environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
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Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 718, 2009

PROJECT TITLE

Proposed 30-year Ash Disposal Facility at Kendal Power Station, Mpumalanga

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4.2 The specialist appointed in terms of the Regulations_

I, Reneé von Gruenewaldt, declare that --

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

R von Gruenewaldt

Signature of the specialist:

Airshed Planning Professionals

Name of company (if applicable):

20/05/2016

Date:

Disposal of Ash at Kendal Power Station – Site H: Air Quality Impact Assessment

Project done on behalf of **Zitholele Consulting**

Project Compiled by:
T Bird

Project Manager
R von Gruenewaldt

Report No: 13ZIT01 | **Date:** June 2016

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Report Details

Reviewed by	13ZIT01
Status	Final v3
Report Title	Disposal of Ash at Kendal Power Station – Site H: Air Quality Impact Assessment
Date	June 2016
Client	Zitholele Consulting
Prepared by	Terri Bird, PhD (Wits)
Reviewed by	R. von Gruenewaldt, (Pr. Sci. Nat.), MSc (University of Pretoria)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	Airshed is an independent consulting firm with no interest in the project other than to fulfil the contract between the client and the consultant for delivery of specialised services as stipulated in the terms of reference.
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Revision Record

Revision Number	Date	Reason for Revision
Draft	April 2015	For client review
Final	June 2016	Updated based on client feedback

Abbreviations

Airshed	Airshed Planning Professionals (Pty) Ltd
ADF	Ash disposal facility
AMS	American Meteorological Society
ASTM	American Society for Testing and Materials
DEA	Department of Environmental Affairs
HPA	Highveld Priority Area
SA	South African
SABS	South African Bureau of Standards
NAAQS	South African National Ambient Air Quality Standard(s)
NDCR(s)	South African National Dust Control Regulation(s)
TSP	Total Suspended Particulates
US-EPA	United States Environmental Protection Agency

Glossary

Air pollution[(a)]	The presence of substances in the atmosphere, particularly those that do not occur naturally
Dispersion[(a)]	The spreading of atmospheric constituents, such as air pollutants
Dust[(a)]	Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size
Instability[(a)]	A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude, the maximum perturbation amplitude always remaining larger than the initial amplitude
Mechanical mixing[(a)]	Any mixing process that utilizes the kinetic energy of relative fluid motion
Oxides of nitrogen (NO_x)	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)
Particulate matter (PM)	Total particulate matter, that is solid matter contained in the gas stream in the solid state as well as insoluble and soluble solid matter contained in entrained droplets in the gas stream
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm
Stability[(a)]	The characteristic of a system if sufficiently small disturbances have only small effects, either decreasing in amplitude or oscillating periodically; it is asymptotically stable if the effect of small disturbances vanishes for long time periods

Notes:

(a) Definition from American Meteorological Society's glossary of meteorology (AMS, 2014)

Symbols and Units

°C	degrees Celsius
CH_4	Methane
CO	Carbon monoxide
g	gram(s)
ha	hectare
kg	kilograms
km	kilometre
1 kilogram	1 000 grams
km^2	square kilometre
m	metre
m/s	metres per second
µg	microgram(s)
$\mu g/m^3$	micrograms per cubic metre
µm	micrometre
mg	milligram(s)
$mg/m^2.day$	milligrams per square metre per day
m^2	square meter
mm	millimetres
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Ozone
Pb	lead
$PM_{2.5}$	Inhalable particulate matter
PM_{10}	Thoracic particulate matter
SO_2	Sulfur dioxide
tpa	tonnes per annum
TSP	Total Suspended Particulates
1 ton	1 000 000 grams

Executive Summary

The proposed location of the Kendal 30-year ash disposal facility (ADF) is to the north of the current Kendal Power Station ADF; south of the R555 regional road. Residential areas in the region include Ogies (~10 km north-east), Delmas (~30 km south-west), Phola (~11 km north-east), and Kendal town (~3 km north). The nearest residential areas (Ogies and Kendal town, and individual residences to the north of the proposed ADF) are the most likely residential areas to be affected by the ash disposal process. To accommodate the remaining life of power station a minimum of 404.7 ha will be required if the power station life is extended to 2058. Operation of the proposed ADF will continue according to the current operations manual, which includes dust suppression by water sprays and revegetation.

Criteria pollutants of concern include particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10}) and particulate matter with an aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$). Dispersion modelling assessed the potential impact of the ADF on ambient concentration of these pollutants, as well as the potential impact on nuisance dustfall. Particulate emissions were quantified for an unmitigated scenario where the full ADF footprint (404.7 ha) was exposed to windblown emissions and no mitigation measures are applied. An operational scenario was also considered, based on the operations manual, where only 80 ha of the footprint is operational and exposed to windblown particulate emissions.

Meteorological data from the Kendal 2 monitoring station over the period January 2009 to October 2012 was used. The dominant wind direction is from the west-north-west with a frequency of occurrence approaching 12%, where easterly winds are the next most dominant (frequency of 10%).

Ash disposal activities at the proposed Kendal 30-year ADF will impact ambient air quality by exposing the public, represented by nearby communities and individual homesteads, to elevated levels of airborne particulates and the associated potential human health impacts. Findings from the dispersion modelling assessment include:

- The unmitigated scenario providing a scenario of the worst case impact of the ADF on local communities and surrounding environment. The simulated area of non-compliance for the three particulate fractions considered (PM_{10}, $PM_{2.5}$ and total suspended particulates (TSP)) cover a large proportion of the modelling domain, especially in the downwind direction (predominantly the south-east).
- Dispersion modelling of the operational scenario (only 80 ha exposed at any time) simulated a decrease in the non-compliant area. However, mitigation of particulate emissions will be critical in order to minimise the area of off-site non-compliance.

The following mitigation measures are recommended as a minimum:

- Regular wetting of exposed areas of disposal ash using water sprays to achieve at least 50% control efficiency;
- Stabilization of the exposed areas with a top-soil covering;
- Wetting of exposed top-soil for additional mitigation of particulate emissions from the top-soil layer; and,
- Revegetation of the ADF through application of a deeper top-soil layer and seeding with appropriate grass seeds (control efficiency of 80% or better).

Stringent mitigation management measures need to be implemented in order to minimise the impacts from the ADF on the surrounding communities. Given the potential of NAAQS being exceeded at sensitive receptors to the north and the east-southeast due to windblown dust from the ADF, it is recommended that a health risk assessment be conducted to understand the risks. If the risks are significant, these communities need to be relocated to outside the potential air quality impact area.

The proposed Kendal 30-year ADF is located in the Highveld Priority Area – an area of typically poor air quality. As a result of the high background particulate values, the residual impact ratings – after mitigation of emissions from the ADF – are MODERATE for all pollutants and compliance time-frames.

For compliance with the NDCR, a seven point dust bucket network is proposed at sensitive receptors surrounding the ADF. In addition PM_{10} sampling at two locations (north and east-southeast) has been recommended for compliance with NAAQS.

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1 INTRODUCTION

Kendal Power Station is a coal-fired power generation facility on which construction started in mid-1982 and the last unit came online in 1993. The power station is located in the Nkangala District of Mpumalanga, approximately 10 km south-west of the town of Ogies. Kendal Power Station disposes of boiler - and fly-ash in a dry (8 to 15% moisture content conditioning) format, which is transported by means of conveyors. The ash is distributed onto the ash disposal facility by means of a stacker at a rate of approximately 4.6 million tons per year for all six generating units.

Airshed Planning Professionals (Pty) Ltd was appointed by Zitholele Consulting to determine the potential for dust impacts on the surrounding environment and human health from the proposed operations, with specific reference to air quality.

1.1 Description of Project Activities from an Air Quality Perspective

The current ash disposal facility (ADF) is primarily surrounded by coal-mining operations, the Kendal Power Station and agricultural activities. Residential areas in the region include Ogies (~10 km north-east), Delmas (~30 km south-west), Phola (~11 km north-east), and Kendal town (~3 km north). Individual residences (i.e. farm houses) are also in the immediate vicinity of the proposed operations and are considered to be sensitive receptors with respect to air quality.

The proposed ADF will be located within 10 km of the current ADF. After a site selection process, the site designated as Site H, was identified as feasible for further investigation during the impact assessment. Site H lies to the north of the current operational ADF (Figure 1-1). The size of the ADF is planned to be 404.7 ha. Disposal of the ash at Site H will be via fixed and extendable conveyors, where the ash will be in a moisture conditioned state (8 – 10% moisture content); following the same operational processes currently undertaken. This disposal process will result in emissions of particulates and therefore the pollutants of concern with potential human health impacts are: PM_{10} (particulate matter with an aerodynamic diameter of less than 10 µm) and $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm). Total suspended particulates (TSP) will impact the environment via dustfall.

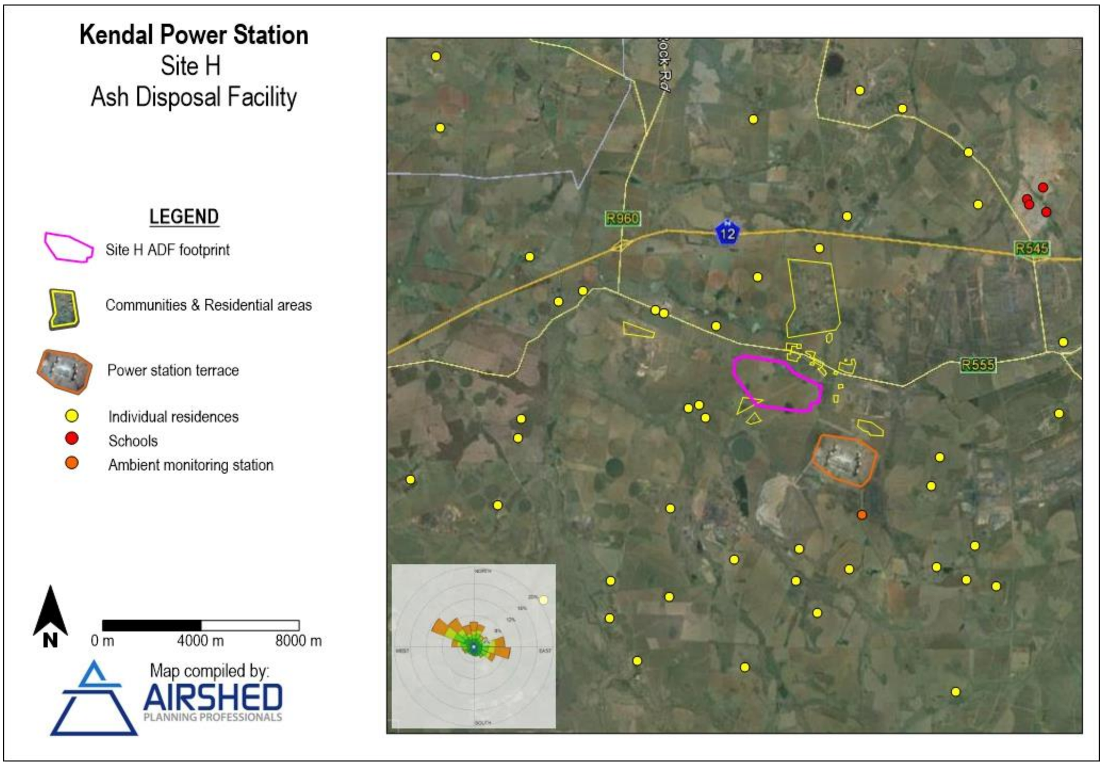

Figure 1-1: Location map of proposed Site H Kendal ADF

1.2 Approach and Methodology

1.2.1 Atmospheric Dispersion Model Selection

Dispersion models compute ambient pollutant 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 from 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.

The US Environmental Protection Agency's (US-EPA) approved regulatory model – AERMOD - was selected for this study. It is one of the models recommended for Level 2 assessments, for near-source (impacts less than 50 km from source) applications in all terrain types, in the South African Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804;11 July 2014).

The AERMOD suite of models was developed under the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of the-art science in regulatory models (Hanna, et al., 1999). The AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

- AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature however retains the single straight line trajectory limitation of ISCST3 (Hanna, et al., 1999).

- AERMET is a meteorological pre-processor for the AERMOD model. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes two files for use in the dispersion modelling simulations: a file with meteorological data representative for the surface atmosphere, and a file with data representing upper air meteorology.
- AERMAP is a terrain pre-processor designed to simplify and standardize the input of terrain data for the AERMOD model. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. For each receptor, output includes location and height scale, which are elevations used for the computation of air flow around hills.

There will always be some error in any geophysical model and total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors (including emission calculations); and the uncertainty due to stochastic processes in the atmosphere (variations in meteorology over periods shorter than model input (1 hour). Examples include turbulence and wind gusts).

The stochastic uncertainty includes all errors or uncertainties in data such as source variability (including seasonal variations of the operational area; variability in the day-to-day activity within the operational area), observed concentrations, and meteorological data. Even if the field instrument accuracy is excellent, there can still be large uncertainties due to unrepresentative placement of the instrument (or taking of a sample for analysis). Model evaluation studies suggest that the data input error term is often a major contributor to total uncertainty. Even in the best literature tracer studies, on which emission factors are based, the source emissions are known to have only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors, due to the nature of averaging sub-hourly winds to an hourly average, are the major cause of poor agreement, especially for relatively short-term predictions. In addition, if the instrument has minor installation discrepancy from true north this could result in large errors at long downwind distances. All of the above factors contribute to the inaccuracies not even associated with the mathematical models themselves.

The range of uncertainty of dispersion modelling predictions is expected to range between -50% and +200%, i.e. a “factor of two”. The factor of two accuracy is mainly as a result of poor correlations between paired concentrations at fixed stations, which may be due to ‘‘reducible’’ uncertainties in knowledge of the precise plume location and to unquantified inherent uncertainties. For example, Pasquill (1974) estimated that, apart from data input errors, maximum ground-level concentrations at a given hour for a point source in flat terrain could be in error by 50% due to these uncertainties. Uncertainty of 5 to 10 degrees in the measured wind direction, which transports the plume, can result in concentration errors of 20% to 70% for a particular time and location, depending on stability and station location. Such uncertainties do not indicate that an estimated concentration does not occur, only that the precise time and locations are in doubt. The accuracy improves with fairly strong wind speeds and during neutral atmospheric conditions.

Input data types required for the AERMOD model include: meteorological data, source data, and information on the nature of the receptor grid. Each of these data types will be described below.

1.2.2 Meteorological Data Requirements

AERMOD requires two specific input files, representing surface and upper air meteorology, generated by the AERMET pre-processor. AERMET is designed to be run as a three-stage processor and operates on three types of data: upper air data; on-site measurements; and, national meteorological databases, if available (not available for South Africa). For this assessment, on-site surface meteorological data (including wind speed, wind direction and temperature) recorded at the

Eskom-operated Kendal 2 ambient air quality monitoring station was used to generate AERMOD-ready meteorological files. The meteorological period of this assessment was between January 2009 and October 2012.

1.2.3 Source Data Requirements

The AERMOD model is able to model point, area, volume and line sources. The windblown dust from the ADF was modelled as an area source. For area sources, AERMOD requires input data relating to the location and size of the source, release height, and emission rate (in grams per second per square metre – g/s/m^2).

1.2.4 Modelling Domain

The dispersion of pollutants was modelled for an area covering 25 km by 25 km for the Project site. The modelling domain was selected on the basis of the sources of emissions and potential impact areas. This area was divided into a grid with a resolution of 100 m (north-south) by 100 m (east-west). AERMOD simulates ground-level concentrations for each of the receptor grid points.

1.3 Assumptions, Exclusions and Limitations

The following Assumptions and Limitations should be considered when interpreting the findings from the air quality assessment for the continuous ADF.

- Meteorological data was acquired from the Eskom operated monitoring station downwind of the Kendal Power Station, for January 2009 to October 2012. Due to the proximity (approximately 5 km) between the power station and its ADF. The topography of the area is relatively flat and therefore the meteorological data should be representative of the site. This meteorological data set was also used for the air quality basic assessment of the Kendal Continuous ADF (Bird & von Gruenewaldt, 2014).
- More recent ambient monitored data was not provided during assessment process. This is not considered to be a significant limitation as the operations in the area have not changed over the intervening period. The data provided is thus considered to be representative of the area.
- It is assumed that the current particle size distribution of the ash is representation of the ash that will be generated during the life-time of the proposed ADF.
- The impact assessment only considered the potential impacts from the proposed Site H ADF (although alternative locations were considered during the scoping phase of assessment). It was assumed that the current ADF and Kendal continuous ADF activities would have ceased by the time site H is operational and would be completely rehabilitated.
- It is assumed that only 80 ha will be exposed during the operational scenario. The remainder of the ADF will be revegetated or have effective mitigation measures applied.
- The dispersion model cannot compute real-time processes (including day-to-day movement of ash after deposition from the conveyor and stack and reshaping activities; or, during upset conditions when the designed disposal process is unavailable such as conveyor maintenance). The end-of-life, worst-case, area footprint for the maximum extent of the continuous ash disposal was used in the model.
- The selection of a modelling domain takes account of the expected impacts and it is possible that the impacts, when modelled, extend beyond the modelling domain. This occurred for the projected $PM_{2.5}$ concentrations exceeding the

permissible frequency of exceedance in the unmitigated scenario; however exceedance of the guideline outside of the modelling domain is not expected to cover a substantial area.

2 REGULATORY REQUIREMENTS AND ASSESSMENT CRITERIA

2.1 Ambient Air Quality Standards for Criteria Pollutants

2.1.1 National

The South African Bureau of Standards (SABS) assisted the Department of Environmental Affairs (DEA) in the development of ambient air quality standards for criteria pollutants. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), $PM_{2.5}$, PM_{10}, ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene. The standards for criteria pollutants of concern associated with the ash disposal at the proposed facility are given in Table 2-1.

Table 2-1: National Ambient Air Quality Standards (Government Gazette 32816, 2009) applicable to the Kendal Site H ADF project

Substance	Molecular Formula / Notation	Averaging Period	Concentration (µg/m³)	Permitted Frequency of Exceedance	Compliance Date
Particulate Matter	$PM_{2.5}$	24 hour	65	4	Immediate – 31 Dec 2015
			40	4	1 Jan 2016 – 31 Dec 2029
			25	4	1 Jan 2030
		1 year	25	0	Immediate – 31 Dec 2015
			20	0	1 Jan 2016 – 31 Dec 2029
			15	0	1 Jan 2030
	PM_{10}	24 hour	75	4	1 Jan 2015
		1 year	40	0	1 Jan 2015

2.2 National Dust Control Regulations

The National Dust Control Regulations (NDCR) were gazetted on 1 November 2013 (No. 36974). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas. The standard for acceptable dustfall rate is set out in Table 2-2. The method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body.

Table 2-2: Acceptable dustfall rates

Restriction Area	Dustfall Rate (D) (mg/m²/day, 30 days average)	Permitted Frequency of Exceeding Dustfall Rate
Residential area	D<600	Two in a year, not sequential months
Non-residential area	600<D<1200	Two in a year, not sequential months

3 DESCRIPTION OF THE RECEIVING/BASELINE ENVIRONMENT

3.1 Air Quality Sensitive Receptors

The NAAQS (Section 2.1.1) are based on human exposure to specific criteria pollutants and as such, possible sensitive receptors were identified where the public is likely to be unwittingly exposed. NAAQS are enforceable outside of power station and ADF boundaries and therefore a number of sensitive receptors have been identified (Figure 1-1). These sensitive receptors are small residential communities (yellow polygons in Figure 1-1); and, individual residences and farmsteads in the vicinity of the proposed ADF. The closest residences to the proposed ADF could be affected on any particular day depending on wind speed and wind direction although on an annual basis residences to the south-east of the proposed site are likely to be impacted on more days per year than other residences. The simulated ground-level concentrations of PM_{10} and $PM_{2.5}$ are compared against relevant NAAQS (Section 4.2) and dustfall rates compared with the NDCR acceptable dustfall rates, at these sensitive receptors (Section 4.3).

3.2 Summary of Meteorological Conditions

The meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere (Pasquill & Smith; 1983; Godish, 1990).The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The vertical component is defined by the stability of the atmosphere and the depth of the surface mixing layer. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (due to buildings, topography, vegetation cover, etc.). The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of cross-wind spreading (Shaw & Munn, 1971; Pasquill & Smith, 1983; Oke, 1990).

Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations and diurnal and seasonal changes in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). Atmospheric processes at macro- and meso-scales influence the atmospheric dispersion potential of a particular area. The analysis of meteorological data observed for the proposed site will form the basis for dispersion modelling of the ventilation potential of the site.

The analysis of at least one year of hourly average meteorological data for the study is required to facilitate a reasonable understanding of the ventilation potential of the site, as per the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804, vol. 589; 11 July 2014) that recommend a minimum of 1 year on-site meteorology, or three years off-site meteorology, for Level 2 assessments, such as this assessment. The most important meteorological parameters to be considered are: wind speed, wind direction, ambient temperature, atmospheric stability and mixing depth. Atmospheric stability and mixing depths are not routinely recorded and frequently need to be calculated from diagnostic approaches and prognostic equations, using as a basis routinely measured data, e.g. temperature, predicted solar radiation and wind speed.

Meteorological data for the Kendal ADF project was available from the Eskom-operated Kendal 2 ambient air quality monitoring station. Eskom provided data for the period 1 January 2009 to 31 December 2012 (Table 3-1) – a period of almost four years, a period in compliance with the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804, vol. 589; 11 July 2014). The following sections summarise the meteorological conditions at the site over this period.

Table 3-1: Data availability of meteorological parameters in the Kendal 2 data set (January 2009 to October 2012)

Year	Wind speed	Wind direction	Temperature
2009 (January to December)	96%	96%	96%
2010 (January to December)	93%	93%	93%
2011 (January to December)	87%	87%	87%
2012 (January to October)	75%	75%	75%

3.2.1 Surface Wind Field

The dominant wind direction (Figure 3-1), during the period January 2009 to October 2012, is west-north-west with a frequency of occurrence approaching 12%. Easterly sector winds are the next dominant with a frequency of 10%. Winds from the southern and south-western sectors occur relatively infrequently (<4% of the total period). Calm conditions (wind speeds <1 m/s) occur 6.66% of the time. A frequent north-westerly flow dominates day-time conditions with >12% frequency of occurrence. At night, an increase in easterly flow is observed (~11% frequency).

During summer months, winds from the east become slightly more frequent (Figure 3-2). There is an increase in the frequency of calm periods (i.e. wind speeds <1 m/s) during the autumn (6.64%) and winter months (5.85%) with an increase in the westerly flow. During spring-time, winds from the north-westerly sector dominate, frequently in the range of 5.0 to 10.0 m/s, with calm conditions only 2.18% of the time.

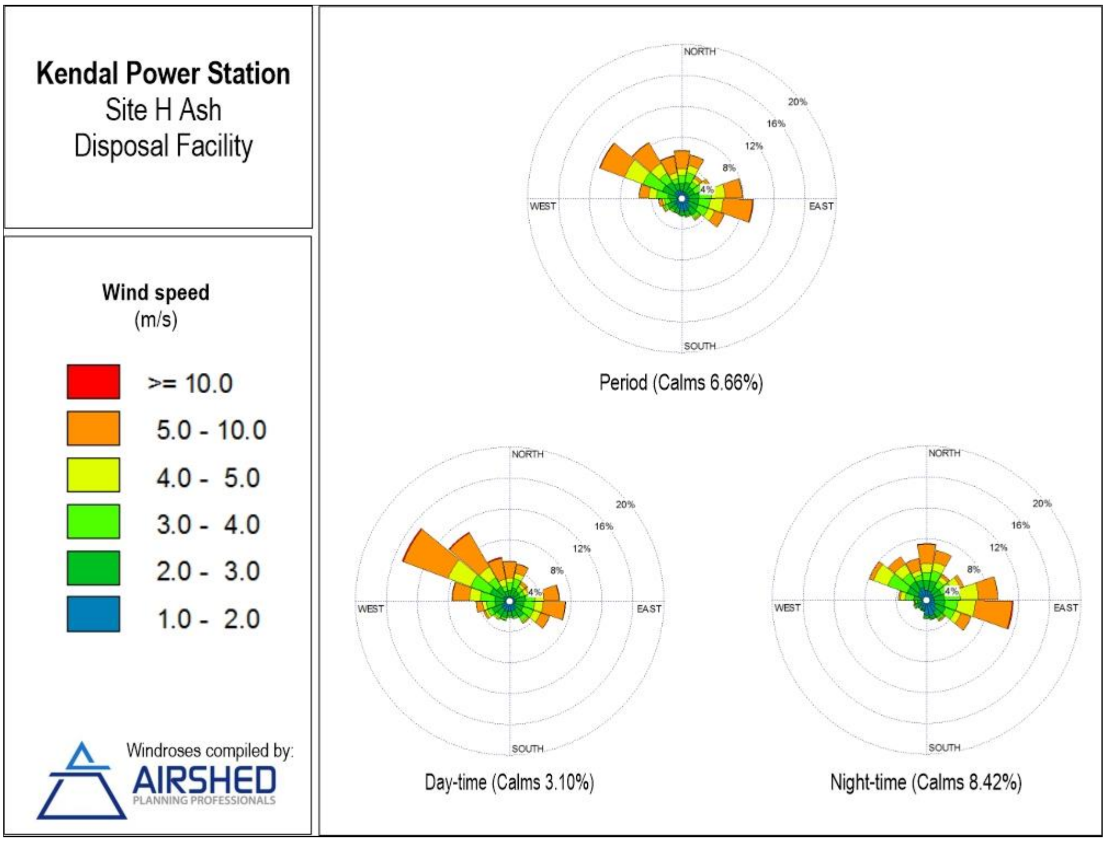

Figure 3-1: Period, day-time and night-time wind roses for Kendal monitoring station (January 2009 – October 2012)

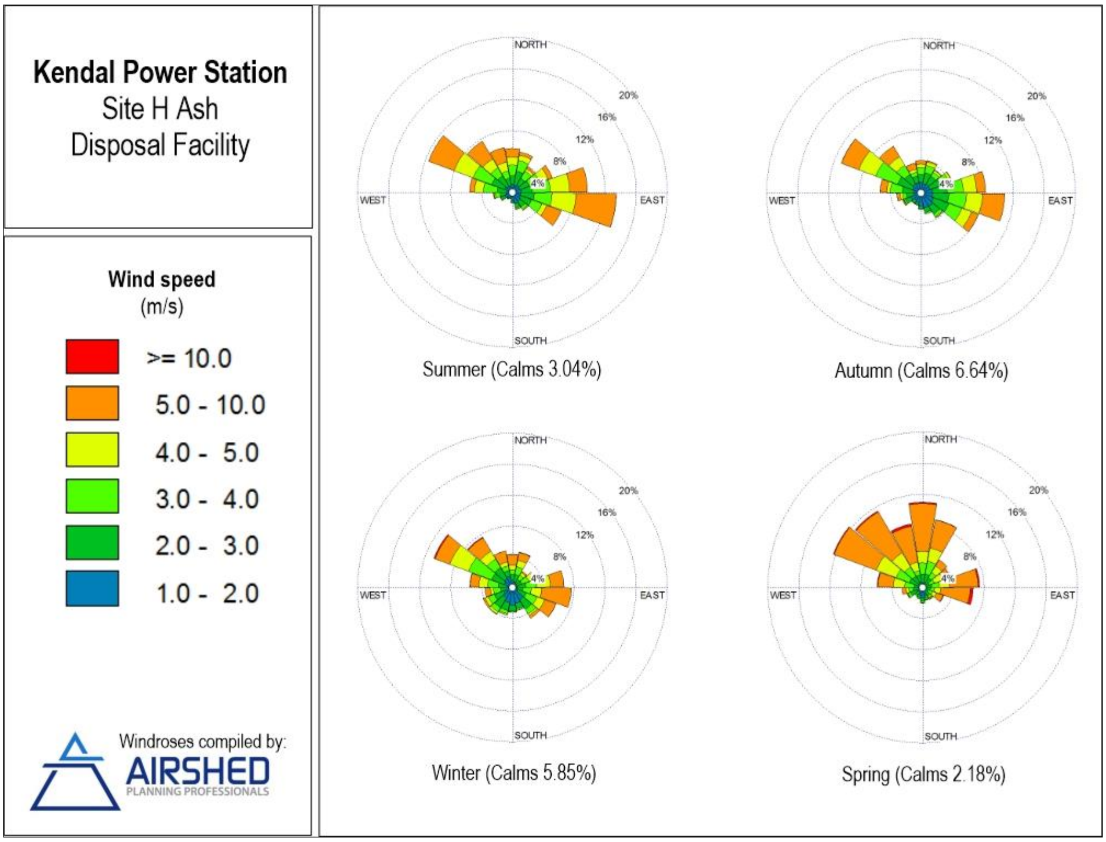

Figure 3-2: Seasonal wind roses for Kendal monitoring station (January 2009 – October 2012)

3.2.2 *Surface Temperature*

Air temperature provides an indication of the extent of insolation, and will therefore influence the rate of development and dissipation of the mixing layer, and therefore pollutant dispersion. The monthly temperature range for the area is given in Figure 3-3. Average daily maximum, minimum and mean temperatures for the site are given as 26.5°C, 9.6°C and 16.2°C, respectively, based on the measured data at Eskom's Kendal Power station for the period January 2009 - October 2012. Average daily maximum temperatures range from 31.5°C in December to 19.9°C in June, with daily minima ranging from 14.5°C in December to 2.1°C in July (Figure 3-3).

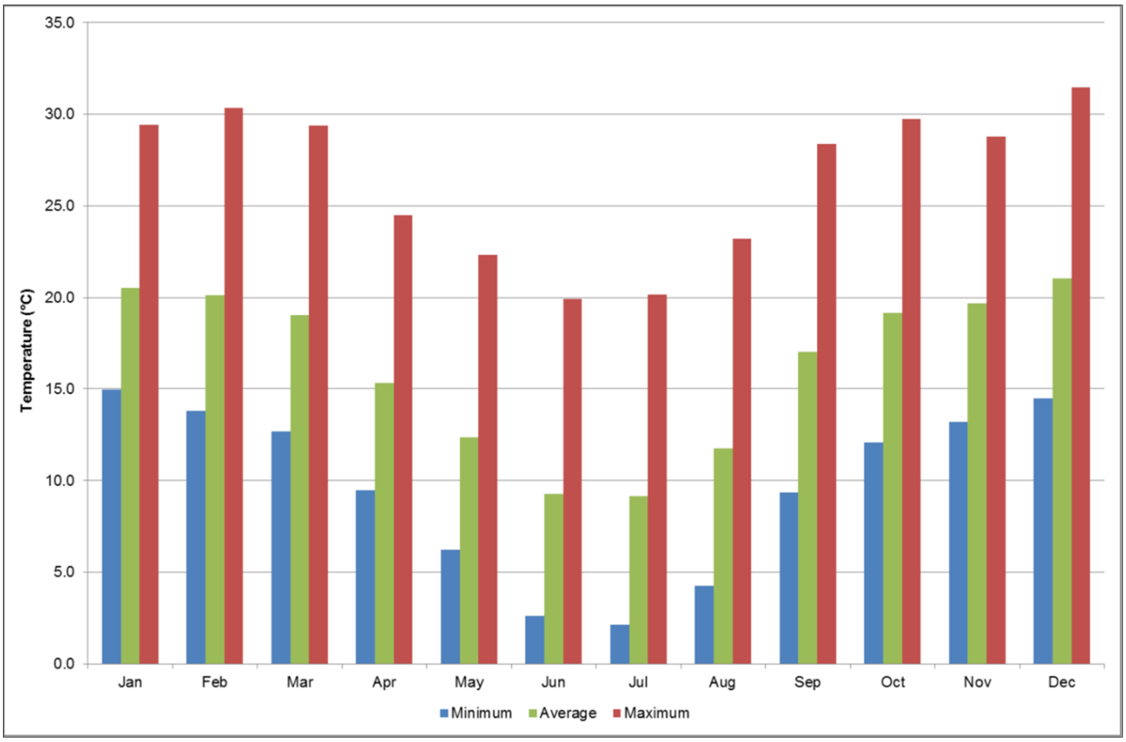

Figure 3-3: Minimum, maximum and average monthly temperatures near Kendal Power Station during the period January 2009 – October 2012

3.2.3 *Precipitation and Evaporation*

Rainfall represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies. Precipitation records for Kendal were not available; long-term precipitation records for Middleburg and Bethal are presented below in the absence of these records. Long-term total annual rainfall figures for various stations within the Emalahleni region is in the range of 730 mm to 750 mm (Table 3-2). Rain falls mainly in summer from October to April, with the peak for the region being in January.

Long-term monthly average evaporation across the Mpumalanga province is presented in Figure 3-4. The annual range varies between 1 537 and 2 335 mm. Maximum evaporation is expected in December and January, while the minimum is expected in June. Variation within months is lowest in winter months (June, July and August).

Table 3-2: Long-term mean monthly rainfall figures (mm) for various stations within the Emalahleni region.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Middelburg (1904 – 1950)	132	103	88	42	19	7	9	8	22	63	124	118	735
Bethal (1904 – 1984)	134	94	78	46	19	7	8	10	25	78	128	120	747

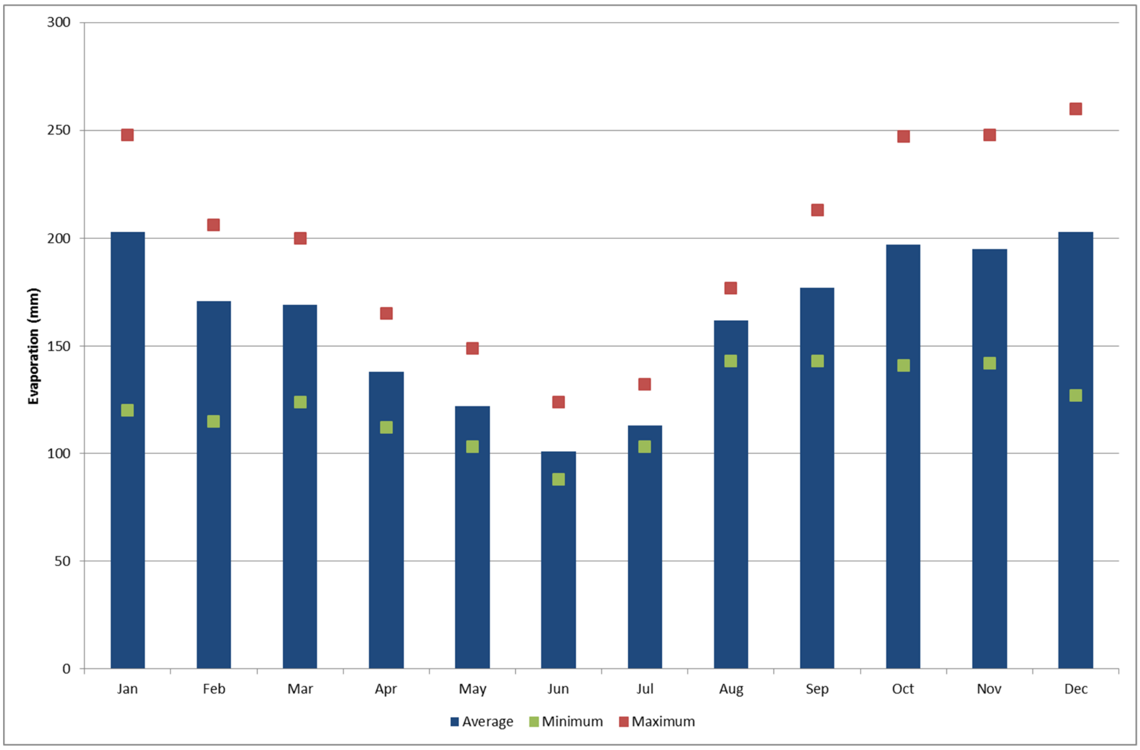

Figure 3-4: Long-term monthly average evaporation (mm) across Mpumalanga (Scultze, et al., 1997)

3.3 Status Quo Ambient Air Quality

3.3.1 Highveld Priority Area

The Highveld Airshed Priority Area (HPA) was declared the second national air quality priority area (after the Vaal Triangle Airshed Priority Area) by the Minister of Environmental Affairs at the end of 2007 (HPA, 2011). This required that an Air Quality Management Plan for the area be developed. The plan includes the establishment of emissions reduction strategies and intervention programmes based on the findings of a baseline characterisation of the area. The implication of this is that all contributing sources in the area will be assessed to determine the emission reduction targets to be achieved over the following few years.

The DEA published the management plan for the Highveld Priority Area in September 2011. Included in this management plan are seven goals, each of which has a further list of objectives that has to be met. The seven goals for the Highveld Priority area are as follows:

- **Goal 1:** By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards.

- **Goal 2:** By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dust fall-out limit values.
- **Goal 3:** By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards.
- **Goal 4:** By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy.
- **Goal 5:** By 2020, a measurable increase in awareness and knowledge of air quality exists.
- **Goal 6:** By 2020, biomass burning and agricultural emissions will be 30% less than current.
- **Goal 7:** By 2020, emissions from waste management are 40% less than current.

The Kendal ADF, current and the proposed footprint, fall within the HPA. Therefore the particulate emissions from the facility will contribute to the air quality of the HPA. The ADF is located in the vicinity of the Emalahleni Hot Spot (HPA, 2011) and the ambient air quality, with particular reference to particulates, is outlined below.

The poor ambient air quality in the Emalahleni Hot Spot is a result of emissions from power generation, metallurgical manufacturing processes, open-cast coal mining and residential fuel burning; where industrial processes dominate the source contribution (HPA, 2011). Dispersion modelling simulations, reported in the HPA Air Quality Management Plan show exceedances of the daily PM_{10} limit for more than 12 days across the Emalahleni Hot Spot (HPA, 2011). Monitored daily PM_{10} (Figure 3-5) and $PM_{2.5}$ (Figure 3-6) concentrations within the Hot Spot, at Witbank show regular exceedances of the daily limit, between 2009 and 2014. The HPA Air Quality Management Plan (HPA, 2011) reported exceedance of the annual limit, for 2008 / 2009, at one of the two monitoring stations in Witbank with an annual averages ~83 µg.m^{-3} for Witbank 2.

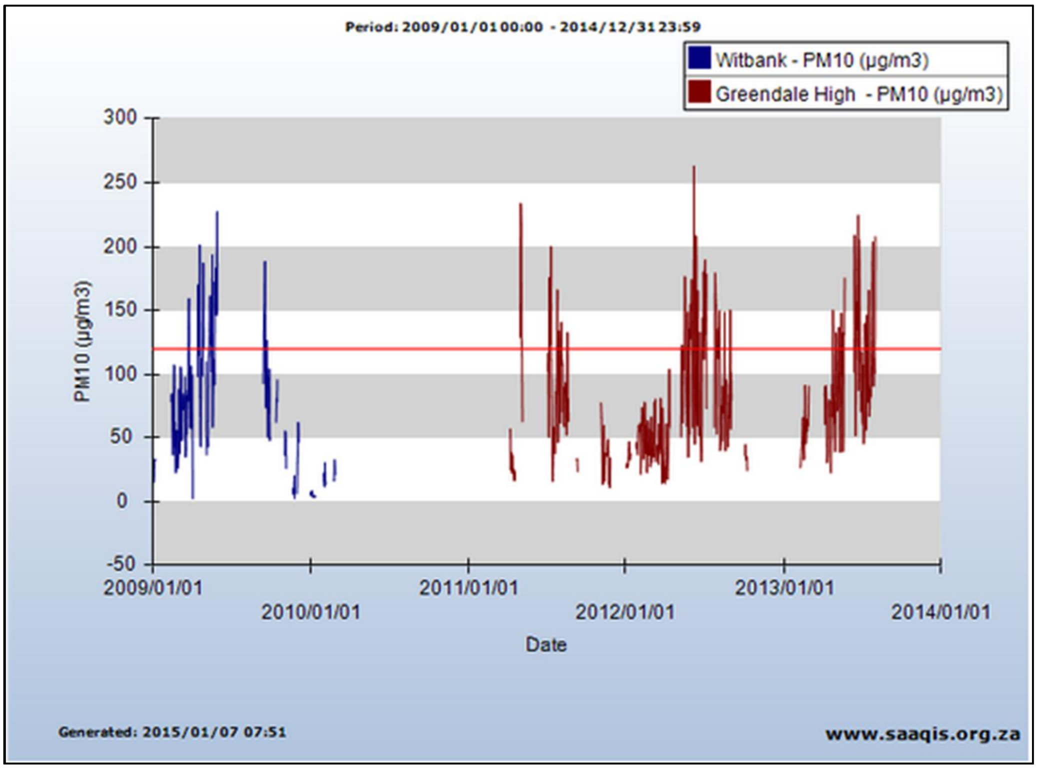

Figure 3-5: Daily PM_{10} concentrations monitored at two stations in the Emalahleni Hot Spot between 2009 and 2014 (from www.saaqis.org.za). The horizontal red line indicates the daily limit concentration applicable during the period (120 µg.m^{-3}).

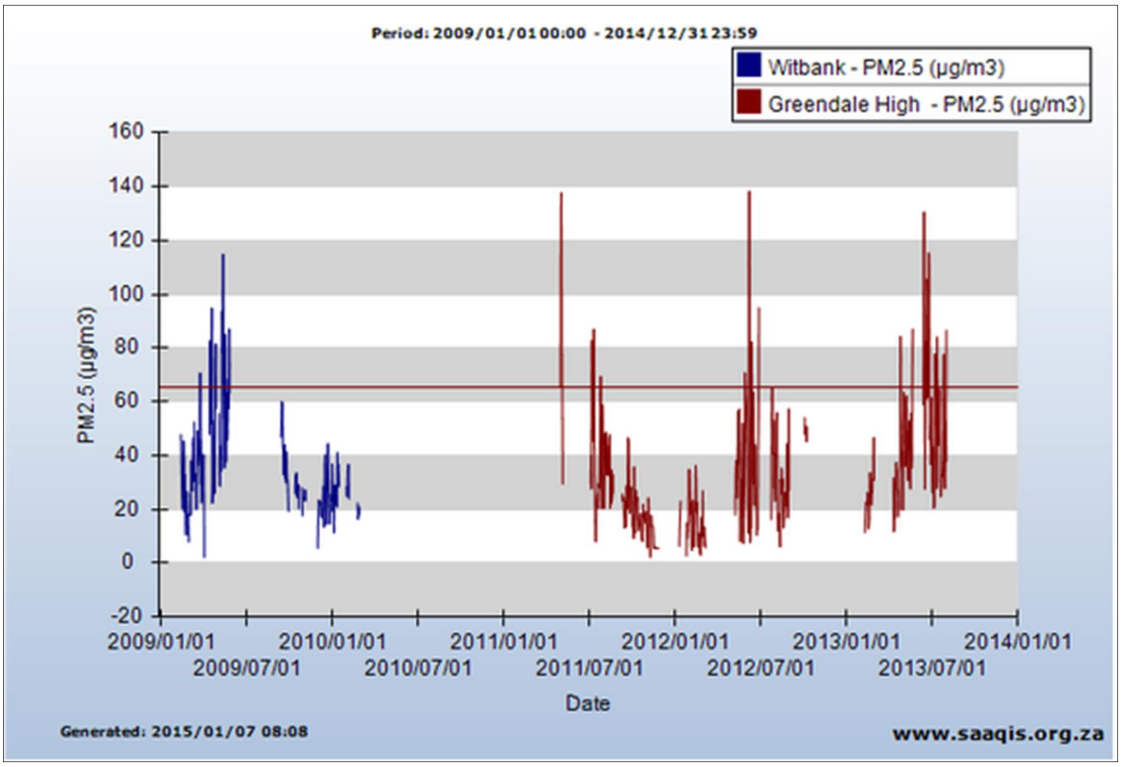

Figure 3-6: Daily $PM_{2.5}$ concentrations monitored at two stations in Emalahleni Hot Spot between 2009 and 2015 (from www.saaqis.org.za). The horizontal red line indicates the daily limit concentration applicable during the period (65 µg.m^{-3}).

3.3.2 Ambient Air Quality within the Kendal Power Station Vicinity

Eskom manages an ambient air quality station near Kendal to assess impacts on air quality from the Kendal Power Station and other pollution sources – for example mining, agriculture and domestic fuel burning - in the area. The monitoring station is located ~1.5 km south-south-east of the power station and is equipped for continuous monitoring of ambient concentrations of fine particulate matter (PM_{10}), among other pollutants. The daily average PM_{10} concentrations for the period 1 September 2012 to 31 August 2013 are presented in Figure 3-7. The NAAQS daily PM_{10} standard allows for four exceedances of the daily concentration limit (Section 2.1.1). At the Kendal 2 monitoring station, 14 daily exceedances were recorded between 1 September 2012 and 31 August 2013 when compared to the NAAQ limit concentration (120 µg/m^3). Compared with the NAAQ limit applicable in 2015 (75 µg/m^3), 99 daily exceedances were recorded in the same period. More recent PM_{10} data recorded at this station was not available. Ambient data for the period corresponding to the meteorological data was not available.

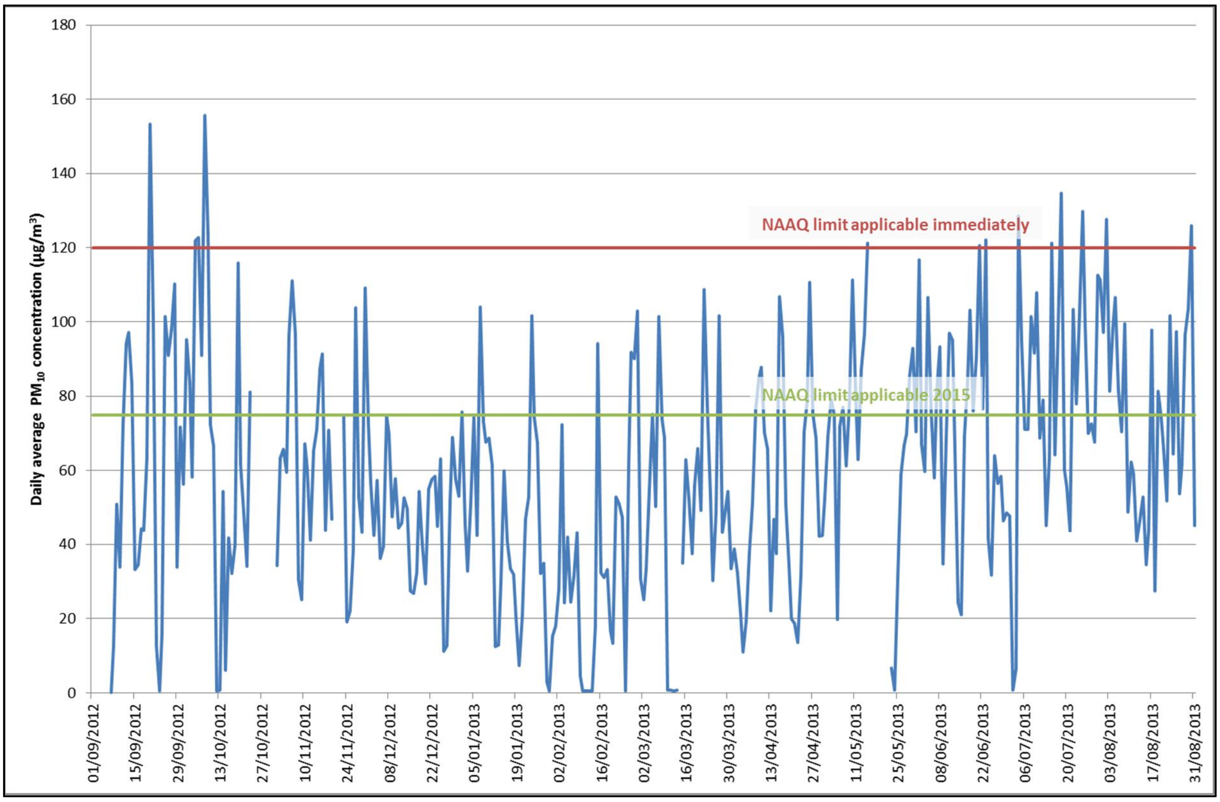

Figure 3-7: Daily average PM_{10} ground level concentrations (µg/m^3) at the Eskom Kendal 2 monitoring station (for the period September 2012 to August 2013)

4 Impact of Proposed Project on the Receiving Environment

4.1 Atmospheric Emissions

The main pollutant of concern associated with the proposed operations is particulate matter. Particulates are divided into different particle size categories with Total Suspended Particulates (TSP) associated with nuisance impacts (dustfall) and the finer fractions of PM_{10} and $PM_{2.5}$ linked with potential health impacts. PM_{10} is primarily associated with mechanically generated dust whereas $PM_{2.5}$ is associated with combustion sources. Gaseous pollutants (such as SO_2, NO_X, CO, etc.) derive from vehicle exhausts and other combustions sources. These are, however, insignificant in relation to the particulate emissions and will not be considered in detail in this assessment.

The establishment of the ADF will result in particulate emissions (Table 4-1) during the following operations:

- land preparation during establishment and progression of the ADF;
- freshly exposed topsoil, as a step in rehabilitation of the ADF, that will be prone to wind erosion before establishment of vegetation; and,
- movement of vehicles across exposed soil or ash will also be a source of pollution.

The subsequent sections provide a generic description of the parameters influencing dust generation from the various aspects identified.

Table 4-1: Activities and aspects identified for the construction, operational and closure phases of the proposed operations

<table>
<tr><th>Pollutant(s)</th><th>Aspect</th><th>Activity</th></tr>
<tr><td colspan="3">Construction</td></tr>
<tr><td rowspan="5">Particulates</td><td rowspan="4">Construction of progressing ADF site</td><td>Clearing of groundcover</td></tr>
<tr><td>Levelling of area</td></tr>
<tr><td>Wind erosion from topsoil storage piles</td></tr>
<tr><td>Tipping of topsoil to storage pile</td></tr>
<tr><td>Vehicle activity on-site</td><td>Vehicle and construction equipment activity during construction operations</td></tr>
<tr><td>Gases and particles</td><td>Vehicle and construction equipment activity</td><td>Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers</td></tr>
<tr><td colspan="3">Operational phase - Continuous ash disposal</td></tr>
<tr><td rowspan="2">Particulates</td><td>Wind erosion from ADF</td><td>Exposed dried out portions of the ADF</td></tr>
<tr><td>Vehicle activity on-site</td><td>Vehicle activity at the ADF</td></tr>
<tr><td>Gases and particles</td><td>Vehicle activity</td><td>Tailpipe emissions from vehicle activity at the ADF</td></tr>
<tr><td colspan="3">Rehabilitation</td></tr>
<tr><td rowspan="4">Particulates</td><td rowspan="2">Rehabilitation of ADF</td><td>Topsoil recovered from stockpiles</td></tr>
<tr><td>Tipping of topsoil onto ADF</td></tr>
<tr><td>Wind erosion</td><td>Exposed cleared areas and exposed topsoil during rehabilitation</td></tr>
<tr><td>Vehicle activity on unpaved roads and on-site</td><td>Truck activity at site during rehabilitation</td></tr>
<tr><td>Gases and particles</td><td>Vehicle activity</td><td>Tailpipe emissions from trucks and equipment used for rehabilitation</td></tr>
</table>

4.1.1 Construction Phase

The construction phase is relevant as the ADF is established and during continuous ash disposal, as this would normally comprise a series of different operations including land clearing, topsoil removal, road grading, material loading and hauling, stockpiling, compaction, etc. Each of these operations has a distinct duration and potential for dust generation. It is anticipated that the extent of particulate emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

It is not anticipated that the various construction activities will result in higher off-site impacts than the operational activities. The temporary nature of the construction activities, and the likelihood that these activities will be localised and for small areas at a time, will reduce the potential for significant off-site impacts. The Australian Environmental Protection Agency recommends a management zone of 300 m from the nearest sensitive receptor when materials handling activities occur (AEPA, 2007).

4.1.2 Operational Phase – Continuous ash disposal

4.1.2.1 Dispersion Modelling Scenarios

The upgrade in the operating life of the Kendal Power Station, from 40 to 60 years, requires additional capacity for ash disposal between 2030 and 2055, after the capacity of the Kendal Continuous ADF has been reached. Due to the boundary and operating equipment limits the required additional capacity requirements cannot be met at the current site. A short-term (10-year) facility adjacent to the current facility is in advanced stages of authorisation (Kendal Continuous Project); where approval has been granted for a stream diversion allowing the maximum possible short-term facility footprint. At the start of this assessment two scenarios were considered for the proposed ADF facility:

- Scenario 1 – Maximum continuous dump option
  - Stream diversion is approved by the authorities and a smaller area is required for the proposed ADF (404.7 ha)
- Scenario 2 – Minimum continuous dump option
  - Stream diversion is not approved by the authorities and a larger area is required for the proposed ADF (409 ha)

Approval for the stream diversion was granted, by the relevant authorities, during the assessment process and thus the results in this report focus on the first scenario based on the 404.7 ha ADF footprint.

The dispersion model setup included two emission scenarios for the 404.7 ha footprint.

- Unmitigated emissions
  - This is the worst case scenario where the ADF would be left completely uncovered and dust suppression is not applied. This scenario is included to illustrate the value of applying effective particulate emission controls to the ADF.
- Operational scenario
  - This scenario is based on the operational practice of an uncovered 80 ha area of ADF where active deposition occurs. The remainder of the ADF is assumed to have near zero emissions through a combination of dust suppression through wetting and revegetation.
- Mitigated operational scenario
  - This scenario is based on the operational practice of an uncovered 80 ha as above, and also assumes a system of

water sprays to reduce particulate emissions from the operational area by 50%.

The assessment only considered the potential impacts from the proposed Site H ADF. It was assumed that the current ADF and Kendal continuous ADF activities would have ceased by the time site H is operational and would be completely rehabilitated.

During the assessment process the footprint of the proposed ADF was altered to allow for a contingency period for the decommissioning of the power generating units at the Kendal Power Station. A comparison of the impact of the extended life footprint (404.7 ha) and the originally proposed 30-year footprint (383 ha) is included in Appendix A.

4.1.2.2 Emissions Quantification

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining) (Shao, 2008).

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

Estimating the amount of windblown particles to be generated from the proposed ADF is not a trivial task and requires detailed information on the particle size distribution, moisture content, silt content and bulk density (explained in Appendix B). Dust will only be generated under conditions of high wind speeds and from areas where the material is exposed and has dried out (US EPA, 1995a). An ash sample from the current Kendal Power Station ADF was obtained for analysis of the particle size distribution (Table 4-2).

Table 4-2: Particle size distribution for the ash material at the Kendal Power Station

Size (µm)	Fraction
477.01	0.0018
258.95	0.0503
103.58	0.1950
76.32	0.0895
30.53	0.2783
22.49	0.0761
10.48	0.1388
5.69	0.0708
2.65	0.0511
1.06	0.0295

An hourly emissions file was created for the ADF for each of the dispersion modelling scenarios (Section 4.1.2.1). The calculation of an emission rate for every hour of the simulation period was carried out using the ADDAS model. This software is based on the dust emission models proposed by Marticorena and Bergametti (1995) and Shao (2008). The models attempt to account for the variability in source erodibility through the parameterisation of the erosion threshold (based on the particle size distribution of the source) and the roughness length of the surface (detail provided in Appendix B). One of the primary parameters in the calculation of wind-blown particulate emissions is wind speed. Using the hourly wind speed ADDAS calculates an emission rate and prepares an hourly file for inclusion into AERMOD. Annual emissions calculated from the hourly emissions files for each scenario are presented for comparison in Table 4-3.

Table 4-3: Annual emission rates for the modelled scenarios

Scenario	Particulate fraction	Annual emissions (tpa)
Unmitigated emissions (363 ha)	TSP	48 480
	PM_{10}	19 275
	$PM_{2.5}$	5 555
Operational scenario (80 ha)	TSP	10 684
	PM_{10}	4 248
	$PM_{2.5}$	1 224
Mitigated Operational scenario (80 ha)	TSP	5 342
	PM_{10}	2 124
	$PM_{2.5}$	612

4.1.2.3 Emergency Scenario – Road Haulage of Ash to ADF

During times when the ash disposal conveyors are non-operational, ash may need to be hauled via truck from the emergency dump (E-dump) to the ADF. Emissions will primarily be as a result of dust entrainment from the unpaved ADF access roads by the haul trucks. The distance travelled is likely to be approximately 2 km. It is anticipated that the extent of particulate emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

During extended periods of ash haulage, especially when coincidental with dry windy conditions, vehicle entrainment may result in higher off-site impacts than the operational activities. It is therefore recommended that provision be made for dust suppression, by means of water, on the haul roads during periods when road haulage is necessary.

4.1.3 Rehabilitation

It is planned that rehabilitation will occur continuously throughout the disposal of ash and will include the removal and tipping of topsoil onto the completed ADF surface areas. Dust may be generated from the dried out exposed ash surfaces before it is covered with topsoil. Operationally topsoil is likely to have grass seeds included prior to spreading over the ash surface. Water sprays will both encourage grass seed germination and suppress dust emissions. After vegetation is established the potential for dust generation will reduce significantly. The tipping of topsoil and vehicle entrainment on associated unpaved roads will also result in dust generation.

It is assumed that all ash disposal activities will have ceased during closure phase, when the power station has reached end of life. Because most of the rehabilitation is undertaken during the operations, the ADF should be almost completely rehabilitated by the closure phase. The potential for impacts after closure will depend on the extent of continuous rehabilitation efforts on the ADF.

The significance of the rehabilitation activities is likely to be linked to impacts from windblown dust from the exposed dried out ash, topsoil and vehicle entrainment during the rehabilitation process. Windblown dust is likely to only impact off-site under conditions of high wind speed with no mitigation in place. If rehabilitation takes place as planned, i.e. dust suppression, vegetation cover, the impacts should be limited to be within the site boundary. As vegetation cover increases, the potential for wind erosion will decrease.

4.2 Screening of Simulated Human Health Impacts

The simulated pollutant concentrations were compared to the NAAQS for the applicable averaging periods. The closest residences to the proposed ADF could be affected on any particular day depending on wind speed and wind direction although on an annual basis residences to the south-east of the proposed site are likely to be impacted on more days per year than other residences due to the prevailing wind.

4.2.1 Unmitigated Emission Scenario - Impact on PM_{10} and $PM_{2.5}$

Dispersion modelling was undertaken to simulate second highest daily and annual average ground-level concentrations for PM_{10} as a result of particulate emissions from the Kendal Site H ADF. These averaging periods were selected to facilitate the comparison of predicted pollutant concentrations with the NAAQS. This is in accordance with the Regulations Regarding Air Dispersion Modelling (Government Gazette No. 37804, vol. 589; 11 July 2014) which recommends the use of the 99th percentile concentrations for short-term assessment with NAAQS. The highest simulated concentrations are considered to be outliers as a result of complex variability of meteorological processes that may cause exceptionally high concentrations. All simulated averages are based on simulations across the full meteorological period (almost 4 years). It should be noted that the ground-level concentration isopleths depicted in the figures present interpolated values from the concentrations predicted by AERMOD for each of the receptor grid points specified. Filled areas in the isopleth plots indicate simulated areas of non-compliance with the relevant daily and annual NAAQS.

Unmitigated emissions from the ADF were simulated to result in non-compliance with the daily PM_{10} NAAQS, by exceeding the daily limit concentration on more than 4 occasions per year, over a large portion of the modelling domain, especially the area to the south-east of the proposed location, affecting all the local communities and many individual homesteads (Figure 4-1 presents the highest number of days exceeded per grid intercept point across the meteorological period). Exceedance of the annual PM_{10} NAAQS was simulated for a more localised area; affecting the power station terrace, existing ADF and communities situated along the R555 regional road.

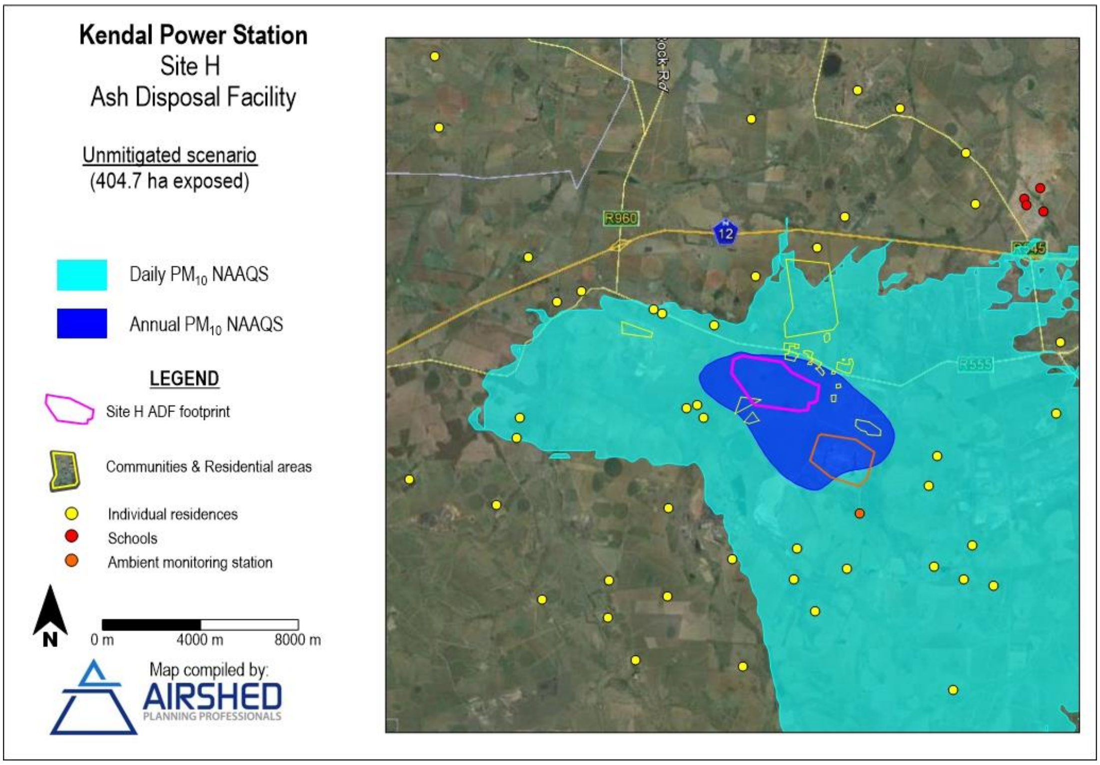

Figure 4-1: Simulated PM_{10} concentrations as a result of the ash disposal at Kendal Power Station – unmitigated emissions scenario, indicating areas of non-compliance with the daily and annual NAAQS

The NAAQS applicable to ambient $PM_{2.5}$ concentrations indicate a phased approach to improving ambient air quality. The more lenient NAAQS are applicable between 1 January 2016 and 31 December 2029 (daily average limit concentration of 40 µg/m^3 where four exceedances of the limit are allowed; and, annual average concentration below 20 µg/m^3 ensures compliance); after which the more stringent (daily average limit concentration of 25 µg/m^3 where four exceedances are allowed; and, an annual average concentration below 15 µg/m^3 ensures compliance) NAAQS apply. Because the operational lifetime of the ADF will span both NAAQS period, the simulated $PM_{2.5}$ concentrations as a result of the unmitigated emissions scenario have been plotted against both standards.

As for PM_{10}, simulated $PM_{2.5}$ concentrations, as a result of the unmitigated scenario, exceed the NAAQS predominantly in the south-east of the source (Figure 4-2). Simulated annual average $PM_{2.5}$ concentrations are non-complaint with the 2016 – 2029 NAAQS (i.e. annual average concentrations are greater than 20 µg/m^3) up to 2.0 km from the source (Figure 4-2). Under the more stringent NAAQS applicable after 2030, unmitigated emissions from the ADF were simulated to result in impacts over a larger area, where annual average $PM_{2.5}$ concentrations are non-compliant with the NAAQS (i.e. annual average concentrations are greater than 15 µg/m^3) up to 2.5 km to the south-east of the source.

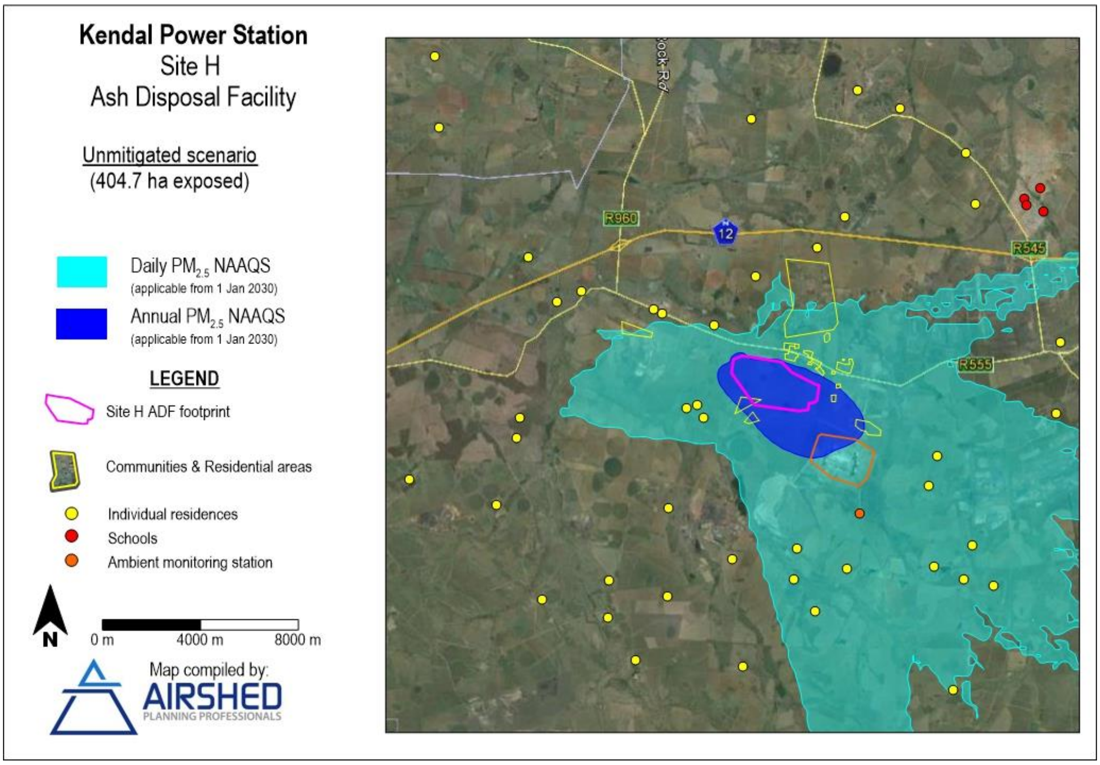

Figure 4-2: Simulated PM2.5 concentrations as a result of the ash disposal at Kendal Power Station – unmitigated emissions scenario, indicating areas of non-compliance with the daily and annual NAAQS applicable between 1 January 2016 and 31 December 2029

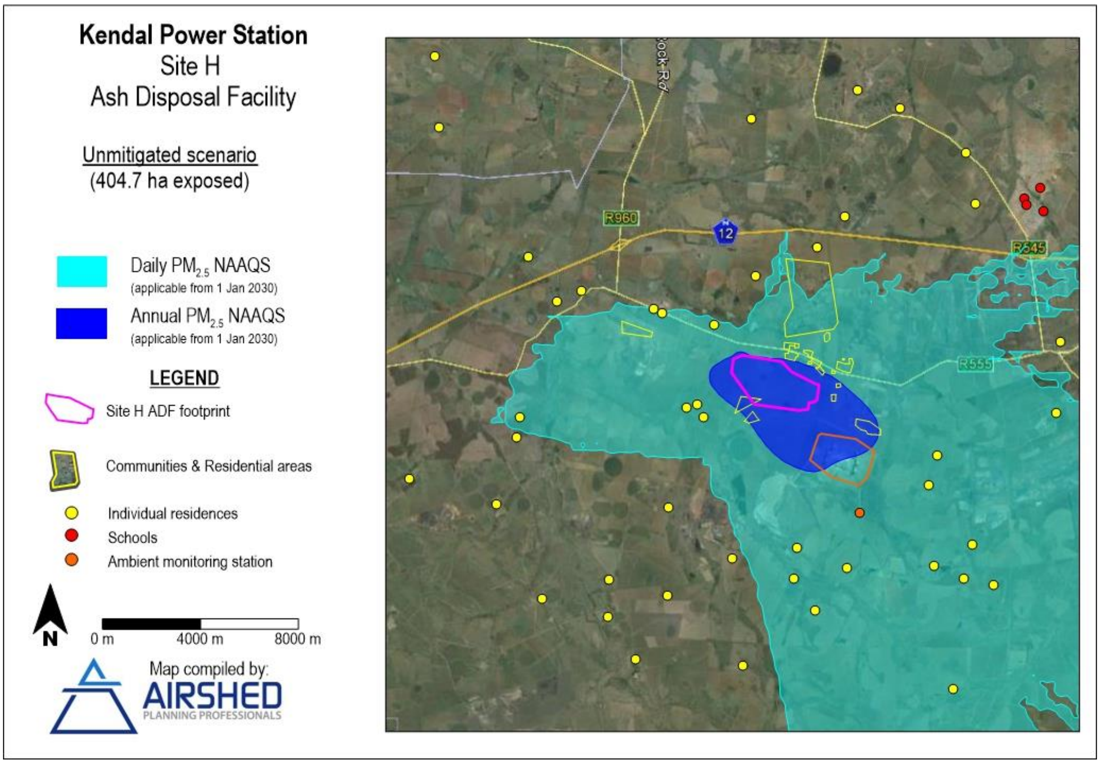

Figure 4-3: Simulated PM2.5 concentrations as a result of the ash disposal at Kendal Power Station – unmitigated emissions scenario, indicating areas of non-compliance with the daily and annual NAAQS applicable from 1 January 2030

4.2.2 *Operational Scenario - Impact on PM_{10} and $PM_{2.5}$*

The proposed Kendal Site H ADF is planned to continue the disposal of ash from the Kendal Power Station as per the current disposal approach, where an 80 ha area is the active operational area. Dispersion modelling included the assessment of impacts as a result of emissions from a theoretical 80 ha operational area, within the full footprint of the ADF.

As a result of the smaller active area, and assuming that emissions from the remainder of the ADF are controlled via water sprays and revegetation, the area where simulated PM_{10} concentrations exceed the daily and annual NAAQS is smaller than under the unmitigated emissions scenario (Figure 4-4). Residential areas near the ADF, power station and along the R555 regional road will have more than four days where the PM_{10} concentrations exceed the daily limit. However, simulated annual average PM_{10} concentrations are compliant with the NAAQS across most of the modelling domain.

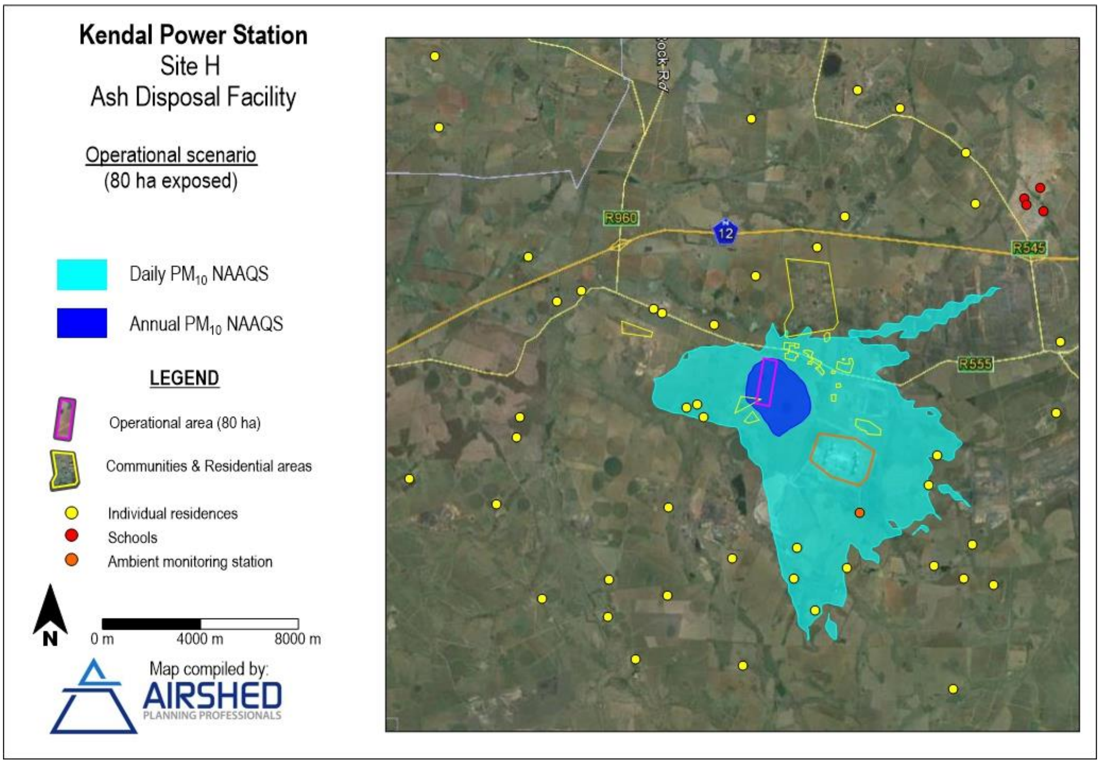

Figure 4-4: Simulated PM_{10} concentrations as a result of the ash disposal at Kendal Power Station – unmitigated operational scenario, indicating areas of non-compliance with the daily and annual NAAQS

Similarly, simulated daily and annual $PM_{2.5}$ concentrations as a result of the operational scenario results in a smaller area non-compliant with the NAAQS (Figure 4-5) compared with the unmitigated emissions scenario (Figure 3-1). Under the most stringent NAAQS (applicable from 2030) the simulated non-compliant area affects receptors up to 8.0 km to the south of the facility (Figure 4-6).

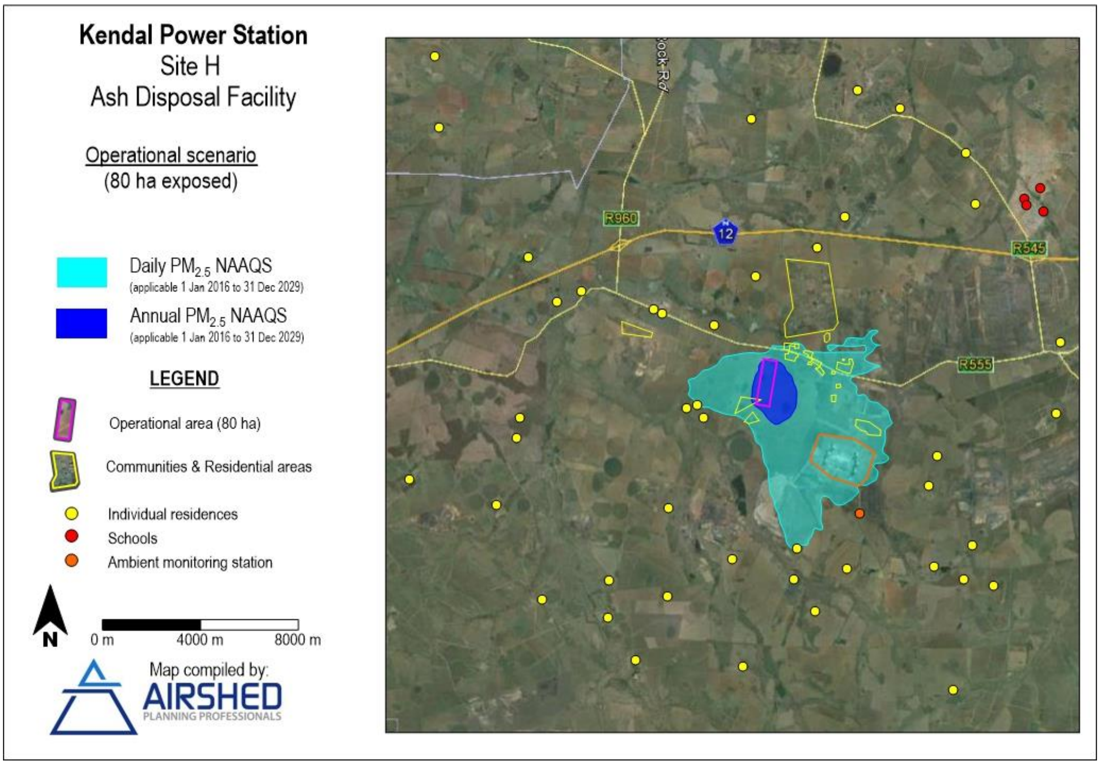

Figure 4-5: Simulated $PM_{2.5}$ concentrations as a result of the ash disposal at Kendal Power Station – unmitigated operational scenario, indicating areas of non-compliance with the daily and annual NAAQS applicable between 1 January 2016 and 31 December 2029

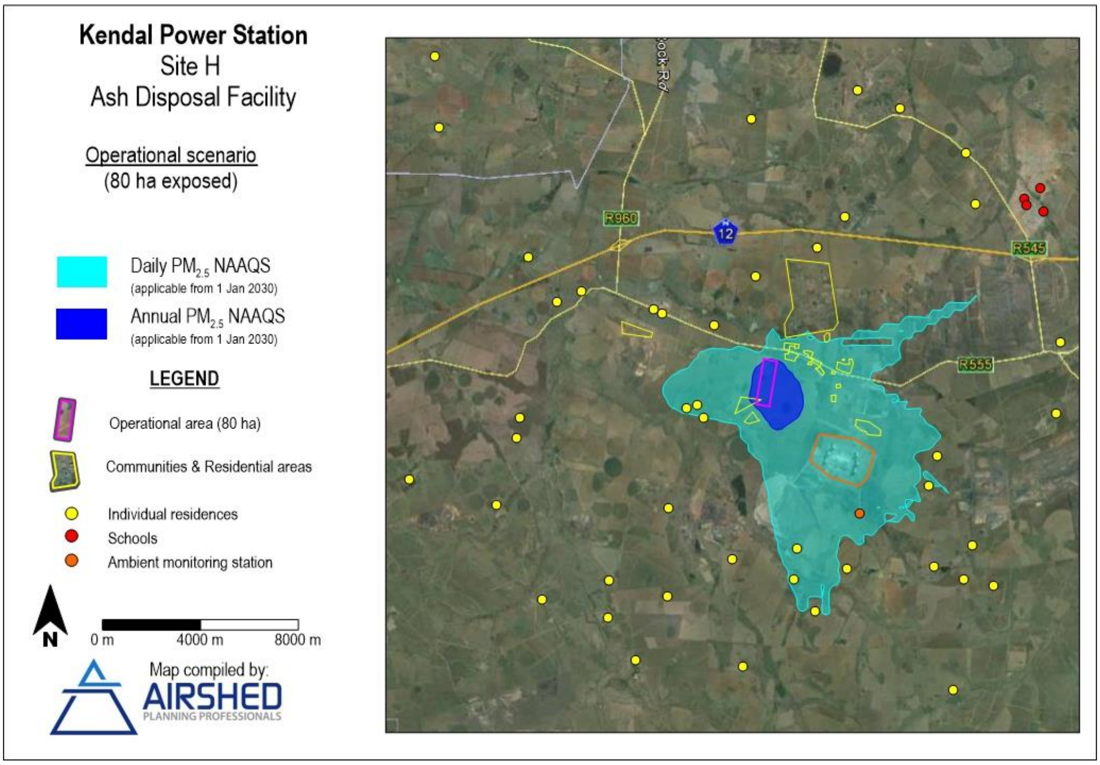

Figure 4-6: Simulated PM2.5 concentrations as a result of the ash disposal at Kendal Power Station – unmitigated operational scenario, indicating areas of non-compliance with the daily and annual NAAQS applicable from 1 January 2030

The impact of particulate emissions from the ADF on ambient concentrations will be dependent on the specific location of the 80 ha operational area. During dispersion modelling the operational area was located in the middle of the final footprint across the full width (north-south orientation). In practice, this area will migrate across the final footprint area as disposal of ash occurs. The simulated impact distance (where impact is considered non-compliance with the relevant standard) from the theoretical 80 ha operational area was approximated, using mapping software, in the four cardinal directions (north, east, south, and west) and in the predominant impact directions (Table 4-4). These distances were used to generate isopleth plots in order to assess the potential off-site impact of the operational scenario irrespective of the location of the 80 ha area within the full design ADF footprint (Figure 4-7 to Figure 4-9).

Table 4-4: Simulated particulate impact distance from operational area in four cardinal directions and predominant wind direction(s)

Particulate fraction	Standard	Approximated impact distance (m)					
		North	East	South	West	Predominant direction (degrees from north)	
PM_{10}	NAAQS Annual	160	1 100	735	525	1 700 (110°)	1 175 (175°)
	NAAQS Daily	1 550	4 500	4 130	3 875	7 500 (135°)	8 750 (175°)
$PM_{2.5}$	2016 NAAQS Annual	135	700	470	250	1 100 (120°)	600 (175°)
	2016 NAAQS Daily	600	3 215	3 125	2 625	5 000 (135°)	5 500 (175°)
	2030 NAAQS Annual	155	950	625	375	1 320 (120°)	850 (175°)
	2030 NAAQS Daily	1 100	4 000	4 000	3 750	7 250 (135°)	8 000 (175°)

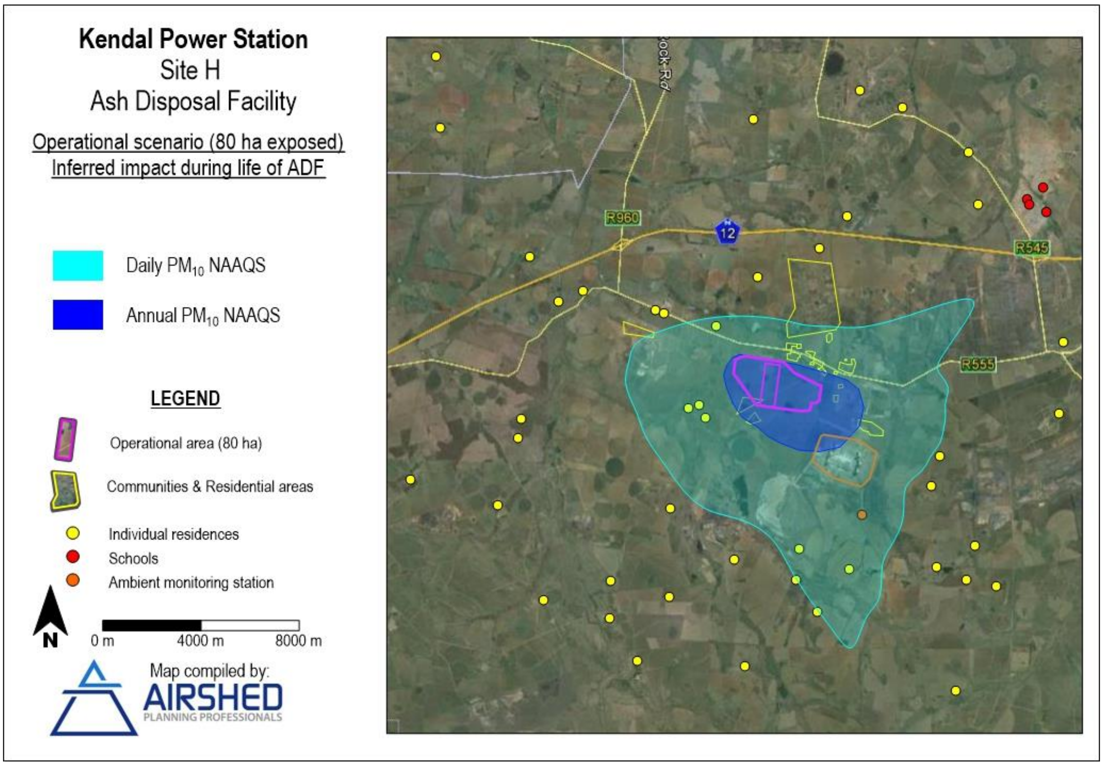

Figure 4-7: Inferred impact on PM_{10} concentrations as a result of the ash disposal at Kendal Power Station – operational scenario, irrespective of location of operational area

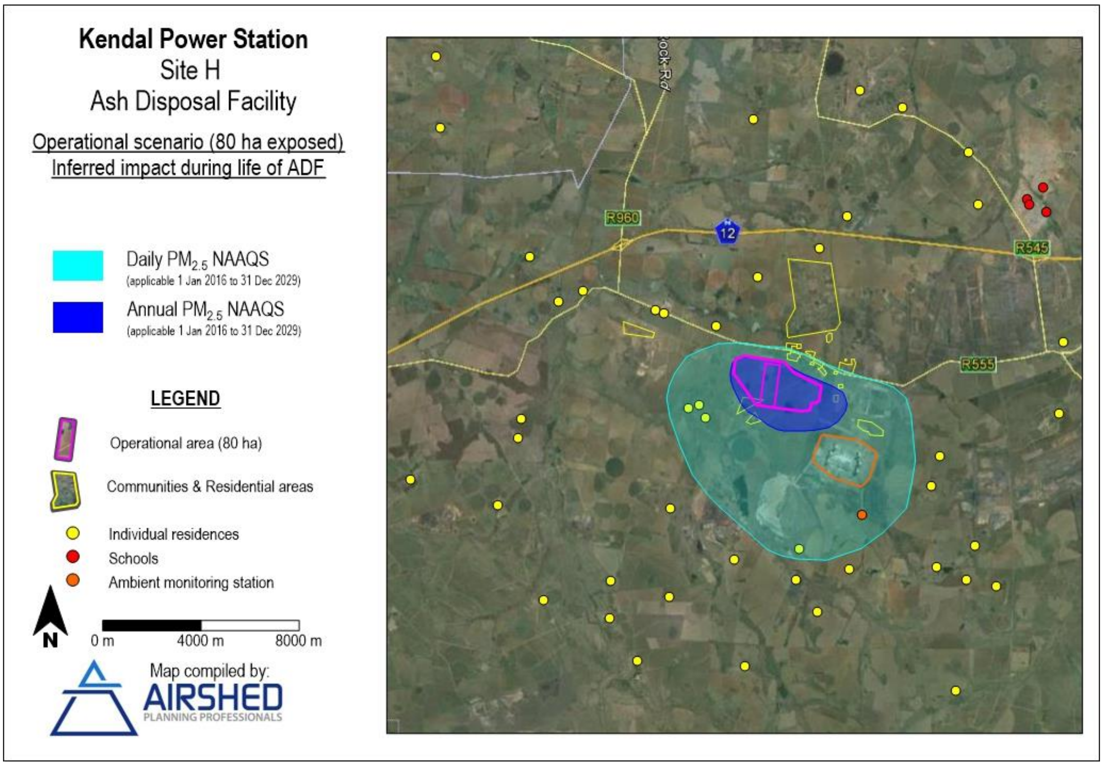

Figure 4-8: Inferred impact on $PM_{2.5}$ concentrations as a result of the ash disposal at Kendal Power Station – operational scenario, irrespective of location of operational area (NAAQS applicable between 1 January 2016 and 31 December 2029)

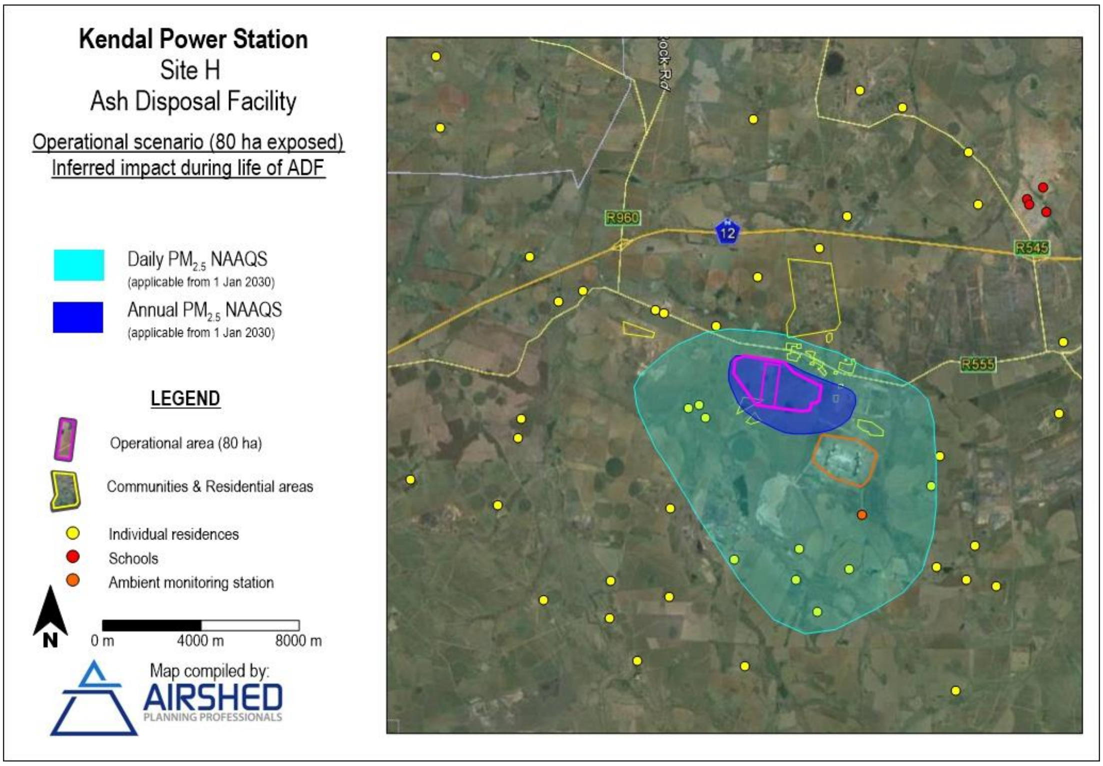

Figure 4-9: Inferred impact on $PM_{2.5}$ concentrations as a result of the ash disposal at Kendal Power Station – operational scenario, irrespective of location of operational area (NAAQS applicable from 1 January 2030)

4.2.3 Mitigated Scenario

A mitigated scenario was simulated where the use of water-sprays on the operational area would reduce the emissions and impact from the ADF by 50%. This is the control efficiency of water sprays expected on mining stockpiles (NPI, 2012). Effective use of watering to maintain the moisture content of the ash at 5% could, however, increase the control efficiency up to 74% as noted in the Kusile Ash Disposal Facility impact assessment (Bird, et al., 2014).

As a result of the control of emissions by water sprays, the area where simulated PM_{10} concentrations exceed the daily and annual NAAQS is smaller than the uncontrolled scenarios (Figure 4-10). Simulated annual average PM_{10} concentrations are compliant with the NAAQS across the domain, except for a small area to the south of the proposed ADF.

Simulated daily and annual $PM_{2.5}$ concentrations as a result of the mitigated operational scenario results in an even smaller area non-compliant with the NAAQS (Figure 4-11) compared with the uncontrolled scenarios (Figure 4-2 and Figure 4-5). Under the most stringent NAAQS (applicable from 2030) the simulated non-compliant area affects receptors up to 5.0 km to the south of the facility (Figure 4-12).

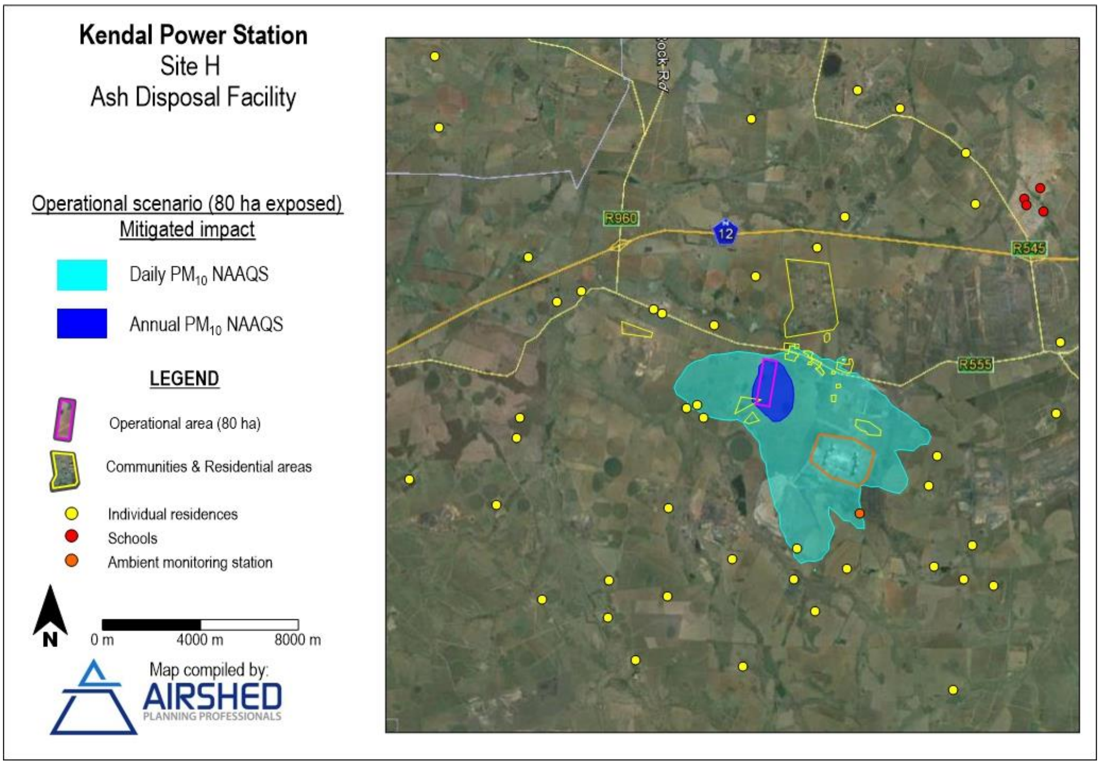

Figure 4-10: Simulated PM_{10} concentrations as a result of the ash disposal at Kendal Power Station – mitigated operational scenario, indicating areas of non-compliance with the daily and annual NAAQS

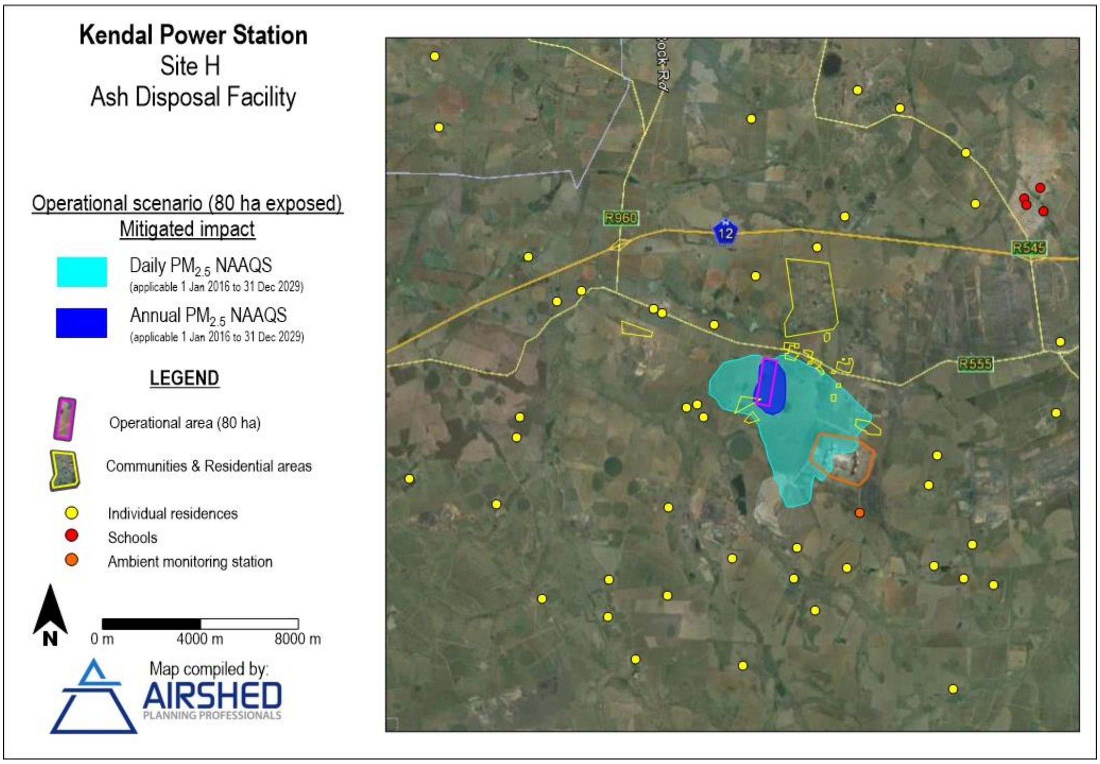

Figure 4-11: Simulated $PM_{2.5}$ concentrations as a result of the ash disposal at Kendal Power Station – mitigated operational scenario, indicating areas of non-compliance with the daily and annual NAAQS applicable between 1 January 2016 and 31 December 2029

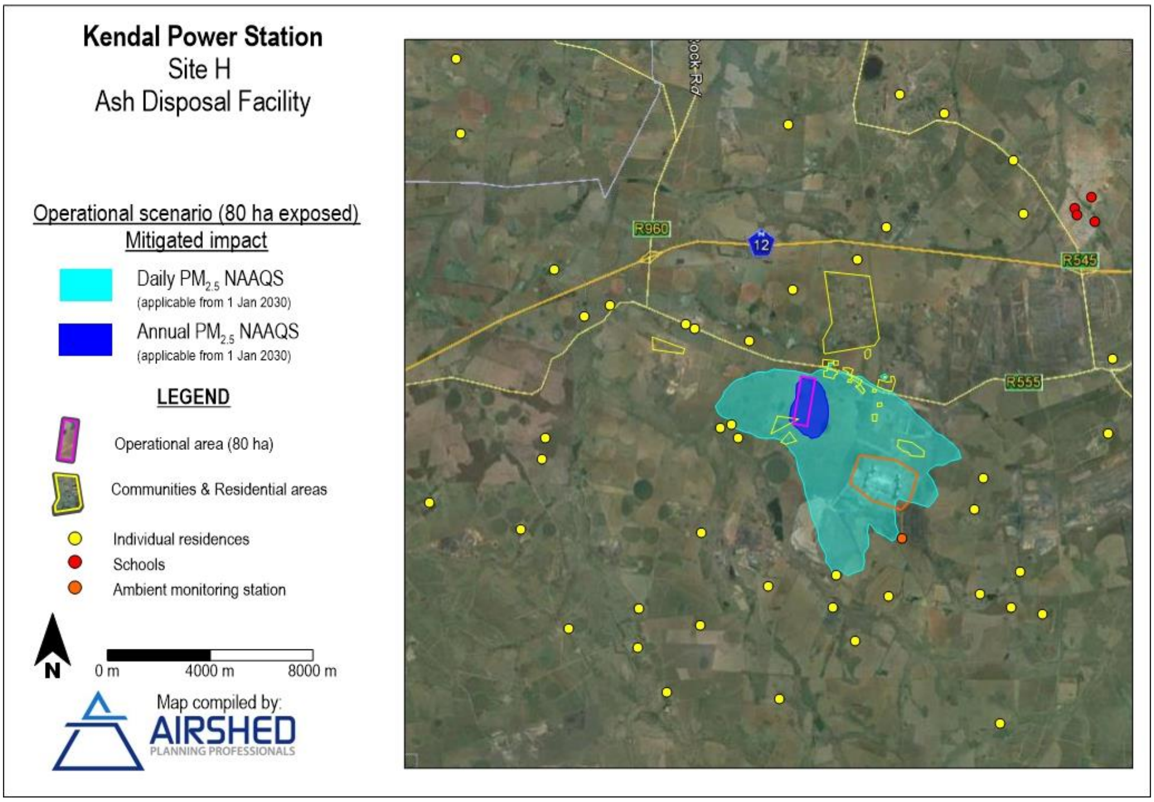

Figure 4-12: Simulated $PM_{2.5}$ concentrations as a result of the ash disposal at Kendal Power Station – mitigated operational scenario, indicating areas of non-compliance with the daily and annual NAAQS applicable from 1 January 2030

4.3 Analysis of Emissions' Impact on the Environment (Dustfall)

4.3.1 Unmitigated Emissions Scenario - Simulated Dustfall Rate

Dispersion modelling was used to simulate dustfall rates as a result of particulate emissions from the Kendal Site H ADF where no mitigation was applied to the full ADF footprint. An isopleth plot was generated from the results indicating the area of non-compliance with the NDCR acceptable dustfall rate for residential areas (Figure 4-13). Simulated dustfall rates under the unmitigated scenario show exceedances of the acceptable dustfall rate for residential areas (600 mg/m²/day) up to 3.4 km from the eastern boundary of the ADF footprint, affecting communities to the east and south-west.

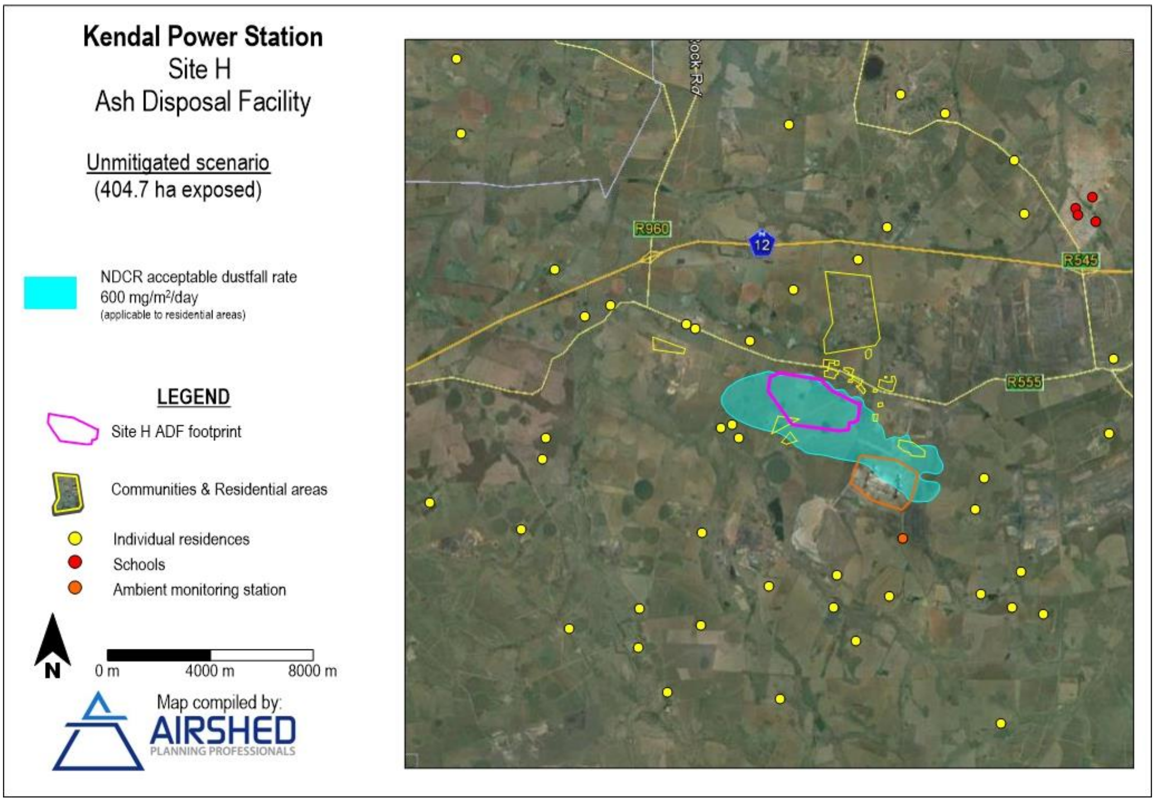

Figure 4-13: Simulated dustfall rates as a result of the ash disposal at Kendal Power Station – unmitigated emissions scenario, indicating areas of non-compliance with the NDCR residential standard

4.3.2 Operational Scenario - Simulated Dustfall Rate

The influence of an operational scenario, where an operational area of 80 ha is open to entrainment and dispersal, on dustfall rates was also considered in the dispersion modelling. Simulated dustfall rates show that non-compliance with the NDCR is more localised to the west and south-western boundary of the operational area (Figure 4-14). As for the finer particulates (PM_{10} and $PM_{2.5}$) the location of this operational area was theoretical and thus the impact is indicative of the specific location. A generalised impact area was compiled based on the distances of non-compliance from the edges of the theoretical operational area in the four cardinal directions and predominant wind directions (Table 4-5). These distances were used to generate a generalised isopleth plot in order to assess the potential off-site impact of the operational scenario irrespective of the location of the 80 ha area within the full design ADF footprint (Figure 4-15). Communities to the south-west of the ADF are likely to be the most affected by the operational activities of ash disposal. Mitigated emissions through the effective use of water-sprays are likely to reduce impacts to near site (~200 m or less) (Figure 4-16).

Table 4-5: Simulated dustfall rate impact distance from operational area in four cardinal directions and predominant wind direction(s)

Particulate fraction	Standard	Approximated simulated impact distance (m)					
		North	East	South	West	Predominant direction (degrees from north)	
TSP	NDCR	200	250	330	655	380 (170°)	160 (202°)

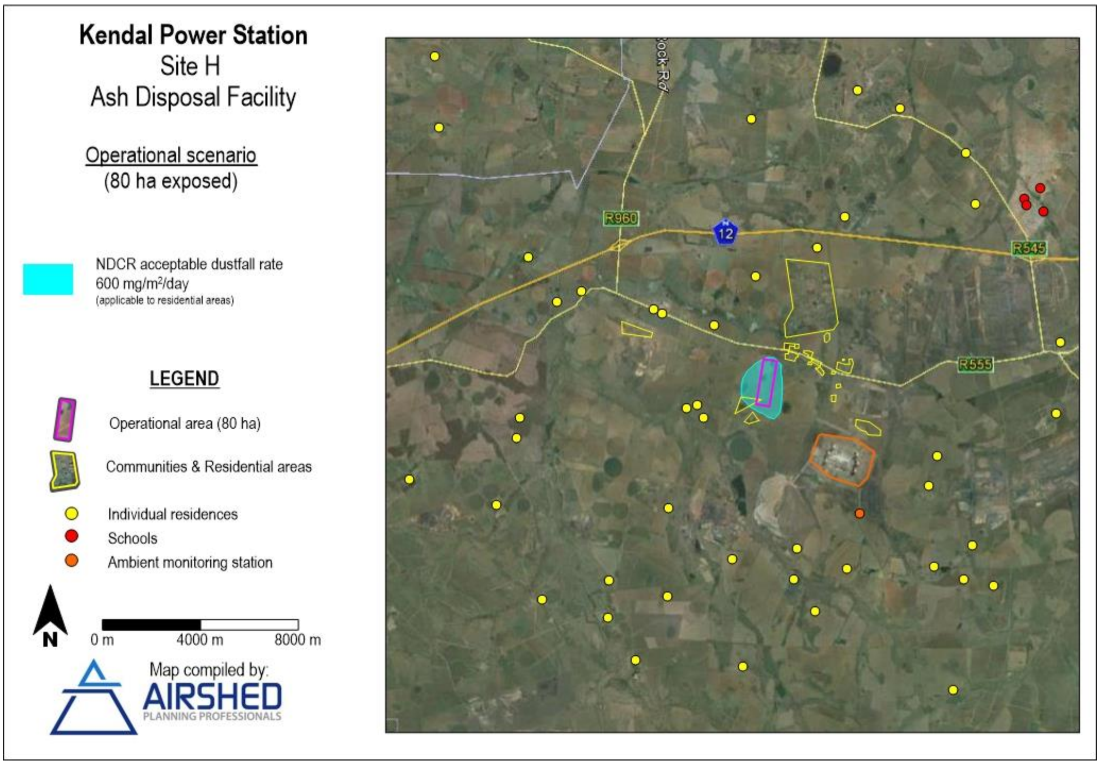

Figure 4-14: Simulated dustfall rates as a result of the ash disposal at Kendal Power Station – unmitigated operational scenario, indicating areas of non-compliance with the NDCR residential standard

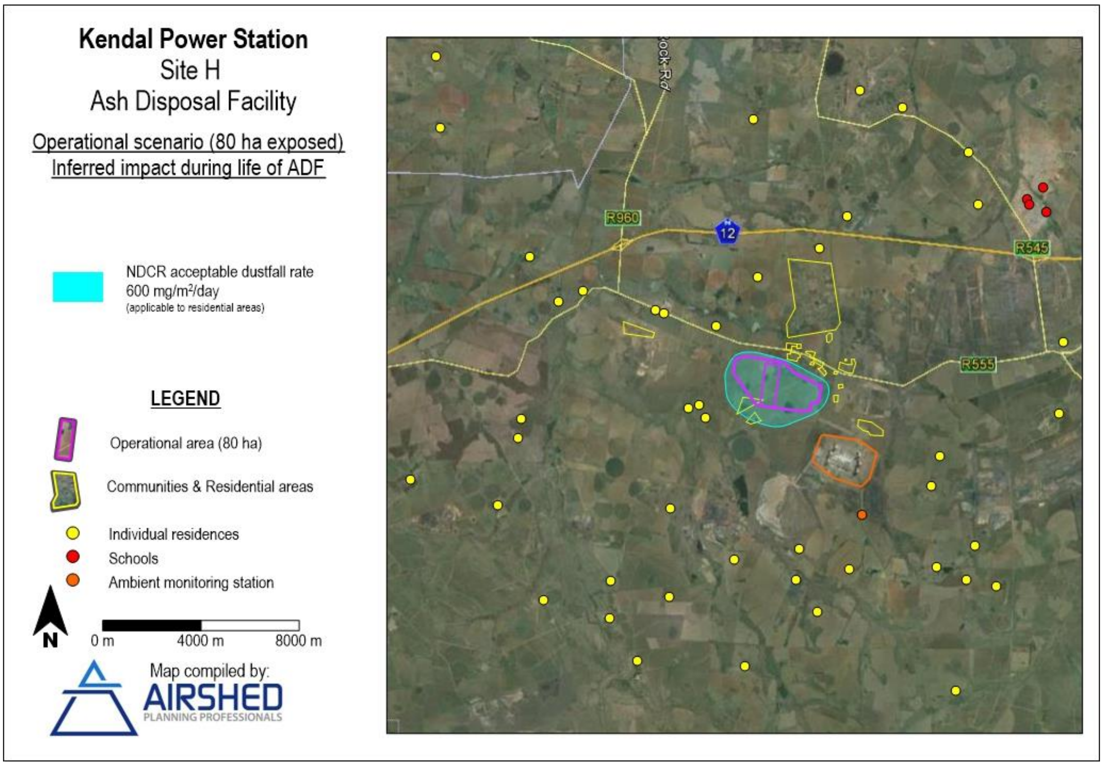

Figure 4-15: Generalised impact on dustfall rates as a result of the ash disposal at Kendal Power Station – unmitigated operational scenario, irrespective of location of operational area

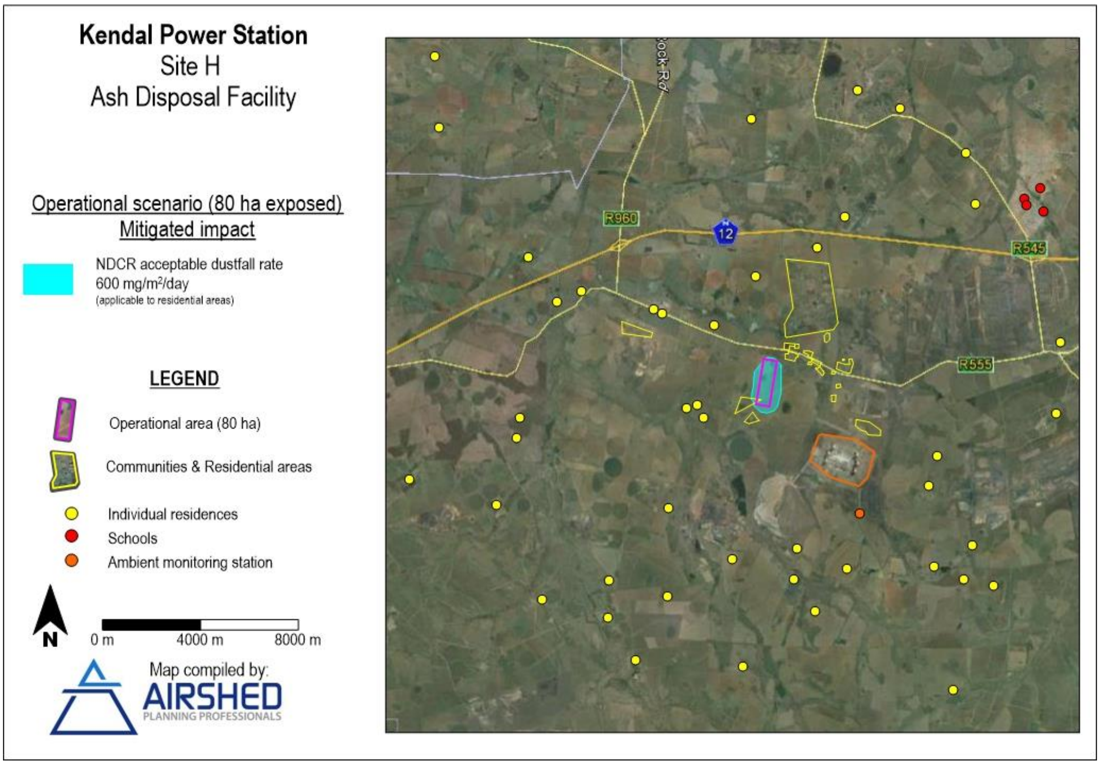

Figure 4-16: Simulated dustfall rates as a result of the ash disposal at Kendal Power Station – mitigated operational scenario, indicating areas of non-compliance with the NDCR residential standard

4.4 Impact Significance Rating

The environmental impact significance rating that follows applies to the operational phase of the proposed Kendal Site H ADF. Impact rating scale was provided by Zitholele Consulting (Appendix C). The operational phase is considered to be the phase with the largest impact on ambient air quality. The Construction and Rehabilitation (Closure) phases are not likely to impact the ambient air quality more than the existing (status quo) status. All impacts are based on the dispersion modelling results where the certainty of impacts is considered "**very likely**" because of uncertainties associated with dispersion modelling, as discussed in Section 1.2.1. The impact significance rating for the operational scenario is presented in Table 4-6.

4.4.1 Existing Status

The existing sources of particulate emissions in the vicinity include: agricultural activities; domestic fuel burning; coal mining; the current Kendal ADF; and, the Kendal Power Station. The site is located within the Highveld Priority Area near the Emalahleni Hot Spot – an area of already poor air quality. The available data show that between 2009 and 2014 the daily PM_{10} concentrations were non-compliant with the daily NAAQS (i.e. more than 4 days per year where the concentration exceeds the 75 µg/m^3 limit concentration). The existing air quality is of MODERATE significance at a *regional* scale. The impacts of the existing air quality *could happen* in the long-term, resulting in a **MODERATE** impact risk.

4.4.2 Proposed Project Impact

Impacts from the unmitigated operational ADF will likely result in elevated ambient PM_{10} concentrations, exceeding the annual NAAQS, outside of the Eskom property boundary, affecting communities to the north (along the R555), east and south of the proposed ADF. The scale of impact of the operational ADF on ambient $PM_{2.5}$ concentrations is likely to be similar to PM_{10}

concentrations. The impacts of the proposed ADF, when unmitigated, are *very-likely* to result in impacts of HIGH significance at the *regional* scale over the long-term, resulting in **HIGH** impact risk.

4.4.3 Mitigation Measures

The windblown dust from the ash disposal facility is potentially significant during periods of high winds given the close proximity of sensitive receptors to the site. It is recommended that the sidewalls of the ADF be vegetated by means of the application of a top-soil layer and seeding with appropriate grass seeds. The vegetation cover should be such to ensure at least 80% control efficiency. The top surface area should only have 80 ha of ash material exposed at any time. The un-active surface should be stabilised with topsoil and seeded with appropriate grass seed as soon as possible. Exposed topsoil surfaces (before vegetation has established) must be watered regularly to eliminate additional windblown dust from these surfaces. Water spraying system should be implemented on the surface of the ADF covering the outer perimeter of the facility and the active 80 ha area, spraying water when winds exceed 4 m/s.

4.4.4 Residual Impact

The residual impact of the ADF after the effective application of mitigation measures is based on the inferred impacts of the 80 ha operational scenario. This scenario is *very-likely* to result in impacts of HIGH significance at a *regional* scale over the medium-term, resulting in **MODERATE** impact risk.

Table 4-6: Impact rating matrix for the Kendal Site H ADF

OPERATIONAL PHASE							
Activity	**Description of Impact**	**Impact type**	**Spatial Scale**	**Duration**	**Significance**	**Probability**	**Rating**
Construction phase	Non-compliance with annual PM_{10} standards at sensitive receptors	Existing	4	3	3	3	2 - LOW
		Proposed Project	2	2	2	4	1.6 - LOW
		Residual	2	1	1	4	1.1 - LOW
	Impact area where dustfall rates exceed 600 mg/m^2/day	Existing	2	3	2	3	1.4 - LOW
		Proposed Project	2	2	2	4	1.6 - LOW
		Residual	1	1	1	4	0.8 - VERY LOW
Disposal of ash (operational phase)	Non-compliance with annual PM_{10} standards at sensitive receptors	Existing	4	4	3	3	2.2 - MOD
		Proposed Project	4	4	4	4	3.2 - HIGH
		Residual	4	3	4	4	2.9 - MOD
	Impact area where non-compliance with daily PM_{10} standards was simulated	Existing	4	4	3	3	2.2 - MOD
		Proposed Project	4	4	4	4	3.2 - HIGH
		Residual	4	3	4	4	2.9 - MOD
	Non-compliance with annual $PM_{2.5}$ standards at sensitive receptors	Existing	4	4	1	3	1.8 - LOW
		Proposed Project	3	4	4	4	2.9 - MOD
		Residual	3	3	4	4	2.7 - MOD
	Impact area where dustfall rates exceed 600 mg/m^2/day	Existing	2	3	2	3	1.4 - LOW
		Proposed Project	3	4	4	4	2.9 - MOD
		Residual	2	3	4	4	2.4 - MOD
Rehabilitation phase	Non-compliance with annual PM_{10} standards at sensitive receptors	Existing	4	3	3	3	2 - LOW
		Proposed Project	2	2	2	4	1.6 - LOW
		Residual	2	1	1	4	1.1 - LOW
	Impact area where dustfall rates exceed 600 mg/m^2/day	Existing	2	3	2	3	1.4 - LOW
		Proposed Project	2	2	2	4	1.6 - LOW
		Residual	1	1	1	4	0.8 - VERY LOW

5 Recommended Air Quality Management Measures

5.1 Air Quality Management Objectives

The objective of air quality management will be to minimise particulate emissions from the ADF to maintain or improve the ambient air quality and reduce nuisance impacts of dustfall.

5.2 Source Specific Recommended Management and Mitigation Measures

The following sections describe the mitigation and management measures appropriate to each stage of the ADF development. These are described as distinct phases here, but in practise will occur concurrently.

5.2.1 Construction Phase

The construction of the ADF will be a mostly sporadic process, including vegetation and top-soil clearing ahead of the active disposal area. The complexity of estimating particulate emissions during this phase is a result of the types of activities, the varying duration and extent of each activity. The impact of the construction phase on air quality is expected to be limited to on-site impacts. Typical dust suppression techniques, for example, water sprays, will reduce particulate emissions to low levels especially during dry and windy conditions.

5.2.2 Operational Phase

The dispersion model simulations show that mitigation of particulate emissions will be critical to minimise areas of non-compliance with NAAQS and NDCR. The current Kendal Ash Disposal Operations Manual makes provision for dust suppression through water sprays and revegetation of the ADF. Effective application of these measures will be necessary to limit emissions, especially during dry and windy conditions. During periods when the ash will be moved to the ADF by haul truck, it will be necessary to mitigate particulate emissions from the haul roads with watering or, if expected for a prolonged period, chemical suppressants.

5.2.3 Rehabilitation Phase

The mitigation measures applied during the operational phase should continue during the rehabilitation phase to limit particulate emissions from the ADF. This will include dust suppression by watering and covering with top-soil and replanting of grass seeds.

5.3 Performance Indicators

5.3.1 Source Monitoring

Visual identification of dust plumes from the ADF will be an important initial indicator of ineffective mitigation measures. Response to minimise particulate emissions during these periods should be as rapid as possible. To avoid these conditions the following activities are recommended.

- Monitoring local weather forecasts for windy and/or dry conditions – for example during late winter, spring, and early summer. Contingency systems should be in place to respond with additional dust suppression during these periods.
- Regular checks of the dust suppression equipment, for example the water spray systems and efficient repairs where necessary.

- Regular visual inspection of revegetated areas for complete vegetation cover. Where un-vegetated patches open up, water sprays should be used to minimise particulate emissions until the topsoil can be replaced and reseeded.

5.3.2 Ambient Air Quality Monitoring

In order to ensure that mitigation is effective it is recommended that a dustfall monitoring network is established and is operational in the appropriate vicinity of the ADF. The location of the dust buckets was informed by the location of sensitive receptors together with simulated impact areas of non-compliance with NAAQS due to the proposed project operations. Locations for a dust bucket network are proposed in Figure 5-1. In addition, PM_{10} sampling is recommended at sensitive receptors to the north and east- southeast of the ADF.

The Air Quality Basic Assessment for the Kendal Continuous ADF (Bird & von Gruenewaldt, 2014) included a screening exercise of simulated ambient concentration of metals, where the findings were that the risk of increased life-time cancer risk as a result of exposure to arsenic, nickel and chromium was low or very low and well within health effect screening levels. However, concerns have been raised with regards to the metal content of the particulate emissions (Section 6.1 in Bird & von Gruenewaldt, 2014). It is therefore, also recommended that short-term filter-based PM_{10} monitoring campaigns be run annually, at communities to the north and downwind of the proposed ADF so that ambient metal concentrations can be determined and tracked over time.

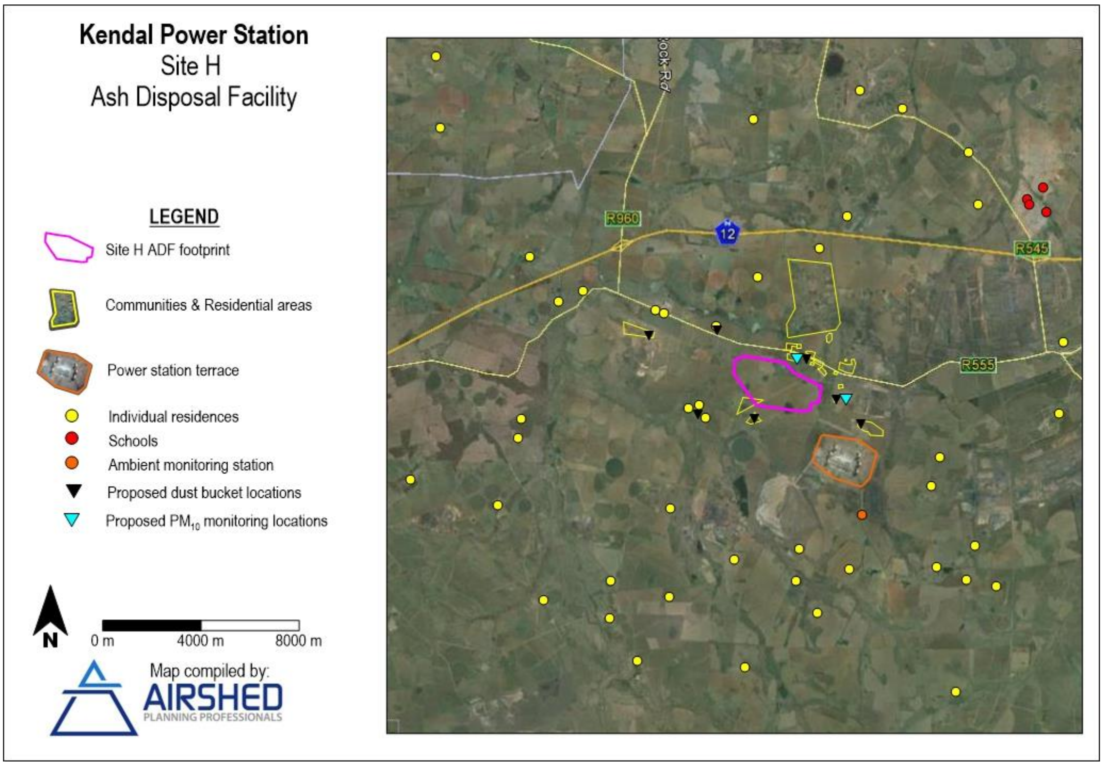

Figure 5-1: Proposed dust bucket and PM_{10} monitoring locations

5.4 Record-Keeping, Environmental Reporting and Community Liaison

5.4.1 Periodic Inspections and Audits

The NDCR requires that monitoring reports be submitted to the local air quality officer when exceedances of the dustfall standards occur.

5.4.2 Liaison Strategy for Communication with I&APs

Public concern regarding particulate emissions and subsequent impact on ambient air quality was raised during the assessment of impact of the Kendal Continuous ADF. It was suggested that a collaborative Environmental Management forum be established, including representatives from the mining houses as well as Kendal and Kusile Power stations. This forum would be an appropriate forum for communication with I&APs potentially affected by ash disposal activities. This recommendation applies to the continuation of ash disposal on the proposed Site H ADF.

6 CONCLUSIONS

Ash disposal activities at the proposed Kendal Site H ADF will impact ambient air quality by exposing the public, represented by nearby communities and individual homesteads, to elevated levels of airborne particulates and the associated potential human health impacts. Findings from the dispersion modelling assessment include:

- The unmitigated scenario provides a scenario of the worst case impact of the ADF on local communities and surrounding environment. The simulated area of non-compliance for the three particulate fractions considered (PM_{10}, $PM_{2.5}$ and TSP) cover a large proportion of the modelling domain, especially in the downwind direction (predominantly the south-east).
- Dispersion modelling of the operational scenario (only 80 ha exposed at any time) simulated a decrease in the non-compliant area. However, mitigation of particulate emissions will be critical in order to minimise the area of off-site non-compliance.

The following mitigation measures are recommended as a minimum:

- Regular wetting of exposed areas of disposal ash using water sprays to achieve at least 50% control efficiency;
- Stabilization of the exposed areas with a top-soil covering;
- Wetting of exposed top-soil for additional mitigation of particulate emissions from the top-soil layer; and,
- Revegetation of the ADF through application of a deeper top-soil layer and seeding with appropriate grass seeds (control efficiency of 80% or better).

Stringent mitigation management measures need to be implemented in order to minimise the impacts from the ADF on the surrounding communities. Given the potential of NAAQS being exceeded at sensitive receptors to the north and the east-southeast due to windblown dust from the ADF, it is recommended that a health risk assessment be conducted to understand the risks. If the risks are significant, these communities need to be relocated to outside the potential air quality impact area.

The proposed Kendal Site H ADF is located in the Highveld Priority Area – an area of typically poor air quality. As a result of the high background particulate values, the residual impact ratings – after mitigation of emissions from the ADF – are MODERATE for all pollutants and compliance time-frames.

For compliance with the NDCR, a seven point dust bucket network is proposed at sensitive receptors surrounding the ADF. In addition PM_{10} sampling at two locations (north and east-southeast) has been recommended for compliance with NAAQS.

7 References

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8 APPENDIX A: ADF FOOTPRINT SCENARIOS

During the assessment process a contingency period for the decommissioning of the power generating units at the Kendal Power Station was added to extend the life of the power station to 2058. This contingency period (5 years) would require an additional 45 ha for ash disposal. The annual emissions from the larger source (end-of-life 2058) would result in larger annual emissions in an unmitigated scenario (Table 8-1 and Figure 8-1). However, in practise the 80 ha operational area will still be applicable. The slightly larger footprint, should the end-of-life of the power station only be in 2058, will therefore impact the duration of operations by an additional five years. The impact from the operational scenario of the larger footprint is not likely to have a significant additional effect in the short-term (as illustrated by daily PM_{10} for the unmitigated scenario in Figure 8-2).

Table 8-1: Annual emissions for each site alternative for each of the modelled scenarios

Scenario	Particulate fraction	Annual emissions (tpa)	
		End of life - 2053 (363 ha)	End of life – 2058 (405 ha)
Unmitigated emissions (363 ha)	TSP	48 480	54 090
	PM_{10}	19 275	21 506
	$PM_{2.5}$	5 555	6 198
Operational scenario (80 ha)	TSP	10 684	10 684
	PM_{10}	4 248	4 248
	$PM_{2.5}$	1224	1224

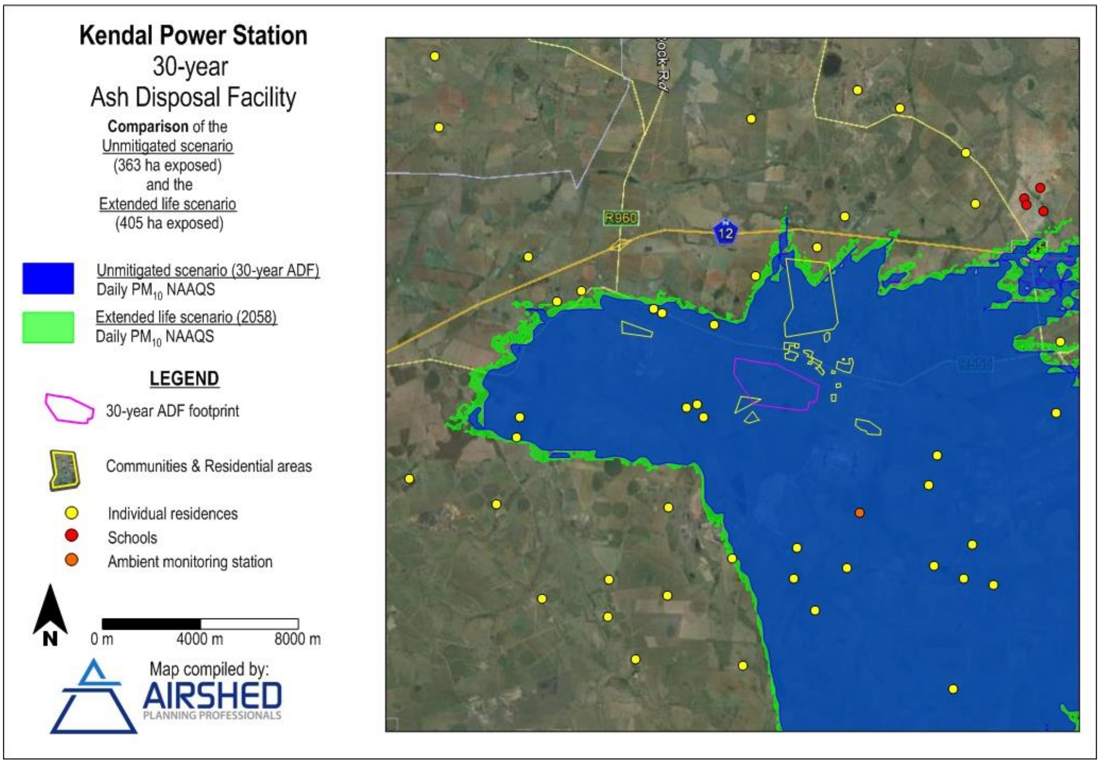

Figure 8-1: Simulated daily PM_{10} NAAQS exceedances comparing the Unmitigated scenario (Figure 4-1) and the Extended life (2058) scenario

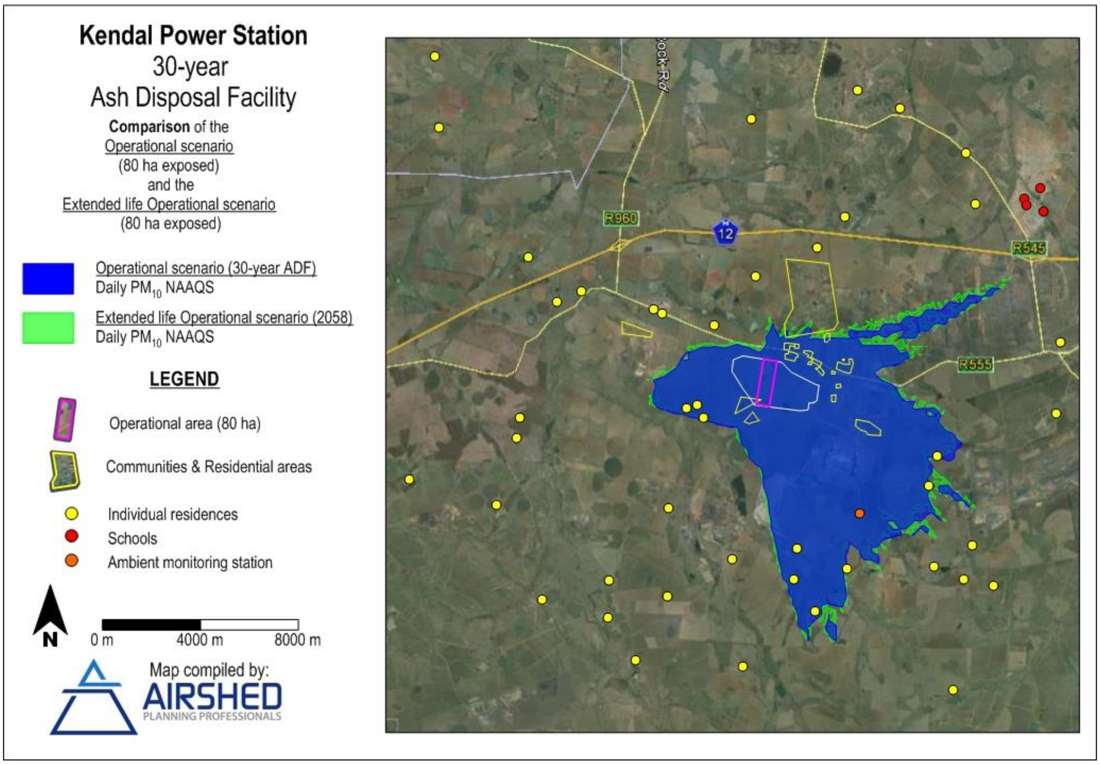

Figure 8-2: Simulated daily PM_{10} NAAQS exceedances comparing the Operational scenario under the 30-year ADF (Figure 4-4) and the Extended life (2058) scenario

9 APPENDIX B: FUGITIVE PARTICULATE EMISSIONS FROM EXPOSED AREAS

Significant emissions arise due to the mechanical disturbance of granular material from disturbed 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 contents, whether due to precipitation or deliberate wetting, promote the aggregation and cementation of fines to the surfaces of larger particles, thus decreasing the potential for particulate emissions. Surface compaction and ground cover similarly reduces the potential for dust generation. The shape of a storage pile or disposal dump influences the potential for particulate 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 of material from the surface, the nature of dispersion of the dust plume, and the rate of deposition, which may be anticipated (Burger, 1994).

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining).

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

Estimating the amount of windblown particles to be generated from a stockpile is not a trivial task and requires detailed information on the particle size distribution, moisture content, silt content and particle density. Dust will only be generated under conditions of high wind speed which is likely to occur when winds exceed 5.4 $m.s^{-1}$ (US-EPA, 1995b).

An hourly emissions file was created for each of these source groups. The calculation of an emission rate for every hour of the simulation period was carried out using the ADDAS model. This software is based on the dust emission models proposed by Marticorena and Bergametti (1995) and Shao (2008). The models attempt to account for the variability in source erodibility through the parameterisation of the erosion threshold (based on the particle size distribution of the source) and the roughness length of the surface.

In the quantification of wind erosion emissions, the models incorporates the calculation of two important parameters, viz. the threshold friction velocity of each particle size, and the vertically integrated horizontal dust flux, in the quantification of the vertical dust flux (i.e. the emission rate). In the Marticorena and Bergametti Model, the vertical flux is given by the following equation:

$$F(i) = G(i)10^{(0.134(\%clay)-6)}$$

for

$$Q(i) = 0.261\left[\frac{P_a}{g}\right]u^{*3}(1+R)(1-R^2)$$

and $$R = \frac{u_*^{\ t}}{u^*}$$

where,

$F_{(i)}$	=	emission rate (g/m²/s) for particle size class i
P_a	=	air density (g/cm³)
g	=	gravitational acceleration (cm.s^{-2})
u_*^t	=	threshold friction velocity (m/s) for particle size i
u^*	=	friction velocity (m.s^{-1})

With the model based on Shao (2008), the horizontal flux is as described by the equation above and the vertical flux is given by

$$F(i) = \beta(i)Q(i)u_*^{-2}$$

for

$$\beta(i) = 10^{-5}\left[1.25\ln(d_s) + 3.28\right]\exp\left(-140.7d_d + 0.37\right)$$

where,

d_s	=	the saltator particle size (mm)
d_d	=	the dust particle size (mm)

Dust mobilisation occurs only for wind velocities higher than a threshold value, and is not linearly dependent on the wind friction and velocity. The threshold friction velocity, defined as the minimum friction velocity required to initiate particle motion, is dependent on the size of the erodible particles and the effect of the wind shear stress on the surface. The threshold friction velocity decreases with a decrease in the particle diameter, for particles with diameters >60 µm. Particles with a diameter <60 µm result in increasingly high threshold friction velocities, due to the increasingly strong cohesion forces linking such particles to each other (Marticorena & Bergametti, 1995). The relationship between particle sizes ranging between 1 µm and 500 µm and threshold friction velocities (0.24 to 3.5 m.s^{-1}), estimated based on the equations proposed by Marticorena and Bergametti (1995), is illustrated in Figure 9-1.

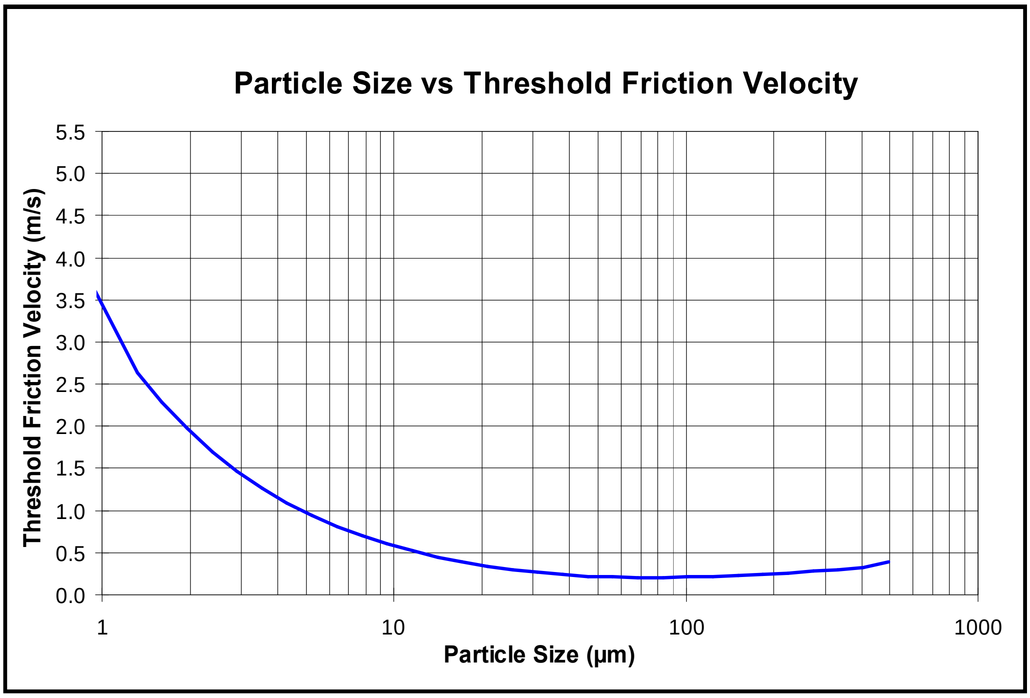

Figure 9-1: Relationship between particle sizes and threshold friction velocities using the calculation method proposed by Marticorena and Bergametti (1995)

10 APPENDIX C: IMPACT ASSESSMENT METHODOLOGY AS PROVIDED BY ZITHOLELE CONSULTING

The impacts will be ranked according to the methodology described below. Where possible, mitigation measures will be provided to manage impacts. In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared with each other. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology was used to describe impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in Table 10-1.

Table 10-1: Quantitative rating and equivalent descriptors for the impact assessment criteria

Rating	Significance	Extent Scale	Temporal Scale
1	VERY LOW	*Proposed site*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

10.1.1 Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1 000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in Table 10-2 below.

Table 10-2: Description of the significance rating scale

Rating		Description
5	Very high	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	High	Impact is of substantial order within the bounds of impacts, which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some

Rating		Description
		combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	Moderate	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	Low	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	Very low	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity are needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	No impact	There is no impact at all - not even a very low impact on a party or system.

10.1.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in Table 10-3.

Table 10-3: Description of the significance rating scale

Rating		Description
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a regional scale (District Municipality to Provincial Level).
3	Local	The impact will affect an area up to 10 km from the proposed site.
2	Study Site	The impact will affect an area not exceeding the Eskom property.
1	Proposed site	The impact will affect an area no bigger than the ash disposal site.

10.1.3 Duration Scale

In order to accurately describe the impact it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in Table 10-4.

Table 10-4: Description of the temporal rating scale

Rating		Description
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium term	The environmental impact identified will operate for the duration of life of facility.
4	Long term	The environmental impact identified will operate beyond the life of operation.
5	Permanent	The environmental impact will be permanent.

10.1.4 *Degree of Probability*

Probability or likelihood of an impact occurring will be described as shown in Table 10-5 below.

Table 10-5: Description of the degree of probability of an impact occurring

Rating	Description
1	Practically impossible
2	Unlikely
3	Could happen
4	Very Likely
5	It's going to happen / has occurred

10.1.5 *Degree of Certainty*

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard "degree of certainty" scale is used as discussed in Table 10-6. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 10-6: Description of the degree of certainty rating scale

Rating	Description
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.
Don't know	The consultant cannot, or is unwilling, to make an assessment given available information.

10.1.6 *Quantitative Description of Impacts*

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale as described below:

$$\textbf{\textit{Impact Risk}} = \frac{(\text{SIGNIFICANCE} + \textit{Spatial} + \text{Temporal})}{\mathbf{3}} \times \frac{\text{Probability}}{\mathbf{5}}$$

An example of how this rating scale is applied is shown below (Table 10-7):

Table 10-7: Example of Rating Scale

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
	LOW	*Local*	Medium-term	*Could Happen*	
Impact to air	**2**	**3**	**3**	**3**	**1.6**

Note: The significance, spatial and temporal scales are added to give a total of 8, that is divided by 3 to give a criteria rating of 2.67. The probability (3) is divided by 5 to give a probability rating of 0.6. The criteria rating of 2.67 is then multiplied by the probability rating (0.6) to give the final rating of 1.6.

The impact risk is classified according to five classes as described in Table 10-8 below.

Table 10-8: Impact Risk Classes

Rating	Impact Class	Description
0.1 – 1.0	**1**	**Very Low**
1.1 – 2.0	**2**	**Low**
2.1 – 3.0	**3**	**Moderate**
3.1 – 4.0	**4**	**High**
4.1 – 5.0	**5**	**Very High**

Therefore with reference to the example used for air quality above, an impact rating of 1.6 will fall in the Impact Class 2, which will be considered to be a low impact.

10.1.7 Cumulative Impacts

It is a requirement that the impact assessments take cognisance of cumulative impacts. In fulfilment of this requirement the impact assessment will take cognisance of any existing impact sustained by the operations, any mitigation measures already in place, any additional impact to environment through continued and proposed future activities, and the residual impact after mitigation measures.

It is important to note that cumulative impacts at the national or provincial level will not be considered in this assessment, as the total quantification of external companies on resources is not possible at the project level due to the lack of information and research documenting the effects of existing activities. Such cumulative impacts that may occur across industry boundaries can also only be effectively addressed at Provincial and National Government levels.

10.1.8 Notation of Impacts

In order to make the report easier to read the following notation format is used to highlight the various components of the assessment:

- Significance or magnitude- IN CAPITALS
- Temporal Scale – in <u>underline</u>
- Probability – in <u>*italics and underlined*</u>
- Degree of certainty - in **bold**
- Spatial Extent Scale – in *italics*