Project done for

Lidwala Consulting Engineers

Proposed Expansions of the Wet Ash Disposal facilities at Hendrina Power Station:

Air Quality Evaluation

Report No.: APP/10/LCE-01 Rev 0.1

DATE: October 2011

R von Gruenewaldt

Airshed Planning Professionals (Pty) Ltd

P O Box 5260
Halfway House
1685

Tel : +27 (0)11 805 1940
Fax : +27 (0)11 805 7010
e-mail : mail@airshed.co.za

REPORT DETAILS

Reference	APP/10/LCE-01
Status	Revision 0.1
Report Title	Proposed Expansions of the Wet Ash Disposal facilitiesat Hendrina Power Station: Air Quality Evaluation
Date	October 2011
Client	Lidwala Consulting Engineers
Prepared by	Reneé 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. 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.
Copyright Warning	With very few exceptions, the copyright in all text and other matter (including the manner of presentation) is the exclusive property of Airshed Planning Professionals (Pty) Ltd. It is a criminal offence to reproduce and/or use, without written consent, any matter, technical procedure and/or technique contained in this document.
Acknowledgements	The authors would like to express their appreciation for the discussions and technical input from Ashlea Strong from Lidwala Consulting Engineers.

Table of Contents

List of Figures

List of Tables

List of Acronyms and Symbols

Airshed	Airshed Planning Professionals (Pty) Ltd
Australian EPA	Australian Environmental Protection Agency
Australian NPI	Australian National Pollution Inventory
m	metre
m^2	Metre squared
m/s	Metre per second
$mg/m^2/day$	Milligram per metre squared per day
mamsl	metres above mean sea level
NAAQS	National Ambient Air Quality Standards
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10µ
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5µ
SA	South Africa
tpa	Tonnes per annum
TSP	Total Suspended Particles
US	United States
US.EPA	United States Environmental Protection Agency
°C	Degrees Celsius

Glossary

"**air pollution**" means any change in the composition of the air caused by smoke, soot, dust (including coal), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances.

"**ambient air**" is defined as any area not regulated by Occupational Health and Safety regulations.

"atmospheric emission" or **"emission"** means any emission or entrainment process emanating from a point, non-point or mobile source that results in air pollution.

"particulates" comprises a mixture of organic and inorganic substances, ranging in size and shape. These can be divided into coarse and fine particulate matter. The former is called Total Suspended Particulates (TSP), whilst thoracic particles or PM_{10} (particulate matter with an aerodynamic diameter of less than 10 µm) fall in the finer fraction. PM_{10} is associated with health impacts for it represents particles of a size that would be deposited in, and damaging to, the lower airways and gas-exchanging portions of the lung. TSP, on the other hand, is usually of interest in terms of dust deposition (nuisance).

1 Introduction

Hendrina Power Station is located near Hendrina in the Mpumalanga Province and falls within the Steve Tshwete Local Municipality. Eskom Holdings Limited is planning to expand the current ashing system at the Hendrina Power Station with the development of a proposed new wet ash disposal facility and associated infrastructure.

Airshed Planning Professionals (Pty) Ltd was appointed by Lidwala Consulting Engineers to determine the potential for dust impacts on the surrounding environment and human health from the proposed operations. Practical mitigation measures need to be considered for the planning/construction and operational phases of the project. The rehabilitation of the site also needs to be assessed.

1.1 Site Description

The proposed activities are primarily surrounded by agricultural small holdings, power generation and neighbouring mining operations. Major residential areas in the region include Middleburg (~25km northwest), eMalahleni (~35km west-northwest), Bethal (~45 km southwest) and Ermelo (~60km southeast). Smaller residential areas in the region include Arnot (~20 km northeast), Pullen's Hope (~1.8 km north), Komati (~12 km southwest), KwaZamokuhle (~17 km southeast) and Hendrina (~17 km southeast) which may include schools and hospitals/clinics. Individual residences (i.e. farm houses) are also in the immediate vicinity of the proposed operations.

1.2 Air Quality Evaluation Approach

The study followed a qualitative approach, using available meteorological data and pollutants typically associated with the proposed activities to evaluate the potential for off-site impacts.

A qualitative assessment is undertaken based on the evaluation of existing windblown dust from ash dump studies, together with the dispersion potential of the site and magnitude of expected impacts from the proposed activities. Based on the qualitative evaluation, mitigation measures are proposed.

1.3 Report Outline

Section 2 of the report provides a description on the site specific dispersion potential through the discussion of near-site surface meteorology.

Section 3 describes the expected process and the associated sources of air pollution followed by the qualitative assessment of the proposed operations on the surrounding environment. A management plan is provided.

Section 4 gives the main findings with recommendation.

The references are provided in Section 5.

2 Air Quality Baseline Evaluation

The baseline evaluation primarily comprises the assessment of near-site surface meteorology. No Eskom ambient monitoring data are available at the Hendrina Power Station Site to provide an indication of the background air pollution in the region. Use was therefore made of the closest Department of Environmental Affairs monitoring site at the Hendrina residential area.

2.1 Regional Climate and Atmospheric Dispersion Potential

The meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere (Pasquill and 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. The wind direction and the variability in wind direction, determine the general path pollutants will follow, and the extent of cross-wind spreading (Shaw and Munn, 1971; Pasquill and 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 must be accounted for to accurately parameterise the atmospheric dispersion potential of a particular area. A qualitative description of the synoptic climatology of the study region is provided based on a review of the pertinent literature. The analysis of meteorological data observed for the proposed site, where available, and data for neighbouring sites will provide the basis for the parameterisation of the meso-scale ventilation potential of the site.

The analysis of at least one year of hourly average meteorological data for the study site is required to facilitate a reasonable understanding of the ventilation potential of the site. 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.

No meteorological data are available for the Hendrina Power Station site and use was made of the MM5 calculated meteorological data for the proposed operations. Data for the period 1 January 2007 to 31 December 2009 were available for use in the study.

2.1.1 Local wind field

Figure 1 provides period wind roses for the proposed Hendrina wet ash disposal site, with Figure 2 including the seasonal wind roses for the same site. The predominant wind direction is northwesterly and easterly with a >10% frequency of occurrence. Winds from the southwesterly sectors are relatively infrequent occurring <5% of the total period. Calm conditions (wind speeds < 1 m/s) occur for 11% of the time.

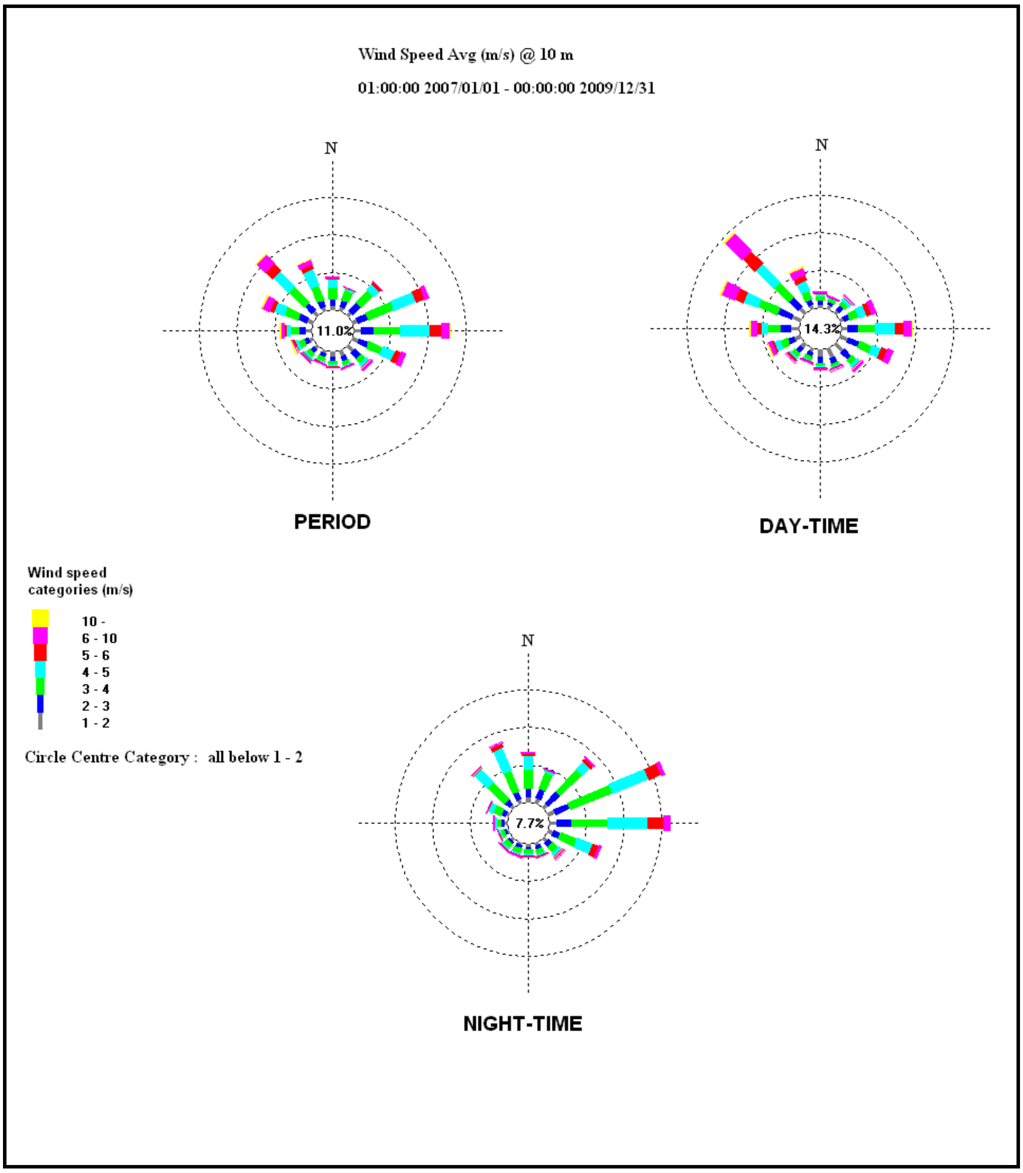

Figure 1: Period, day-time and night-time wind roses for Hendrina Wet Ash Disposal facility (1 January 2007 to 31 December 2009)

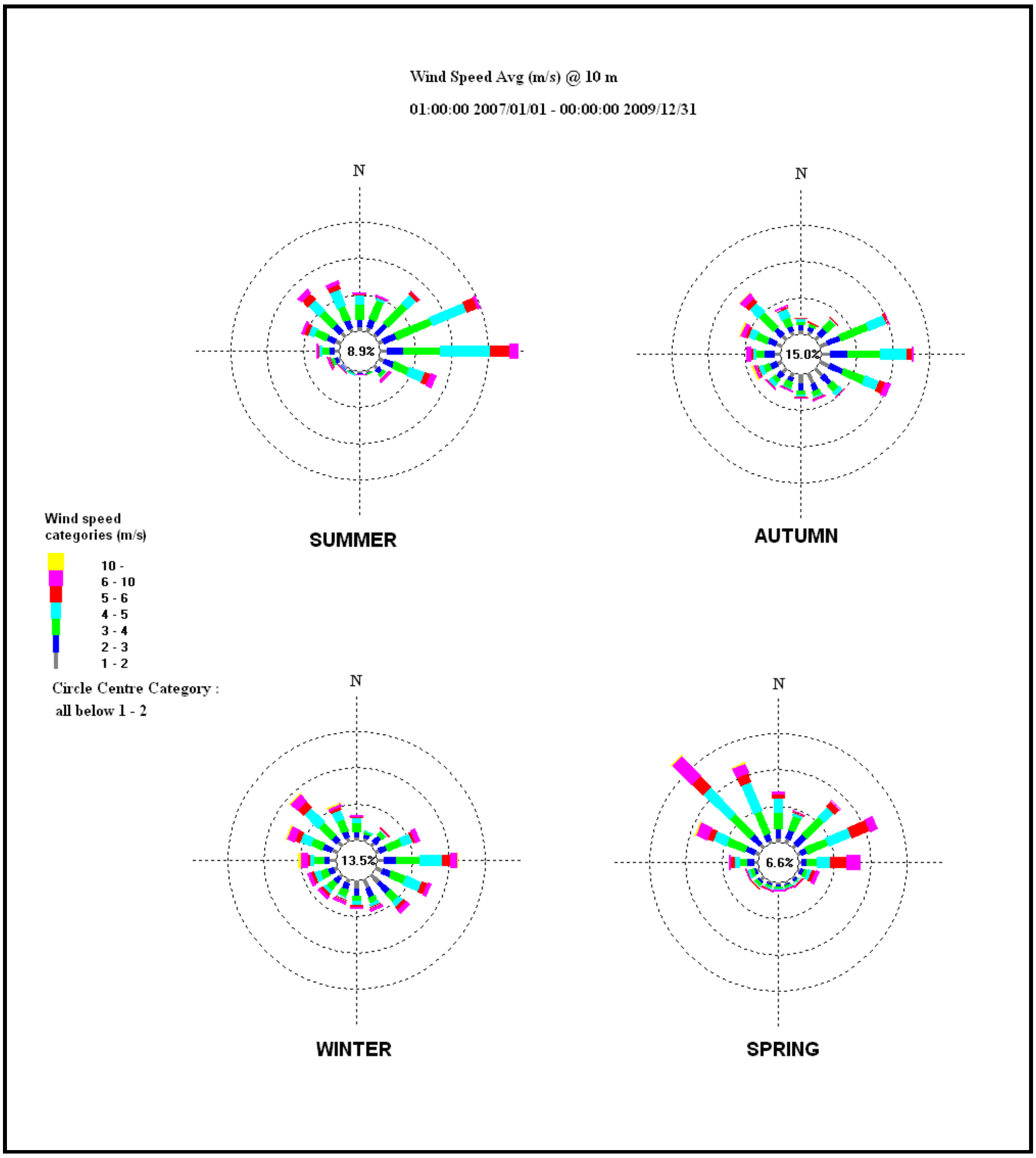

Figure 2: Seasonal wind roses for Hendrina Wet Ash Disposal facility (1 January 2007 to 31 December 2009)

A frequent northwesterly flow dominates day-time conditions with ~15% frequency of occurrence. During the night-time an increase in easterly and east-northeasterly flow is observed with a decrease in northwesterly air flow.

During summer months, winds from the east become more frequent, due to the strengthened influence of the tropical easterlies and the increasing frequency of occurrence of ridging anticyclones off the east coast. There is an increase in the frequency of calm periods (i.e. wind speeds <1 m/s) during the winter months of 13.5%.

Wind speeds in general range between 0 m/s and 14 m/s, with an average of 3.4 m/s.

2.1.2 *Surface Temperature*

Air temperature has important implications for the buoyancy of plumes; the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise. Temperature also provides an indication of the extent of insolation, and therefore of the rate of development and dissipation of the mixing layer.

The diurnal temperature profile for the site (2009) is given in Figure 3. Annual maximum, minimum and mean temperatures for the site are given as 25.7℃, 2.2℃ and 15℃, respectively, based on the calculated MM5 data for the period 2009. Average daily maximum temperatures range from 25.7℃ in December to 12.6℃ in July, with daily minima ranging from 16.6℃ in January to 2.2℃ in July (Figure 4).

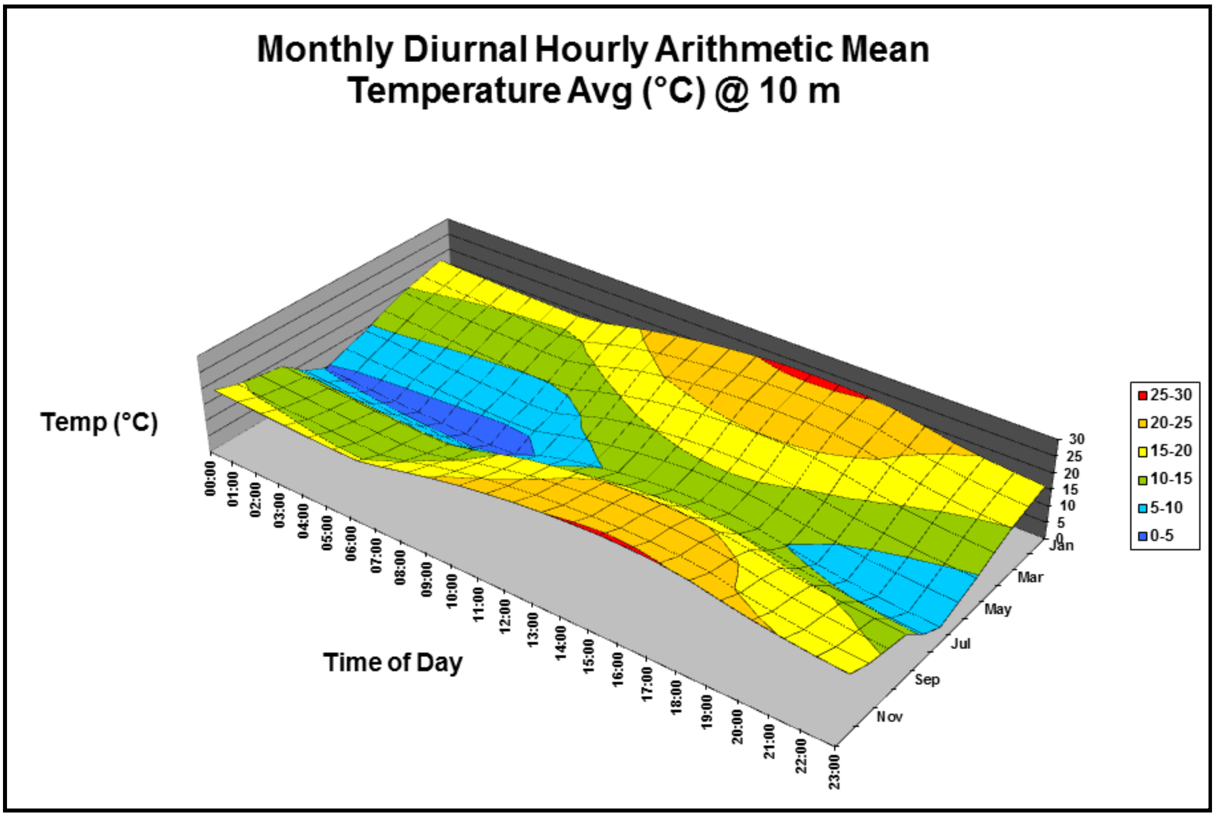

Figure 3: Diurnal temperature profile for the site (2009)

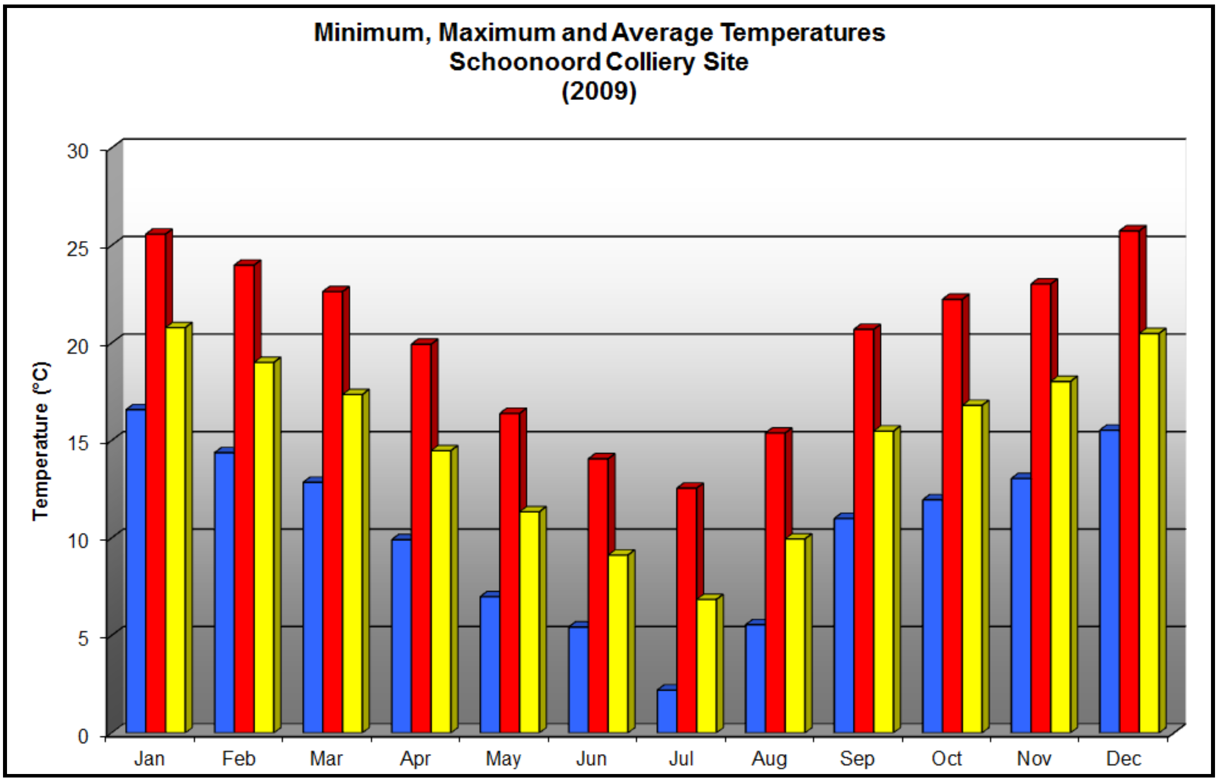

Figure 4: Minimum, maximum and average monthly temperatures for the site during the period 2009

2.1.3 Precipitation

Rainfall represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies.

Monthly rainfall for the site (2007 – 2009) is given in Table 1. Average monthly rainfall for this period is in the range of 306 mm. The study area falls within a summer rainfall region, with over 85% of the annual rainfall occurring during the October to March period.

Table 1: Monthly average rainfall for the site for the period 2007 – 2009

Month	Average rain (mm)	Average No. hours>0.254mm	Average No. days>0.254mm
Jan	973	182	21
Feb	315	87	13
Mar	236	74	12
Apr	107	37	7
May	60	19	3
Jun	23	10	2

Month	Average rain (mm)	Average No. hours>0.254mm	Average No. days>0.254mm
Jul	13	6	1
Aug	77	10	2
Sep	157	31	5
Oct	432	111	18
Nov	616	149	20
Dec	669	142	21

2.1.4 Atmospheric Stability

The vertical component of dispersion is a function of the extent of thermal turbulence and the depth of the surface mixing layer. Unfortunately, the mixing layer is not easily measured, and must therefore often be estimated using prognostic models that derive the depth from some of the other parameters that are routinely measured, e.g. solar radiation and temperature. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the *mixing layer* to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground based inversions and the erosion of the mixing layer. The mixing layer ranges in depth from ground level (i.e. only a stable or neutral layer exists) during night-times to the base of the lowest-level elevated inversion during unstable, day-time conditions.

Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in **Error! Reference source not found.**.

Table 2: Atmospheric Stability Classes

A	very unstable	calm wind, clear skies, hot daytime conditions
B	moderately unstable	clear skies, daytime conditions
C	unstable	moderate wind, slightly overcast daytime conditions
D	neutral	high winds or cloudy days and nights
E	stable	moderate wind, slightly overcast night-time conditions
F	very stable	low winds, clear skies, cold night-time conditions

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

For low level releases, such as due to vehicle entrainment from unpaved roads, the highest ground level concentrations will occur during weak wind speeds and stable (night-time) atmospheric conditions. Wind erosion, on the other hand, requires strong winds together with fairly stable conditions to result in high ground level concentrations i.e. neutral conditions.

2.2 Ambient Air Quality within the Region

The Department of Environmental Affairs (DEA) operates a monitoring network over the Highveld region at the residential areas of Hendrina, Ermelo, Middleburg, Secunda and eMalahleni. The closest monitoring station to the proposed operations is located at Hendrina. The highest daily and monthly PM_{10} concentrations for the period 2008-2010 are given in Figure 5 and Figure 6 respectively.

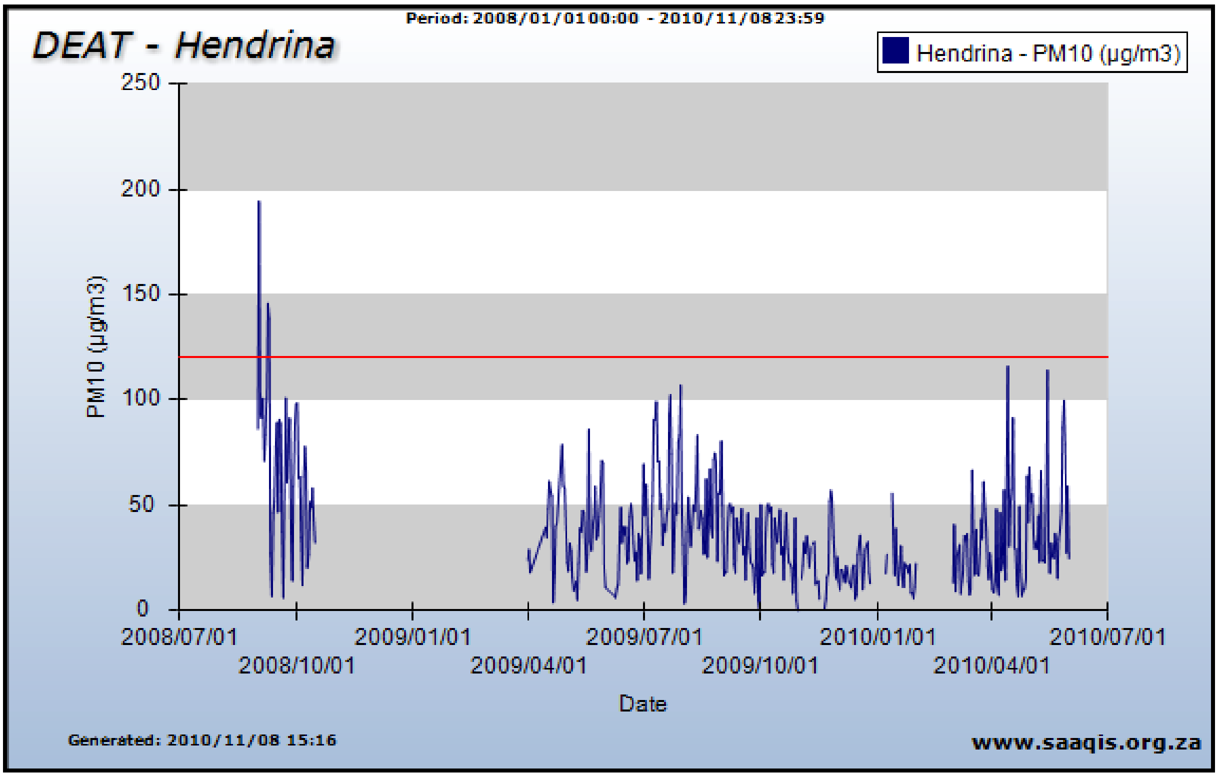

Figure 5: Daily measured PM_{10} ground level concentrations (µg/m³) at the Hendrina DEA monitoring station (for the period 2007-2010) (as downloaded from the SAAQIS website)

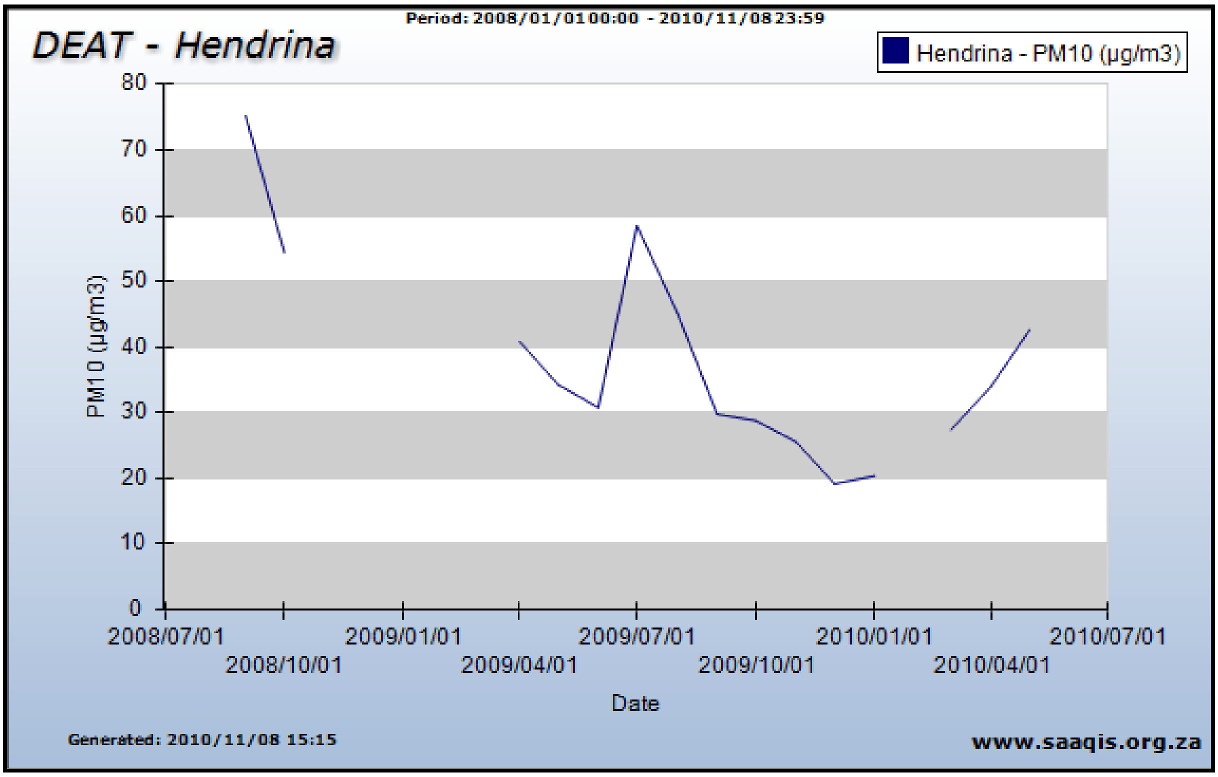

Figure 6: Monthly measured PM_{10} ground level concentrations (µg/m³) at the Hendrina DEA monitoring station (for the period 2007-2010) (as downloaded from the SAAQIS website)

Exceedances of SA air quality PM_{10} limits were found to occur at the Hendrina monitoring station. However, the National Ambient Air Quality Standards (NAAQS) allow 4 daily exceedances per calendar year. When compared to the NAAQS applicable immediately till 31 December 2014, the predicted PM_{10} concentrations for the period 2008 – 2010 were found to result in less than 4 allowable exceedances. For the NAAQS applicable from 1 January 2015, the predicted concentrations for the period 2008 – 2010 were found to result in more than 4 allowable exceedances for the period 2009. Annual concentrations were estimated from the monthly PM_{10} concentrations for the period April 2009 to March 2010.

High ambient particulate concentrations have been found to coincide with low ambient temperatures and low rainfall (Burger, 1994). Increases in domestic coal burning and poor atmospheric dispersion potentials, together with persistent industrial emissions, combine to produce elevated ambient concentrations during winter months. High concentrations during summer months are usually associated with increases in fugitive dust emissions. Rainfall events result in a reduction of airborne concentrations due to reductions in the potential for fugitive dust emissions and due to the removal of particulates in the atmosphere by raindrops.

3 Air Quality Evaluation

3.1 Process Description and Source Identification

The project includes the expansion of the Wet Ash Disposal facilities at the Hendrina Power Station in the Mpumalanga Province. The coal-fired power generation process results in large quantities of ash, which is disposed of in ash disposal facilities. Generally, Eskom uses coal of a low grade (called middlings coal) which produces a larger mass of ash during combustion. Over time, the quality of the coal provided to Eskom has degraded, due to higher ash quantities in the coal. With regards to ash management, Eskom uses either wet or dry methods of ash disposal. The Hendrina Power Station utilises a wet ashing disposal method. This process entails the hydraulic conveyance of ash where ash is mixed with water and pumped in the form of slurry via steel pipelines. The slurry is allowed to settle in the ash disposal facility, and the water decanted to storage dams for re-use.

The Wet Ash Disposal facilities expansion will need to be big enough to dispose of 43.3 million m^3 ash. The footprint of the proposed expansion (including the ash disposal facility and associated infrastructure) is estimated to be in the order of 209 ha. However, the final shape and design of the footprint is still to be determined through conceptual engineering and design.

In addition to the expansion of the Wet Ash Disposal facilities the project will also include the expansion of the relevant infrastructure associated with the ashing system, including:

- Ash water return dams
- Pipelines
- Solution trenches
- Pump stations
- Seepage recovery dam
- Seepage water collection system
- Access roads

Closure of the ash disposal facility operations will include rehabilitation of the site through the covering of the ash disposal facility with topsoil before vegetation can take place. Tipping of topsoil onto the cleared areas will generate dust and the freshly exposed topsoil will be prone to wind erosion before vegetation takes over. Movement of vehicles will also be a source of pollution.

The main pollutant of concern associated with operations is particulate matter. Particulates are divided into different particle size categories with Total Suspended Particulates (TSP) associated with nuisance impacts and the finer fractions of PM_{10} (particulates with a diameter less than 10 µm) and

$PM_{2.5}$ (diameter less than 2.5 µm) 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 sulphur dioxide, oxides of nitrogen, carbon monoxide, etc.) derive from vehicle exhausts and other combustions sources such as vehicles. These are however insignificant in relation to the particulate emissions and are not discussed in detail.

Table 3 provides a list of all sources of air pollution associated with the proposed project. The subsequent sections provide a generic description of the parameters influencing dust generation from the various aspects identified.

Table 3: Activities and aspects identified for the construction, operational and closure phases of the proposed Wet Ash Disposal facilities expansion project

<table>
<tr><th>Pollutant(s)</th><th>Aspect</th><th>Activity</th></tr>
<tr><td colspan="3">Construction Phase</td></tr>
<tr><td rowspan="5">Particulates</td><td rowspan="4">Construction of proposed disposal 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</td></tr>
<tr><td rowspan="2">Particulates</td><td>Wind erosion</td><td>Exposed ash disposal facility</td></tr>
<tr><td>Vehicle activity on-site</td><td>Vehicle activity at the ash disposal facility</td></tr>
<tr><td>Gases and particles</td><td>Vehicle activity</td><td>Tailpipe emissions from vehicle activity at the ash disposal facility</td></tr>
<tr><td colspan="3">Closure/Rehabilitation Phase</td></tr>
<tr><td rowspan="4">Particulates</td><td rowspan="2">Rehabilitation of mined and disturbed areas</td><td>Topsoil recovered from stockpiles</td></tr>
<tr><td>Tipping of topsoil onto ash disposal facility</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>

3.1.1 Construction Phase

The construction phase normally comprises a series of different operations including land clearing, topsoil removal, road grading, material loading and hauling, stockpiling, compaction, (etc.). Each of these operations has their own duration and potential for dust generation. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

3.1.2 Operation Phase

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 wet ash disposal facility is not a trivial task and requires detailed information on the particle size distribution, moisture content, silt content and bulk density. Dust will only be generated under conditions of high wind speeds (US.EPA, 1995).

3.1.3 Closure Phase

It is assumed that all ashing activities will have ceased during the Closure Phase. The potential for impacts during the closure phase will depend on the extent of rehabilitation efforts on the ash disposal facility. The closure phase will mainly include materials handling activities, wind erosion and to a lesser extent vehicle and equipment movement on site.

3.2 Qualitative Evaluation

3.2.1 Construction Phase

It is not anticipated that the various construction activities will result in higher off-site impacts than the operational phase 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.

According to the Australian Environmental Protection Agency on recommended separation distances from various activities, a buffer zone of 300 m from the nearest sensitive receptor is required when extractive industries occur without blasting and a distance of 500 m when blasting will take place (AEPA, 2007).

3.2.2 Operational Phase

The current air quality at the proposed site is not known. However, ambient air quality measurements of PM_{10} at the closest DEA monitoring site indicate elevated ambient air quality levels. The ash disposal operations will give rise to dust generation. These operations, as discussed under Section 3.1.2, are low level release sources meaning that the dust gets generated at heights of between 0.5 m and 1 m from the ash disposal facility surface.

Wind erosion, will occur during strong wind conditions when wind speeds exceed the critical threshold required to lift and suspend the coal particles. This threshold is determined by the parameters that resist removal such as the particle size distribution of the bed material, moisture content and vegetation. A typical wind speed threshold is given as 5.4 m/s for storage piles (US.EPA, 1995). Wind data for the proposed ash disposal facility site (2007 – 2009) indicate an average wind speed of 3.4 m/s and a maximum of 14 m/s. The percentage when wind speeds exceed the 5.4 m/s threshold is 11.3%.

To provide an indication of the potential distance and significance of impacts from these activities, the US.EPA screening model (TScreen) is used. This model represents a quick method to calculate and “flag” the “worst-case” concentration that might occur. Screening models require very little input and have a built-in set of meteorological conditions based on stability classes (Section 2.1.4). It is a quick screening tool to identify possible sources that might require more detailed modelling. **It is important to note that these models do not use actual meteorological data, but rather set stability classes that will produce the highest impacts**. **The impacts are therefore not related to the actual wind directions or speeds.** More sophisticated Gaussian plume and puff models such as the US.EPA regulatory AERMOD and CALPUFF models use actual meteorological conditions. For the purpose of this study, a screening model is sufficient as the focus of this study is merely to provide an indication of the potential significance of the operations on the surrounding environment.

Figure 5 provides a graphic representation of the possible highest daily PM_{10} ground level concentrations at set distances from the proposed ash disposal facility. This is with no mitigation in place. The concentrations are irrespective of actual wind speed and direction and reflect the worst-case scenario. The National Ambient Air Quality Standards (NAAQS) for PM_{10} over a day are 120 $\mu g/m^3$ at present and 75 $\mu g/m^3$ from beginning 2015, with four exceedances of these limits allowed over a one year period. The screening model is not sophisticated enough to indicate the number of exceedances but it provides an indication of the distance at which the limit is exceeded. With no mitigation in place, the 2015 limit of 75 µg/m³ is exceeded further than 3 km due to windblown dust from the ash disposal facility. According to the Australian National Pollution Inventory (NPI) wind erosion can be reduced by 50% through water sprays and up to 30% by installing wind breaks. With water sprays enduring 50% reduction from wind erosion, windblown dust will be below the NAAQS limit of 75 µg/m³ at a distance of ~2km from the source.

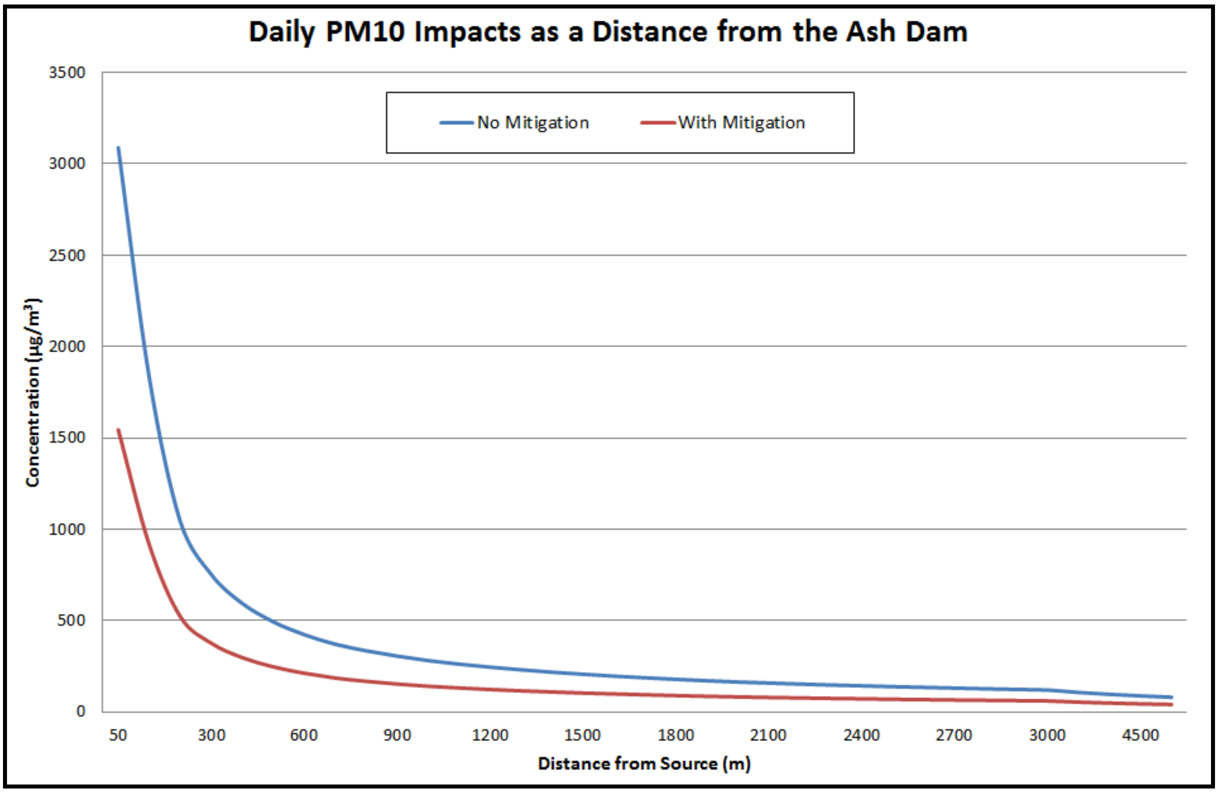

Figure 7: Estimated highest daily PM_{10} ground level concentrations at set distances from the emission source without

3.2.3 Closure Phase

The significance of the closure phase is likely to be linked to impacts from windblown dust. Windblown dust is likely to only impact off-site under conditions of high wind speed with no mitigation in place. If rehabilitation as indicated takes place i.e. vegetation cover, the impacts should be limited to be within the site boundary. As vegetation cover increases, the potential for wind erosion will decrease.

3.3 Dust Management Plan

Based on the qualitative evaluation of the proposed operations, management objectives are considered as summarised in Tables 4 to 6.

Table 4: Air Quality Management Plan: Construction Phase

ASPECT	IMPACT	MANAGEMENT ACTIONS/OBJECTIVES	RESPONSIBLE PERSON(S)	TARGET DATE
Land clearing activities such as dozing and scraping of vegetation and topsoil	PM_{10} concentrations and dust fallout	• Water sprays at area to be cleared. • Moist topsoil will reduce the potential for dust generation when tipped onto stockpiles. • Ensure travel distance between clearing area and topsoil piles to be at a minimum.	Environmental Manager Contractor(s)	Pre- and during construction
Wind erosion from exposed areas at dumpsite	PM_{10} concentrations and dust fallout	• Ensure exposed areas remain moist through regular water spraying. • Dust fallout bucket to be placed to the east and to the west of the dumpsite with monthly dust fallout rates not exceeding 1200 mg/m²/day[a].	Environmental Manager Contractor(s)	On-going and post-operational

Notes:

[a] South African Dust Fall limit of 1200 mg/m²/day for heavy commercial and industrial sites not to be exceeded for two sequential months and not more than three exceedances in a year.

Table 5: Air Quality Management Plan: Operational Phase

ASPECT	IMPACT	MANAGEMENT ACTIONS/OBJECTIVES	RESPONSIBLE PERSON(S)	TARGET DATE
Wind erosion	PM_{10} concentrations and dust fallout	• Ensure water sprays at and around the ash disposal facility • Dust fallout bucket to be placed to the west and to the southeast (dominant wind direction) of the ash disposal facility with monthly dust fallout rates not exceeding 1200 mg/m²/day[a]	Environmental Manager	On-going and post-operational phase

Notes:

[a] South African Dust Fall limit of 1 200 mg/m²/day for heavy commercial and industrial sites not to be exceeded for two sequential months and not more than three exceedances in a year.

Table 6: Air Quality Management Plan: Closure Phase

ASPECT	IMPACT	MANAGEMENT ACTIONS/OBJECTIVES	RESPONSIBLE PERSON(S)	TARGET DATE
Wind erosion from exposed areas	PM_{10} concentrations and dust fallout	• Cover ash disposal facility with previously collected topsoil. • Apply water sprays to ensure the material remain moist. • Ensure vegetation cover on the ash disposal facility.	Contractor(s) Environmental Manager	On-going and post-operational

4 Conclusion

There is a probability for unacceptably high ground level PM_{10} concentrations from the proposed ash disposal facility operations at the farm nearest to the ash disposal facility (800 m to the south). This will be mainly due to the windblown dust incidences from the ash disposal facility. PM_{10} concentrations are likely to exceed the NAAQS 2015 limit of 75 µg/m³ for more than 3 km from the source. Impacts from the ash disposal facility may be high but with water sprays in place, these impacts will reduce significantly. The potential for impacts at the sensitive receptors will also depend on the wind direction and speed which could not be accounted for in this assessment.

In conclusion, if unmitigated, the windblown dust from the ash disposal facility may result in significant PM_{10} ground level concentrations. As the background ambient PM_{10} ground level concentrations may also be elevated in the area (based on measured PM_{10} concentrations at Hendrina) it is recommended that the ash disposal facility be mitigated where possible in order to minimise the impacts from this source on the surrounding environment.

4.1 Recommendation

Fugitive dust can easily be mitigated. It is recommended that the dust management measures as stipulated in Tables 4, 5 and 6 be applied to ensure the proposed activities have an insignificant impact on the surrounding environment and human health.

It is also recommended that single dust fallout buckets be installed downwind of the tailings dam in order to monitor the impacts from this source.

5 References

AEPA, 2007: Guidelines for Separation Distances. Australian Environmental Protection Agency, December 2007.

Burger LW (1994). Ash Dump Dispersion Modeling, in Held G: Modeling of Blow-Off Dust From Ash Dumps, Eskom Report TRR/S94/185, Cleveland, 40 pp.

Cowherd, C., and Englehart, J.; 1984: *Paved Road Particulate Emissions*, EPA-600/7-84-077, US Environmental Protection Agency, Cincinnati, OH.

EPA, 1995: Compilation of Air Pollution Emission Factors (AP-42) 6th edition, Volume 1, as contained in the *AirCHIEF (AIR cleaninghouse for inventories and Emission Factors) CD-ROM (compact disk read only)*, US Environmental Protection Agency, Research Triangle Park, North Carolina.

Godish, R., **1990**: *Air Quality*, Lewis Publishers, Michigan, 422 pp.

Goldreich, Y. and P.D. Tyson, 1988: Diurnal and Inter-Diurnal Variations in Large-Scale Atmospheric Turbulence over Southern Africa. *South African Geographical Journal, 70(1)*, 48-56.

NPI, 2001. Emissions Estimation Technique Manual for Mining. Version 2.3. National Pollutant Inventory (NPI), Environment Australia, 5 December 2001.

Oke, T.T., 1990: *Boundary Layer Climates*, Routledge, London and New York, 435 pp.

Pasquill F and Smith FB, 1983: *Atmospheric Diffusion: Study of the Dispersion of Windborne Material from Industrial and Other Sources*, Ellis Horwood Ltd, Chichester, 437 pp.

Preston-Whyte, R.A. and P.D. Tyson, 1989: *The Atmosphere and Weather of Southern Africa*, Oxford University Press, Cape Town.

Shao, Y., 2008: Physics ad Modelling of Wind Erosion. Atmospheric and Oceanographic Science Library, 2nd Revised and Expanded Edition, Springer Science.

Shaw RW and Munn RE, 1971: Air Pollution Meteorology, in BM McCormac (Ed), *Introduction to the Scientific Study of Air Pollution*, Reidel Publishing Company, Dordrecht-Holland, 53-96.