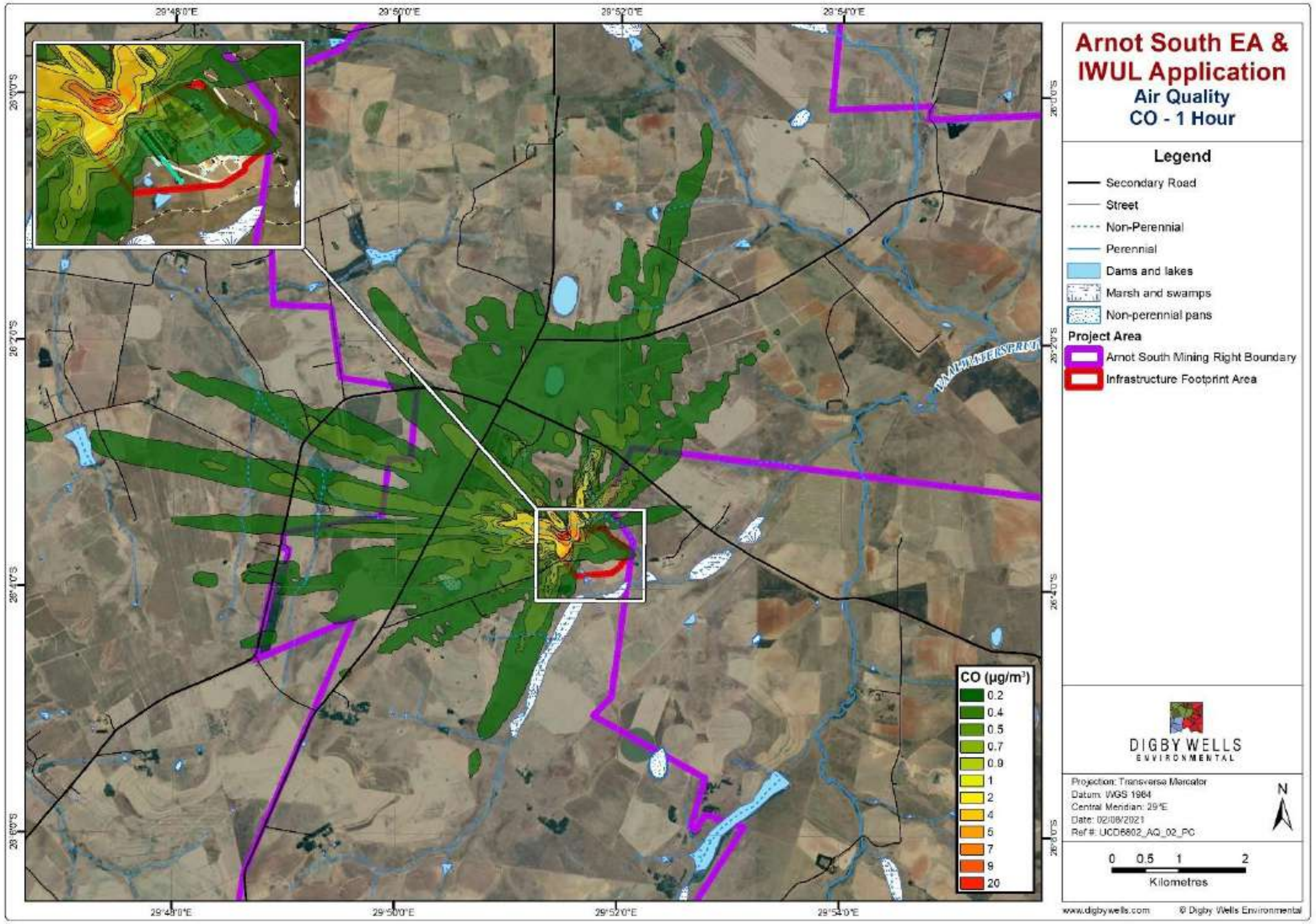

Figure 7-9: Predicted 1-hour CO Ground Level Concentration (mg/m³)

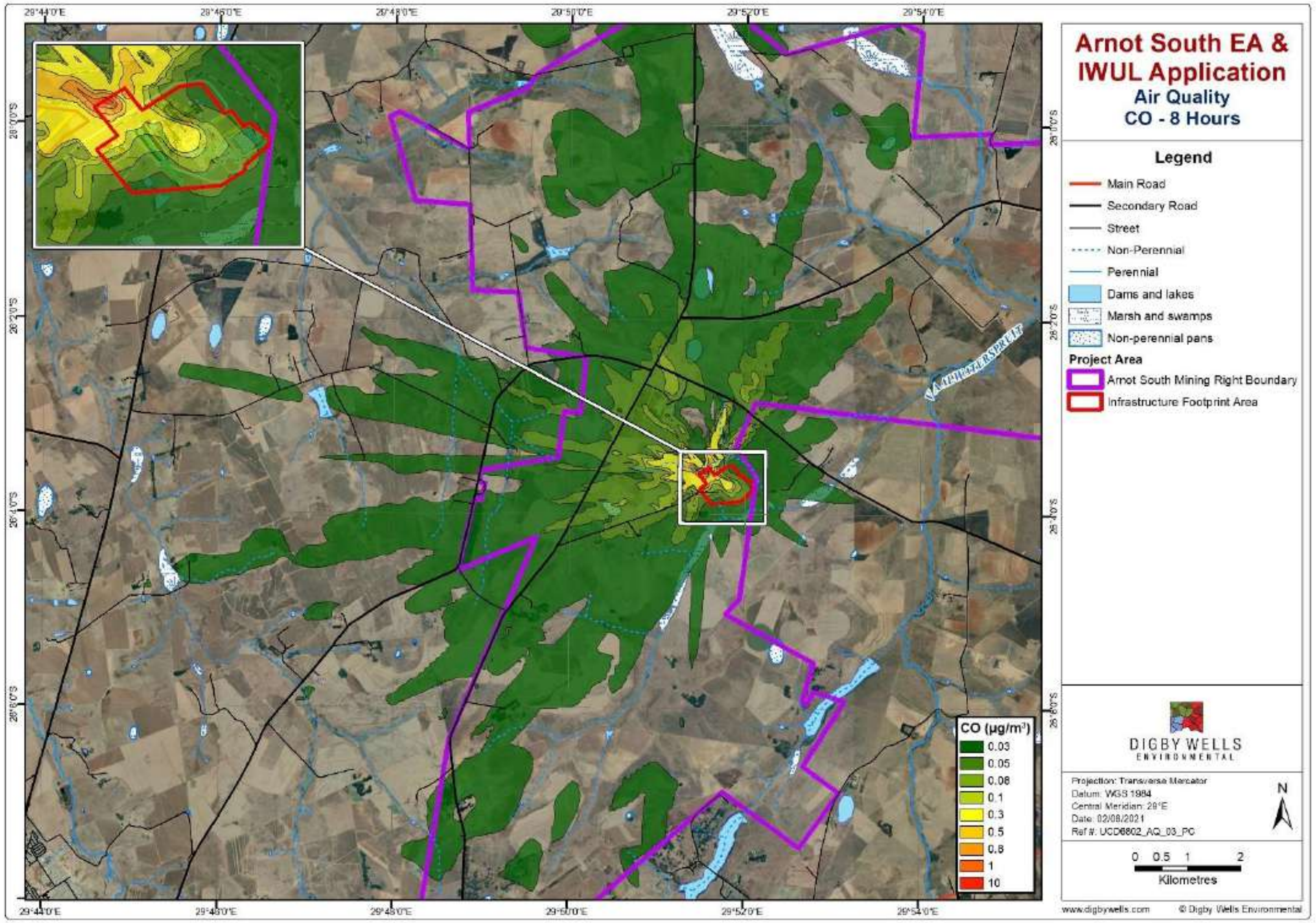

Figure 7-10: Predicted 8 hours CO Ground Level Concentration (mg/m³)

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. without mitigation measures factored into the model runs, except for the dustfall rates. The aforementioned was to show the effectiveness of mitigation measures. These findings are summarised as follows:

- For this assessment, the maximum GLC of $PM_{2.5}$ predicted was 29.6 µg/m³. This was below the daily limit value of 40 µg/m³. The GLC at the sensitive receptors (SR1) and SR2 were lower than the daily standard. The annual GLC of $PM_{2.5}$ predicted will not exceed the regulatory limit value of 40 µg/m³ onsite and at selected receptors.
- For PM_{10}, the daily limit value of 75 µg/m³ is likely to be exceeded along the dirt road from the plant to the edge of the western boundary (dirt road that runs south to the R38 route). The predicted daily GLC at the nearest sensitive receptors SR1 and SR2 were lower than the daily limit. The predicted annual GLC showed that exceedances will occur along the dirt road to the edge of the western boundary. The predicted annual GLC at the nearest sensitive receptors SR1 and SR2 were below the annual limit value.
- The predicted dustfall rates confirmed that the non-residential limit of 1,200 mg/m²/d will be exceeded onsite and along the dirt road leading to the western boundary. However, these exceedances will be confined within the project boundary. With mitigation in place, the areas with exceedance shrunk significantly. The predicted dustfall rates at the selected receptors without and with mitigation were lower than the limit.
- For gases, the model predictions confirmed that the SO_2 24-hr GLC will be very low and unlikely to exceed the limit of 200 µg/m³. The predicted NO_2 1-hr GLC showed exceedances of the South African standard of 200 µg/m³ onsite and beyond the western boundary. Being a gas, this pollutant will dissipate quickly to negligible levels further away from the project area. The predicted NO_2 annual levels were very low, hence, could not plot. The model simulations returned predicted CO 1-hr and CO 8-hr GLCs that were below the South African standard of 30 mg/m³ and 10 mg/m³ onsite and at the surrounding sensitive receptors. During the operational phase, the occurrence of CO exceedances are not anticipated due to the low GLC predicted.

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 of 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
Removal of vegetation/topsoil for the establishment of mining and linear infrastructure	Generation of dust, leading to poor air quality; Soiling of surfaces due to dustfall; and Diesel storage results in the release of volatiles leading to poor air quality
Diesel storage and explosives magazine	
Construction of project infrastructure, and ventilation fans	
Construction of access road and haul roads	
Stockpiling of soils, rock dump, and discard dump establishment.	

9.1.1. Impact Description

The construction of project infrastructure will occur in phases and will be short-term in nature. Therefore, the anticipated impacts will be negligible.

Activities associated with site clearing will result in the generation of fugitive dust comprising of TSP, PM_{10}, and $PM_{2.5}$. Also, use of the haul roads and erosion of bare soil surfaces, construction of infrastructural and topsoil stockpiling will result in the entrainment of dust. In addition, excavation, loading, and tipping of construction material will lead to dust generation. The release of volatiles from diesel storage will result in poor air quality in the vicinity of the tank. 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 and downwind locations and at sensitive receptors; and
- Application of dust suppressants e.g. Dust-A-Side on haul roads and exposed areas to prevent emissions and ensure compliance.

9.1.1.3. Impact Ratings

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

Table 9-2: Significance Ratings for Site Clearing, Construction of Infrastructure, Access Road, Stockpiling of Topsoil, and Establishment of Rock / Discard Dumps

<table>
<tr><th colspan="4">Activity and Interaction: Site Clearing, Construction of Infrastructure, Access Road, Stockpiling of Topsoil and Establishment of Rock and Discard Dumps</th></tr>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td colspan="4">Impact Description: Reduction in ambient air quality</td></tr>
<tr><td colspan="4">Prior to mitigation/ management</td></tr>
<tr><td>Duration</td><td>Short term (1)</td><td>Dust generation will be short-term in the construction phase</td><td rowspan="5">Negligible (negative) – 30</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The emission of pollutants will be limited to each activity and immediate surroundings.</td></tr>
<tr><td>Intensity</td><td>Minor (2)</td><td>Minor implications on the surrounding air quality are anticipated</td></tr>
<tr><td>Probability</td><td>Almost certain (6)</td><td>There is a possibility that generated dust will impact ambient air quality.</td></tr>
<tr><td>Nature</td><td>Negative</td><td></td></tr>
<tr><td colspan="4">Mitigation/ Management actions</td></tr>
<tr><td colspan="4">• Application of a dust suppressant on the haul roads and exposed areas;
• Limit activity to non-windy days (wind speed less than 5.4 m/s);
• Set maximum speed limits on haul roads and have these limits enforced;
• 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; and
• The drop heights when loading onto trucks and at tipping points should be minimised.</td></tr>
<tr><td colspan="4">Post- mitigation</td></tr>
<tr><td>Duration</td><td>Short term (1)</td><td>Dust generation will be short-term in the construction phase</td><td rowspan="3">Negligible (negative) – 12</td></tr>
<tr><td>Extent</td><td>Very Limited (1)</td><td>After mitigation measures are implemented, It is expected that the dust generated will be limited to isolated parts of the site.</td></tr>
<tr><td>Intensity</td><td>Minimal (1)</td><td>Generated dust will have negligible impacts on the ambient air quality after mitigation</td></tr>
</table>

Activity and Interaction: Site Clearing, Construction of Infrastructure, Access Road, Stockpiling of Topsoil and Establishment of Rock and Discard Dumps			
Dimension	**Rating**	**Motivation**	**Significance**
Probability	Probable (4)	Probable that the impact on ambient air quality will occur.	
Nature	Negative		

9.2. Operational Phase

Activities that will be conducted during the Operational Phase that may have implications on the ambient air quality of the Project 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
Ventilation fans and infrastructure area containing stockpile areas	Generation of dust, leading to poor air quality; Soiling of surfaces due to dustfall; and Particulates and gaseous emissions from the underground via the ventilation shaft
Underground blasting	
Maintenance of haul roads, and stockpile areas.	
Removal of rock(blasting)	
Concurrent rehabilitation as mining progresses	

9.2.1. Impact Description

The operation of the ventilation shaft, use and maintenance of the haul roads and concurrent rehabilitation as mining progresses will result in the emission of particulate and gaseous pollutants to the ambient 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 are in compliance with the relevant standards.

9.2.1.2. Management Actions

- Air quality monitoring to ensure compliance at upwind and downwind locations.

- Application of dust suppressants e.g. Dust-A-Side on haul roads and exposed areas to ensure compliance.
- Use of dust mitigation equipment at the vent exit point.

9.2.1.3. Impact Ratings

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

Table 9-4: Significance Ratings for Operation of the Underground Mine, Ventilation Shaft, Use and Maintenance of Haul Road and Concurrent Rehabilitation

Activity and Interaction: Operation of the Underground Mine, Ventilation Shaft, Use and Maintenance of Haul Road, and Concurrent Rehabilitation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Dust generation and release of gaseous pollutants leading to poor air quality			
Prior to mitigation/ management			
Duration	Project life (5)	Dust and gaseous pollutants will be generated for the project life	Minor (negative) – 72
Extent	Local (3)	Pollutants may extend across the project site area and beyond.	
Intensity	Serious (4)	Serious impact on ambient air quality	
Probability	Almost certain (6)	It is almost certain that the impact will occur.	
Nature	Negative		
Mitigation/ Management actions			
• Application of dust suppressant on the unpaved haul roads and exposed areas; • Limit dust-generating activity to non-windy days (wind speed less than 5.4 m/s); • Set maximum speed limits on dirt roads and have these limits enforced; • The drop heights when loading onto trucks and at tipping points should be minimised; and • Dust mitigation equipment for the vent shaft.			
Post- mitigation			
Duration	Project life (5)	Dust and gaseous pollutants will be generated for the project life	Negligible (negative) – 27
Extent	Limited (2)	Airborne emissions will be limited to the site boundary and its immediate surrounding after mitigation.	
Intensity	Minor (2)	Minor impacts anticipated after mitigation	

Activity and Interaction: Operation of the Underground Mine, Ventilation Shaft, Use and Maintenance of Haul Road, and Concurrent Rehabilitation			
Dimension	**Rating**	**Motivation**	**Significance**
Probability	Unlikely (3)	Unlikely that impacts 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
Post-closure monitoring and rehabilitation	
Closure of the underground mine	

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 area will involve the use of heavy machinery 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. Mitigation measures will be implemented to ensure that emissions remain below limit values.

9.3.1.2. Management Actions

- Air quality monitoring at upwind and downwind locations.
- 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, Rehabilitation, Post Closure Monitoring and Closure of Underground Mine

Activity and Interaction: Demolition and Removal of Infrastructure and Rehabilitation			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Dust generation leading to poor air quality			
Prior to mitigation/ management			
Duration	Medium-term (3)	Dust will be generated in the medium term	Minor (negative) – 28
Extent	Limited (2)	Limited to each activity area and immediate surroundings.	
Intensity	Minor (2)	Minor effect on surrounding air quality is anticipated	
Probability	Probable (4)	Almost certain that generated dust will impact ambient air quality.	
Nature	Negative		
Mitigation/ Management actions			
• Application of dust suppressant on the haul roads and exposed areas; • Limit activity to non-windy days (wind speed less than 5.4 m/s); • Set maximum speed limits on dirt roads and have these limits enforced; • 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; • The drop heights when loading onto trucks and at tipping points should be minimised • Rehabilitation of disturbed land to allow for vegetation growth.			
Post- mitigation			
Duration	Medium-term (3)	Dust will be generated in the medium term	Negligible (negative) – 15
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	Unlikely (3)	Unlikely that impacts will occur after mitigation.	
Nature	Negative		

9.4. Cumulative Impacts

The cumulative impacts could not be conducted as site-specific air quality data was not available. However, the predicted GLCs of the pollutants shows that future impacts will not be severe outside the project boundary and at sensitive receptors.

9.5. Unplanned and Low-Risk Events

Table 9-7 highlights some likely unplanned events related to this Project. This was based on expert knowledge drawn from experience in the 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 9-7: 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 a wind storm event Exposed areas prone to erosions should be avoided or minimised at all times

10. Environmental Management Programme

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 Programme (EMPr) are specified.

Table 10-1: Environmental Management Programme

Activity	Potential Impacts	Aspects Affected	Phase	Mitigation Measures	Mitigation Type	Time period for implementation
• Site clearing; • Diesel storage and explosive magazine; • Access and haul road construction; • Construction of surface infrastructure. • Stockpiling of soil, construci=tion of rock dump and discard dump	Poor air quality due to the generation of dust and volatiles	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); • Minimise fuel leaks or spills and ensure compliance with the general health and safety regulations which apply to the storage and handling of explosives • Keep the area of disturbance to a minimum and avoid any unnecessary clearing, digging, or scraping, especially on windy days; • Minimise the drop heights when loading onto trucks and at tipping points; and • Set maximum speed limits and have these limits enforced.	• 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
• Operation of the ventilation shaft; • Operation of the underground mine • Use and maintenance of the access and haul roads and stockpile areas; • Concurrent rehabilitation.	Poor air quality due to the generation of dust	Air Quality	Operation	• Apply wetting agents, dust suppressants, and binders on exposed areas and haul roads; • Conduct mining activities judiciously on 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; • Minimise the drop heights when loading onto trucks and at tipping points; • Set maximum speed limits and have these limits enforced; and • Application of the mitigation equipment at the vent shaft	• 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 life mine.
• 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	• Apply wetting agents, dust suppressants, and binders on exposed areas; • Conduct mining activities judiciously on 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; • Minimise the drop heights when loading onto trucks and at tipping points; • Set maximum speed limits and have these limits enforced; • The dismantling of infrastructure must occur in phases; and • The rehabilitated landscape should be vegetated.	• 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 an air quality monitoring network be set up and maintained for the LoM to ensure that generated emissions associated with the day to day activities at the mine are below regulatory limit values. The frequency of monitoring will ensure that diurnal, seasonal, annual, and inter-annual ambient air quality records are available to inform management decision making. Table 11-1 shows the criteria pollutants that should be measured and the frequency of monitoring.

Table 11-1: Recommended Monitoring Plan

Method	Frequency	Target	Responsibility
Monitoring in accordance with: • EN14097 for $PM_{2.5}$; • EN12341 for PM_{10}; and • American Standard Test Method ASTM 1739-98 in SANS1137:2019	• Continuous PM_{10}, $PM_{2.5}$ monitoring; • Continuous monitoring of gases: SO_2, NO_2, and CO; • Monthly dustfall monitoring;	Particulate pollutants from the ongoing mining operation must be kept below the South African standards: • GN R 1210 of 24 December 2009 • GN R 486 of June 2012; and • GN R 827 of 1 November 2013	A designated Environmental Officer (EO) is onsite to collect ambient air quality data and submit it to an independent consultant for interpretation and reporting.

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&AP). If comments or concerns are received in future, they will be documented in line with the prescribed regulatory requirements and the EA application will be updated.

13. Recommendations

Based on the results from this assessment, the following recommendations should apply:

- Commission an ambient air quality network before the construction phase;
- Designate a qualified person to act as the EO, who will oversee the monitoring process and implementation of mitigation measures;
- 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 air quality management and mitigation, including regular appropriate restrictions on vehicle movements and speeds; 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 model simulations have shown that the GLCs and areas where exceedances are likely to occur without mitigation measures in place. These areas are confined within the project boundary.

With appropriate mitigation measures and management measures in place, it is anticipated emissions will be lower than regulatory limit values for most of the time, hence, the mine will operate within compliance. The air quality specialist will recommend that the EA Application be approved, provided the recommended mitigation measures are implemented.

15. Conclusion

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 were reduced to “negligible negative”. Since anticipated emissions from the operational phase activities are likely to have minimal impacts on receptors outside the Project boundary, with adequate mitigation and management intervention measures in place, such impacts can be minimised significantly.

Some of the mitigation measures and management intervention measures recommended are repeated and they include:

- Application of dust suppressants/binders 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 vent shaft; and
- Operation of ambient air quality monitoring network to collect valuable data needed to assess the effectiveness of mitigation measures put in place during operation.

Once the mine implements these recommendations outlined in this report, emissions from mining operation can be contained to below standards, thus, 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

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 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)