DIGBY WELLS ENVIRONMENTAL

AIR QUALIY IMPACT ASSESSMENT FOR THE PROPOSED KLISPRUIT WELTEVREDEN COLLIERY

AIR QUALITY

Project Number:

BHP2690

Prepared for:

BHP BILLITON ENERGY COAL SOUTH AFRICA (BECSA)

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Name	**Responsibility**	**Signature**	**Date**
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EXECUTIVE SUMMARY

OUTLINE OF THE PROJECT

Digby Wells Environmental (hereafter Digby Wells) was requested by BHP Billiton Energy Coal South Africa (Pty) Limited (BECSA) to conduct an Environmental Impact Assessment (EIA) and provide an Environmental Management Plan (EMP) including the public consultation process and specialist studies for the proposed Klipspruit Weltevreden (KPSX: Weltevreden) and associated infrastructure. The study encompasses several specialist studies of which Air Quality Impact Assessment (AQIA) forms an integral component.

The overall objective of this AQIA is to identify the potential concerns, and develop management measures to optimise the project benefits and minimise any adverse impacts that may result from the proposed KPSX: Weltevreden near Phola, Mpumalanga.

This AQIA study was compiled taking cognisance of the various South African National Standards (SANS) in order to evaluate impacts and assess environmental risks from the proposed project.

KNOWLEDGE GAPS

Monitoring of ambient PM_{10} and $PM_{2.5}$ is not undertaken at the moment by BECSA in the vicinity of the proposed KPSX: Weltevreden project. These pollutants are regulated and monitoring is deemed essential as the day to day activities from the proposed KPSX Weltevreden operation impact ambient particulate matter concentrations in the area.

Background ambient air quality assessment was limited to the existing dust monitoring data, which was used to determine current dust deposition rates in the area. The air quality and climate assessment was carried out as a desktop study – using modelled meteorological data, as site specific information was not available.

BASELINE ASSESSMENT

In the baseline assessment, modelled meteorological data set from Lakes Environmental was analysed. Meteorological parameters such as rainfall, relative humidity, temperature and wind speed for the area were assessed. The predominant winds are from north northeast (NNE) and north (N) for the KPSX: Weltevreden project area. The NNE and N winds occur 8.4% and 8% of the time respectively, with wind speed greater than 5.4 m/s accounting for 9% throughout the period (2011-2013). Over the three year period, winds capable of generating dust occurred for some 99 days. Calm conditions (wind speeds < 0.5 m/s) occurred for 3.2% of the time.

Dust deposition measurements conducted in the area confirm that fallout rates are generally high at some sites: KPF05, Bankfontein, and Phola in the vicinity of the proposed KPSX: Weltevreden project area. Majority of the other sites were within the National Dust Control Regulation (2013) standard of 600 mg/m²/day for residential areas. Although several exceedances were recorded, these were not in for sequential months.

IMPACT ASSESSMENT

A domain of 20x20 km was defined, with a reference mid-point within the future project area. This domain, defined as the zone of potential impact due to air pollution emanating from the proposed KPSX: Weltevreden operation stretches 10 kilometres North, South, East and West from the reference point. This zone of impact encompasses Ogies and Phola communities, including scattered farm houses and other sensitive receptors.

An emissions inventory was established comprising emissions for construction and operation of the proposed KPSX: Weltevreden project. Emission inventory analysis ensures inputs data are available for dispersion model simulations. This inventory calculated emissions of total suspended particulate (TSP), PM_{10} and $PM_{2.5}$ from the material handling (tipping) processes, topsoil and overburden stockpile, run-off-mine (ROM), roads as well as drilling and blasting operations. It was assumed that the mine will use electricity from the national grid, and no on-site power generators (although a standby generator is always available), hence emissions from this source was not qualified.

The grid mesh was 250 metres resulting in a total of 6 561 grid points. Each of the grid points has x and y (Cartesian co-ordinates) values in metres. Terrain effects were imported from NASA Shuttle Topography Radar Mission (STRM3) global database with ~90 m accuracy and processed by the AERMAP module of AERMOD. The operating hours at the mine is assumed to be 24 hours per day and 329 days a year. The 1-hour, 24-hour and annual averaging times have been used for consistency. Predicted concentrations and deposition rates obtained are attributed to mine operation only.

RESULTS

The predicted highest PM_{10} concentrations at any point on the mine boundary were in exceedance of the South African Air Quality standards for both averaging periods. The highest PM_{10} daily (528 µg/m³) and annual average (81 µg/m³) without mitigation are higher than the current South African standards of 75 µg/m³ (daily) and 40 µg/m³ (annual) respectively. Much of the areas impacted are confined to the mine project area.

The highest $PM_{2.5}$ daily (138 µg/m³) without mitigation exceeded the current South African standards of 65 µg/m³. However, the annual average (22 µg/m³) is within the current standard of 25 µg/m³.

The highest dust deposition rates predicted at any point on the mine boundary or beyond exceeded 2 400 mg/m^2/day. The deposition rate predicted outside the mine boundary is higher than the current limit of 600 mg/m^2/day and 1 200 mg/m2/day for residential and non-residential areas. The dispersion model shows that exceedances will be observed along the haul road and in adjacent areas. Hence, mitigation measures are recommended to contain emissions from hauling of coal and overburden during the operational phase of the mine.

The concentrations of the various pollutants have been evaluated at the mine boundary and at selected sensitive receptors. The potential is there to exceed established regulatory standards without mitigation measures in place. Once mitigations measures are applied, it is anticipated that predicted ambient pollutant burden from KPSX: Weltevreden will be reduced to within compliance at the mine boundary.

CONCLUSION

The conclusion reached in this reported is informed by observed and modelled data. An air quality impact assessment study was undertaken for the KPSX: Weltevreden proposed mine area. Pollutants assessed in the study includes: particulate matter – TSP (dust deposition), PM_{10} and $PM_{2.5}$. Other pollutants common to mining operation of this nature i.e. gaseous pollutant were not assessed.

The ambient dust deposition rates measured recorded some exceedances of the residential and non-residential limits. The permissible frequency of exceedance of two within a year was not violated at the monitoring sites. For the modelled results, the highest dust deposition rates predicted at any point on the mine boundary exceeded 2 400 mg/m^2/day. This value is higher than the current limit of 600 mg/m^2/day (residential) and 1200 mg/m^2/day (non-residential) recommended in the National Dust Control Regulation (2013).

The highest PM_{10} daily (528 µg/m^3) and annual average (81 µg/m^3) without mitigation observed at the mine boundary were in exceedance of the current South African standards of 75 µg/m^3 and 40 µg/m^3 respectively. However, concentrations at the selected receptors are within compliance. Although there are sections of Phola community that will be exposed the concentrations of 75 µg/m^3.

The highest $PM_{2.5}$ daily (138 µg/m^3) without mitigation exceeded the current South African standards of 65 µg/m^3. However, the annual average (22 µg/m^3) is within the current standard of 25 µg/m^3 but higher than the future standard of 20 µg/m^3 which will come into effect 1 January 2016.

The findings from the study should inform mine management on the monitoring and mitigation measures to ameliorate impact on the atmospheric environment. Some of the numerous mitigation measures recommended are listed below:

- The area of disturbance at all times must be kept to a minimum and no unnecessary clearing, digging or scraping must occur, especially on windy days (with wind speed ≥ 5.4 m/s).
- The drop heights when loading onto trucks and at tipping points should be minimised. Coupled with the use of dust suppressants and binders on haul roads to reduce dust generation.
- There is need to minimise travel speed and distance. Dust generating capacity of particles less than 10 µm is contained by 58% when vehicle speed is reduced from 25 mph (40 km/h) to 15 mph (24 km/h).
- Routine maintenance and vegetation of storage facilities i.e. topsoil and overburden stockpiles are imperative throughout the lifespan of the mine to avoid exposing surfaces to wind erosion.
- Hazardous waste storage areas should be kept clear of combustible materials and rubbish (oily rags, oil, grease, cartons etc.) to avoid fire outbreak and release of dangerous substances into the atmosphere.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF PLANS

LIST OF ABBREVATIONS

AQG	Air Quality Guidelines
APPA	Atmospheric Pollution Prevention Act
AQIA	Air Quality Impact Assessment
ASTM	American Society for Testing and Materials
BECSA	BHP Billiton Energy Coal South Africa
^{o}C	Degrees Celsius
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
km	Kilometre
KPS	Klipspruit South
KPSX	Klipspruit Extension
km^2	Kilometre squared
m	Metre
m^2	Metre squared
mg	Milligram
mm	Millimetre
MM5	Mesoscale model - Fifth generation
NDCR	National Dust Control Regulation
NEM:AQA	National Environmental Management: Air Quality Act
NEMA	National Environmental Management Act
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
PM_{10}	Particulate Matter less than 10 microns in diameter
PSU/NCAR	Pennsylvania State University / National Center for Atmospheric

	Research
ROM	Run of Mine
SANS	South African National Standards
TSP	Total Suspended Particulates
WHO	World Health Organisation

1 INTRODUCTION

Digby Wells Environmental (hereafter Digby Wells) was requested by BHP Billiton Energy Coal South Africa Proprietary Limited (BECSA) to conduct an Environmental Impact Assessment (EIA) for the proposed inclusion of the Klipspruit Extension (KPSX) Weltervreden opencast operation and associated infrastructures.

A number of specialist studies have been requested, including an Air Quality Impact Assessment (AQIA) study, which will form part of the EIA being undertaken by Digby Wells Environmental.

As a prelude to the AQIA – the baseline conditions i.e. the background levels of ambient pollutant concentrations pre-mining operations, current pollution sources and their locations, detailed description of the meteorology and climatology, local topography and physical conditions affecting pollutants dispersion, and sensitive receptors in the vicinity of the propose mining area likely to be impacted as a result of the proposed project, will be identified.

Activities often associated with mining operations such as: drilling, blasting, loading and offloading of trucks, transport, crushing and screening of ore and the milling of materials are known sources of dust and coupled with the presence of coal conveyance structures, product stockpiles, ROM stockpile, processing plant, waste rock dumps and discard dumps can affect the composition of ambient air quality. In the event of spontaneous combustion, exacerbation of poor air quality – both within and outside the mine premises is common. Environmental impacts are associated with increased gaseous and particulate matter loading and also soil contamination from deposited materials leading to heavy metal contamination.

The overall objective of this baseline assessment is to establish the nature of current ambient air quality, for which future changes and management measures can be compared, in order to optimise the project benefits and minimise or avoid any adverse impacts that may result.

2 TERMS OF REFERENCE

As a vital component of the whole, an air quality baseline study have been undertaken and an impact assessment will be conducted at a later stage to determine the associated impacts from the proposed project on surrounding air quality and on human health, coupled with recommendations for mitigation of impacts.

The terms of reference for the baseline air quality characterisation included:

- Identification of sensitive receptors based on the area that could potentially be affected by the proposed project;
- Assessment of available ambient air quality data;
- Identification of significant information gaps; and

- Compilation of a baseline assessment report employing desktop study approach of available climatic modelled data and published reports.

2.1 Background and Context

The KPSX: Weltervreden Project is focusing on the exploitation of various portions of the farms: Grootpan 7 IS, Hartebeestlaagte 325 JS, Wildebeestfontein 327 JS, Tweenfontein 328 JS and Weltervreden 324 JS as an open pit operation north-east of Ogies in Nkangala District Municipality, Mpumalanga Province.

The current KPSX: Weltevreden contains coal resource of approximately 660Mt, in close proximity to the existing Klipspruit (KPS) operation. The KPSX Project has been initiated in order to extend the life of KPS beyond 2020, leverage off of the existing export infrastructure, and maintain BECSA's export profile.

3 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations were identified:

- Adequate ambient air quality monitoring data does not exist to evaluate the baseline air quality situation in the vicinity of the proposed KPSX opencast project area;
- Use will be made of modelled, site-specific meteorological data for the baseline assessment, to compliment available local hourly meteorological data for the study area; and
- Data input into the model has been based on all documentation provided by the Client. It is assumed that the information provided by the Client is accurate and complete.

4 STUDY AREA

The proposed site for the KPSX: Weltevreden opencast operation is located approximately 8 km northeast of Ogies (Plan 1 – Regional Setting), a small settlement in the Nkangala District Municipality, Mpumalanga Province.

The proposed location of KPSX: Weltevreden opencast encompasses Portion Grootpan 7 IS, Hartebeestlaagte 325 JS, Wildebeestfontein 327 JS, Tweenfontein 328 JS and Weltervreden 324 JS (Plan 2 – Local Setting).

5 EXPERTISE OF THE SPECIALIST

Matthew Ojelede completed his BSc (Hons) degree at the University of Benin, Edo State, Nigeria; an MSc in Environmental Science (Wits University) and a PhD in Environmental Management from the University of Johannesburg. He has been in the Atmospheric Research field since 2005 and now actively involved in the assessment of atmospheric pollution, dispersion modeling and emissions inventories compilation. Authored and co-authored research articles in peer reviewed journals and Dispersion Modelling Impact Assessments Reports. He has attended specialised courses in atmospheric dispersion modelling (AERMOD and CALPUFF).

6 REGIONAL CLIMATE AND FACTORS INFLUENCING AIR DISPERSION

6.1 Regional Climate

South Africa is located in the sub-tropics where high pressures and subsidence dominate. However, the southern part of the continent can also serve as a source of hot air that intrudes sub-tropics, and that sometimes lead to convective movement of air masses. On average, a low pressure will develop over the southern part of the continent, while the normal high pressures will remain over the surrounding oceans. These high pressures are known as Indian High Pressure Cell and Atlantic High pressure Cell. The intrusion of continents will allow for the development of circulation patterns that will draw moisture (rain) from either tropics (hot air masses over equator) or from the mid-latitude and temperate latitudes.

Southern Africa is influenced by two major high pressure cells, in addition to various circulation systems prevailing in the adjacent tropical and temperate latitudes. The mean circulation of the atmosphere over Southern Africa is anticyclonic throughout the year (except near the surface) due to the dominance of the three high pressure cells, namely South Atlantic High Pressure, off the west coast, the South Indian high pressure off the east coast and the continental high pressure over the interior.

It is these climatic conditions and circulation movements that are responsible for the distribution and dispersion of air pollutants within proposed KPSX: Weltevreden opencast area and between neighbouring provinces and countries bordering South Africa.

6.2 Topography

The topography of the area is generally flat and stretches in some places. There are no significant topographical features like ridgelines and mountain peaks that are prominent features in some landscapes (Plan 3 – Topography).

6.3 Vegetation

The site occurs within the Highveld Grassland. The vegetation communities associated with the KPSX: Weltevredenopencast area are characteristic of veldt vegetation. Farming and mining activities are the predominant land uses in the vicinity.

6.4 Climate and Meteorological Overview

Ambient air quality in this region of South Africa is strongly influenced by regional atmospheric movements, together with local climatic and meteorological conditions. The most important of these atmospheric movement routes are the direct transport towards the Indian Ocean and the recirculation over the sub-continents.

The country experiences distinct weather patterns in summer and winter that affect the dispersal of pollutants in the atmosphere. In summer, unstable atmospheric conditions result in mixing of the atmosphere and rapid dispersion of pollutants. Summer rainfall also aids in removing pollutants through wet deposition. In contrast, winter is characterised by atmospheric stability caused by a persistent high pressure system over South Africa. This dominant high pressure system results in subsidence, causing clear skies and a pronounced temperature inversion over the Highveld. This inversion layer traps the pollutants in the lower atmosphere, which results in reduced dispersion and a poorer ambient air quality. Preston-Whyte and Tyson (1988) describe the atmospheric conditions in the winter months as highly unfavourable for the dispersion of atmospheric pollutants.

Precipitation reduces erosion potential by increasing the moisture content of materials. This represents an effective mechanism for removal of atmospheric pollutants and is therefore considered during air pollution studies. Rain-days are defined as days experiencing 0.1 mm or more rainfall.

Site specific MM5 modelled meteorological data set for full three calendar years (2009 – 2011) was obtained from the Lakes Environmental Consultants in Canada to determine local prevailing weather conditions. This dataset consists of surface data, as well as upper air meteorological data that is required to run the dispersion model. It is required if site specific surface and upper air meteorological data is not available. The Pennsylvania State University / National Center for Atmospheric Research (PSU/NCAR) meso-scale model (known as MM5) is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model designed to simulate or predict meso-scale atmospheric circulation. This data has been tested extensively and has been found to be extremely accurate.

Modelled meteorological data for the period January 2011 to December 2013 was obtained for a point in the proposed KPSX: Weltevreden open pit site (25.991436 S, 29.099525 E). Data availability was 100%.

Generally, a data set of greater than 90% is required in order for that month/year to be considered representative of the assessed area (SANS, 2005).

Dispersion of atmospheric pollutants is a function of the prevailing wind characteristics at any site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

The amount of particulate matter generated by wind is highly dependent upon the wind speed. Below the wind speed threshold for a specific particle type, no particulate matter is liberated, while above the threshold, particulate matter liberation tends to increase with the wind speed. The amount of particulate matter generated by wind is also dependent on the material's surface properties. This includes whether the material is crusted, the amount of non-erodible particles and the particle size distribution of the material.

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 of wind speed and direction categories. The figure given at the bottom of the legend described the frequency with which calms occurred, i.e. periods during which the wind speed was below 0.5 m/s.

The spatial and annual variability in the wind field for the KPSX: Weltevreden area modelled data is clearly evident in Figure 6-1. The predominant wind direction is from the north northeast accounting for about 8.4% of the time, and north (8%) with wind speed greater than 5.4 m/s occurring 9% throughout the period. Secondary wind speeds were also observed from the east southeast (7%) and east (6%). Over the three year period, winds capable of generating dust occurred for some 99 days. Calm conditions (wind speeds < 0.5 m/s) occurred for 3.2% of the time. Wind class frequency distribution per sector is given in Figure 6-4 and Table 6-1.

The diurnal patterns during the night, showed winds coming from the NE and SE sector, while the morning afternoon and evening experienced winds from the NE, SE and NW sectors respectively, with the dominant winds coming from the north northeast (Figure 6-2). During the last three years, strong winds greater than 8.8 m/s occurred for approximately 1% of the time. This equates to 11 days throughout the entire three year period.

Calm conditions in the morning, afternoon, evening and night time were: 5.2%, 10%, 5.4% and 2.4%. Average wind speeds were 3.25 m/s (morning), 2.86 m/s (afternoon), 3.26 m/s (evening) and 3.39 m/s (night time).

The seasonal patterns show Spring have been dominated by winds from the N (16%) and NNE (13.3%) respectively. Wind speed greater than 5.4 m/s was observed 14% of the time. Average wind speed was 3.74 m/s and calm 2.3%. Summer was dominated by winds from the NNE (13%) and N (12%), and winds between 5.4 m/s was observed 3.7% of the time in Spring. In Autumn, winds from the ESE (10%), and SE (9.7%) dominated. Wind greater than 5.4 m/s capable of generating dust occurred some 5.2% of the time. Winter was dominated by winds from SE (10%), ESE (9.8%) and N (8%) with winds greater than 5.4 m/s occurring some 12% of the time.

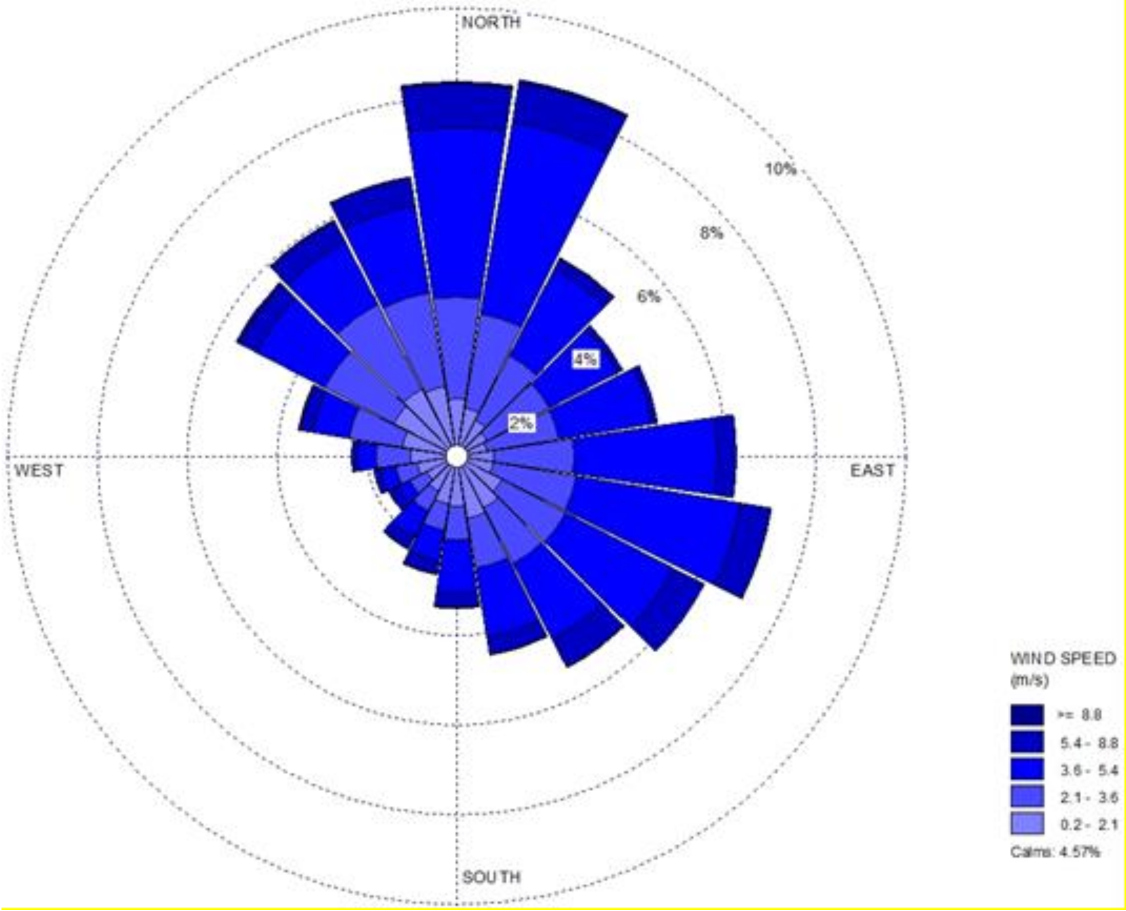


Figure 6-1: Surface wind rose for KPSX: Weltervreden modelled data, 01 January 2011 – 31 December 2013

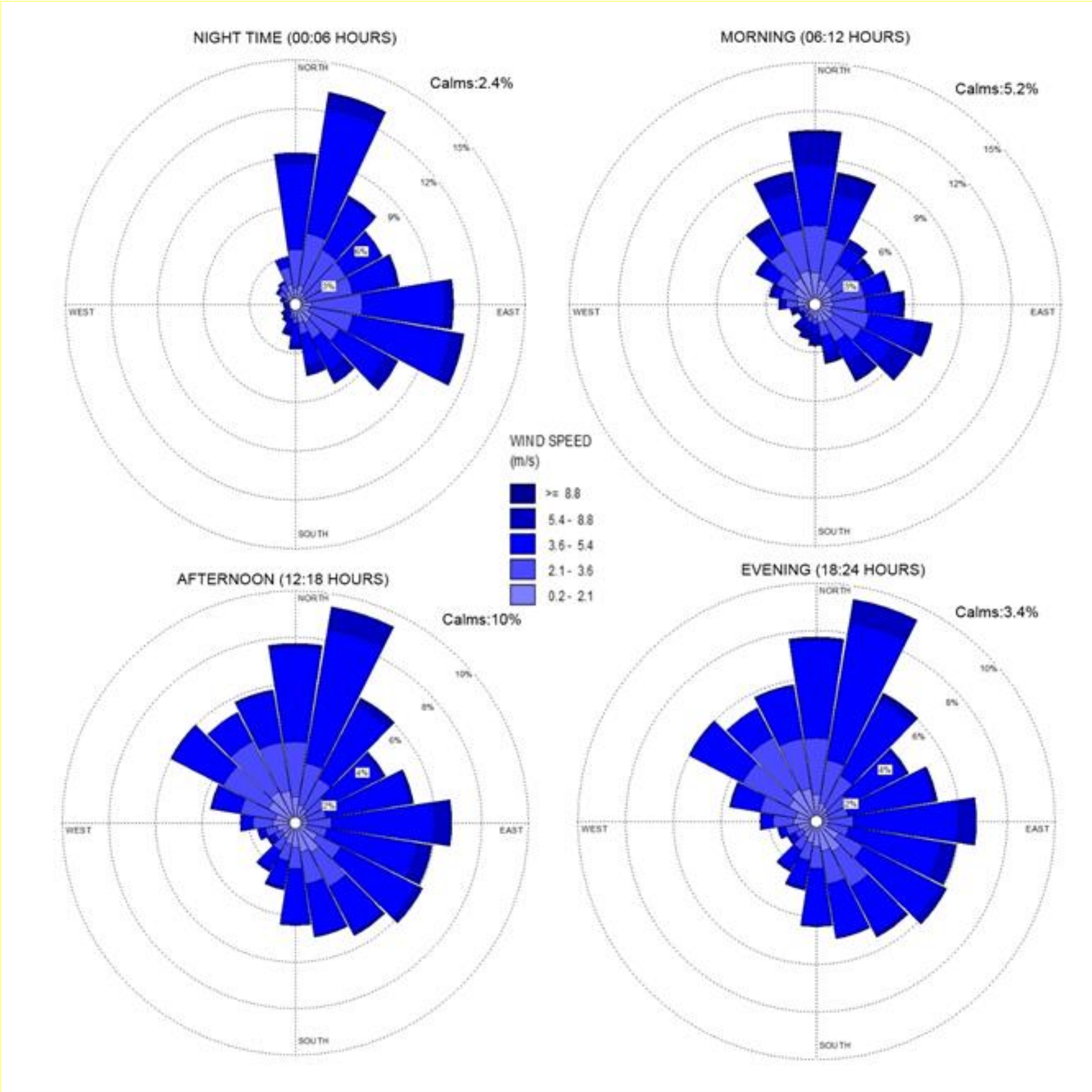


Figure 6-2: Diurnal variation of winds between Morning 06:00 – 12:00 (top right), Afternoon 12:00 – 18:00 (bottom right), Evening 18:00 – 24:00 (bottom right) and Night time 00:00 – 06:00 (top left) (modelled data 01 January 2011 – 31 December 2013)

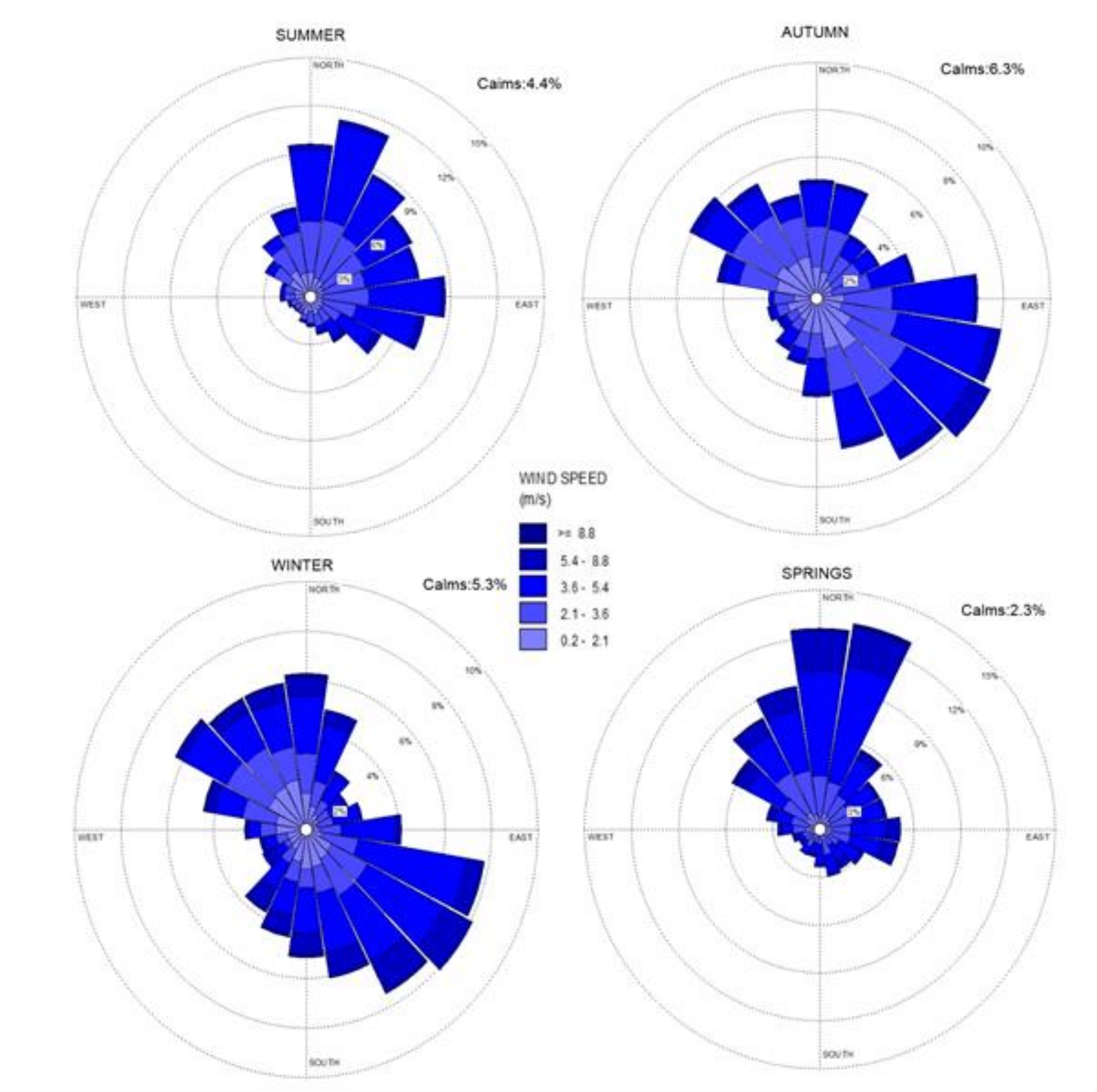


Figure 6-3: Seasonal variation of winds in spring season (September – November) (bottom right), summer season (December - February) (top left), autumn season (March – May) (top right) and winter season (June – August) (bottom left) (modelled data 01 January 2011 – 31 December 2013)

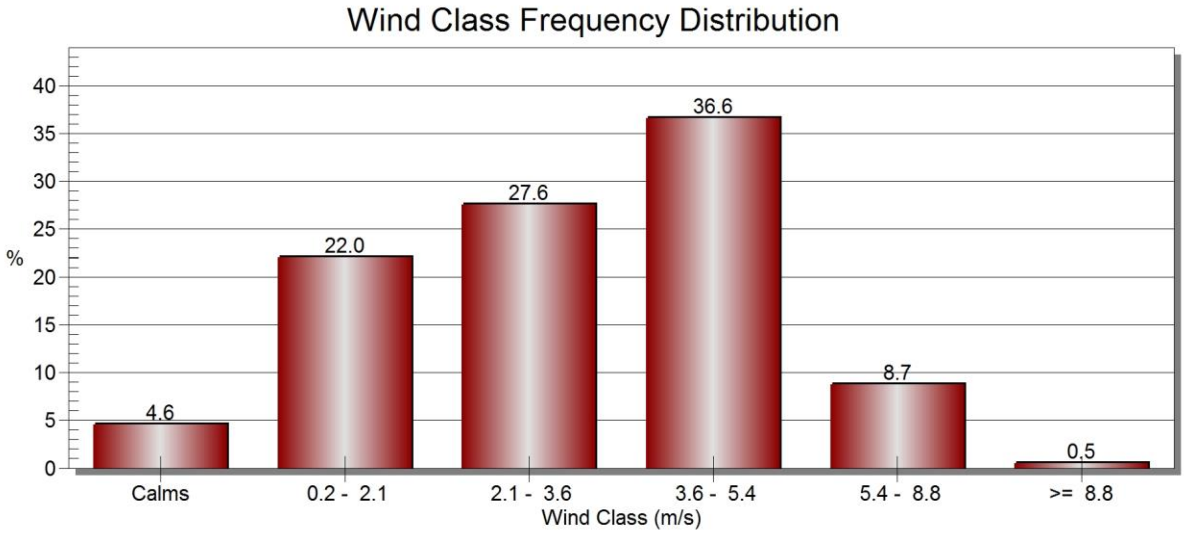


Figure 6-4: Wind Class Frequency Distribution for KPSX: Weltervreden opencast pit modelled data, 01 January 2011 – 31 December 2013

Table 6-1: Wind Class Frequency Distribution per Direction for KPSX: Weltervreden modelled data, 01 January 2011 – 31 December 2013

Directions		Wind Classes (m/s)					
		0.2 - 2.1	**2.1 - 3.6**	**3.6 - 5.4**	**5.4 - 8.8**	**>= 8.8**	**Total (%)**
1	N	1.608	2.802	4.916	1.281	0.065	10.671
2	NNE	1.247	2.505	4.444	0.821	0.061	9.078
3	NE	1.064	1.954	2.304	0.232	0.019	5.573
4	ENE	0.848	1.954	2.353	0.144	0.004	5.303
5	E	1.030	2.239	4.049	0.544	0.000	7.862
6	ESE	1.049	2.209	4.193	0.939	0.011	8.402
7	SE	1.543	1.897	2.912	0.947	0.015	7.314
8	SSE	1.741	1.502	1.981	0.547	0.038	5.809
9	S	1.460	0.958	1.414	0.407	0.030	4.269
10	SSW	1.308	0.684	0.848	0.376	0.034	3.250
11	SW	1.011	0.521	0.563	0.346	0.015	2.456
12	WSW	1.057	0.566	0.399	0.217	0.004	2.243
13	W	1.293	1.023	0.559	0.182	0.004	3.060
14	WNW	1.654	1.631	1.281	0.414	0.053	5.033
15	NW	2.099	2.555	2.140	0.585	0.103	7.482
16	NNW	2.026	2.555	2.243	0.764	0.030	7.619
	Sub-Total	22.039	27.555	36.599	8.748	0.487	95.427
	Calms						**4.57**
	Missing/Incomplete						**0**
	Total						**100**

6.4.1 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

Meteorological data from Lakes Environmental were obtained for modelling purposes as the South African Weather Service does not have upper data an input parameter for the Model. The lakes data are obtained from pseudo met-station at the site (KPSX: Weltevreden) that would give representative and accurate climate data.

Using a 5th generation Mesoscale Model, prognostic meteorological records are generated from a pseudo met-station at the specified site location.

Three-year average maximum, mean and minimum temperatures for KPSX: Weltevreden area are given in Table 6-2. The average daily maximum temperatures range from 8.1°C in June to 21°C in February, with daily minima ranging from 8.1°C in June to 20°C in January (Figure 6-5). Annual mean temperature for KPSX: Weltevreden area is given as 14.8°C. It is worth mentioning that the highest temperature recorded was 30.2 °C and a lowest of -1 C in the area.

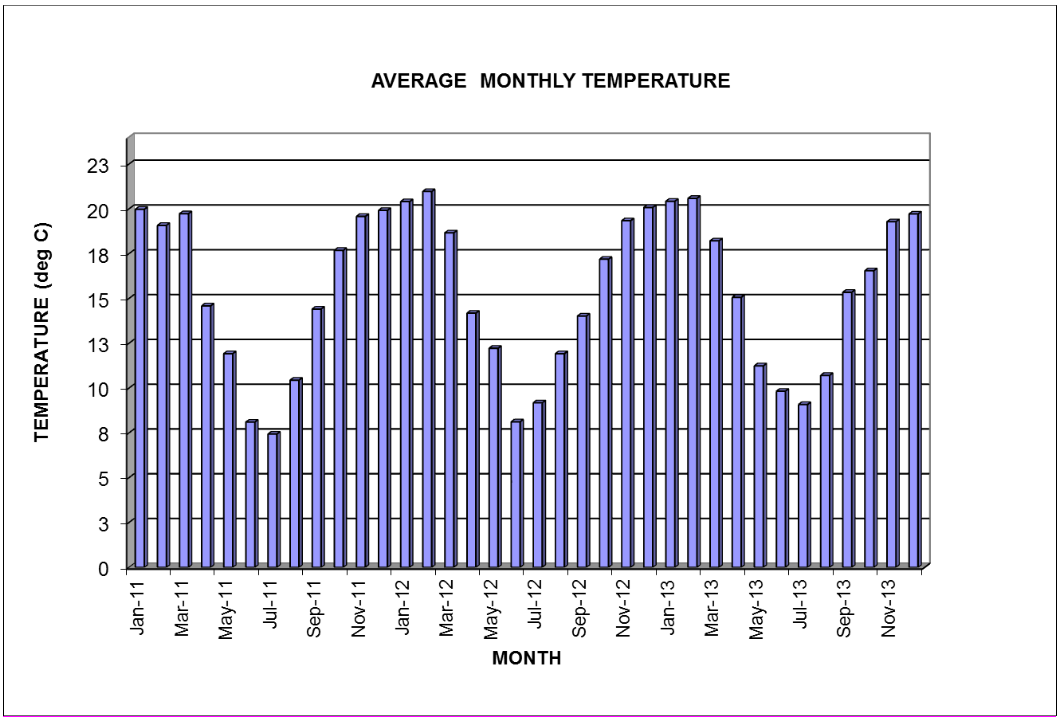


Figure 6-5: Average monthly temperature derived from the KPSX: Weltevreden modelled data (2011-2013)

Table 6-2: Average monthly minimum, maximum and mean temperature values derived from the KPSX: Weltevreden modelled data (2011-2013)

Temp(°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	20.4	21.0	19.7	14.6	12.2	8.1	9.2	11.9	14.4	17.7	19.6	20.1	15.74
Monthly Min.	20.0	19.1	18.7	14.2	11.9	8.1	7.4	10.4	14.0	17.2	19.3	19.9	15.02
Monthly Mean	20.2	20.0	11.9	14.4	12.1	8.1	8.3	11.2	14.2	17.4	19.5	20.0	14.78

6.4.2 Wind Speed

The data in Table 6-4 is representative of the wind speed for the KPSX: Weltevredenarea. The annual maximum, minimum and mean wind speed is given as 3.5 m/s, 3 m/s and 3.3 m/s, respectively (Figure 6-7). For the period under survey, 2011 – 2013 the highest wind speed observed in the area was 12.3 m/s. Wind speed greater than 5.4 m/s occurred some 9% throughout the period, accounting for 99 day (~33 days each year). The potential is there for wind erosion in the proposed KPSX: Weltevreden mining area.

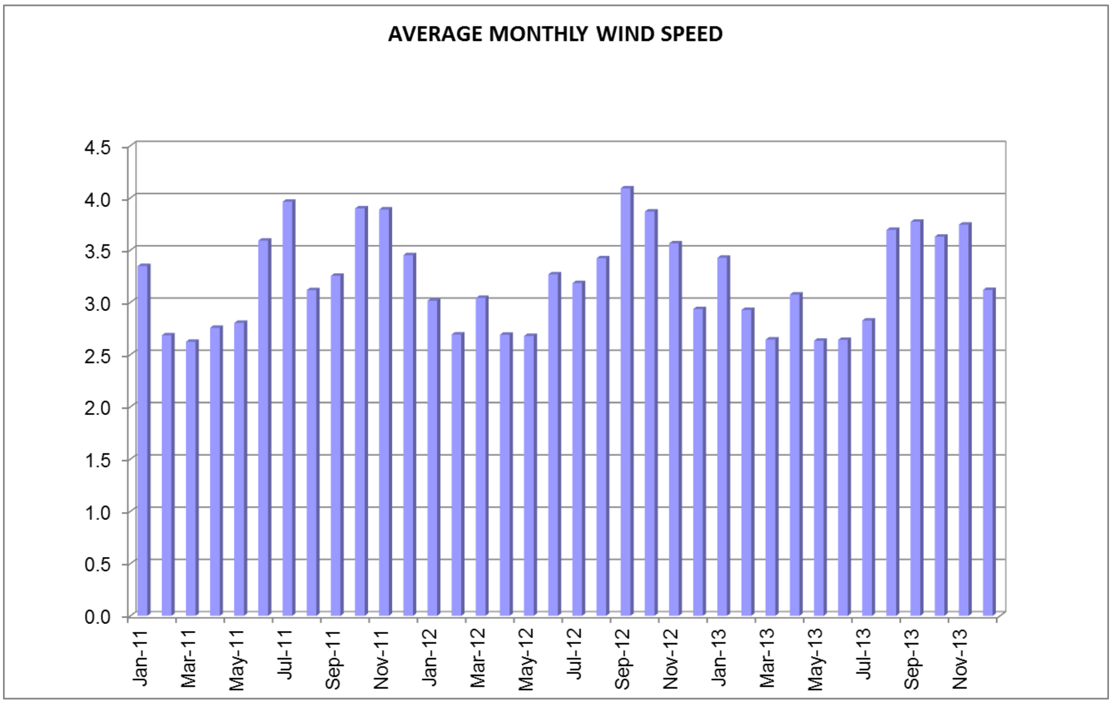


Figure 6-6: Average Monthly Wind Speed derived from the KPSX: Weltervreden modelled data (2011-2013)

Table 6-3: Average Monthly Wind Speed derived from the KPSX: Weltervreden modelled data (2011-2013)

Relative Humidity (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	3.4	2.9	3.0	3.1	2.8	3.6	4.0	3.7	4.1	3.9	3.9	3.5	3.49
Monthly Min.	3.0	2.7	2.6	2.7	2.6	2.6	2.8	3.1	3.3	3.6	3.6	2.9	2.97
Monthly Mean	3.3	2.8	2.8	2.8	4.2	3.2	2.2	3.4	3.7	3.8	3.7	3.2	3.25

6.4.3 Relative Humidity

The data in Table 6-4 is representative of the relative humidity for the KPSX Weltevreden mining area. The annual maximum, minimum and mean relative humidity is given as 71 %, 67 % and 70 %, respectively (Figure 6-7). The daily maximum relative humidity remains above 60 % for most of the year, and range from 64 % in November to 77 % in July. The daily minimum relative humidity recorded range between 61.1 % (October) and 69.6 % in occurring in September.

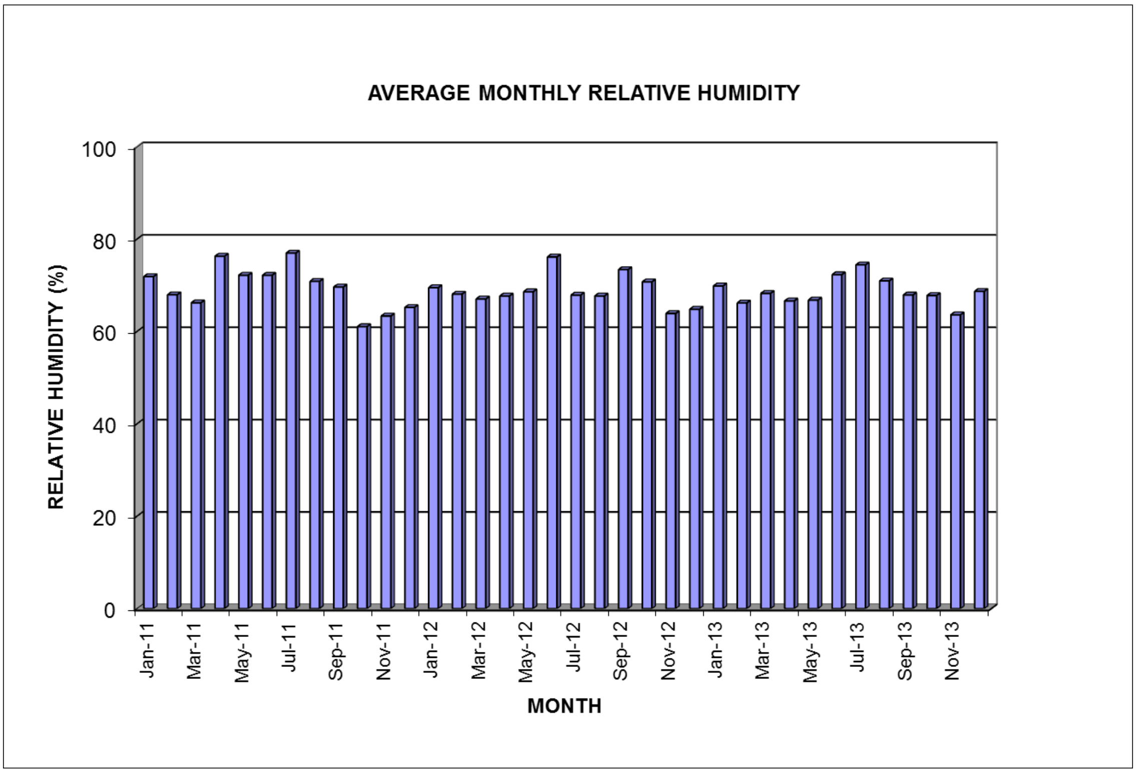


Figure 6-7: Average Monthly Relative Humidity derived from the KPSX: Weltervreden modelled data (2011-2013)

Table 6-4: Average Monthly Relative Humidity derived from the KPSX: Weltervreden modelled data (2011-2013)

Relative Humidity (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	71.9	68.1	67.0	76.3	72.2	76.1	77.0	70.9	73.4	70.7	63.9	65.2	71.07
Monthly Min.	69.5	68.0	66.2	67.7	68.6	72.2	67.9	67.7	69.6	61.1	63.4	64.8	67.22
Monthly Mean	70.7	68.0	72.2	72.0	70.4	74.2	72.4	69.3	71.5	65.9	63.6	65.0	69.60

6.4.4 Precipitation

As shown in Table 6-5 below, the three year (2011-2013) annual total rainfall maximum and average for the KPSX: Weltevreden site are 1,064.9 mm and 795.3 mm respectively. The highest total monthly precipitation (228.1 mm) was observed in December. The rate decreases down to 4.1 mm in June. The maximum total rainfall and averages observed for each month over the three year period under survey are depicted in Figure 6-8 below.

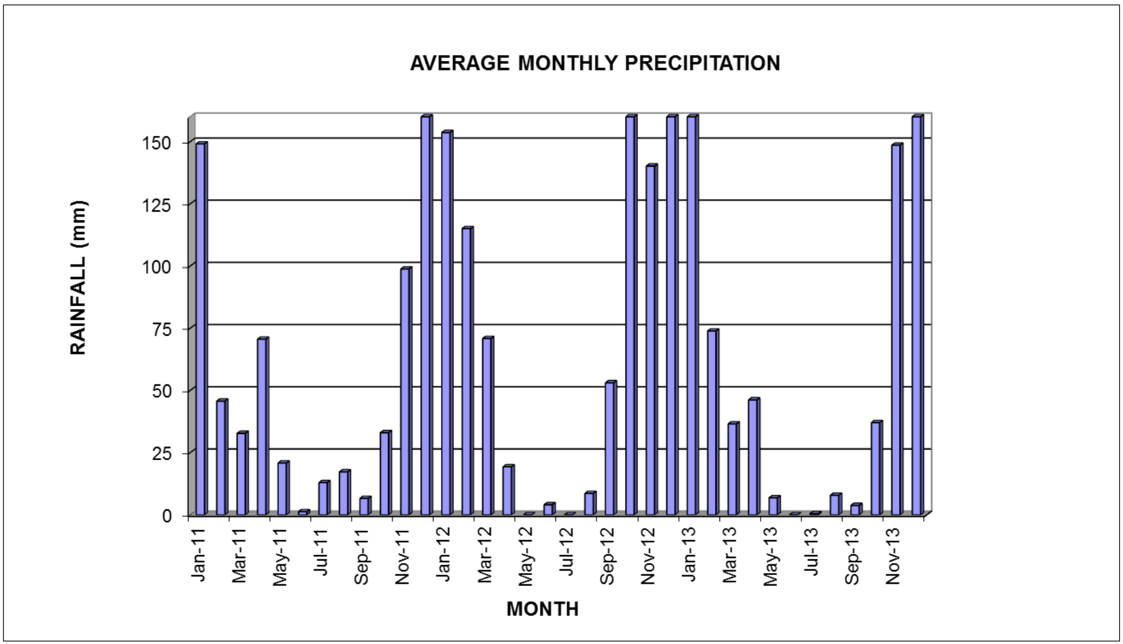


Figure 6-8: Average Monthly Precipitation derived from the KPSX: Weltervreden modelled data (2011-2013)

Table 6-5: Average Monthly Precipitation derived from the KPSX: Weltervreden modelled data (2011-2013)

Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Total Monthly Rainfall (Max).	153.7	115.1	70.9	70.6	20.8	4.1	13.0	17.3	53.1	178.3	140.2	228.1	1064.9
Average Total Monthly Rainfall	151.4	80.4	20.8	45.0	10.4	2.7	6.5	13.0	29.8	105.7	119.5	210.1	795.3

6.4.5 Evaporation

The South African Weather Service is no longer doing measurements of evaporation, hence historical data are relied upon to assess this parameter. As shown in Table 6-6, the annual maximum, minimum and mean monthly evaporation rates for the Bethal area for the period 1963-1987 are 213 mm, 90 mm and 144 mm, respectively. The highest monthly maximum evaporation (264 mm) occurred in December. The rate decreases to the lowest in 8 mm in July. The monthly minimum evaporation ranges between 8 mm (July) and 156 mm in December.

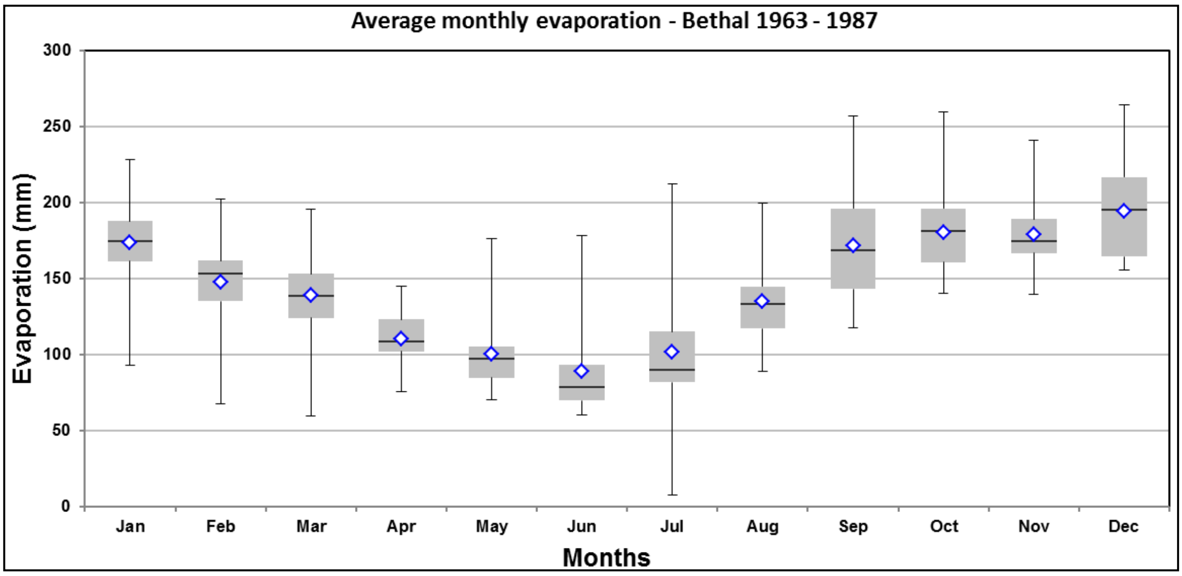


Figure 6-9: Average Monthly Evaporation for Bethal S-Pan Evaporation Station (1963 – 1987) (Source: South African Weather Service)

Table 6-6: Maximum, minimum and mean monthly evaporation rates for the Bethal (Symon's Pan) S-Pan evaporation station for 1963-1987 period (South African Weather Service)

Evaporation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	228	202	196	145	176	178	212	200	257	259	241	264	213
Monthly Min.	93	68	60	76	71	61	8	89	118	140	140	156	90
Monthly Mean	173	147	139	110	100	89	102	135	171	181	179	195	144

6.4.6 Boundary Layer Properties and Atmospheric Stability

The region of the atmosphere governing transport and dispersion of the majority of the pollutants is the planetary boundary layer. This layer is defined as the layer where the wind structure is influenced by the surface of the Earth.

The height of the planetary boundary layer varies with the atmospheric stability and this is important for the concentrations of pollutants in the air because the majority of the pollutant mass typically is confined within this layer. During night-time when conditions in most cases are stable, the planetary boundary layer is shallow, down to 20-50 metres and the surface concentration of pollutants can therefore be quite high, especially close to emission sources that are active during the night. Under unstable conditions the planetary boundary layer can be as high as 2 kilometres and pollutants are in this case distributed in the air column mainly by convective turbulence. In the vicinity of the top of the boundary layer, the horizontal winds are typically stronger and the pollutants that end up at these higher levels may be transported far away from the emission sources. In neutral conditions emitted pollutants are quickly mixed in the air by mechanical turbulence and the surface concentration is not particularly high. During neutral conditions the strong horizontal wind speeds can transport pollutants across large distances.

The atmospheric conditions may be divided into three broad classes in terms of stability: neutral, stable and unstable conditions. These major three categories are characterised by the following:

- *Neutral* conditions where the temperature is homogeneous throughout the boundary layer. This situation typically occurs in the transition from day to night and is characterised by strong winds and clouds and large amounts of mechanical turbulence.
- *Stable* conditions where the temperature is lowest close to the surface and increases towards the top of the boundary layer. This situation typically occurs during night-time or in winter situations and is characterised by little turbulence and a strong stratification of the planetary boundary layer which is quite shallow. This class can be further divided into stable and very stable classes.
- *Unstable* conditions where the temperature of the air closest to the surface is higher than the temperature of the air above it. This situation typically occurs during daytime at summer when the sun is shining and it is characterised by large amounts of convective turbulence usually resulting in the formation of cumulus clouds during the day. This class can be further divided into very unstable, moderately unstable and unstable classes.

The refined classes of atmospheric stability classes are further defined in the Table 6-7 and Table 6-8.

Table 6-7: Atmospheric Stability Classes

Designation	Stability Class	Atmospheric Condition
A	Very unstable	Calm wind, clear skies, hot daytime conditions
B	Moderately unstable	Clear skies, daytime conditions
C	Unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind, slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

Table 6-8: Meteorological conditions that define the Pasquill stability classes

Surface wind speed	Daytime incoming solar radiation			Night time cloud cover	
m/s	Strong	Moderate	Slight	> 50%	< 50%
< 2	A	A – B	B	E	F
2 – 3	A – B	B	C	E	F
3 – 5	B	B – C	C	D	E
5 – 6	C	C – D	D	D	D
> 6	C	D	D	D	D

*Note: Class D applies to heavily overcast skies, at any wind speed day or night.

7 LEGAL CONTEXT

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and wellbeing World Health Organization (WHO, 2000). 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 time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

The prevailing legislation in the Republic of South Africa with regards to the Air Quality field is the National Environment Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA). The NEM: AQA serves to repeal the Atmospheric Pollution Prevention Act (45 of 1965) (APPA) and various other laws dealing with air pollution.

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. Each of these spheres of government is obliged to appoint an air quality officer and to co-operate with each other and co-ordinate their activities through mechanisms provided for in the National Environment Management Act, 1998 (Act 107 of 1998) (NEMA).

The purpose of NEM: AQA is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air quality management planning;
- Air quality monitoring and information management;
- Air quality management measures; and

- General compliance and enforcement.

Amongst other things, it is intended that the setting of norms and standards will achieve the following:

- The protection, restoration and enhancement of air quality in South Africa;
- Increased public participation in the protection of air quality and improved public access to relevant and meaningful information about air quality; and
- The reduction of risks to human health and the prevention of the degradation of air quality.

The Minister of Water and Environmental Affairs, released on the 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). In line with National Dust Control Regulation and on the basis of the cumulative South African experience the National Department of Environmental Affairs published the acceptable dust fallout rates in residential and non-residential areas.

The New National Dust fallout standard is given in the Table 7-1 below.

Table 7-1: Acceptable dust fall rates as measured (NEMAQA - NDCR, 2013)

Restriction Areas	Dust fall rate (mg/m^2/day, 30-days average)	Permitted Frequency of exceeding dust fall rate
Residential Area	D < 600	Two within a year, not sequential months
Non-Residential Area	600 < D < 1200	Two within a year, not sequential months

Dustfalls that exceed the specified rates but that can be shown to be the result of some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such an event might typically result in excessive dustfall rates across an entire metropolitan region, and not be localized to a particular operation. Natural seasonal variations, for example the naturally windy months each year, will not be considered extreme events for this definition (SANS 1929:2011).

Any person who conducts any activity in such a way as to give rise to dust in quantities and concentrations that may exceed the dustfall standard (Table 7-1) set out in regulation 3 must, upon receipt of a notice from an air quality officer, implement a dustfall monitoring programme (NEMAQA-NDCR, 2013).

In the National Dust Control Regulation, terms like target, action and alert thresholds have been omitted. Another notable observation was the reduction of the *margin of tolerance* from the usual three to two incidences within a year (NEMAQA-NDCR, 2013). The National Dust

Control Regulation actually adopted a more stringent approach than the previous standard, and would require dedicated mitigation plans now that it is in force.

Also, the DEA has established National Ambient Air Quality Standards for PM_{10} (Table 7-2) and particulate matter of aerodynamic diameter less than 2.5 µm since June 2012 (GN486: 2012) as depicted in Table 7-3.

Table 7-2: National Ambient Air Quality Standards as of 24 December 2009

National Ambient Air Quality Standards for Sulphur Dioxide (SO_2)				
AVERAGING PERIOD	**LIMIT VALUE (µg/m³)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
10 Minutes	500	191	526	Immediate
1 hour	350	134	88	Immediate
24 hours	125	48	4	Immediate
1 year	50	19	0	Immediate
The reference method for the analysis of SO_2 shall be ISO 6767.				

National Ambient Air Quality Standards 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.				

National Ambient Air Quality Standards for Particulate Matter (PM_{10})			
AVERAGING PERIOD	**LIMIT VALUE (µg/m³)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
24 hour	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.			

National Ambient Air Quality Standards for Ozone (O_3)				
AVERAGING PERIOD	**LIMIT VALUE (µg/m³)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
8 hours (running)	120	61	11	Immediate
The reference method for the analysis of ozone shall be the UV photometric method as described in				

SANS 13964.

National Ambient Air Quality Standards for Benzene (C_6H_6)				
AVERAGING PERIOD	**LIMIT VALUE (µg/m^3)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 year	5	1.6	0	1 January 2015
The reference methods for the sampling and analysis of benzene shall either be EPA Compendium method TO-14 A or method TO-17.				

National Ambient Air Quality Standard for Lead (Pb)				
AVERAGING PERIOD	**LIMIT VALUE (µg/m^3)**	**LIMIT VALUE (ppb)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 year	0.5		0	Immediate
The reference method for the analysis of lead shall be ISO 9855.				

National Ambient Air Quality Standards for Carbon Monoxide (CO)				
AVERAGING PERIOD	**LIMIT VALUE (mg/m^3)**	**LIMIT VALUE (ppm)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
1 hour	30	26	88	Immediate
8 hour (calculated on 1 hourly averages)	10	8.7	11	Immediate
The reference method for analysis of CO shall be ISO 4224.				

Table 7-3: Established National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$)

National Ambient Air Quality Standards for Particulate Matter ($PM_{2.5}$)			
AVERAGING PERIOD	**LIMIT VALUE (µg/m^3)**	**FREQUENCY OF EXCEEDANCE**	**COMPLIANCE DATE**
24 hours	65	0	Immediate – 31 December 2015
24 hours	40	0	1 January 2016 – 31 December 2029
24 hours	25	0	01 January 2030
1 year	25	0	Immediate – 31 December 2015
1 year	20	0	1 January 2016 – 31 December 2029
1 year	15	0	01 January 2030
The reference method for the determination of PM2.5 fraction of suspended particulate matter shall be EN 14907.			

8 HEALTH EFFECTS OF THE IDENTIFIED POLLUTANTS

8.1 Particulates

The main pollutant of concern identified as a result of the construction and operational phases of the mining development will be the particulate matter, whether in the form of total suspended particulates (TSP), PM_{10} or $PM_{2.5}$.

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

In terms of health effects, particulate air pollution is associated with complaints of the respiratory system (WHO, 2000). Particle size is important for health because it controls where in the respiratory system a given particle deposits. Fine particles are thought to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Manahan, 1991). Larger particles are deposited into the extra-thoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2000).

Particulate matter (PM) is a type of air pollution that is present wherever people live. It is generated mainly by human activities: transport, energy production, domestic fuel combustion and by a wide range of industries. There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur.

The range of adverse health effects of PM is broad, involving respiratory and cardiovascular systems in children and adults. Both short- and long-term exposures lead to adverse health effects. Very young children, probably including unborn babies, are particularly sensitive to the adverse effects of PM. The evidence is sufficient to infer a causal relationship between exposure to PM and deaths from respiratory diseases in the post-neonatal period. Adverse effects of PM on lung development include reversible deficits of lung function as well as chronically reduced lung growth rate and long-term lung function deficit. The available evidence is also sufficient to assume a causal relationship between exposure to PM and aggravation of asthma, as well as cough and bronchitis symptoms. Daily mortality and hospital admissions have been linked with short term variation of PM levels. Increased mortality from cardiovascular and respiratory diseases and from lung cancer has been observed in residents of more polluted areas.

Based on the existing evidence of adverse health effects at low levels of exposure, WHO revised its Air Quality Guidelines (AQG) for PM in 2005. For $PM_{2.5}$, the new AQG values are

10 µg/m^3 for the annual average and 25 µg/m^3 for the 24-hour mean (not to be exceeded for more than 3 days/year). The corresponding guidelines for PM_{10} were set as 20 µg/m^3 and 50 µg/m^3.

Ambient PM_{10} concentrations are a good approximation of population exposure to PM from outdoor sources. Numerous epidemiological studies conducted in Europe and in other parts of the world have shown adverse health effects of exposure to PM_{10} and $PM_{2.5}$ at concentrations that are currently observed in Europe and the rest of the world. WHO estimated that approximately 700 annual deaths from acute respiratory infections in children aged 0–4 years could be attributed to PM_{10} exposure in the WHO European Region in the late 1990s alone. Population health effects of exposure to PM in adults are dominated by mortality associated with long-time exposure to fine PM ($PM_{2.5}$). Short-term and long-term health effects associated with exposure to particulate matter are presented in Table 8-1.

8.1.1 Short-term exposure

Recent studies suggest that short-term exposure to particulate matter is associated with health effects, even at low concentrations of exposure. Various studies undertaken during the 1980s and early 1990s have looked at the relationship between daily fluctuations in particulate matter and mortality at low levels of exposure. Pope *et al* (1992) studied daily mortality in relation to PM_{10} concentrations in Utah Valley during the period 1985 - 1989. A maximum daily average concentration of 365 µg/m^3 was recorded with effects on mortality observed at concentrations of < 100 µg/m^3. The increase in total daily mortality was 13% per 100 µg/m^3 increase in the 24 hour average. Studies by Schwartz (1993) in Birmingham recorded daily concentrations of 163 µg/m^3 and noted that an increase in daily mortality was experienced with an increase in PM_{10} concentrations. Relative risks for chronic lung disease and cardiovascular deaths were higher than deaths from other causes.

However, in the past, daily particulate concentrations were in the range 100 – 1000 µg/m^3 whereas in more recent times, daily concentrations are between 10 – 100 µg/m^3. Overall, exposure-response can be described as curvilinear, with small absolute changes in exposure at the low end of the curve having similar effects on mortality to large absolute changes at the high end (WHO, 2000; 2002).

Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function. Pope and Dockery (1992) studied panels of children in Utah Valley in winter during the period 1990 – 1991. Daily PM_{10} concentrations ranged between 7 – 251 µg/m^3. Peak Expiratory Flow was decreased and respiratory symptoms increased when PM10 concentrations increased. Pope and Kanner (1993) utilised lung function data obtained from smokers with mild to moderate chronic obstructive pulmonary disease in Salt Lake City. The estimated effect was a 2% decline in Forced Expiratory Volume over one second for each 100 µg/m^3 increase in the daily PM10 average.

8.1.2 Long-term exposure

Long-term exposure to low concentrations (~10 µg/m^3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2000;2002).

Studies have indicated an association between lung function and chronic respiratory disease and airborne particles. Older studies by Chestnut *et al* (1991) found that Forced Vital Capacity decreases with increasing annual average particulate levels with an apparent threshold at 60 µg/m^3. Using chronic respiratory disease data, Schwartz (1993) determined that the risk of chronic bronchitis increased with increasing particulate concentrations, with no apparent threshold.

Few studies have been undertaken documenting the morbidity effects of long-term exposure to particulates (Table 8-1). Recently, the Harvard Six Cities Study showed increased respiratory illness rates among children exposed to increasing particulate, sulphate and hydrogen ion concentrations. Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10 µg/m^3 increase in annual average particulate concentrations.

Table 8-1: Short-term and long-term health effects associated with exposure to PM (after WHO, 2004)

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	• Lung inflammatory reactions • Respiratory symptoms • Adverse effects on the cardiovascular system • Increase in medication usage • Increase in hospital admissions • Increase in mortality	• Increase in lower respiratory symptoms • Reduction in lung function in children • Increase in chronic obstructive pulmonary disease • Reduction in lung function in adults • Reduction in life expectancy • Reduction in lung function development

9 BASELINE ASSESSMENT

Major atmospheric pollutants in the proposed KPSX: Weltevreden Project area will be influenced by several local and regional pollutants signature, which include:

- Coal-fired power plants
- Operational opencast and underground coal mines in the Mpumalanga Highveld
- Agricultural activities in the area.

In terms of air quality, the main pollutants of concern will be associated with dust generated from coal mining operations and agricultural activities due to wind erosion, vehicular movement on unpaved, dry and dusty roads.

9.1 Dust Fallout Baseline

Dust deposition data is crucial as it shows monthly, seasonal, and inter-annual variability in dust fallout rates – pre and during mining scenarios. The amount of dust collected at any given time is a function of the rate of deposition, which may vary widely depending on meteorological factors such as wind speed and direction, variations in the number of sources and mitigation measures adopted, and the background level of pollutants. The dust fallout sampling, analyses, comparison and interpretation was conducted according to the recommended SANS 1929:2011 (adapted from ASTM1739-98): "Ambient Air Quality – Limits for common pollutants".

The deposition results are illustrated by means of tables and graphs expressed in the units of $mg/m^2/day$ averaged over a 30-day period. South African Bureau of Standards (SANS 1929:2011) has published an important standard in terms of air quality underlying limits for dust fallout rates. In terms of dust deposition standards, a four-band scale use to apply – with target, action and alert thresholds clearly spelt out, with three permissible frequencies of excesses.

In November of 2013, Minister of Water and Environmental Affairs, released the NDCR, in terms of Section 53, read with Section 32 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). In line with NDCR and on the basis of the cumulative South African experience the National Department of Environmental Affairs published the acceptable dust fallout rates in residential and non-residential areas.

The New National Dust fallout standard is given in the Table 9-1 below.

Table 9-1: Acceptable dust fall rates as measured (NEMAQA - NDCR, 2013)

Restriction Areas	Dust fall rate ($mg/m^2/day$, 30-days average)	Permitted Frequency of exceeding dust fall rate
Residential Area	D < 600	Two within a year, not sequential months
Non-Residential Area	600 < D < 1200	Two within a year, not sequential months

In 2007 baseline monitoring and assessment was done by Airshed Planning Professionals (Pty) Ltd and results were presented in the report prepared for Oryx Environmental (Pty) Ltd (Air Quality Impact Assessment for the proposed change in mining operation at the Klipspruit Colliery near Ogies in Mpumalanga – Report Number.: APP/07/ORYX - November 2007).

From the report, it was ascertained that PM_{10} monitoring was not conducted. However, dust monitoring network designed and maintained by the then Annegarn Environmental Research (AER) Pty Ltd (now SGS Environmental) for Klipspruit Colliery was reported. Results of dust monitoring conducted for the period February 2002 to January 2004 and the first quarter of

2012 are discussed below. The dust monitoring points where deposition rates were monitored are depicted in Table 9-2.

Table 9-2: 2012 Dust monitoring sites and coordinates

Site ID	Latitude	Longitude
Enslin	S26°03.916'	E029°00.489'
Nursery	S26°04.513'	E029°02.665'
Ogies School	S26°02.905'	E029°04.067'
Wash Bay	S26°03.102'	E029°02.495'
Nursery MD	S26°04.513'	E029°02.666'
Phola MD	S26°00.952'	E029°02.125'
SFF MD	S26°02.115'	E029°03.312'

*MD Multi-directional

9.2 Particulate and Gaseous Pollutants

Particulate matter - PM_{10} (particulate matter with an aerodynamic diameter of less than 10 µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm) are of health significance (Harrison and van Grieken, 1998). Data for both sets of pollutants were not available for assessment. This a data gap as mining operation often impacts on the ambient particulate loading of both pollutants in any airshed.

The fine particles can also contain the secondarily formed aerosols such as sulphates and nitrates, combustion particles and re-condensed organic and metal vapours, which might result from spontaneous combustion.

Since site specific information for these criteria pollutants is not available. This should be prioritised before the project commences in order to ascertain impacts and adequate mitigation measure needed. Ideally, ambient monitoring units should be commissioned to record valuable data indicative of the current air quality scenario in the area.

10 Results

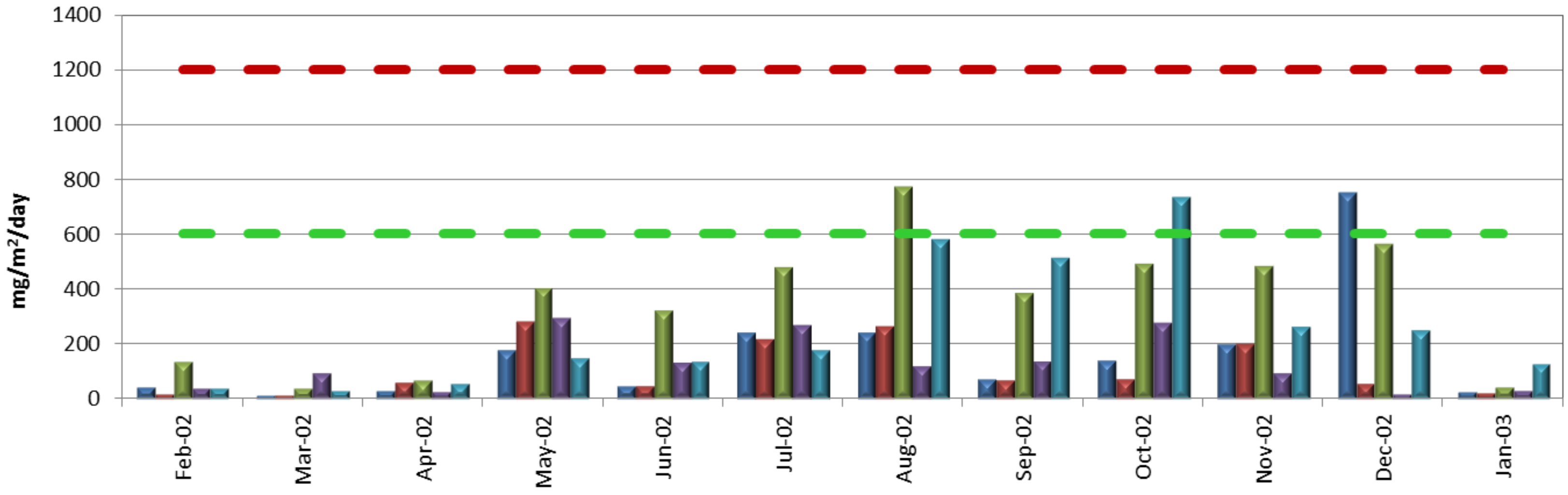
10.1 Measured Dust Fallout Levels

Average daily dust fall out levels recorded over the period February 2002 to January 2003 and February 2003 to January 2004 are presented in

Figure 10-1 and Figure 10-2. Dust fall out monitoring was averaged over 30 day periods. The measured background dust fall out levels were generally found to be low, although exceedances were observed at some sites.

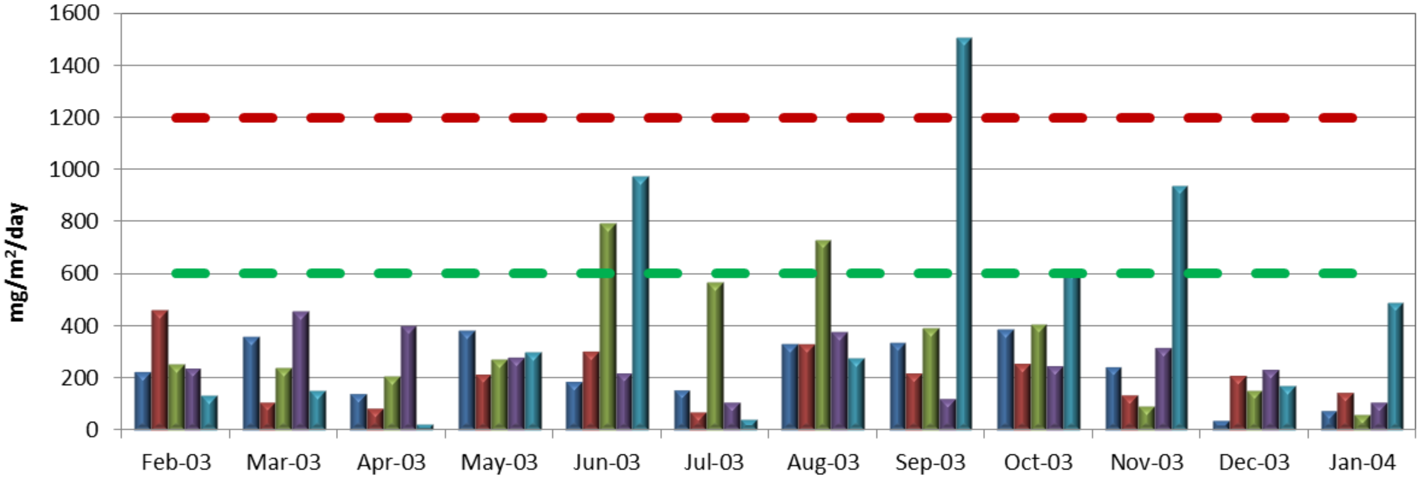
The South African standard - SANS 1929:2011 was not violated, except for site "Phola" in 2003 (September, October and November) with three months exceeding the current residential threshold of 600 mg/m²/day. Once, in September 2003 the industrial threshold was exceeded at the site with dust deposition rate of 1506 mg/m²/day measured (Figure 10-2). By 2012, based on available data, the site (Windmill) was decommissioned. Sites such as nursery and Phola were converted to multi-directional sites, and new sites SFF Dam (multi-directional) and Wash Bay were commissioned.

The dust deposition recorded during the months of February, March and April of 2012 are within the recommended NDCR (2013) for residential areas (Table 9-1). The values observed in 2012 were way below the non-residential limit of 1200 mg/m²/day (Figure 10-3).



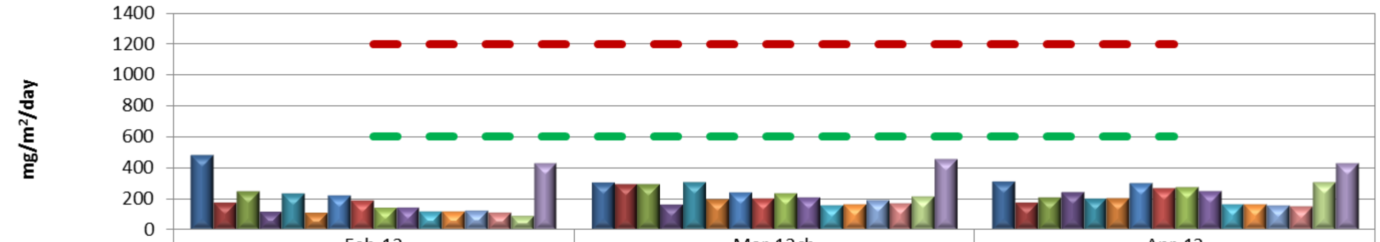
	Feb-02	Mar-02	Apr-02	May-02	Jun-02	Jul-02	Aug-02	Sep-02	Oct-02	Nov-02	Dec-02	Jan-03
Windmill	40	13	30	176	45	242	239	69	140	199	752	26
Enslin	15	11	56	277	46	217	263	67	72	199	55	21
Nursery	135	38	67	403	321	477	773	385	491	484	565	41
Ogies	37	92	23	293	132	264	116	135	276	91	14	28
Phola	36	27	53	145	136	178	582	511	733	263	248	124
Residentail	600	600	600	600	600	600	600	600	600	600	600	600
Non-Residential	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200

Figure 10-1 Plots showing the dust deposition rates



	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04
Windmill	221	356	135	379	181	150	326	331	383	237	36	71
Enslin	457	105	80	212	297	65	328	213	254	132	204	143
Nursery	253	238	208	273	795	567	728	390	403	90	150	60
Ogies	235	450	395	277	217	102	371	116	244	311	227	105
Phola	134	149	22	297	976	39	276	1506	613	938	170	487
Residential	600	600	600	600	600	600	600	600	600	600	600	600
Non-Residential	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200

Figure 10-2: Average daily dust fall out levels recorded from January 2003 – December 2004



	Feb-12	Mar-12ch	Apr-12
Enslin	480	306	311
Nursery	175	290	172
Nursery E	244	288	208
Nursery N	116	160	236
Nursery S	230	303	199
Nursery W	110	194	199
Phola E	220	241	300
Phola N	187	197	267
Phola S	143	229	273
Phola W	142	208	242
SFF Dam E	113	154	160
SFF Dam N	118	163	160
SFF Dam S	119	188	152
SFF Dam W	111	170	151
Ogies School	89	210	305
Wash Bay	428	455	424
Residential	600	600	600
Non-Residential	1200	1200	1200

Figure 10-3: Average daily dust fall out levels recorded from January 2003 – December 2004

The dust deposition record from the report number - APP/07/ORYX - November 2007 prepared by Airshed Planning Professionals (Pty) Ltd confirmed the dust deposition scenario in the KPSX mining area, near Ogies in Mpumalanga.

The 2002 records showed that some sites such Phola, Nursery and windmill exceeded the recommended NDCR (2013) standard for residential areas of 600 mg/m^2/day averaged over 30 days. This was well within the tolerance window specified by the standard "*Two within a year, not sequential months*".

In 2003, the site Nursery recorded two exceedances of the recommended NDCR (2013) standard and Phola exceeded the industrial threshold once and the residential limit twice during the one year sampling period. Thus, Phola sites mentioned above violated the tolerance window, as three consecutive months recorded dust deposition rates above the recommended tolerance level.

The 2012 dust deposition record (Figure 10-3) showed the dust deposition rates observed at the current sites were all within the 600 mg/m^2/day recommended for residential areas. Sites such as Phola and Nursery that recorded exceedances in 2002/2003 are now within compliance.

11 Methodology, Results and Discussion for Dispersion Modelling

11.1 Emissions Inventory

The establishment of an emissions inventory forms the basis for any air quality impact assessment. Air pollution emissions may typically be obtained using actual sampling at the point of emission, or estimating it from mass and energy balances or emission factors which have been established at other similar operations. The method adopted here is the latter. Emission factors published by the US-EPA in its AP-42 document "Compilation of Air Pollution Emission Factors" and Australian National Pollutant Inventory "Emission Estimation Technique (EET)" manuals have been used.

There are various sources of emissions anticipated from any mining operation, from the construction, operational and decommissioning phases. Envisaged emissions from the proposed mining operation include:

- Inhalable fraction (airborne material that enters the nose and mouth during breathing, which can be deposited anywhere in the respiratory tract - aerodynamic diameters less than or equal to 10 µm). While the respirable fraction encompasses the airborne material that penetrates the lower gas exchange region of the lungs (aerodynamic diameters less than or equal to 2.5 µm));
- Total suspended particulates (TSP);
- Diesel particulate matter (DM), being emitted from haul trucks and diesel generators;
- Gaseous emissions from haul trucks and off road mine vehicles i.e. oxides of nitrogen (NO and NO_2, jointly known as NO_x);

- Sulphur dioxide (SO_2) from mine vehicles;
- Carbon monoxide (CO) from haul trucks and mine vehicles.

An emissions inventory was established comprising emissions from construction and operational activities at the proposed KPSX:Weltevreden Project. Some activities associated with the operation are highlighted (Table 11-1). The establishment of this emissions inventory is necessary to provide the source and emissions data required as input to the dispersion simulations. It was assumed that the mine will rely solely on the national grid for power, hence emissions from diesel generators on-site were not quantified. The will be intermittent and resulting emissions will be negligible.

Table 11-1: Activity and source of of emmissions for the proposed KPSX: Weltevreden Project

Source	Activity
Construction	
	Site clearing
	Mine fleet heavy equipment
Operational	
Material handling	Tipping from excavator to haul truck
	Tipping from haul truck to ROM stockpile and Waste Rock Dump
	Tipping from front end loader to truck
	Tipping from truck to crusher
	Tipping from crusher to conveyor
	Tipping from conveyor to product stockpile
Vehicle activity on haul roads	Trucks from pit to ROM and Waste Rock Dump
Wind erosion	Haul roads
	Topsoil storage pile
	Waste Rock Dump
	ROM stockpile
Screening and Crushing	Crushing

Emission factors from the US EPA AP42 database were used for the purposes of predicting vehicle wheel entrainment emissions for the site. It must be noted that these factors are known to conservatively overestimate particulate emission rates from unpaved roads. It is worth mentioning that emissions quantification for the study was informed by vehicle data from similar studies, and the same applies to surface particle size distribution data.

11.1.1 Construction Phase

11.1.1.1 Mine Fleet Equipment (Road Dust Emissions)

During the construction phase, clearing of vegetation and stripping of soil, excavation and loading of topsoil onto trucks or stockpiles will occur accompanied by removal of topsoil, erosion and suspension of loose dust particulate matter. Although this phase will be short-term, quantification of emissions have been conducted for fugitive dust generation from dirt roads and cleared areas using known emission factors from the USEPA 2006.

Movement of construction vehicles such as bulldozers, graders and a host of machineries lead to dust generation. Road dust emissions from construction vehicles during clearing were estimated. For this activity, 10 working hours per day was assumed for the dusty construction works. Emission factors from the United States Environmental Protection Agency (U.S EPA) AP-42 factor for heavy construction vehicle of 2.69 Mg/hectare/year were used. A summary of the emission burden from heavy construction vehicles is presented below (Table 11-2).

Table 11-2: Summary of particulate matter from construction vehicles on dirt roads

Pollutant	Emissions (t/y)
PM2.5	31.2
PM10	148.6
TSP	297.2

In our calculation of erosion from cleared areas, we assumed that only 25% of the entire surface area will be cleared at a time. Emissions from construction were modelled in accordance with best practice as recommended by USEPA AP-42 manual.

11.1.2 Operational Phase

Emissions associated with the operational phase encompass those from a variety of sources: drilling and blasting, excavation, material handling, gaseous emissions from vehicles, emissions from dirt road, wind erosion from stockpiles and emissions from standby generators. To quantify emissions, the specifications and dimension of the various sources, the meteorology of the area and the particle size distribution materials were used as input parameters. Emphasis is often placed on particulate matter emissions two primary sources; wind erosion from exposed surfaces, and dust generated from haul roads. Wind generated erosions is expected to be exacerbated during the dry and windy season. Gaseous emissions from the mine fleet of vehicles and other mine machineries (i.e. were not appraised).

11.1.2.1 Material handling operations

This process includes the transfer of ore from the pits to the ROM stockpile, front end loader to trucks, trucks to crusher, and from crushers to conveyor belt. The crusher will reduce the size of the ore which is then transferred via the conveyor belt to the Plant. The tipping process and crushing are associated with fugitive emissions, which depend on various factors such as wind speed, wind direction and precipitation. The higher the moisture content of the material, the less fugitive dust released during the process. To calculate the emissions from the material handling operations, equations from US EPAP-42 emission factors were utilised. The throughput of 8 000 000 tonnes annually was used in our assessment, which translates to 913 tonnes per hour (Table 11-3). The latter will apply if the mine operates for 90 percent of the time (329 days in year).

Table 11-3: Throughput from material handling operations

Operation	Throughput t/hour
Tipping from conveyor/truck to crusher	913
Tipping crusher to conveyor	913
Tipping conveyor to plant	913

11.1.2.2 Vehicle activity on haul roads

CAT® 785D trucks with rated payload of 150 tonnes are assumed to be employed in transporting excavated materials from the pits stockpiles. This emission inventory calculated emissions from the pits through the haul road to product stockpile and waste rock dumps. The estimate took into cognisance the annual tonnage and hauling of ore and waste rock and the travel distances to and fro on the 13.0 kilometre length of road (Table 11-4). Emission factor was estimated, which served as input data in the dispersion model.

Table 11-4: Parameters of the unpaved haul road for the proposed operations

Road	Length (m)	Width (m)
Road	13 000	10

11.1.2.3 Wind erosion from topsoil stockpile, ROM stockpile and waste rock dump

There are two main types of stockpiles: long term and short term. The waste rock dump (WRD) facility and the topsoil stockpile are both considered long term stockpiles. The latter will be vegetated and not disturbed for a long period, only utilised during the reclamation of the mine. A ROM stockpile will be a short term stockpile, as there will be constant offload and removal of ore from the stockpile. The following are the specifications of the significant sources of the wind erosion used in the dispersion modelling (Table 11-5).

Table 11-5: Parameters for the topsoil, ROM and WRD stockpiles

Source	Height (m)	Area (m^2)	X length (m)	Y length (m)	Moisture content (%)
Overburden	30	1 501 416	1324	1134	6.9

Pit	50	504 240	660	764	4.3
Topsoil stockpile	20	1 072 450	1205	890	6.9
ROM	11	504 240	660	764	6.9

An emission factor is a representative value that attempts to relate an activity with the release of pollutant (s) to into the atmosphere. Emission factors and emission inventories are fundamental tools for air quality management. The emission factors are frequently the best or only method available for estimating emissions produced by varying sources. Emission estimates are important, amongst others, for developing emission control strategies, determining applicability of permitting and control programmes and ascertaining the effects of sources and appropriate mitigation measures.

To determine the significance of the potential for impacts, it is necessary to quantify atmospheric emissions and predicted airborne pollutant concentrations occurring as a result of each emission source. Empirically derived *predictive emission factor equations* are available for the quantification of TSP, PM_{10} and $PM_{2.5}$, for various sources. These derived emission factors served as input data for our dispersion model, to predict the ground level concentrations and pollutant spread from the project area.

For the fine dust component of particulate emissions from industrial wind erosion, a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. However, a ratio of 0.21 was used in our estimate based on findings from literature survey. Industrial wind erosion is associated with crushed aggregate materials, such as coal or metallic ore piles. Examples would include open storage piles at mining operations (USEPA, 2006). The parameters used in the calculations of the emissions associated with wind erosion are given below (Table 11-6).

Table 11-6: Wind erosion from exposed areas and derived emission factors without mitigation

Activity	Unit	TSP emission factors	PM_{10} emission factors	$PM_{2.5}$ emission factors
Overburden	$g/m^2/s$	6.9E-08	3.5E-08	7.3E-09
Pit	$g/m^2/s$	6.9E-08	3.5E-08	7.3E-09
Topsoil stockpile	$g/m^2/s$	9.4E-08	4.7E-08	9.9E-09
ROM	$g/m^2/s$	8.1E-08	4.0E-08	8.5E-09
Unpaved roads erosion (ore)	g/s	16.40	4.22	0.84

Significant emissions can arise due to the mechanical disturbance of granular material from open areas and storage piles. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation. Any factor that binds the erodible material, or otherwise reduces the availability of erodible material on the surface, decreases the erosion potential of the fugitive source. High moisture content, whether due to precipitation or deliberate wetting, promotes the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for dust emissions. Surface compaction and ground cover similarly reduces the potential for dust generation. The shape of a storage pile influences the potential for dust emissions through the alteration of the airflow field. The particle size distribution of the material on the disposal site is important since it determines the rate of entrainment from the surface, the nature of dispersion of the dust plume, and the rate of deposition.

Dust emissions due to the erosion of open storage piles and exposed areas occur when the threshold wind speed is exceeded (Cowherd *et al.*, 1988; EPA, 1995). The threshold wind speed is dependent on the erosion potential of the exposed surface, which is expressed in terms of the availability of erodible material per unit area (mass/area). Studies have shown that when the threshold wind speed is exceeded, erosion rates tend to increase rapidly (Cowherd *et al.*, 1988).

It is anticipated that significant amounts of dust will be eroded from identified sources at the KPSX: Weltevreden mining area at wind speeds of greater than 5.4 m/s (i.e. threshold friction velocity of 0.26 m/s). Fugitive dust generation resulting from wind erosion under high winds (i.e. > 5.4 m/s) is directly proportional to the wind speed. Wind speeds of 5.4 m/s and stronger occur in the area 9 % of the time. An average wind speed of 3.2 m/s was calculated from the KPSX: Weltevreden modelled data.

Wind erosion is generally a selective material-loss process, which moves particles of various size fractions at different mass-flow rates. One also needs to understand how the particle-size distribution (PSD) is related to material properties of the eroded material.

PSD is the key parameter, determining the entire process of wind erosion, from entrainment through transport to deposition. Table 11-7 gives PSD as adopted from a similar opencast operation. These values were used as input parameters into the model for dust deposition.

Table 11-8 gives an overview of annual emissions from ROM stockpile, topsoil stockpile, crushers, tipping and unpaved roads.

Table 11-7: Particle size distribution for proposed mining activities

SOURCE	PARTICLE SIZE FRACTION (%)			
	75µm	30 µm	10 µm	2.5 µm
Topsoil stockpile	0.26	0.30	0.24	0.20
Run of Mine (ROM)	0.49	0.27	0.14	0.10
Waste rock dump (WRD)	0.44	0.27	0.15	0.14

Table 11-8: Estimated annual emissions for the wind erosion sources

Activity	Annual emissions (t/year)		
	TSP	PM_{10}	$PM_{2.5}$
Overburden	99.34	49.67	10.43
Pit	77.73	38.86	8.16
Topsoil stockpile	225.93	112.96	23.72
ROM	89.39	44.69	9.39
Crusher	5.85	0.65	0.13
Tipping	18.81	8.89	1.78
Total emissions	**517.05**	**255.72**	**53.61**

11.1.2.4 Screens and Crushers

Crushers are used to reduce the size of the ore for ease of processing. In most cases this is a significant source of fugitive dust with large quantities of respirable fractions of dust produced. The crushers will be working for 7884 hours per year. The parameters used in the calculations of the emissions are given below (Table 11-9).

Table 11-9: Tonnes of material and moisture content feed to the Crushers

Source	Tonnes per annum	Moisture content (%)
Primary Crusher	8,000,000	6.9
Secondary Crusher	8,000,000	6.9
Tertiary Crusher	8,000,000	6.9

11.1.2.5 Gaseous emissions from generators

Emission rates from standby diesel generator NOx, CO, HC were not quantified. The assumption is that the mine will rely solely on power from the national grid. Standby generator will be used sparingly and associated emissions will be very low.

12 Methodology, Results and Discussion for Dispersion Modelling

12.1 Dispersion Modelling

Atmospheric dispersion modelling is the mathematical simulations of how airborne pollutants disperse in the ambient atmosphere, making use of algorithms that mimic the dispersion and transformation of pollutants in the natural atmosphere. With the latter, downwind concentration of air pollutants emitted from various sources can be predicted. Isopleths of pollutants concentration generation are then used to assist in the design and assessment of various control strategies and abatement technologies for emission reductions.

The mathematical equations employed in these models, attempt to describe processes observed in nature, which enables scientists to create replicas of natural systems with a computer, so that the causes and effects of system behaviour may be better understood. The primary focus of dispersion modelling is to estimate the ambient concentrations of primary pollutants that have been emitted in the atmosphere. There are a number of dispersion models that have been developed around the world. The widely used AERMOD dispersion model is one such example.

12.1.1 AERMOD Suite of Models

Dispersion models are used to predict the ambient concentration in the air of pollutants emitted to the atmosphere from a variety of processes (South African National Standards - SANS 1929:2011). Dispersion models compute ambient concentrations as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements. It is therefore important to carefully select a dispersion model for the purpose.

All emission scenarios have been simulated using the USA Environmental Protection Agency's Preferred/Recommended Models: AERMOD modelling system (as of December 9, 2006, AERMOD is fully promulgated as a replacement to ISC3 model).

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

There are two input data processors that are regulatory components of the AERMOD modelling system: AERMET, a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data pre-processor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSCREEN, a screening version of AERMOD; AERSURFACE, a surface characteristics pre-processor, and BPIPPRIME, a multi-building dimensions program incorporating the GEP technical procedures for PRIME applications.

AERMOD model is capable of providing ground level concentration estimates of various averaging times, for any number of meteorological and emission source configurations (point, area and volume sources for gaseous or particulate emissions), as well dust deposition estimates.

The effect of complex terrain is modelled by changing the plume trajectory and dispersion to account for disturbances in the air flow due to the terrain. This may increase or decrease the concentrations calculated. The influence of the terrain will vary with the source height and position and the local meteorology. Table 12-1 gives an overview of meteorological parameters and basic setup options for the AERMOD model runs.

Table 12-1: Summary of meteorological and AERMET parameters used for this study

Number of grids (spacing)	1 (250 m)
Number of grids points	81x81
Years of analysis	Jan 2011 to Dec 2013
Centre of analysis	Ogies (25.991436 S, 29.099525 E)
Meteorological grid domain	20 km (east-west) x 20 km (south-north)
Meteorological grid cell resolution	20 km x 20 km
Station Base Elevation	1541 m
MM5-Processed Grid Cell (Grid Cell Centre)	25.991436 S, 29.099525 E
Anemometer Height	13 m
Surface meteorological stations	1 site at the proposed KPSX: Weltevreden site using data generated by AERMET
Upper air meteorological stations	1 site at the proposed KPSX: Weltevreden site using data generated by AERMET
Simulation length	2561 hours (Jan 2011 to Dec 2013)
Sectors	The surrounding area land use type was considered to be *cultivated land*
Albedo	0.28 (generated with the AERMOD Model – when the land use types are specified)
Surface Roughness	0.0725
Bowen Ratio	0.75
Terrain Option	Elevated (The regional setting showed some ridges in the area)

12.1.2 Geophysical Model Input Data

Geophysical data requirements include land use type and terrain elevation. Land use categories and terrain of the surrounding region are defined when processing AERMET and AERMAP respectively. Often, the in-built land use classification type and the terrain heights derived from the 90m SRTM DEM product are employed. The aforementioned parameters exact strong influence on wind speed and turbulence, which are key components for dispersion. AERMOD model system and for this study include: emissions source data, meteorological data and information on the nature of the receptor grid. Parameters required depend on the source type (point, line, area or volume).

Meteorological data is crucial as this principal factor to the dispersion of pollutants in the atmosphere i.e. vertical profiles of wind speed and direction, atmospheric turbulence and ambient air temperature. It is worth mentioning that topography plays a significant role in dispersion of emissions from source. Topographic features create mechanical drag, inducing turbulence and the subsequent dispersion of pollutants and atmospheric mixing / dilution. The topography surrounding the area of the proposed KPSX: Weltevreden project is relatively flat, an average height of 1541 mamsl.

12.2 Impact Assessment Summary

All relevant averaging periods were modelled for pollutants of concern. In all instances the worst case scenario has been presented to demonstrate the highest predicted impact. It is important to note that highest period-averages (i.e. highest hourly-average and highest 24-hour-average) presented in the maps are indicative of the highest expected concentrations for the period-average for the modelled year at each position in the modelled domain, and must not be interpreted as being representative of general conditions. The intent of the maps is to conservatively present the worst case scenario for those averaging periods.

The daily values option controls the output options for tables of concurrent values summarised by receptor for each day processed. For each averaging period for which the daily values option is selected, the model will print in the main output file the concurrent averages for all receptors for each day of data processed. Results are output for each source group.

In general, the ground level concentrations follow closely the main wind directions (wind roses generated for the site). Numerical values of maximum depend on the emission rate and the prevailing meteorological condition of the area. Simulations were undertaken to determine concentrations of particulate matter with a particle size of less than 10 µm in size (PM_{10}), particle size of less than 2.5 µm in size ($PM_{2.5}$) and for dust deposition (≥ 30 µm). These simulations were undertaken to determine concentrations for two different scenarios – mitigation and without-mitigation.

Isopleth plots of predicted concentrations of pollutants: PM_{10}, $PM_{2.5}$, and dust deposition for the worst case scenario (where mitigation measures are not applied for topsoil, overburden dumps and activities like tipping and haulage) were predicted for the respective averaging periods).

The hourly and daily average concentrations were calculated as the 4th highest value (99th percentile). Annual mean values were shown as the highest values (100th percentile) according to the NEM: AQA Air Dispersion Regulation (2012). IFC General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality also stipulate that PM 24-hour value is the 99th percentile, and this was applied to all the pollutants.

Isopleths of ground level concentrations generated for the different pollutants associated with the proposed KPSX: Weltevreden are presented (Figure 12-1 and Figure 12-10).

Simulations were undertaken to determine concentrations of particulate matter with aerodynamic size of 10 µm or less (PM_{10}), aerodynamic size of 2.5 µm or less ($PM_{2.5}$), and of deposition of total suspended particulates (TSP) ≥ 30 µm from the operations of the proposed KPSX: Weltevreden Project. Scenarios with mitigation measures were simulated using the control factors from Australian NPI V3.1 as shown in Table 12-2.

Table 12-2: Estimated control factors for KPSX: Weltevreden Mining Operations

Sources	Control method and emission reduction
ROM stockpile	40% for dust reduction
Waste rock stockpile	40% for telescopic chute with water sprays
TSF	40% vegetation cover
Paved road	40% for water sprays
Crusher	75% water sprays (enclosed)

*Assumed mitigation measures will be implemented by client

12.2.1 Isopleth Plots and Evaluation of Modelling Results

12.2.1.1 PM_{10} predicted impacts

Isopleth plot of predicted highest daily concentration of PM_{10} attributed to the proposed KPSX: Weltevreden operation is given in Figure 12-1. The daily highest ground level concentration of at the mine boundary of 528 µg/m³ was predicted, which extended outside the project area (in the western and south western boundary). The predicted ground level concentration at the mine boundary is in exceedance of the current daily limit of 75 µg/m³ without mitigation. The *major contributors are road, drilling and blasting*). In terms of spatial impact, much of the area impacted is within in project area. Ambient concentrations at the identified receptors are within compliance (

Table 12-4). Although, some sections of Phola are exposed to concentrations above the current standard of 75 µg/m³.

These isopleths are likely concentrations that the proposed KPSX: Weltevreden Mine would have on ambient air quality and not cumulative impact from all the existing sources in the area. *It is therefore possible that the highest daily concentration predicted to occur at a certain locations, this may only be true for one day during the entire period.*

The predicted highest annual values for PM_{10} anticipated from the proposed KPSX: Weltevreden mining operations are given in Figure 12-2. The annual highest ground level concentration of this pollutant predicted outside the mine boundary was 80.6 µg/m³. The latter is in exceedance of the current standard of 40 µg/m³. The ambient concentrations at identified sensitive receptors – Phola, Ogies and Greenside are presented in Table 12-3 and

Table 12-4 below.

Table 12-3: Predicted PM_{10} concentrations at sensitive receptors

Site ID	X	Y	Daily (µg/m^3)	Annual (µg/m^3)
Phola	703844	7124042	62	5.5
Ogies	706036	7117218	33	3.2
Greenside	717564	7126653	14	0.53

Table 12-4: Predicted PM_{10} concentrations at sensitive receptors (Mitigated)

Site ID	X	Y	Daily (µg/m^3)	Annual (µg/m^3)
Phola	703844	7124042	25	3.7
Ogies	706036	7117218	16	1.8
Greenside	717564	7126653	7	0.39

12.2.2 $PM_{2.5}$ Predicted impacts

Isopleth plot of predicted 4th highest daily values for $PM_{2.5}$ generated by the proposed KPSX: Weltevreden Mine is given in Figure 12-3, the maximum ground level concentration of 138 µg/m^3 was predicted both within and outside the mine boundary. This isopleth plot of predicted maximum daily values for $PM_{2.5}$ from all sources without mitigation measures predicted exceeds the current daily limit of 65 µg/m^3 and the future limit of 40 µg/m^3. The predicted $PM_{2.5}$ concentrations around the closest neighbouring residential areas (sensitive receptors – Phola, Ogies and Greenside are below the current and future SA standards (Table 12-5). For $PM_{2.5}$, with mitigation the predicted daily concentrations at the sensitive receptors are reported (Figure 12-8). The ground level concentration decreased with mitigation measures applied.

The isopleth depicting the predicted annual ground level concentrations for $PM_{2.5}$ that will be generated by the proposed KPSX: Weltevreden Mine is presented (Table 12-5). The predicted annual maximum ground level concentration at the mine boundary of 22 µg/m^3 is confined within the project boundary (Figure 12-9). The concentrations at the selected sensitive receptors are presented (Table 12-5).

Table 12-5: Predicted $PM_{2.5}$ concentrations at sensitive receptors (unmitigated)

Site ID	X	Y	Daily (µg/m^3)	Annual (µg/m^3)
Phola	703844	7124042	12.1	1.3
Ogies	706036	7117218	7.2	0.6

Greenside	717564	7126653	2.6	0.1

Table 12-6: Predicted $PM_{2.5}$ concentrations at sensitive receptors (Mitigated)

Site ID	X	Y	Daily (µg/m^3)	Annual (µg/m^3)
Phola	703844	7124042	6.2	0.6
Ogies	706036	7117218	3.8	0.3
Greenside	717564	7126653	1.3	0.07

12.2.3 Dust deposition predicted impacts

The predicted dust deposition rates are very high along the haul road, with deposition rates above 2 400 mg/m2/day. This seems to concentrate along the haul route and deposition rates drops away from the road (Figure 12-5). Major contributions are coming from hauling of coal and overburden waste to product and waste stockpiles respectively. Deposition rates at the selected sensitive receptors are within the NDCR 2013 recommended standard for both residential and industrial areas (i.e. 600 mg/m²/day and 1200 mg/m²/day) Table 9-1.

It should be noted that isopleth plots reflecting daily averaging periods contain only the highest predicted ground level concentrations for that averaging period, over the entire period for which simulations were undertaken. These isopleths are likely concentrations that the proposed KPSX: Weltevreden Mine would exert on ambient air quality and not cumulative impact from all other sources. *It is therefore possible that even though a high daily concentration is predicted to occur at certain locations, that this may only be true for one day during the entire period.*

When the mitigation measures provided in Table 12-2 are implemented simultaneously, the anticipated deposition rates at the selected sensitive receptors were observed to have decreased (Table 12-7). Once mitigation measures are applied the footprint decreased considerably.

Table 12-7: Predicted monthly dust deposition rates at sensitive receptors

Site ID	X	Y	Unmitigated (mg/m^2/day)	Mitigated (mg/m^2/day)
Phola	703844	7124042	186	143
Ogies	706036	7117218	385	122
Greenside	717564	7126653	11	6.2

Summary of isopleth plots generated in the current section are presented in Table 12-8.

Table 12-8: Evaluation of results for particulate matter and deposited nuisance dust for the operational phase

Pollutant	Averaging period	Standard (µg/m³)	Figure
	Unmitigated concentrations		
PM_{10}	24 Hours	75 (1)	Figure 12-1
	Annual	40(1)	Figure 12-2
$PM_{2.5}$	24 Hours	65(1) 40(2)	Figure 12-3
	Annual	25(1) 20(2)	Figure 12-4
Dust Deposition	Monthly	600(3)	Figure 12-5
Mitigated concentrations			
PM_{10}	24 Hours	75 (1)	Figure 12-6
	Annual	40(1)	Figure 12-7
$PM_{2.5}$	24 Hours	65(1) 40(2)	Figure 12-8
	Annual	25(1) 20(2)	Figure 12-9
Dust Deposition	Monthly	600(3)	Figure 12-10

(1) South African- Current National Ambient Air Quality Standards (NAAQS)

(2) South African- Proposed future (from 1 January 2016) National Ambient Air Quality Standards (NAAQS)

(3) National Dust Control Regulation 2013: "Dust fallout Standards"

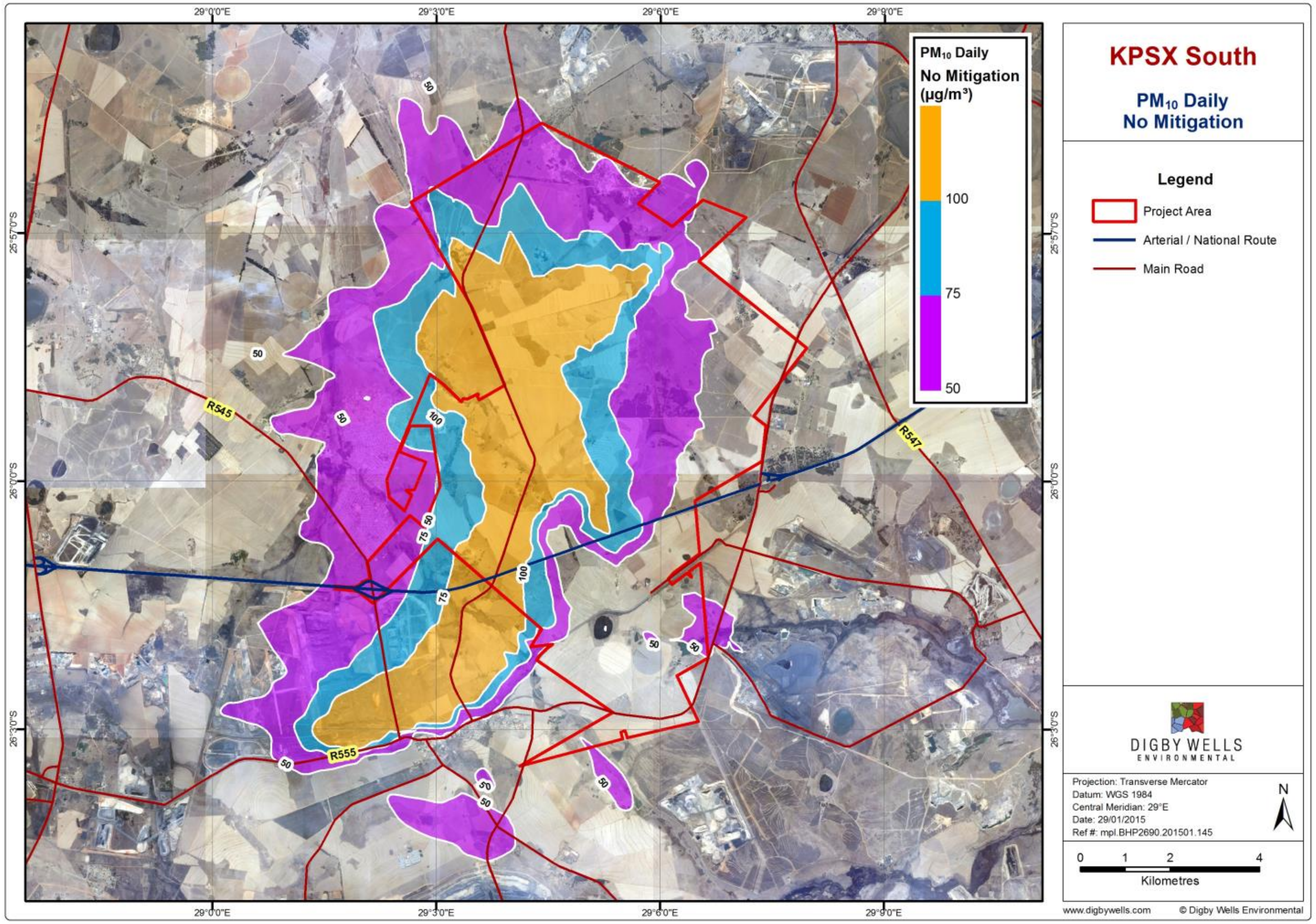


Figure 12-1: Predicted 4th highest (99th percentile) daily PM_{10} concentrations (µg/m^3)

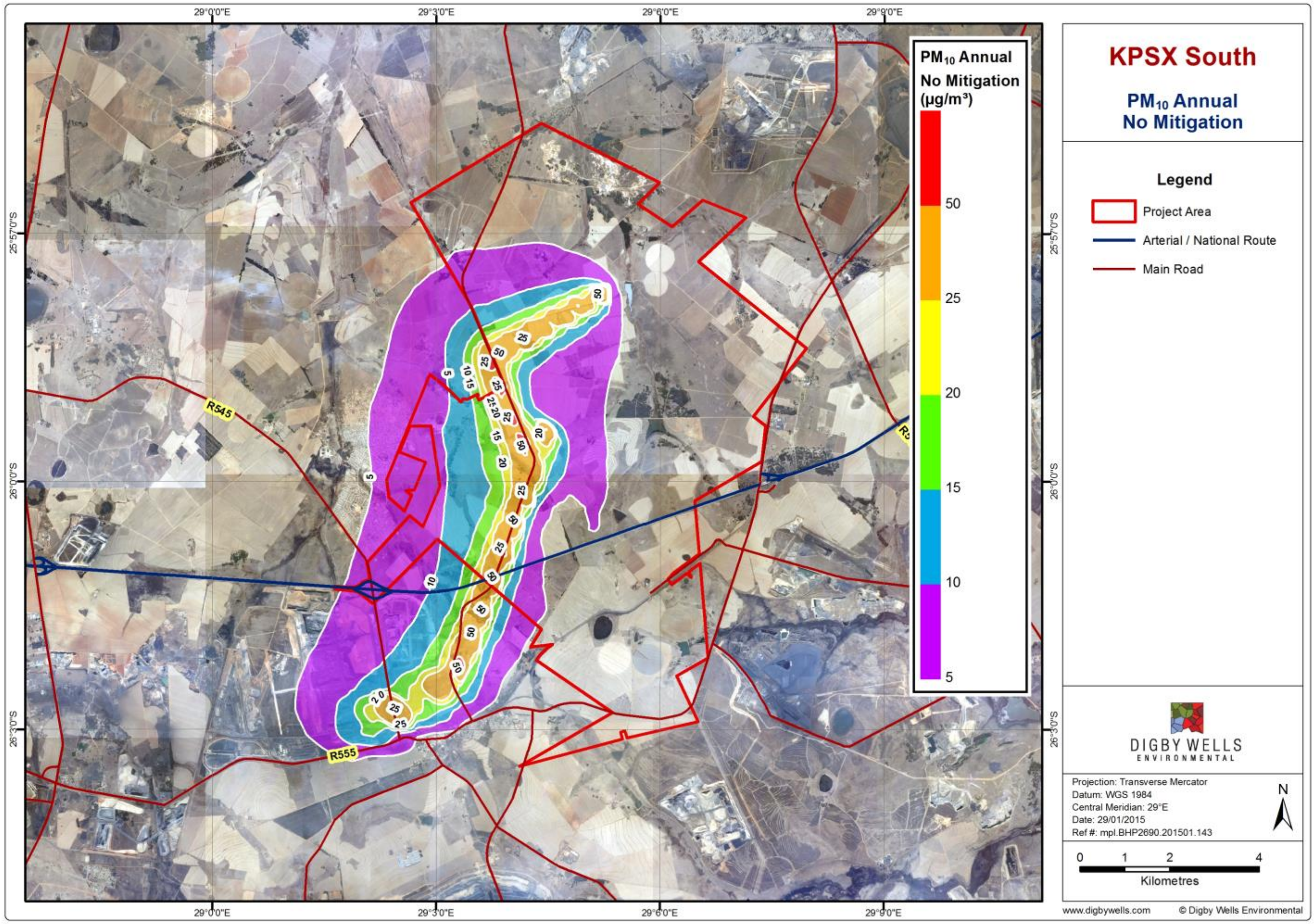


Figure 12-2: Predicted 1st highest (100th percentile) Annual PM_{10} concentrations (µg/m³)

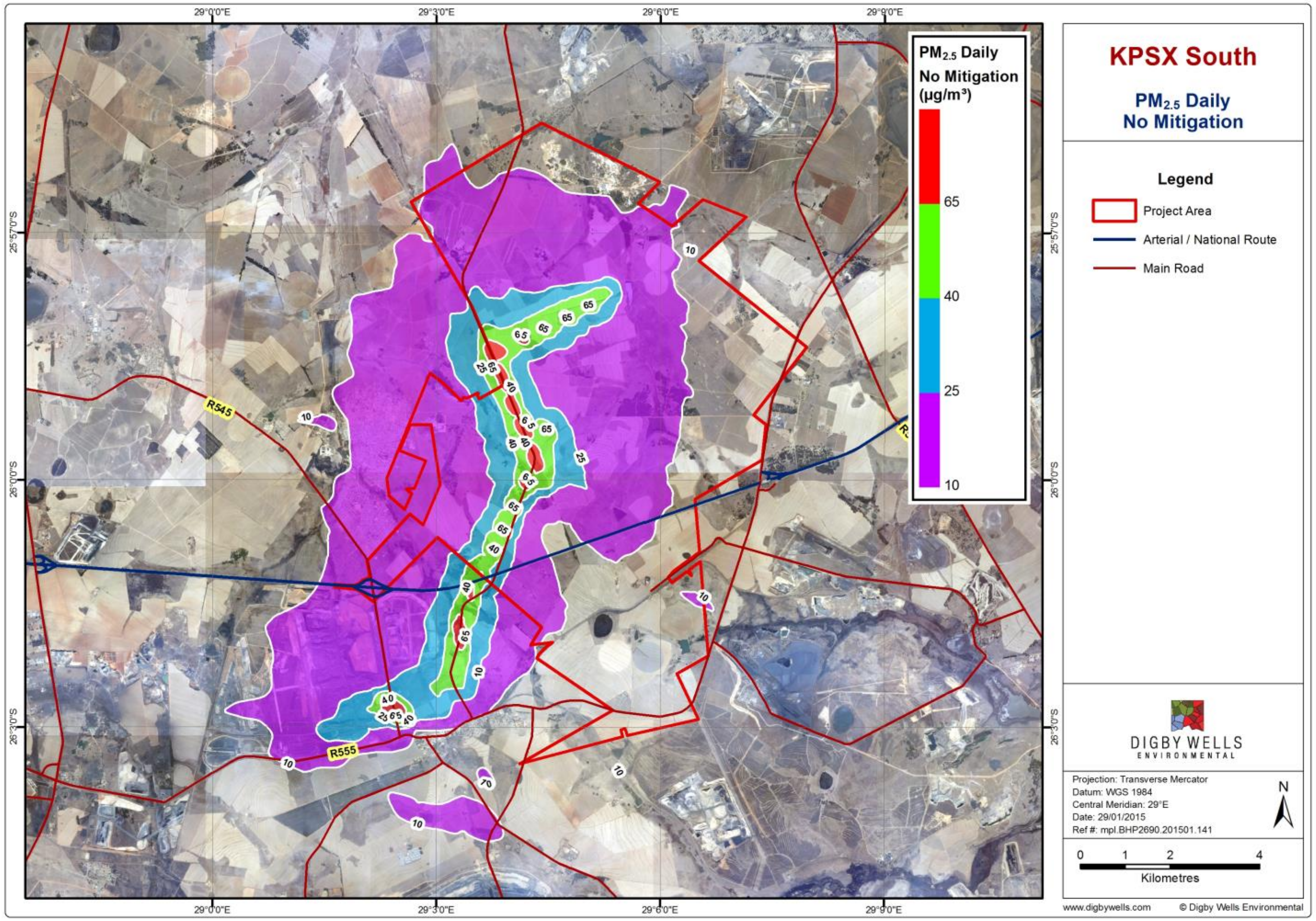


Figure 12-3: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ concentrations (µg/m^3)

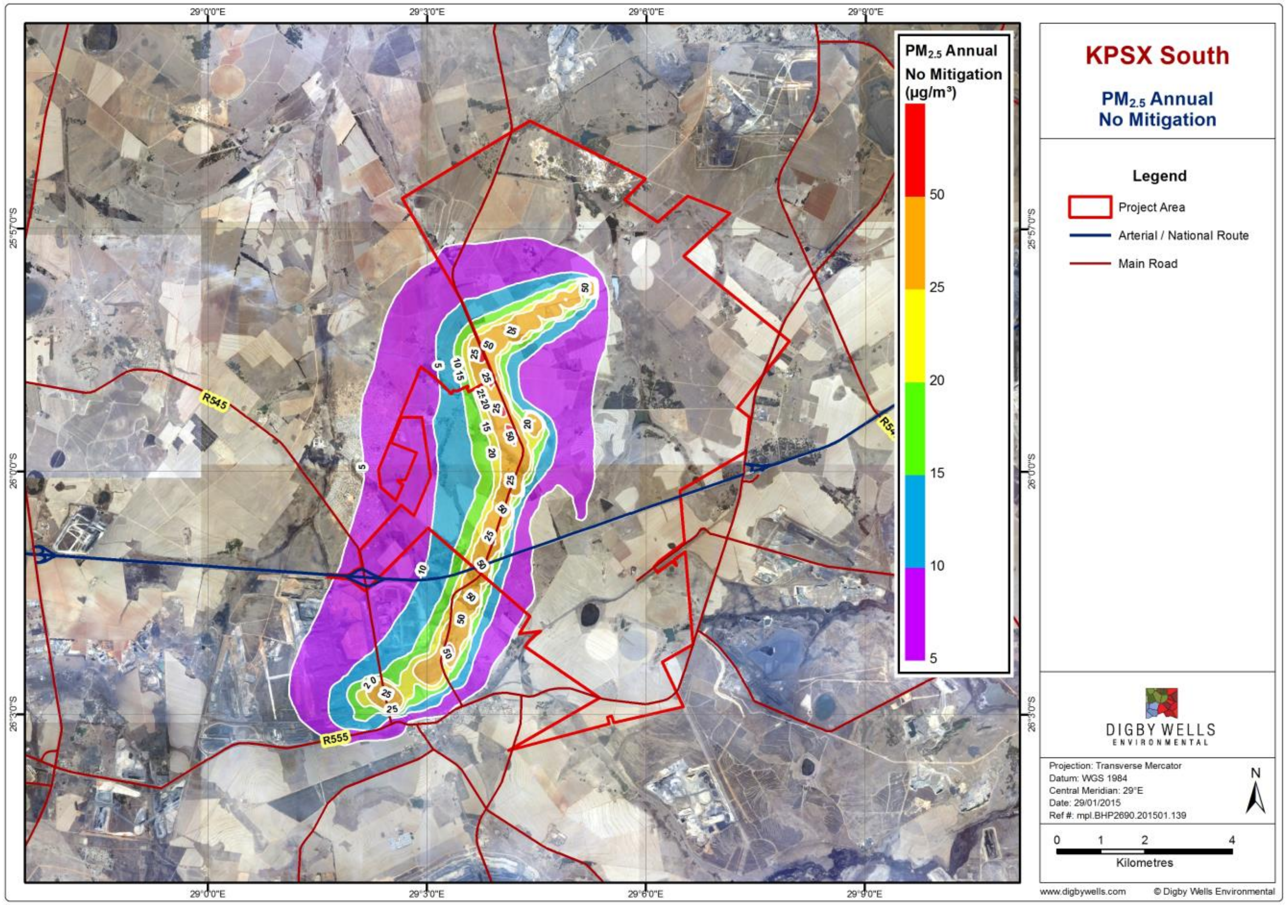


Figure 12-4: Predicted 1st highest (100th percentile) Annual $PM_{2.5}$ concentrations (µg/m³)

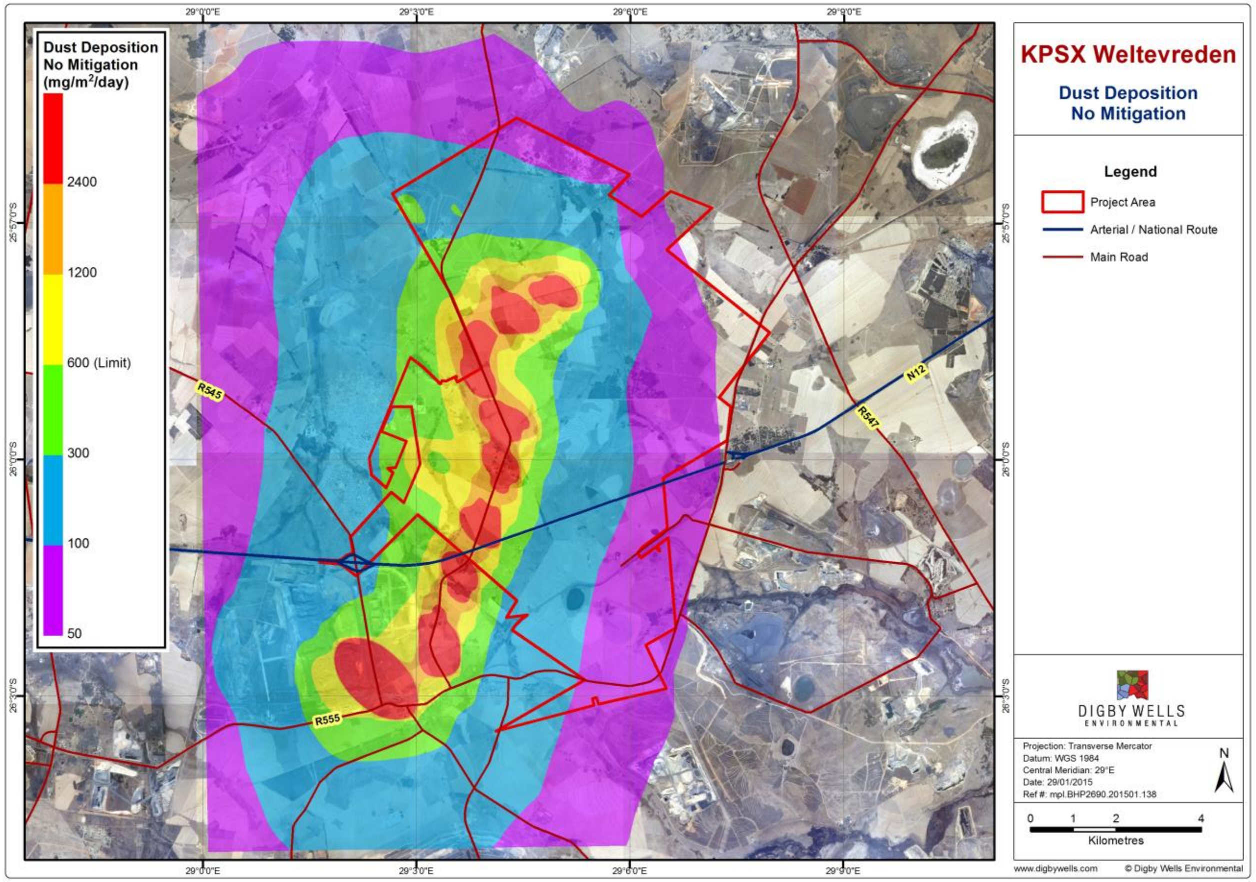


Figure 12-5: Predicted maximum (100th percentile) dust deposition (mg/m^2/day)

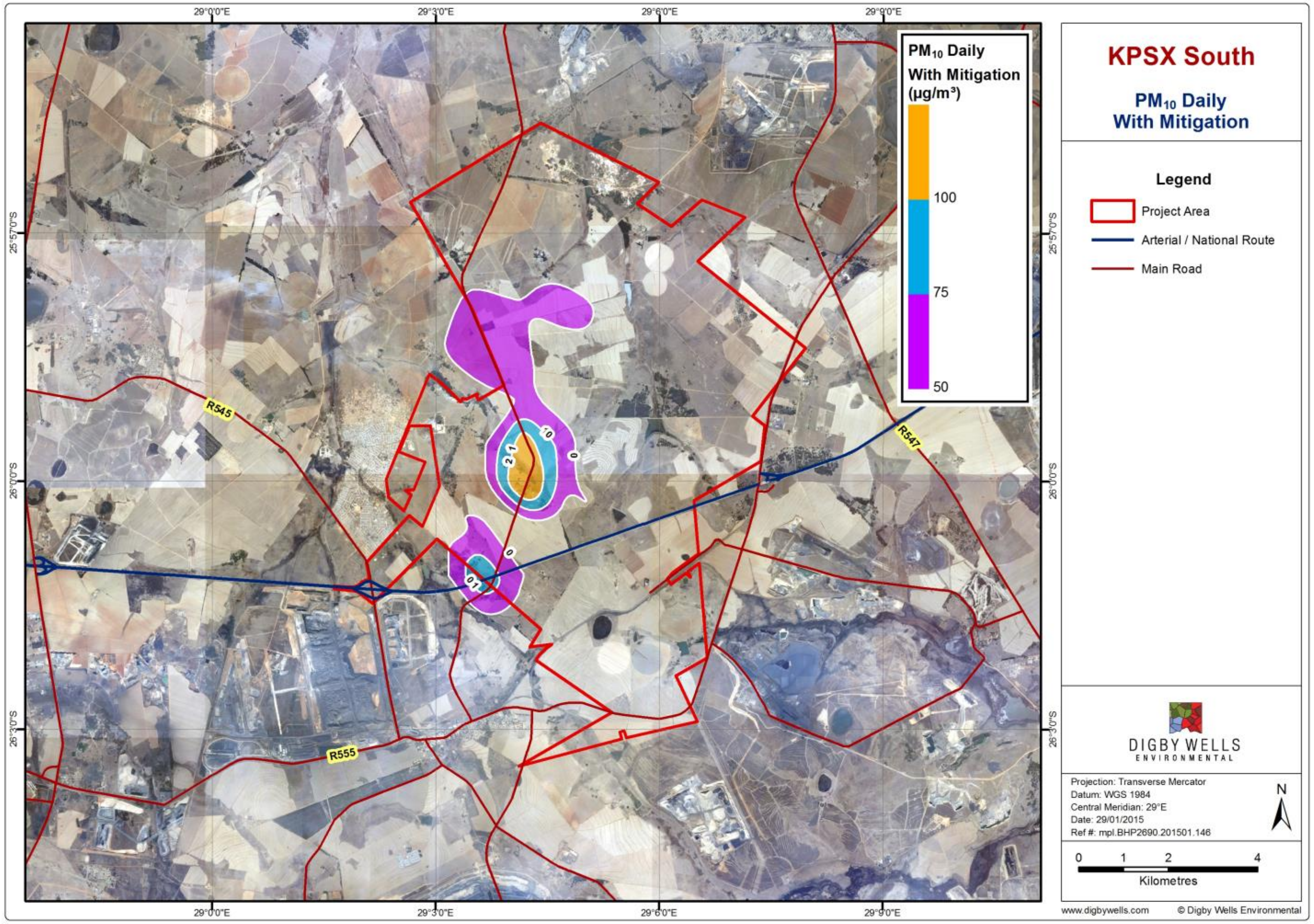


Figure 12-6: Predicted 4th highest (99th percentile) daily PM_{10} concentrations (µg/m³) with mitigation

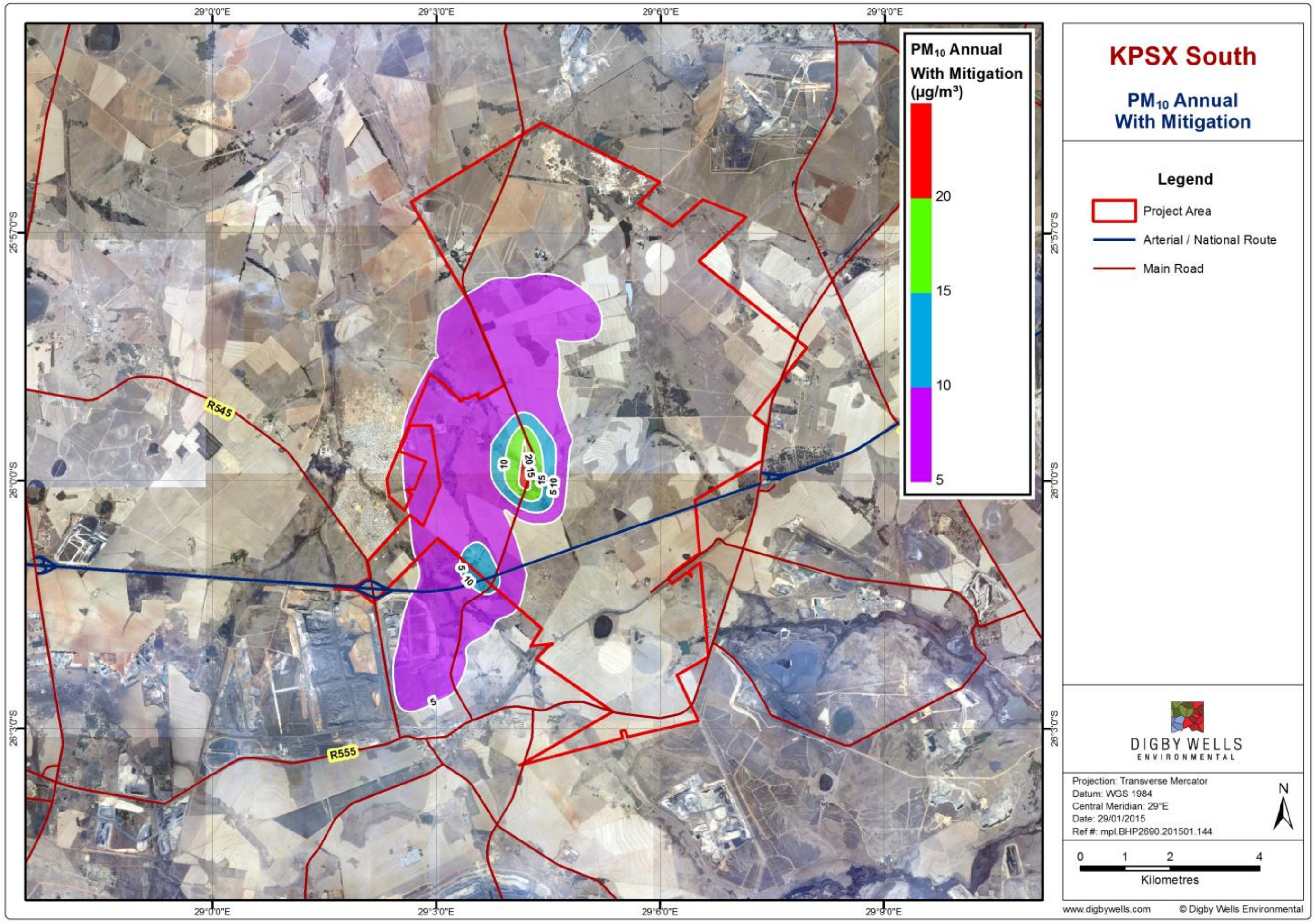


Figure 12-7: Predicted 1th highest (100th percentile) annual PM_{10} concentrations (µg/m^3) with mitigation

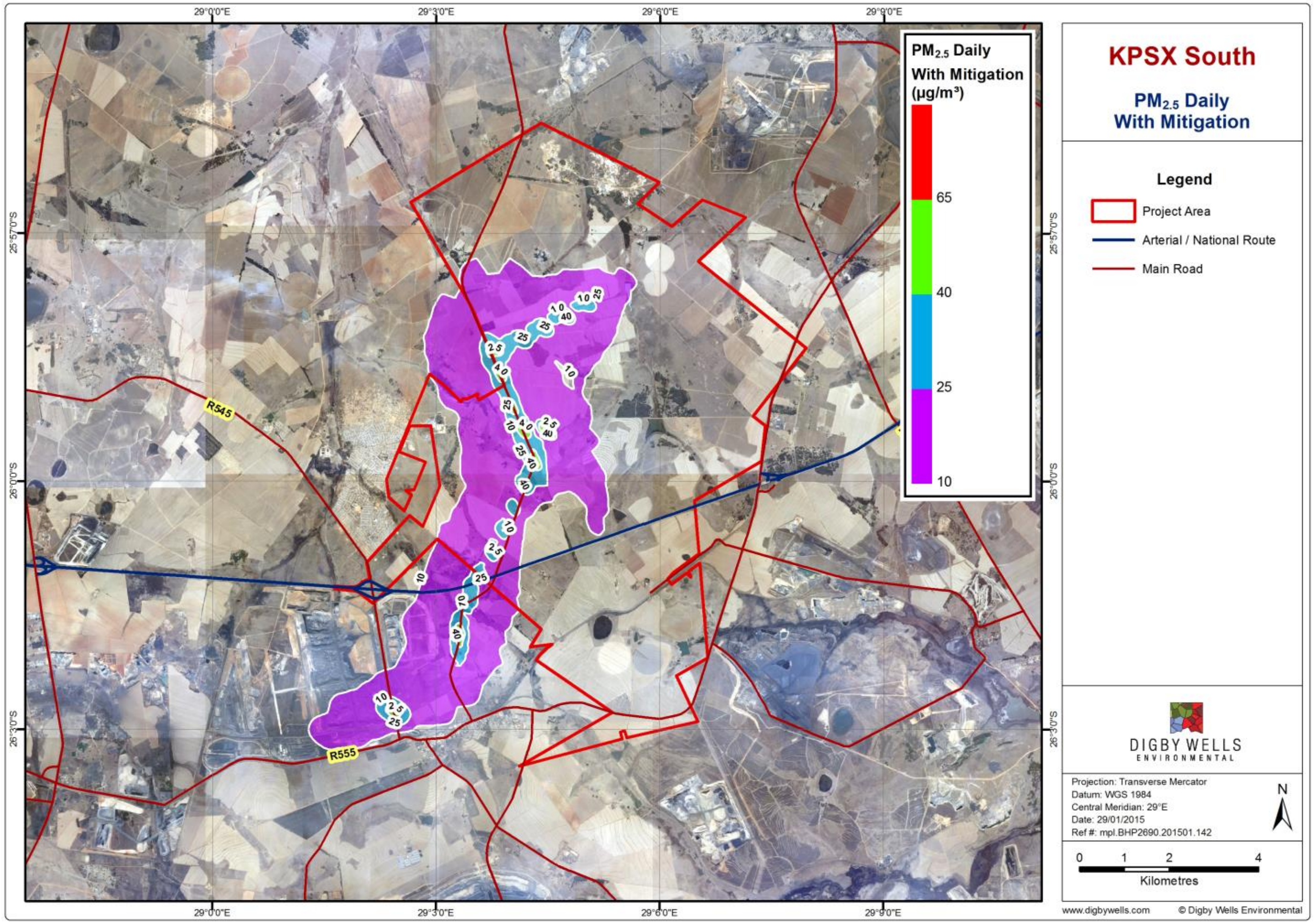


Figure 12-8: Predicted 4th highest (99th percentile) daily $PM_{2.5}$ concentrations (µg/m³) with mitigation

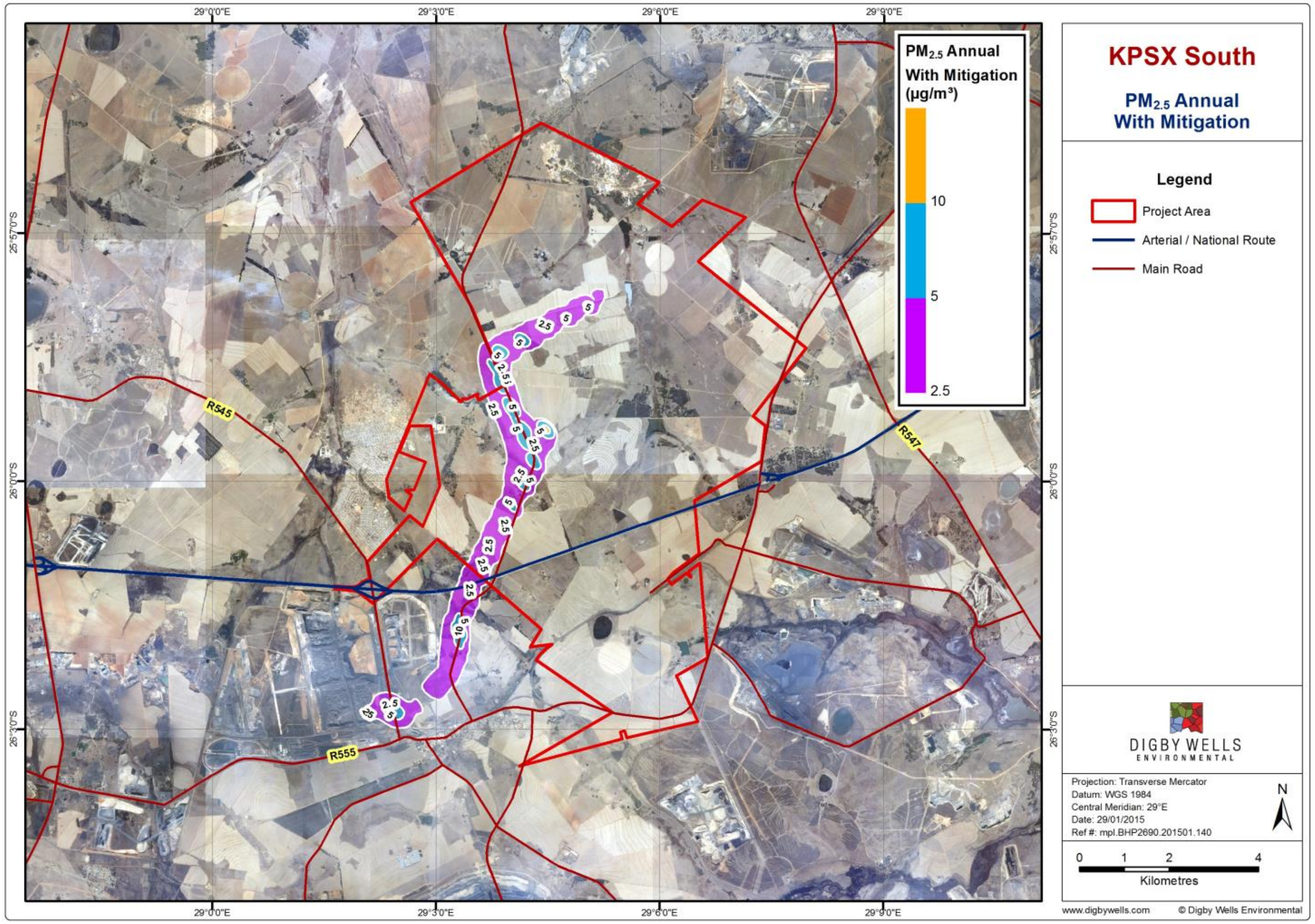


Figure 12-9: Predicted 1th highest (100th percentile) annual $PM_{2.5}$ concentrations (µg/m³) with mitigation

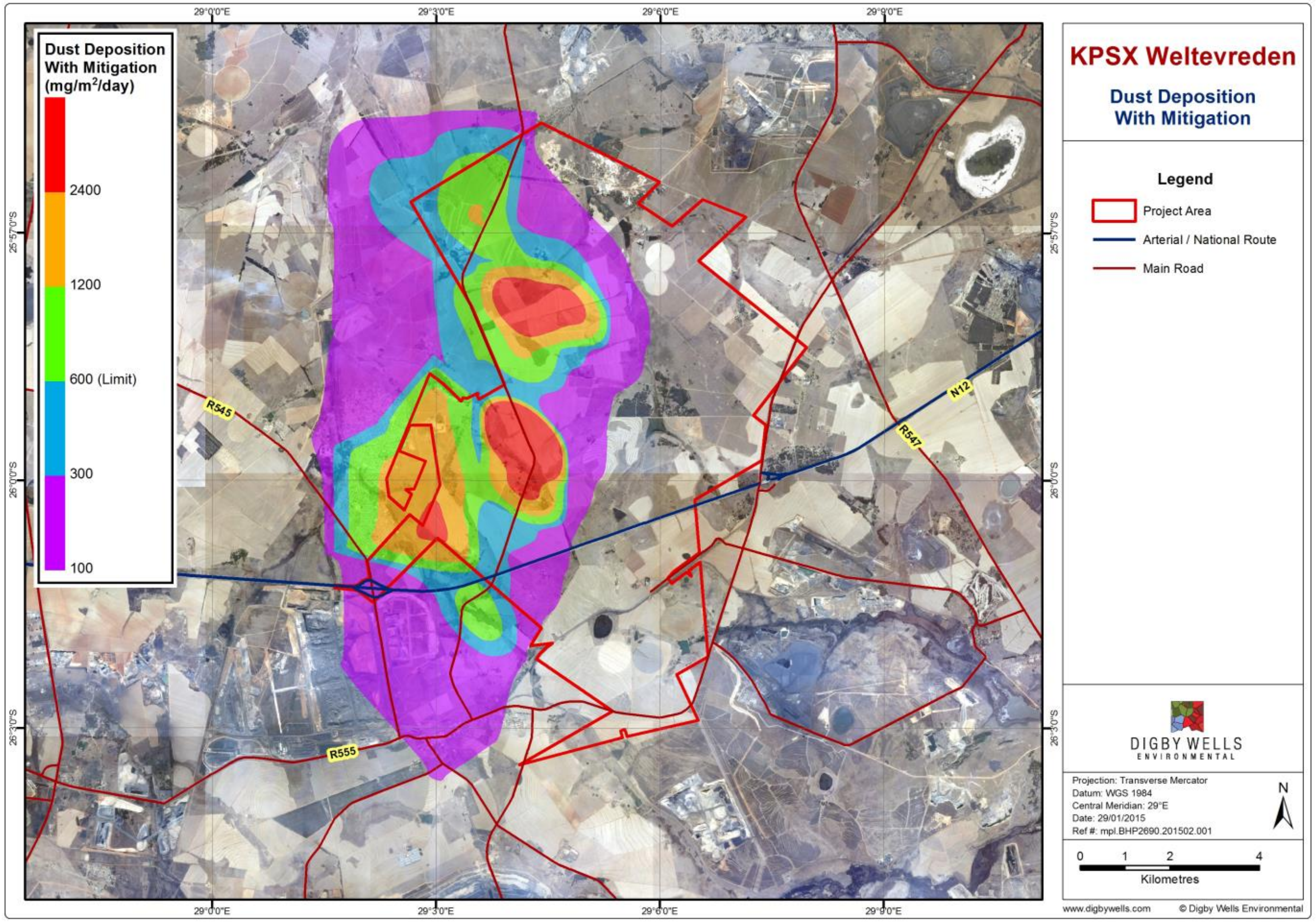


Figure 12-10: Predicted maximum (100th percentile) dust deposition (mg/m^2/day) with mitigation

12.3 Discussion

The impacts arising from identified pollutants associated with the proposed KPSX: Weltevreden Mine operational phase have been appraised using predicted concentration plots from AERMOD dispersion model.

12.3.1 Findings

Impacts associated with the proposed KPSX: Weltevreden Mine have been assessed. The AQIA study shows that the particulate pollution from the proposed mine operation will exert impact on current ambient air quality of the area. With multiple activities conducted at the same time, this results in multiple sources of emission (i.e. drilling and blasting, loading and offloading, hauling of ore and overburden, tipping, amongst others). The main findings of this AQIA study are summarised as follows:

- The predicted highest daily PM_{10} concentrations at the mine boundary exceeded the current the South African Air Quality standards.
  - The predicted highest daily PM_{10} concentration at the mine boundary of 528 µg/m³ without mitigation measures exceeded the current South African standards of 75 µg/m³. Sections of Phola will be exposed to concentration above the standard. The predicted annual maximum concentration at the mine boundary (80.6) exceeded the current standard of 40 µg/m³.
  - The highest $PM_{2.5}$ daily (138 µg/m³) predicted beyond the mine boundary without mitigation exceeded the current South African standards of 65 µg/m³. However, the annual average (22 µg/m³) is within the current standard of 25 µg/m³ and future standard of 20 µg/m³ which will come into effect 1 January 2016.

- The highest dust deposition rates predicted beyond the mine boundary exceeded 2 400 mg/m^2/day. This value is higher than the current limits for residential and non-residential of 600 mg/m2/day and 1200 mg/m2/day (National Dust Control Regulation, 2013). The dispersion model shows that exceedances will be observed along the haul road and adjacent areas. Most of the areas impacted are confined to the mine boundary.
- The concentrations of the various pollutants have been evaluated at the sensitive receptors and levels are within the regulatory standards without mitigation measures in place. Once mitigations measures are applied, emissions from KPSX: Weltevreden are likely to reduce.

In conclusion, if emission of pollutants is contained during the operational phase, especially along the haul road (mitigation measures applied), associated impacts of PM10 and PM2.5 will be reduced in the surrounding areas including sensitive receptors.

12.4 Conclusion

An AQIA was undertaken as a part of an EIA Study for the proposed KPSX: Weltevreden Mine, in the Nkangala District Municipality, Mpumalanga province, South Africa.

Analysis of the meteorology confirms the KPSX: Weltevreden project area is influenced predominant by winds coming from the north northeast (8.4%) and north (8%). Wind speed greater than 5.4 m/s occurred for 9% of the time. Over the three year period, winds capable of generating dust occurred for some 99 days. Calm conditions (wind speeds < 0.5 m/s) occurred for 3.2% of the time.

Pollutants quantified and evaluated in this assessment encompass fine particulates (PM_{10} and $PM_{2.5}$) and deposited nuisance dust. The modelling results presented in this report confirm that the potential is there to exacerbate the current background concentration above regulatory standards. The dispersion modelling results showed exceedances that are mostly confined to the mine project area. Hauling of coal and overburden waste on dirt road represent the main contributor followed by drilling and blasting. Hence, the deposition rates along the haul road and adjacent areas are predicted to be high. Adequate mitigation measures suggested in this report will help reduce emissions from these sources and ensure compliance with regulatory standards. Once dust deposition is contained, the PM_{10} and $PM_{2.5}$ load will also decrease considerably in the environment.

Results of the dispersion modelling exercise show that impacts will be mainly minor (negative). As a result, mitigation measures should be implemented to bring both the mine project area and surroundings into compliance with the NAAQS.

In conclusion, fugitive emissions associated with the operation of the KPSX: Weltevreden Mine have potential to impact areas beyond the project boundary. The most likely areas of impact from these dust sources would be towards the south western of the project boundary. The client provided background information that was used to populate the dispersion modelling suite, and where the gaps existed, default values from the USEPA AP-42 were applied in the dispersion model. It should be noted that the report reflects the operational phase of the KPSX: Weltevreden Mine and modelled for worst-case scenario.

13 Impact Assessment

13.1 Impact Rating and Assessment

The methodology utilised to assess the potential air quality impacts is discussed in detail below. The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact *=* ***+1*** *(Positive Impact) or* ***-1*** *(Negative Impact)*

The weight assigned to the various parameters for positive and negative air quality impacts is provided for in the formula and is presented in Table 13-1. The probability consequence matrix for air quality impacts is displayed in Table 13-2, with the impact significance rating described in Table 13-3. The list of activities used for the impact assessment of the proposed KPSX Weltevreden mine operation is given in Table 13-4.

Table 13-1: Air Quality Impact Assessment Parameter Ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project.	Certain/ Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to	On-going and widespread positive benefits to local communities which	Province/ Region Will affect the entire province	Project Life The impact will cease after the operational life span of the	Likely The impact may occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
	rehabilitate. Very serious widespread social impacts. Irreparable damage to highly valued items.	improves livelihoods, as well as a positive improvement to the receiving environment.	or region.	Project.	
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years.	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.
2	Minor effects on biological or	Low positive impacts	Limited	Short term	Rare/ improbable

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	***Positive Impacts (Type of Impact = +1)***			
	physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	experience by very few of population.	Limited to the site and its immediate surroundings.	Less than 1 year.	Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance that will have no impact on the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Table 13-2: Probability Consequence Matrix for Air Quality Impacts

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

Table 13-3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which may be sufficient by itself to justify implementation of the Project. The impact may result in permanent positive change.	Major (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.	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the Project. These impacts will usually result in positive medium to long-term effect on the social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural environment.	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. 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 social and/or natural environment.	Negligible (negative)
-36 to -72	An important negative impact which 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 social and/or natural environment.	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe effects.	Moderate (negative)
-109 to -147	A very serious negative impact which 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.	Major (negative)

Table 13-4: Project Activities

Activity No.	Activity
Construction Phase	
1	The recruitment, procurement and employment of construction workers, engineers and contractors.
2	The transportation of construction material to the Project site via national, provincial and local roads.
3	Storage of fuel, lubricant and explosives in temporary facilities for the duration of the construction phase. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly.
4	Site clearance and topsoil removal prior to the commencement of physical construction activities, as well as the open pit mining. This activity refers to the conversion of undeveloped, vacant land into industrial use.
5	Construction of surface infrastructure will take place, including the offices and fuel bay, haul roads, PCDs, coal tip and conveyor belt, pipelines and clean water canals and a high mast radio communication tower.
6	The construction of stockpiles, including topsoil, overburden and discard and emergency coal stockpiles.
7	The establishment of the initial boxcut and access ramps to the open pit mining areas.
Operational Phase	
8	Limited employment of skilled and unskilled labour will be required for the operation of the mine and support infrastructure.
9	Storage of fuel in diesel tanks, as well as lubricant and explosives in facilities for the duration of Project. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly.
10	Drilling and blasting of the overburden rock for easy removal by excavators and dump trucks.

Activity No.	Activity
11	Coal removal by truck and shovel methods from the exposed coal seams. The coal is removed with shovels and transported to the plant by conveyor belt by trucks.
12	Vehicular activity on the proposed haul roads. Mining equipment will utilise the haul roads to access open pit areas, as well as to transport coal from the opencast pit to the plant and conveyor belt. The haul road will consist of wetland and stream crossings.
13	Mine water, or dirty water that is located within the opencast pits will need to be diverted by channels and berms to the PCDs to prevent clean water resources from being contaminated. Pipelines will pump the dirty water from the KPSX: Weltevreden PCDs to the KPS PCD.
14	Use of conveyor belts to transport the coal to the stockpiles at the KPS plant.
15	The PCDs will store all dirty water that has come into contact with the opencast pit, overburden stockpiles or emergency coal stockpile.
16	Operation and maintenance of the stockpiles, including topsoil, overburden and discard and ROM coal stockpiles.
17	Waste and sewage generation and disposal. All domestic, industrial and hazardous waste is produced during the mining process. Waste includes cans, plastics, used tyres and oil which must be disposed of in an appropriate manner by a contractor at a licensed waste disposal site. Sewage produced from the office buildings and ablutions will be treated at a sewage plant, septic tank or French drain system.
18	Concurrent replacement of overburden and topsoil and the re-vegetation of mined out strips. The mined strip will be backfilled with the overburden and compacted. Subsequently, the topsoil will be placed on top of the overburden and the area will be vegetated.
Decommissioning Phase	
19	Retrenchment of mine employees and staff will take place following the cessation of the mining operations and coal beneficiation activities.
20	Demolition of infrastructure will take place and includes the PCDs, haul roads, coal tip and conveyor belts, pipelines, high mast radio communication tower, fuel

Activity No.	Activity
	bay and mine offices and workshop.
21	Removal of fuel, lubricant and explosives will be required following the cessation of the mining activities to ensure that there is no health and safety risk to the environment and to people.
22	Final replacement of overburden and topsoil and the establishment of vegetation on the final open cast void. Overburden will be backfilled into the final void and compacted. Subsequently, topsoil will placed and the area vegetated.
23	Waste handling of scrap metal and used oil as a result of the Decommissioning Phase will be undertaken.
Post-closure Phase	
24	Post-closure monitoring and rehabilitation will determine the level of success of the rehabilitation, as well as to identify any additional measures that have to be undertaken to ensure that the mining area is restored to an adequate state. Monitoring will include surface water, groundwater, soil fertility and erosion, natural vegetation and alien invasive species and dust generation from the coal discard dumps.

14 Potential Impacts

14.1 Construction Phase

(Should the impact be positive, please re-word to pre-enhancement and post-enhancement in place of mitigation)

Activity No. 2: The transportation of construction material to the Project site via national, provincial and local roads	
Criteria	**Details / Discussion**
Description of impact	Transportation of the workers and materials on and off site is quite common to operations of this nature. This often leads to the generation of fugitive dust comprising TSP, PM10 and PM2.5, especially from dirt roads as national and provincial roads are tarred. This activity will be short-term, localised, and will have low impacts on the atmospheric environment once the construction phase comes to an end.
Mitigation required	There is need for the application of wetting agents or dust suppressant on the dirt road to avoid incessant suspension and re-suspension or entrainment of dust. Vehicle travel speed and distances should be minimised. Encourage car-pool and

	bulk delivery of materials in order to reduce the number of trip on dirt roads.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	2	(-) 3	7	-49
Post-Mitigation	2	2	2	6	-30

Activity No. 3: Storage of fuel, lubricant and explosives in temporary facilities for the duration of the construction phase. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly					
Criteria	**Details / Discussion**				
Description of impact	Impact is associated with spills and odours. These hazardous products include fuel for the trucks, explosives used in blasting and waste or sewage management. The scale, types and amount of equipment and machinery used on site have bearing on the waste generated. Impacts include evaporation of diesel fuel and heavy fuel from temporary tanks and possible spills during loading of fuel from tanks on site that are used for re-fuelling of heavy machinery and trucks. Some of the waste produced includes waste oils, chemicals and hazardous substances.				
Mitigation required	There is a need to develop a hazardous products and waste management plan. Hazardous substances should be stored and handled in accordance with the local regulations, with such substances stored in clearly labelled containers. Employees should be well trained on the handling and storing hazardous chemicals alongside dealing with emergency procedures.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	2	2	(-) 2	5	-30
Post-Mitigation	1	2	1	4	-20

Activity No. 4: Site clearance and topsoil removal prior to the commencement of physical construction activities, as well as the open pit mining. This activity refers to the conversion of undeveloped, vacant land into industrial use	
Criteria	**Details / Discussion**
Description of impact	A number of activities, such as land clearing, topsoil removal, loading of material, grading, stockpiling, bulldozing and compaction. Each of the aforementioned activities has its own duration and potential for dust generation. This phase is often associated with the generation of fugitive dust i.e. TSP (total suspended particulate), as well as PM_{10} and $PM_{2.5}$ (dust with a size less than 10 µm, and dust with a size less than 2.5 µm giving rise to health impacts). It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the scale and duration of activity, coupled with the prevailing

	meteorological conditions. The construction phase will be short-term, and presumed localised, and will have low impact that will stop once the construction activities are finalised.				
Mitigation required	Removal of topsoil must be limited to non-windy days and months in order to ameliorate suspension of loose particulate matter and subsequent exposure to airborne dust. The area of disturbance must be kept to a minimum at all times and no unnecessary clearing of vegetation must occur. The drop heights when loading topsoil into trucks should be minimised. Water or a binding agent can also be used for dust suppression on exposed surfaces and roads. When using bulldozers and graders, there is need to minimise travel speed and distance to reduce dust generation.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	2	(-) 2	7	-49
Post-Mitigation	3	2	2	6	-42

Activity No. 5: Construction of surface infrastructure will take place, including the offices and fuel bay, haul roads, PCDs, coal tip and conveyor belt, pipelines and clean water canals and a high mast radio communication tower					
Criteria	**Details / Discussion**				
Description of impact	During this phase, it is anticipated there will be construction of infrastructure. This will include access roads, pipes, change houses, admin blocks etc. Activities of vehicles on access roads, levelling and compacting of surfaces will have implications on dust generation.				
Mitigation required	To mitigate the impact of construction activities on atmospheric environment, the following measures should be applied: The area of disturbance must be kept to a minimum and no unnecessary digging or scraping must occur on days with high wind speed (>5.4 m/s). Drop heights should be minimised when loading or dumping soil. Water or a binding agent can be used for dust suppression on roads. When using bulldozers and graders, there is need to minimise travel speed and distance. Studies by Watson et al., 1996 showed that the dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	2	(-) 2	7	-49
Post-Mitigation	3	2	2	5	-35

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Activity No. 6: The construction of stockpiles, including topsoil, overburden and discard and emergency coal stockpiles.					
Criteria	**Details / Discussion**				
Description of impact	During this phase, it is anticipated there will be construction of infrastructure. This will include access roads, pipes, change houses, admin blocks etc. Activities of vehicles on access roads, levelling and compacting of surfaces will have implications on dust generation. During this activity, land clearing, topsoil removal, loading of material, grading, stockpiling, bulldozing and compaction will occur. Each of the aforementioned activities has its own duration and potential for dust generation i.e. TSP (total suspended particulate), as well as PM_{10} and $PM_{2.5}$ (dust with a size less than 10 micron, and dust with a size less than 2.5 micron giving rise to health impacts).				
Mitigation required	To mitigate the impact of construction activities on atmospheric environment, the following measures should be applied: The area of disturbance must be kept to a minimum and no unnecessary digging or scraping must occur on days with high wind speed (>5.4 m/s). Drop heights should be minimised when loading or dumping soil. Water or a binding agent can be used for dust suppression on roads. When using bulldozers and graders, there is need to minimise travel speed and distance. Studies by Watson et al., 1996 showed that the dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	2	(-) 2	7	-49
Post-Mitigation	3	2	2	5	-35

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Activity No. 7: The establishment of the initial boxcut and access ramps to the open pit mining areas.	
Criteria	**Details / Discussion**
Description of impact	During this activity, the construction of a trench or "box cut" usually through the overburden to expose a portion of the coal seam will result in dust generation due to blasting and haulage of material. This will have implications on ambient air quality which will be localised.
Mitigation required	To mitigate the impact of construction activities on the atmospheric environment, the following measures should be applied: removal of topsoil during windy periods (August, September and October) should be done judiciously, due to the high wind speed (≥ 5.4 m/s) associated with this period. The area of disturbance must be kept to a minimum at all times and no unnecessary clearing of vegetation must occur. Drop heights when loaders dump soil into trucks or on topsoil stockpile should be reduced. Travel speed on haul and dirt roads must be reduced. Studies by Watson et

	al., 1996 showed that the dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	3	(-) 3	7	-49
Post-Mitigation	3	3	3	5	-35

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14.2 Operational Phase

Activity No. 9: Storage of fuel in diesel tanks, as well as lubricant and explosives in facilities for the duration of Project. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly.					
Criteria	**Details / Discussion**				
Description of impact	These hazardous products include fuel for the trucks, explosives used in blasting and waste or sewage management. The impacts of the hazardous materials and waste management are related to the types and amount of equipment and machinery used on site. Impacts anticipated include evaporation of diesel fuel and heavy fuel from temporary storage tanks and possible spills on site during re-fuelling of heavy machinery and trucks can lead to a reduction in the quality of air in the immediate vicinity. Damage to containers of bags holding powdery chemicals during material handling can lead to release and subsequent erosion with implication on ambient air quality.				
Mitigation required	Hazardous products and waste management plans must be developed and applied. This will encompass the following: identify anticipated waste streams, inspection and waste minimisation procedures, storage locations, and waste-specific management and disposal requirements. Also, a recycling strategy should be entrenched for workers to apply.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	3	(-) 3	6	-42
Post-Mitigation	3	3	3	4	-28

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Activity No. 10: Drilling and blasting of the overburden rock for easy removal by excavators and dump trucks.	
Criteria	**Details / Discussion**
Description of impact	Drilling is an intermittent exercise that emits fugitive dust and often occurs twice a week. Drilling and blasting often impact on ambient air quality due to the releases of particulate matter from these activities. Drilling leads to release of fugitive dust,

	especially if there are no water sprays. Since this will be a continuous process, for KPSX: Weltevreden Mine it should be properly managed during operation.				
Mitigation required	There is no control or mitigation measure for blasting. However, it is recommended that blasting be limited to non-windy days i.e., wind speed ≥ 5.4 m/s. In order to reduce emissions from drilling, the use of water sprays is recommended, which would result dust generation by some 70%. This should be a routine throughout the lifespan of the mine.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	5	(-) 5	6	-78
Post-Mitigation	2	5	4	5	-55

….

Activity No. 11: Coal removal by truck and shovel methods from the exposed coal seams. The coal is removed with shovels and transported to the plant by conveyor belt by trucks.					
Criteria	**Details / Discussion**				
Description of impact	In the case of KPSX: Weltevreden Mine - the ROM will be hauled by road to the nearby plant for processing using diesel trucks throughout the life of mine. Travel speed on haul roads must be reduced. The reason being that dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h) (Watson et al., 1996)				
Mitigation required	To mitigate the impacts associated with this activity on atmospheric environment, the travel speed haul roads must be reduced. It is confirmed that the dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h) (Watson et al., 1996).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	6	(-) 3	6	-72
Post-Mitigation	3	5	2	4	-40

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Activity No. 12: Vehicular activity on the proposed haul roads. Mining equipment will utilise the haul roads to access open pit areas, as well as to transport coal from the opencast pit to the plant and conveyor belt. The haul road will consist of wetland and stream crossings	
Criteria	**Details / Discussion**
Description of impact	Vehicular activity on the proposed haul roads. Mining equipment will utilise the haul roads to access open pit areas, as well as to transport coal from the opencast pit to the plant and conveyor belt. The haul road will consist of wetland and stream

	crossings.				
Mitigation required	To mitigate the impacts associated with this activity on atmospheric environment, the travel speed haul roads must be reduced. It is confirmed that the dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h) (Watson et al., 1996).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	6	(-) 3	6	-72
Post-Mitigation	3	3	2	4	-40

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Activity No. 14: Use of conveyor belts to transport the coal to the stockpiles at the KPS plant					
Criteria	**Details / Discussion**				
Description of impact	In the case of KPSX: Weltevreden Mine - the ROM the use of conveyor to transport coal to the stockpile will have implications on ambient air quality. This is particularly so if the conveyor belt is not covered, hence subject to wind erosion.				
Mitigation required	To mitigate the impacts associated with this activity on atmospheric environment, the following measures should be applied: there is need to have water sprays at the transfer point while being feed onto the conveyor. It is recommended that the conveyor belt be covered to reduce contact with wind.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	6	(-) 3	6	-72
Post-Mitigation	3	5	2	4	-40

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Activity No. 16: Operation and maintenance of the stockpiles, including topsoil, overburden and discard and ROM coal stockpiles	
Criteria	**Details / Discussion**
Description of impact	The concurrent replacement of overburden, topsoil and the re-vegetation of mined out strip will be an ongoing process during the life of mine. This activity is associated with dust generation and will have implications on ambient air quality of the area until such time when the vegetation cover is fully established.
Mitigation required	In order to reduce emissions from the concurrent replacement of the above storage facilities i.e. topsoil and overburden stockpiles, routine maintenance are imperative throughout the lifespan of the mine, with ongoing re-vegetation to avoid exposed surface to wind erosion.

Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	4	4	(-) 5	6	-78
Post-Mitigation	3	4	3	4	-40

Activity No. 17: Waste and sewage generation and disposal. All domestic, industrial and hazardous waste is produced during the mining process. Waste includes cans, plastics, used tyres and oil which must be disposed of in an appropriate manner by a contractor at a licensed waste disposal site. Sewage produced from the office buildings and ablutions will be treated at a sewage plant, septic tank or French drain system					
Criteria	**Details / Discussion**				
Description of impact	Waste generation peaks during the operational phase as consumption of raw material increases and significant amount of overburden rock removed. Hazardous products include fuel, waste oil, chemicals, explosives and waste, sewage, amongst others. This activity also includes evaporation of diesel fuel and heavy fuel from temporary tanks and possible spills during loading and re-fuelling of heavy machinery and trucks. Hazardous storage areas should be kept clear of combustible material and rubbish (e.g. oily rags, oil, grease, carton etc.)				
Mitigation required	There is a need to develop a waste management plan. This will identify anticipated liquid and solid waste streams and will ensure thorough inspection and waste minimisation procedures are in place. Optimum material handling and recycling strategy should be enforced by management and strict adherence on the part of workers during the operation phase. There is need for the provision of secondary containment for fuel storage. Hazardous substances should be stored and handled in accordance with the local regulations and chemicals must be stored in clearly labelled containers. Employees should be trained on the hazards of handling and storing hazardous chemicals. It is essential to ensure regular training and exercise for the staff on the emergency handling of hazardous waste.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	5	(-) 5	5	-65
Post-Mitigation	3	5	3	4	-44

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14.3 Decommissioning Phase

Activity No. 20: Demolition of infrastructure will take place and includes the PCDs, haul roads, coal tip and conveyor belts, pipelines, high mast radio communication tower, fuel bay and mine offices and workshop	
Criteria	**Details / Discussion**

Description of impact	During this activity, dismantling and demolition of existing infrastructure, transporting and handling of topsoil on unpaved roads in order to bring the site to state suitable for alternative land uses. There is cleaning-up and removal of various infrastructures. Potential for impacts during this phase will depend on the extent of demolition and rehabilitation efforts during closure as well as features which will remain. The impacts on the atmospheric environment during the decommissioning phase will be similar to the impacts during the construction phase. Demolition and removal of all infrastructures will cause fugitive dust emissions. Any implication this activity will have on ambient air quality will short-term and localised.				
Mitigation required	In order to mitigate the impacts of demolition and removal of rubbles on the ambient atmosphere, demolition should be done judiciously during windy periods (August, September and October) with wind speed ≥ 5.4 m/s. The area of disturbance must be kept to the barest minimum, which would limit the area exposed to wind erosion.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	2	(-) 2	6	-42
Post-Mitigation	3	2	2	5	-35

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Activity No. 21: Removal of fuel, lubricant and explosives will be required following the cessation of the mining activities to ensure that there is no health and safety risk to the environment and to people					
Criteria	**Details / Discussion**				
Description of impact	During this activity, removal of fuel, fuel tanks, lubricants and explosive should be carried out judiciously to avoid or minimise spills of hazardous materials. This must be done by a competent person (or an organisation) with enough practical and theoretical knowledge, training and actual experience.				
Mitigation required	Exclude all ignition sources from hazardous areas, i.e. smoking materials, naked flames, tools which may cause sparks, hot surfaces etc. In essence, storage areas should be kept clear of combustible materials and rubbish (oily rags, oil, grease cartons etc.).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	2	(-) 4	6	-54
Post-Mitigation	3	2	2	4	-28

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Activity No. 22: Final replacement of overburden and topsoil and the establishment of vegetation on the final open cast void. Overburden will be backfilled into the final void and compacted. Subsequently, topsoil will placed and the area vegetated.

Criteria	Details / Discussion				
Description of impact	The replacement of overburden, topsoil and the establishment of vegetation on the final open cast void will exacerbate ambient dust levels due to loading, transport and dumping of soil during backfilling. Dust from suspension and re-suspension of road dust will be critical to the ambient particulate loading.				
Mitigation required	In order to reduce emissions from this activity, it is recommended that working on during windy days (wind speed ≥ 5.4 m/s) be minimised to avoid subjecting loose materials to wind erosion. While transporting materials, vehicle speed should be reduced. Dust generating capacity of particles less than 10 micro meters is reduced by 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h) (Watson et al., 1996).				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	5	(-) 5	6	-78
Post-Mitigation	2	5	4	5	-55

….

Activity No. 23: Waste handling of scrap metal and used oil as a result of the Decommissioning Phase will be undertaken.					
Criteria	**Details / Discussion**				
Description of impact	During this activity, removal of scrap metal and used oil should be carried out judiciously to avoid sparks especially around fuel and combustible substances. In the event of fire, this will have an impact on the ambient air quality of surrounding area. Spilling of used oil and the evaporation from such surfaces will impact ambient air quality.				
Mitigation required	Exclude scrap metals from storage areas with combustible materials and rubbish (oily rags, oil, grease cartons etc.). Spills and leaks must be cleared immediately using sand or absorbent material, and should be disposed safely and not exposed to flame.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	2	2	(-) 4	6	-48
Post-Mitigation	2	2	2	4	-24

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14.4 Post-closure Phase

Activity No. 24: Post-closure monitoring and rehabilitation will determine the level of success of the rehabilitation, as well as to identify any additional measures that have to be undertaken to ensure that the mining area is restored to an adequate state. Monitoring will include surface

water, groundwater, soil fertility and erosion, natural vegetation and alien invasive species and dust generation from the coal discard dumps					
Criteria	**Details / Discussion**				
Description of impact	Re-vegetation of the remaining footprint of the mine must be done after the reclamation. The impacts on the atmospheric environment during rehabilitation will be limited to the vehicular activity, spreading of soil and profiling/contouring. The impact will be medium-term, very limited on spatial scale, with limited implication on ambient air quality. Ambient monitoring of the dust deposition can be continued to ensure dust levels are within compliance, confirming the effectiveness of the vegetation cover.				
Mitigation required	It is recommended that the rehabilitation process begin during the operational phase. The objective is to minimise the area exposed to wind erosion. These measures should reduce the potential for fugitive dust generation and render the impacts on ambient air quality negligible.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	2	3	(-) 2	6	-42
Post-Mitigation	1	2	2	6	-30

15 Summary of Significant Impacts

The impact assessment for the proposed KPSX: Weltevreden Project took into cognisance the influence exerted by mainly the construction and operational phases of the project. Activities such as ranging from clearing, grading, bulldozing and stockpiling of topsoil, extraction of ore, hauling, storage and handling of materials were considered.

16 Mitigation and Management Measures

The mitigation and management measures discussed are recommended in order to maintain the quality of air in the vicinity of the proposed project and beyond. The ambient air quality of the proposed KPSX: Weltevreden mining area will be impacted by fugitive emissions – $PM_{2.5}$, PM10 and TSP from the mine operations. *The mitigation and management measures are very similar irrespective of the phase,* a summary of the mitigation and management measures are discussed according to the different phases below:

16.1 Construction Phase

- It is advised that removal of topsoil be done judiciously during windy months, to minimise wind erosion of loose particulate matter.
- The disturbed areas must be kept to a minimum and no unnecessary clearing of vegetation must occur.
- Exposed areas should be re-vegetated to reduce wind erosion.

- During the loading of materials onto trucks or stockpiles, the dropping heights should be minimised.
- Water or other binding agents such as dust-a-side, polymers and adhesives can be used for dust suppression on dirt and haul roads.
- When using bulldozers and graders, there is need to minimise travel speed and distances.
- Reducing speed in haul and dirt roads is an effective way to manage fugitive dust. However reducing speed may lower the production capacity of mines. Studies by Watson et al., 1996 showed that reducing speed reduces the generation of particles less than 10 micro meters by about 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h). Also, it was reported that decreasing the volume of traffic on the haul roads reduces the impacts of dust entrainment.
- The magnitude of coal dust emissions from transport of ore in trucks will depend on a number of factors, such as the level of exposure of the open surface to air moving at high speeds and the inherent dustiness of the material. Hence, it is suggested that trucks loads are covered with tarps.
- The fugitive dust from haul road reduces visibility. Proper road construction is required to manage the fugitive dust from roads. During windy periods, sprinkling of the area until it is moist is ideal for haul roads and traffic routes (Smolen et al., 1988).
- Wind erosion of stockpiles and open areas is reduced when soils are left as clods which are dense thereby resisting erosion. This is done by alternate wetting and drying of the soils, thus firming the crust on dirt roads. This crust becomes stable and resists erosion. Wind barriers can be created using plants, shrubs and trees. Vegetation can be grown on the edges of the stockpile to reduce erosion, and on top once deposition has stopped. Vegetation prevents high winds from getting in contact with surfaces thereby preventing entrainment of loose particulate matter. Mulching of recently disturbed areas can reduce the amount of wind erosion by 80% (Smolen et al., 1988).

16.2 Operational Phase

- Limit drilling and blasting to non-windy days i.e. avoid unfavourable weather conditions. There is need to minimise blast area and when drilling use of water sprays and dust curtains.
- Reducing speed in haul roads is an effective way to manage fugitive dust emissions. However, reducing speed may lower the production of mines. Studies by Watson et al., 1996 showed that reducing speed reduces the generation of particles less than 10 micro meters by about 58% when speed controls are reduced from 25 mph (40 km/h) to 15 mph (24 km/h). Also, it was reported that decreasing the volume of traffic on haul roads also results in the amount of dust airborne.

- Minimize the drop height between loading and dumping of materials.
- Use of chemical dust suppressant, wind breaks and rapid vegetation of exposed areas to curtain wind erosion.

16.3 Decommissioning Phase

- Limit grading and bulldozing to non-windy days i.e. avoid unfavourable weather conditions.
- When using bulldozers, graders, there is need to minimise travel speed.
- It is recommended that the rehabilitated landscape be vegetated and it should begin during the operational phase of the mine. These measures should reduce the potential for fugitive dust generation and render the impacts negligible.
- Use of chemical dust suppressant, wind breaks and rapid vegetation of exposed areas.

NOTE:

Mitigation efficiencies for wind erosion as prescribed by the Australian NPI Emission Estimation Technique Manual for Mining Version 3.1 is reported (Table 16-1) is presented below. The table shows the level of efficiency for the different mitigation methods applied.

Table 16-1: Mitigation efficiencies for wind erosion (After Australian NPI Emission Estimation Technique)

Description	Mitigation efficiency (%)
Wind erosion from stockpiles	50% for water sprays. 30% for wind breaks. 99% for total enclosure. 30% for primary earthworks (reshaping/profiling, drainage structures installed). 30% for rock armour and/or topsoil applied.
Wind erosion	30% for primary rehabilitation 40% for vegetation established, but not demonstrated to be self-sustaining. Weed control and grazing control. 60% for secondary rehabilitation. 90% for re-vegetation. 100% for fully rehabilitated (release) vegetation.

17 Recommendations

Based on the results presented in this report, the following recommendations should be applied during the course of the mining at KPSX: Weltevreden Project:

- During dry conditions, wind erosion of exposed areas can exacerbated ambient concentrations of particulate matter – TSP, PM10 and PM2.5. It is recommended that dust monitoring in the area be revived, as records obtained will aid management decision making process in ameliorating potential impacts. Specific management practices, operational controls and mitigation measures should be implemented to minimise dust and air quality impacts anticipated from the proposed KPSX: Weltevreden project.
- It is anticipated that the dust impacts during the proposed KPSX: Weltevreden project will intensify during the operational phase, but by adopting practical mitigation measures i.e. use of water to dampen dust generating areas such as stockpile, haul roads or exposed soil, housing of crushers, screens, and conveyor belts, use of chemical dust suppressant, wind breaks and rapid vegetation and/or re-vegetation of exposed areas, impacts can be contained to within compliance.
- Good housekeeping practice to minimise the accumulation of loose dust piles.
- It is recommended that particulate monitoring of ambient PM_{10} and $PM_{2.5}$ be initiated alongside the current dust deposition measurements.
- Ensure that adopted air quality management practices are sufficient to achieve current and future air quality standards at the closest receptors for the duration of the project.
- Strict control and reporting procedures should be implemented.

17.1 Monitoring

17.1.1 Dust Monitoring Programme

It is assumed that monitoring of dust deposition rates is on-going in the vicinity of the proposed operation. It is advised that such monitoring be continue during the project life in order to establish historical repository of data needed to fully understand/address fugitive and airborne dust emissions from the proposed construction, operation and closure activities of KPSX: Weltevreden. If sources of fugitive dust are managed effectively, there will be overall reduction in exposure concentrations, associated ailments, reduced risk of damage to property, improved visibility, and fewer disturbances to existing flora and fauna habitats.

17.1.2 PM_{10} Monitoring Programme

KPSX: Weltevreden management should consider setting up PM_{10} monitoring site(s) in the area, to collect data for future assessment of ambient air quality, which will be useful should the mine come under scrutiny from regulatory agencies (proactive approach). Monitoring sites should be selected judiciously, and calibration of monitoring instruments should be conducted once a year to ensure the integrity of the measured data.

17.1.3 Gaseous Monitoring Programme

It is recommended that the management of KPSX: Weltevreden conduct monitoring of relevant gases i.e. sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and volatile organic compounds (VOCs) in the vicinity of the proposed operation at least seasonally. Other gases such as CO, CO_2 and O_3 can be included in the suite of pollutants sampled in the area.

18 Conclusion

The findings reported here are mixtures of observed and modelled data, provided the background and predicted concentration of identified pollutants likely to be emitted from the operation of the KPSX: Weltevreden Mine. The following conclusions were arrived at:

- From the dust deposition data used in this report, dust fallout rates are generally high at some sites: KPF05, Bankfontein, and Phola in the vicinity of the proposed KPSX: Weltevreden mine. Majority of the other sites were within the South African National Standard (SANS) limit for residential areas of 600 mg/m²/day, with one or two months of exceedance but no two sequential months. The predicted maximum dust deposition rate at the outside the mine boundary of 2 400 mg/m^2/day is reported. High dust deposition rates are observed along the haul road, with this source representing the major contributor.
- The predicted daily PM_{10} concentrations at the KPSX: Weltevreden Mine boundary (south western section) of 528 µg/m³ was generated. This is in exceedance of the current NAAQS of 75 µg/m³. Concentrations at the selected sensitive receptors are all within compliance. The highest predicted $PM_{2.5}$ concentration at any point on the mine boundary was 80.6 µg/m³. Although this is in exceedance of the recommended standard of 50 µg/m³, the selected sensitive receptors are all within compliance.
- The predicted highest daily $PM_{2.5}$ beyond the mine boundary is in exceedances of the current regulatory standard of 65 µg/m³. The highest annual concentration is within the standard. All the sensitive receptors selected are in compliance with the standard.

Real-time measurements of PM_{10} and $PM_{2.5}$ are not available. Also, ambient measurement of gaseous pollutants was not available for assessment. If the recommendations are implemented, holistic assessment of particulate and gaseous pollutants in the vicinity of the proposed KPSX: Weltevreden will be available for future assessment of the air quality in the area. Implementation of the above recommendation will confirm the commitment of mine management in terms of ameliorate potential impacts and ensure compliance with regulatory requirements.

19 References

Airshed Report Number.: APP/11/MW02 - November 2012

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Appendix A: CV of Air Quality Specialist

MATTHEW OJELEDE

Unit Manager: Atmospheric Sciences

Division Natural Sciences

Digby Wells Environmental

EDUCATION

BSc (Hons) Geology (University of Benin, Edo State, Nigeria)
MSc Environmental Science (WITS) with course work:

- Environmental Chemistry
- Environmental Management
- Air Quality –Physics and Chemistry of the Urban Atmosphere
- Global Environmental Change: Adaptation and Mitigation
- Geographic Information System
- Mining and the Environment

PhD Environmental Management (UJ)

COURSES

Basic Fire Fighting – Accreditation number: HW591PA0808095

UJ - CALPUFF Advanced techniques in Dispersion Modelling
October 2010

UJ – AERMOD Air Dispersion Modelling
March 2014

Computer Foundation – Advanced GIS Course
May 2011

PROFESSIONAL AFFILIATIONS

National Association for Clean Air (NACA)

South African Society for Atmospheric Sciences (SASAS)

Geo Information Society of South Africa (GISSA)

International Association of Impact Assessment South Africa (IAIAsa)

EMPLOYMENT

June 2012 – September 2012	University of Johannesburg (Researcher)
October 2012 to present	Digby Wells Environmental

EXPERIENCE

- Air dispersion modelling.
- Air quality impact assessments.
- Air quality management plans.

- Preparation of tender proposals, quotes and technical documents.
- Assisting with project management.
- Processing meteorological data.
- Compiling emissions inventories.
- Air quality information unit operational activities: development, implementation, maintenance and support.

Appendix B: Specialist Declaration of Independence

SPECIALIST DECLARATION OF INDEPENDENCE

I, ___Matthew Ojelede___________, declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the project;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- Do not have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity; and
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006.

___Matthew Ojelede__

Name of the specialist

Signature of the specialist

Digby Wells Environmental

Name of company

28/01/2015

Date