Basic Air Quality Assessment for the proposed Letsoai Concentrating Solar Power (CSP) Central Tower Project 1 near Aggeneys, Northern Cape

Project done on behalf of **WSP | Parsons Brinckerhoff, Environment & Energy, Africa**

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Report No: 16WSP02 | **Date:** February 2017

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Report Details

Report number	16WSP02
Status	Final
Report Title	Basic Air Quality Assessment for the proposed Concentrating Solar Power (CSP) Central Tower Project 1 near Aggeneys, Northern Cape
Date	February 2017
Client	WSP | Parsons Brinckerhoff, Environment & Energy, Africa
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Revision Record

Revision Number	Date	Reason for Revision
Rev 0	February 2017	Draft for client review

Abbreviations

AEL	Atmospheric Emissions License
Airshed	Airshed Planning Professionals (Pty) Ltd
Australian EPA	Australian Environmental Protection Agency
CSP	Concentrating Solar Power
CTP	Central Tower Project
HTF	Heat Transfer Fluid
lb	pounds
mamsl	mean sea level
MES	Minimum Emission Standards
MW	Mega Watt
m	metre
m^2	Metre squared
m/s	Metre per second
$mg/m^2.day$	Milligram per metre squared per day
NAAQS	National Ambient Air Quality Standards
NAEIS	National Atmospheric Emissions Inventory System
NDCR	National Dust Control Regulations
NPI	National Pollutant Inventory (Australia)
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
SAAQIS	South African Air Quality Information System
SANS	South African National Standards
tpa	tonnes per annum
tpd	tonnes per day
TSP	Total Suspended Particles
US-EPA	United States Environmental Protection Agency
VKT	Vehicle kilometres travelled
WB	The World Bank
WHO	World Health Organisation
°C	Degrees Celsius
$\mu g/m^3$	Microgram per cubic metre

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1 INTRODUCTION

Two Central Tower (CP) projects are proposed for development near Aggeneys in the Northern Cape Province. Assessments of the potential impacts from air and noise pollution on the receiving environment and people living nearby are required, specifically during the Construction phase.

Airshed Planning Professionals (Pty) Ltd was appointed by WSP / Parsons Brinckerhoff, Environment & Energy, Africa to conduct a basic air quality assessment for the two proposed processes. The main objective of the study is to qualitatively assess the potential for air quality related impacts on the surrounding environment and human health from these two proposed processes, and to provide recommendations on mitigation measures required to ensure minimal impacts during the construction activities.

1.1 Brief process description

Letsoai CSP 1 will be a power generation facility consisting of a Central Receiver Tower and a heliostat field. The plant will generate 150 MW of electricity.

The heliostats (sun-tracking mirrors), typically arranged in an elliptical formation around the focal point, reflect the sunlight to the central receiver. The central receiver is located on top of the central tower and absorbs the concentrated beam radiation, converts it to heat before transferring it to a heat transfer fluid (HTF). This is then turn into steam for conventional power generation. The HTF could be thermal oil or molten salt.

Electricity generation from solar technologies results in negligible atmospheric emissions during operation since no fuels are combusted; however, air pollution in the form of particulate emissions will occur during the construction phase. Activities associated with particulate emissions during the construction phase include: vegetation removal and land clearing; scraping and grading; and the construction of buildings and roads. Gaseous emissions would primarily result from construction equipment tailpipe emissions. The construction phase was given to extend over a period of 12 to 24 months.

1.2 Site Description

The proposed CSP 1 will be located approximately 14.5 km south of the town of Aggeney (Figure 1-1). Other towns in the region include: Pofadder (65 km to the east) and Springbok (114 km to the west).

The economic activities around Aggeneys are dominated by the Black Mountain Mine and farming of livestock. The mine is an underground base-metal operation, producing zinc, lead; copper and silver. A new opencast zinc mine, called Gamsberg Mine, is proposed at the top of the inselberg. Activities will include drilling and blasting, material handling, crushing and screening, various stockpiles and conveyor belts, waste rock dumps, a tailing storage facility, concentrator plant, workshops, access and haul roads, and other mine infrastructure. Additional transport routes, water and energy supply will form part of the project as well as residential housing in Aggeneys (ERM, April 2013).

The study region is sparsely populated, with the only significant population concentration being the mining town of Aggeneys. The main road is the N14.

The vegetation cover of the study area is representative of the Namaqualand Broken Veld category. Grasses are generally sparse in the Gamsberg but are more common on the surrounding plains. Heavy grazing by domestic livestock coupled with periodic drought is believed to have led to reduced vegetation cover resulting in what is regarded as "poor" veld condition.

Ten "Red Data" plant species and species of rare occurrence have been recorded in the region of the Gamsberg (Scorgie, Annegarn, & Burger, 1999).

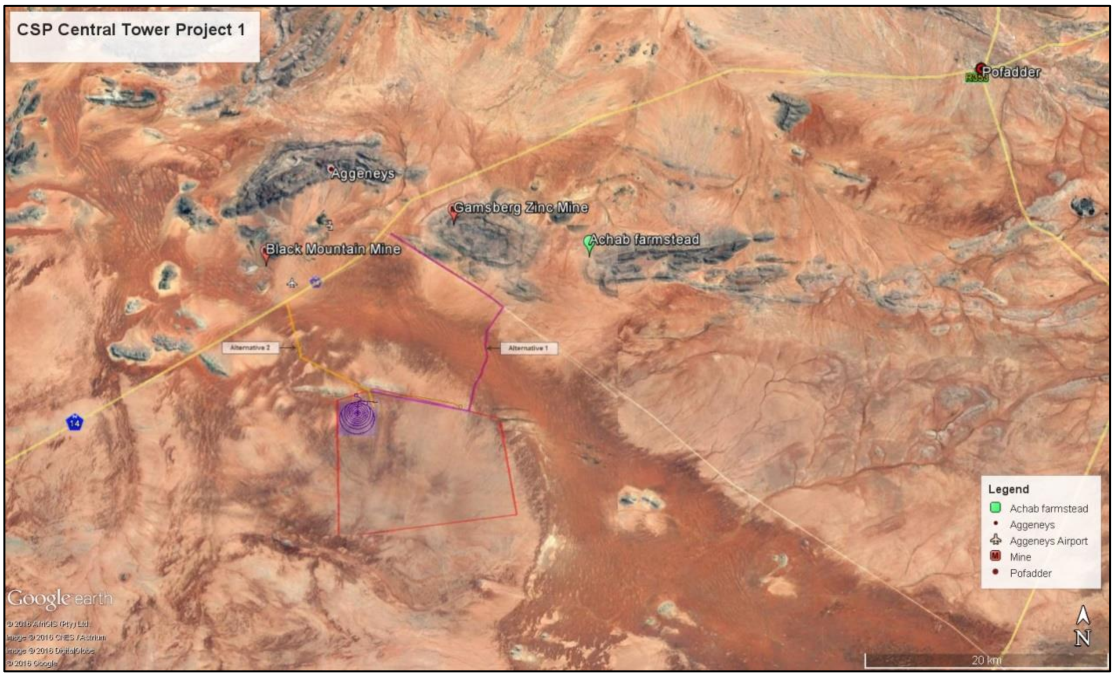

Figure 1-1: Location of the proposed CSP 1 project near Aggeneys, in relation to other sources and receptors

1.3 Air Quality Evaluation Approach

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

The various tasks undertaken as part of the study include:

- A brief description of the weather patterns in the area;
- Identification of existing sources of emission and characterisation of ambient air quality within the region based on observational data recorded to date;
- The legislative and regulatory context, including ambient air quality standards and dust fall classifications.
- Identify all potential sources of atmospheric emissions associated with the solar energy operations.
- Qualitatively assess the potential for impacts from the solar energy facilities.
- Recommendations for a dust management plan for the operations.

2 Legal Overview

The environmental regulations and guidelines governing the emissions and impact of the fugitive dust emissions need to be considered prior to developing a management plan so that National standards and guidelines are met by the actions recommended within the management plan.

The National Environmental Management: Air Quality Act (Act no.39 of 2004) commenced with on 11 September 2005 as published in the Government Gazette on 9 September 2005. Sections omitted from the implementation are Sections 21, 22, 36 to 49, 51(1)(e),51(1)(f), 51(3), 60 and 61. The Act was fully implemented on 1 April 2010, including Section 21 on the Listed Activities and Minimum National Emission Standards. The revised Listed Activities and Minimum Emission Standards were published on 22 November 2013 (Government Gazette 37054, Notice No. 893). Amendments to the Act, primarily pertaining to administrative aspects, were published in 2014 (Government Gazette 37666, Notice No. 390 on 14 May 2014).

The National Framework (first published in Government Gazette Notice No. 30284 of 11 September 2007, and updated in 2013) underpins the Air Quality Act (AQA), providing national norms and standards for air quality management to ensure compliance. The National Framework states that aside from the various spheres of government responsibility towards good air quality, industry too has a responsibility not to impinge on everyone's right to air that is not harmful to health and well-being. Industries therefore should take reasonable measures to prevent such pollution order degradation from occurring, continuing or recurring.

In terms of AQA, certain industries have further responsibilities, including:

- Compliance with any relevant national standards for emissions from point, non-point or mobile sources in respect of substances or mixtures of substances identified by the Minister, MEC or municipality.
- Compliance with the measurements requirements of identified emissions from point, non-point or mobile sources and the form in which such measurements must be reported and the organs of state to whom such measurements must be reported.
- Compliance with relevant emission standards in respect of controlled emitters if an activity undertaken by the industry and/or an appliance used by the industry is identified as a controlled emitter.
- Compliance with any usage, manufacture or sale and/or emissions standards or prohibitions in respect of controlled fuels if such fuels are manufactured, sold or used by the industry.
- Comply with the Minister's requirement for the implementation of a pollution prevention plan in respect of a substance declared as a priority air pollutant.
- Comply with an Air Quality Officer's legal request to submit an atmospheric impact report in a prescribed form.
- Taking reasonable steps to prevent the emission of any offensive odour caused by any activity on their premises.
- Furthermore, industries identified as Listed Activities have further responsibilities, including:
- Making application for an AEL and complying with its provisions.
- Compliance with any minimum emission standards in respect of a substance or mixture of substances identified as resulting from a listed activity.
- Designate an Emission Control Officer **if** required to do so.

Section 51 of the Air Quality Act lists possible offences according to the requirements of the Act with Section 52 providing for penalties in the case of offences.

2.1 Listed activities

The CSP Energy process is not a Listed Activity and will not require an AEL.

2.2 National Ambient Air Quality Standards

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality limits are intended to indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's life-time. Air quality guidelines and standards are normally given for specific averaging periods.

The South African Bureau of Standards (SABS) assisted the Department of Environmental Affairs (DEA) in the development of ambient air quality standards. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for $PM_{2.5}$ PM_{10}, SO_2, NO_2, ozone (O_3), CO, lead (Pb) and benzene. The NAAQS were published in the Government Gazette (no. 32816) on 24 December 2009. With the focus of this assessment on particulate emissions from construction activities, only the NAAQS for PM_{10} and $PM_{2.5}$ are listed in Table 2-1.

Table 2-1: South African national ambient air quality standards (Government Gazette 32816, 2009)

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
Benzene	1 year	10	-	0	Immediate – 31 Dec 2014
	1 year	5[(b)]	-	0	1 Jan 2015
CO	1 hour	30 000	26 000	88	Immediate
	8 hour[(c)]	10 000	8 700	11	Immediate
NO_2	1 hour	200	106	88	Immediate
	1 year	40	21	0	Immediate
PM_{10}	24 hour	120	-	4	Immediate – 31 Dec 2014
	24 hour	75[(b)]	-	4	1 Jan 2015
	1 year	50	-	0	Immediate – 31 Dec 2014
	1 year	40[(b)]	-	0	1 Jan 2015
$PM_{2.5}$	24 hour	65		4	Immediate – 31 Dec 2015
	24 hour	40[(b)]	-	4	1 Jan 2016 – 31 Dec 2029
	24 hour	25	-	4	1 Jan 2030
	1 year	25	-	0	Immediate – 31 Dec 2015
	1 year	20[(b)]	-	0	1 Jan 2016 – 31 Dec 2029
	1 year	15	-	0	1 Jan 2030
SO_2	10 minutes	500	191	526	Immediate
	1 hour	350	134	88	Immediate
	24 hour	125	48	4	Immediate
	1 year	50	19	0	Immediate

Notes:

[1]The number of averaging periods where exceedance of limit is acceptable.

[2]Date after which concentration limits become enforceable.

2.3 National Regulations for Dust Deposition

South Africa's Draft National Dust Control Regulations were published on the 27 May 2011 with the dust fallout standards passed and subsequently published on the 1st of November 2013 (Government Gazette No. 36974). These are called the National Dust Control Regulations (NDCR). The purpose of the regulations is to prescribe general measures for the control of dust in all areas including residential and light commercial areas. SA NDCRs that were published on the 1st of November 2013. Acceptable dustfall rates according to the regulation are summarised in Table 2-3.

Table 2-2: Acceptable dustfall rates

Restriction areas	Dustfall rate (D) in mg/m²-day over a 30 day average	Permitted frequency of exceedance
Residential areas	D < 600	Two within a year, not sequential months.
Non-residential areas	600 < D < 1 200	Two within a year, not sequential months.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

2.4 Greenhouse Gas Emissions

Regulations pertaining to Greenhouse Gas (GHG) reporting using the NAEIS was published in January 2016 (Government Gazette 39578, Volume 607 of 8 January 2016).

The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

The NAEIS web-based monitoring and reporting system will also be used to collect GHG information in a standard format for comparison and analyses. The system forms part of the National Atmospheric Emission Inventory component of the South African Air Quality Information System (SAAQIS).

The DEA is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the Intergovernmental Panel on Climate Change's (IPCC) default emission figures may be used to populate the SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. It has been indicated that these factors will only be published towards the end of 2015 (Jongikhaya, 2015). For this assessment, IPCC emission factors have been used.

Also, a carbon tax bill will be introduced for a further round of public consultation. The Carbon Tax Policy Paper (Department of National Treasury, 2013) stated consideration will be given to sectors where the potential for emissions reduction is limited.

3 Air Quality Baseline Evaluation

The baseline evaluation primarily comprises the assessment of near-site surface meteorology and available ambient concentrations and/ dust fallout rates as reported on previously.

3.1 Influencing meteorological conditions

Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the ventilation potential of the site. The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness.

Meteorological data from the weather station at Black Mountain Mine was made available for use in this assessment (P.D. Venter, personal communication, 10 Feb. 2017). The data set provided extent over the period July 2016 to January 2017, with data available between 68% and 69% of the period. The data set includes wind speed, wind direction, temperature, humidity, pressure and rainfall.

Wind roses represent wind frequencies for the 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

The available data indicate frequent winds from a northerly and north-north-westerly direction. Daytime airflow varies with predominantly north-north-westerly, south-westerly and east-south-easterly winds. At night, winds are mostly from the north-northwest (Figure 3-1).

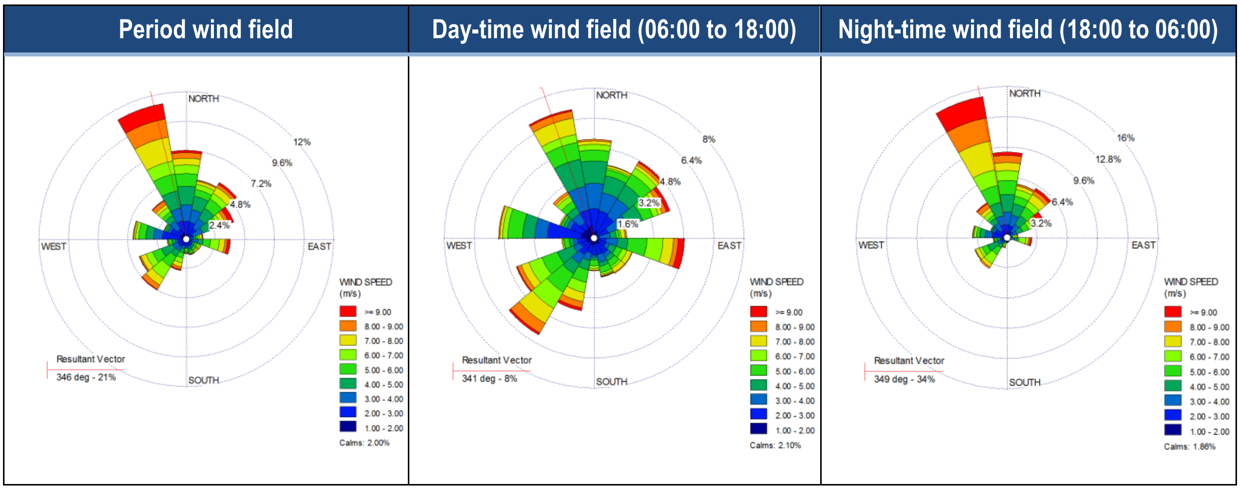

Figure 3-1: Period, day-, and night-time wind roses (Black Mountain Mine, Black Mountain Mine, 18 July 2016 to 10 January 2017)

The average wind speed over the July 2016 to January 2017 period was 4.7 m/s and calm wind conditions prevailed approximately 2% of the time. Wind class frequency distribution data is charted in Figure 3-2.

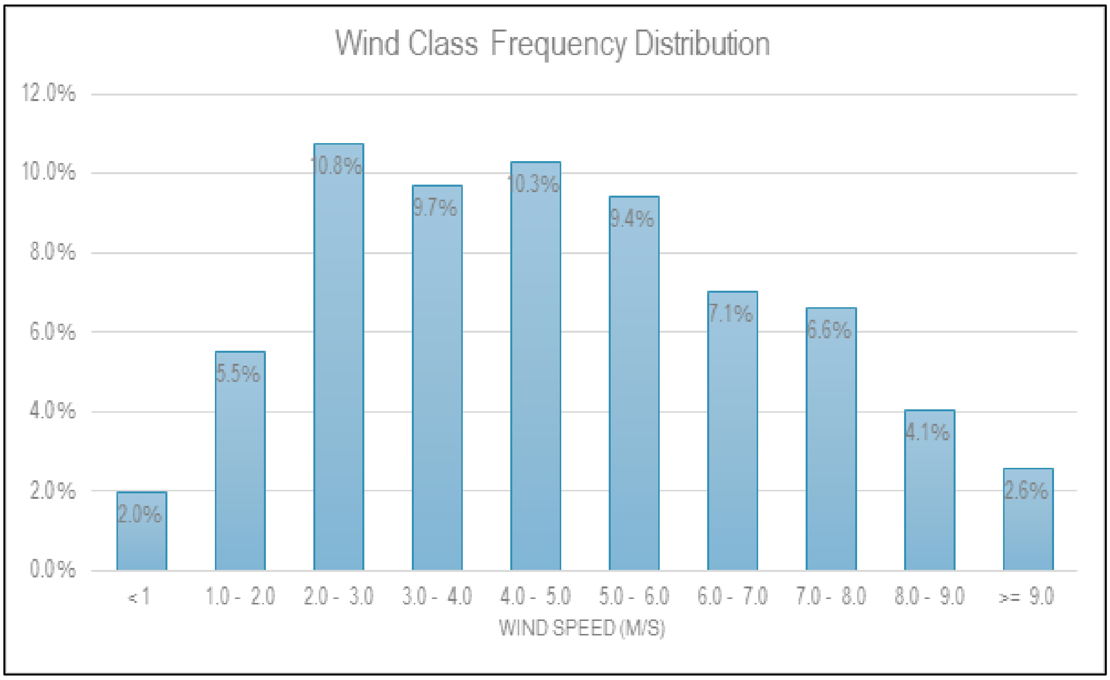

Figure 3-2: Wind class frequency distribution (Black Mountain Mine, July 2016 to January 2017)

Air temperature is an important parameter for the development of the mixing and inversion layers. It also determines the rate of dissipation of pollutants before it reaches ground level. Incoming solar radiation determines the rate of development and dissipation of the mixing layer. Relative humidity is an inverse function of ambient air temperature, increasing as ambient air temperature decreases. Temperatures during the period July 2016 to January 2017 ranged between 0.8°C (25 July 2016) to 39.8°C (31 December 2016). The average hourly temperature profile across the year is shown in Figure 3-3.

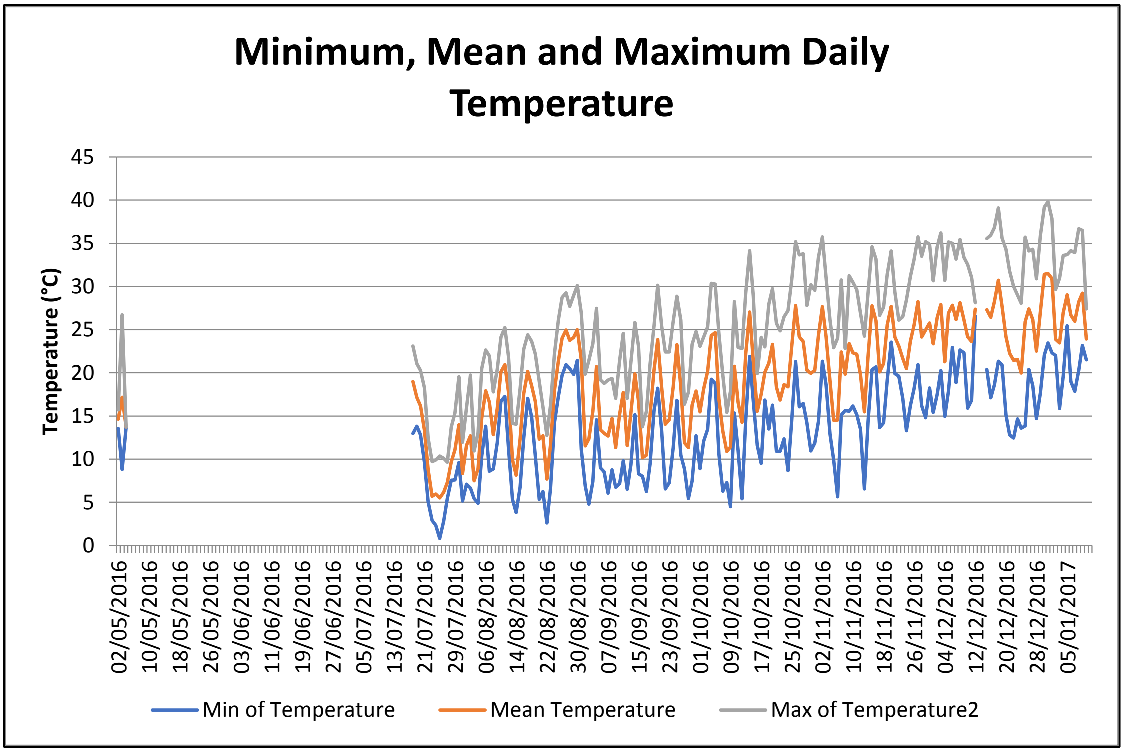

Figure 3-3: Temperature profile for the Black Mountain Mine (July 2016 to January 2017)

Precipitation represents an effective removal mechanism of atmospheric pollutants and is therefore frequently considered during air pollution studies. Rainfall data was included in the data set provided by Black Mountain Mine. During the period July 2016 to January 2017 a total of 37 mm was recorded at the station, with the highest monthly rainfall recorded in December 2016 (Figure 3-4).

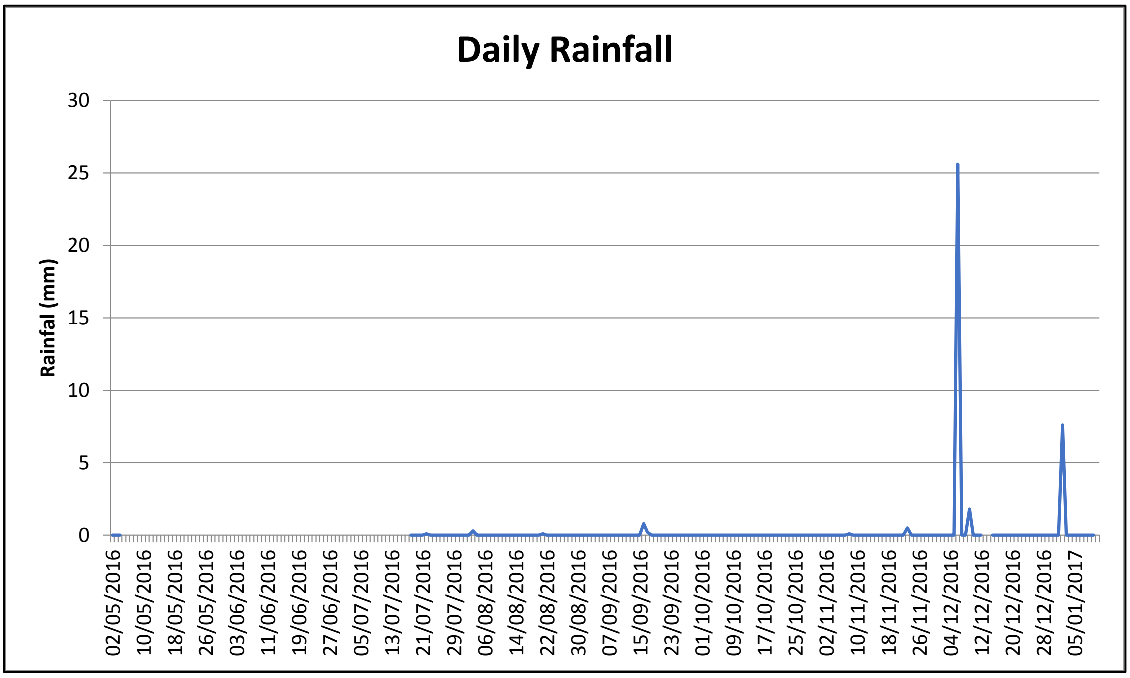

Figure 3-4: Rainfall (mm) recorded at the Black Mountain Mine (July 2016 to January 2017)

3.2 Status Quo of Air Quality

The consideration of the existing air quality is important so as to facilitate the assessment of the potential for cumulative air pollutant concentrations arising due to the proposed development. Sources of atmospheric emission in the study region include: mining activities, vehicle entrainment on paved and unpaved roads, and wind-blown dust from exposed areas. Given the restricted vehicle activity in the area, vehicle exhaust emissions are anticipated to be minimal. There are no industrial operations in the area.

3.2.1 Mining Operations

Operations at the Black Mountain Mine are most likely the largest contributor to particulate emissions in the vicinity. The proposed Gamsberg Opencast Mine will likely be the main source of particulate emissions in the area once it becomes operational. The air quality assessment concluded that the air quality in the area is likely to be affected negatively by the operational phase of the mine but that it can be reduced to a Minor significance with wet suppression methods (Dracoulides & Xu, March 2013).

Particulate emissions sources from mining operations mainly comprise of land clearing operations (i.e. scraping, dozing and excavating), mining operations (drilling and blasting, loading and unloading), materials handling operations (i.e. tipping, off-loading and loading, material transfer points), vehicle entrainment from roads, wind erosion from open areas and ventilation shaft emissions. These activities mainly result in fugitive dust releases with small amounts of NOx, CO, SO_2, methane and CO_2 being released during underground and proposed opencast blasting operations.

3.2.2 Fugitive Dust Sources

These sources are termed fugitive because they are not discharged to the atmosphere in a confined flow stream. Sources of fugitive dust identified to potentially occur in the study area include paved and unpaved roads; agricultural tilling operations; and wind erosion of sparsely vegetated surfaces.

3.2.3 Unpaved and paved roads

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the southern African context. The force of the wheels from vehicles travelling on unpaved road surfaces cause pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic and the silt loading on the roads.

Emission from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the resuspension of loose material on the road surface.

3.2.4 Wind erosion of open areas

Emissions generated by wind erosion are dependent on the frequency of disturbance of the erodible surface. Every time that a surface is disturbed, its erosion potential is restored (US EPA, 2006). Further erodible surfaces may occur as a result of agriculture and/or grazing activities.

3.2.5 Measured data

A baseline air quality study conducted by SRK between June and October 2009, found that PM_{10} concentrations at Aggeneys were well below the daily NAAQ limit of 75 µg/m³, except for one exceedance at the end of October 2009. Dust fallout, collected at and around the proposed Gamsberg Mine site, were high (> 1 200 mg/m²/day – non-residential level) during the months of July and September 2009 but below the residential limit (600 mg/m²/day) during the months of June, August and October 2009 (Dracoulides & Xu, March 2013).

4 QUALITATIVE AIR QUALITY ASSESSMENT

4.1 Emissions Quantification

Table 4-1 provides a list of sources of air pollution associated with the proposed construction activities expected in preparation of the project. The subsequent sections provide a generic description of the parameters influencing particulate emission generation from the various aspects identified.

Table 4-1: Activities and aspects identified for the construction phase of the proposed Central Tower project.

Pollutant(s)	Aspect	Activity
Particulates (TSP, PM_{10} & $PM_{2.5}$)	Construction of buildings and infrastructure	Land clearing activities such as dozing of vegetation and topsoil
		Grading of cleared land surfaces
		Windblown dust from exposed surface
	Vehicle activity on access and on-site temporary unpaved roads	Vehicle and construction equipment activity on the unpaved roads
	Increased vehicle activity on N14 national road	Vehicle entrained dust from paved road (N14)
	Material transfer	Cement transfer to and from silo Unloading of sand and stone aggregate Unloading of concrete Loading and unloading of topsoil
	Windblown dust	Topsoil piles Sand and aggregate storage piles Exposed surfaces
Gases and particles	Vehicle and construction equipment activity	Tailpipe emissions from vehicles and construction equipment such as graders, scrapers and dozers

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 will have their own duration and potential for particulate emission 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.

Information provided on the construction activities were used in the quantification of particulate emissions. Emissions inventories provide the source strength. In the quantification of these releases use was made of the predictive emission factors published by the US-EPA (EPA, 1996) and Australian NPI (Australian NPI Manual for Mining, 2012), since no local emission factors are available. The emission equations are provided in Table 4-2.

4.1.1 Grading and Scraping

Grading and scraping of unpaved road surfaces will give rise to particulate emissions. Graders typically have a blade at the bottom of the equipment removing the top layer of material from the surface. Scrapers work on the same basis but with the blade usually in front. Particulate emissions from graders can be calculated using the US-EPA emission factor for graders and take into account the average speed at which it travels (US EPA, 1996).

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4.1.2 Materials Handling

The handling of topsoil and gravel for construction operations could be a potential significant source of particulates at the various transfer points. The quantity of particulate emitted depends on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters, such as the nature and volume of the material handled. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increases in the moisture content of the material being transferred will decrease the potential for particulate emission, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles. The number of transfer points, the quantify of material, the moisture content of the material and the hourly wind speed will determine the TSP, PM_{10} and $PM_{2.5}$ emissions derived from the various transfer points.

Materials handling operations can be mitigated through water sprays that can result in a 50% reduction in particulate emissions (NPI, 2011).

4.1.3 Concrete batching

Concrete batching comprises of water, cement, sand (fine aggregate) and coarse aggregate. There is a possibility for an on-site batch plant which is would comprise of a central mix drum where the sand, aggregate, cement and water are mixed before being transferred to a transport truck. The raw materials will most likely be delivered to site with trucks.

The main pollutant of concern from concrete batching plants is particulate matter, consisting primarily of cement and pozzolan dust but including some aggregate and sand dust emissions. Most of the material will be stored in silos which can be fitted with fabric filters to control the dust emissions. Fugitive sources include the transfer of sand and aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion from sand and aggregate storage piles.

Controls include water sprays, enclosures, hoods, curtains, etc. A central mix hood is given to have 98% control efficiency (US EPA, 2006).

4.1.4 Vehicle entrainment on unpaved roads on-site

Vehicle-entrained particulate emissions from unpaved roads are significant sources of dust, especially where there are high traffic volumes on a road. The force of the wheels travelling on unpaved roads causes the pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of particulate emissions from unpaved roads will vary linearly with the volume of traffic expected on a road.

The magnitude of particulate emissions from paved and unpaved roads is a function of the “silt loading” present on the road surface, and to a lesser extent of the average weight of vehicles travelling on the road (Cowherd and Engelhart,1984; US EPA, 1996). Silt loading refers to the mass of silt-size material (i.e. equal to or less than 75 microns in diameter) per unit area of the travel surface. Silt loading is the product of the silt fraction and the total loading. The amount of particulates (TSP, PM_{10} and $PM_{2.5}$) can be estimated using the available EPA emission equations accounting for vehicle weight, number of trips and silt content (US EPA, 2006).

Mitigation measures indicate control efficiencies between 50% and 75% through water sprays and a 100% for sealed or salt encrusted roads (NPI, 2011).

4.1.5 Windblown particulates

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 particulates are generated 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).

The main sources of windblown particulates associated with the construction of the proposed project are likely to be: topsoil storage piles, the aggregate storage piles and cleared land that would be prone to wind-blown particulate emissions. Estimating the quantity of windblown particles to be generated from these sources is not a trivial task and requires detailed information on the particle size distribution, moisture content, silt content and bulk density.

Wind erosion will occur during strong wind conditions when wind speeds exceed the critical threshold required to lift and suspend the 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 area (Section 3.1) show an average wind speed of 4.7 m/s with the threshold wind speed (5.4 m/s) exceeded for 25% over the seven month period. Thus the likelihood of wind-blown dust is good especially during the windy months of August to October.

Moisture will act as a binding agent and reduce wind erosion emission by around 50%, depending on the amount of water applied. Alternatives include re-vegetation of temporarily exposed surfaces on which infrastructure will not be constructed (NPI, 2011).

Table 4-2: Emission equations used to quantify the emissions from the construction activities at the proposed CSP 1 Project

Activity	Emission Equation	Source	Information assumed/provided
Grading	$E_{TSP} = 0.0034 \cdot (S)^{2.5}$ $E_{PM10} = 0.0034 \cdot (S)^{2.0}$ Where, E = particulate emission factor in grams per vehicle km travelled (kg/VKT) S = mean vehicle speed (km/h)	NPI Section: Mining	The construction area was given as 930 ha with the actual area assumed to be 62% (9,306.47 m²/day) based on based on Land-Use Requirements for Solar Power Plants in the United States (Ong, Campbell, Denholm, Margolis, & Heath, June 2013). The grader speed was given as between 10 km/hr and 20/km, and the average of 15 km/hr was used. The VKT/day was calculated based on 12 operational hours (6Am – 6PM) assuming 80% availability. Mitigation is given as 50% control efficiency through water sprays.
Scraping	$E_{TSP} = 2.08\ \text{kg/VKT}$ $E_{PM10} = 0.52\ \text{kg/VKT}$ Where, E = particulate emission factor in grams per vehicle km travelled (kg/VKT)	NPI Section: Mining	The construction area was given as 930 ha with the actual area assumed to be 62% (9,306.47 m²/day) based on based on Land-Use Requirements for Solar Power Plants in the United States (Ong, Campbell, Denholm, Margolis, & Heath, June 2013). The grader speed was given as between 10 km/hr and 20/km, and the average of 15 km/hr was used. The VKT/day was calculated based on 12 operational hours (6Am – 6PM) assuming 80% availability. Mitigation is given as 50% control efficiency through water sprays.
Materials handling	$E = 0.0016 \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}}$ Where, E = Emission factor (kg dust / t transferred) U = Mean wind speed (m/s) M = Material moisture content (%) The PM_{10} and TSP fraction of the emission factor is 35% and 74% respectively.	US-EPA AP42 Section 13.2.4	An average wind speed of 4.7 m/s was used based on the meteorological data for the project site for the period July 2016 – January 2017 (Section 3.1). The amount of topsoil was calculated assuming a depth of 30 cm over the actual land clearing area, and a soil density of 1 682.67 kg/m³ (from soil report) equating to 4 697.91 tpd. The amount of building mix to be off-loaded on-site was based on the information provided on bulk construction material of 1 065.21 tpd. Mitigation is given as 50% control efficiency through water sprays.

Activity	Emission Equation	Source	Information assumed/provided
Concrete batching	$$E_{TSP} = 0.572 \text{ lb/ton}$$ $$E_{PM10} = 0.156 \text{ lb/ton}$$ Where, E = particulate emission factor for central mix in pounds pounds per ton of cement and cement supplement loaded (lb/ton)	US-EPA AP42 Section 11.12	The amount of building mix on-site was based on the information provided on bulk construction material of 1 065.21 tpd. Mitigation is given as 98% with a Central mix hood
Vehicle entrainment on unpaved surfaces	$$E = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b} \cdot 281.9$$ Where, E = particulate emission factor in grams per vehicle km travelled (g/VKT) k = basic emission factor for particle size range and units of interest s = road surface silt content (%) W = average weight (tonnes) of the vehicles travelling the road The particle size multiplier (k) is given as 1.5 for PM_{10}, and as 4.9 for TSP The empirical constant (a) is given as 0.9 for PM_{10}, and 4.9 for TSP The empirical constant (b) is given as 0.45 for PM_{10} and TSP.	US-EPA AP42 Section 13.2.2	In the absence of site specific silt data, a silt content of 8.4% was assumed (generic value for Construction sites). The capacity of the haul trucks to be used was given as 30 ton. The layout of the roads was provided – Alternative route 1 and Alternative route 2. The number of truck trips per day was provided by the Transport Study as 22 trips/day. The length of Alternative route 1 was estimated as 12.4 km, resulting in 545.6 VKT/day. The length of Alternative route 2 was estimated as 29.7 km, resulting in 1,307.7 VKT/day. Mitigation is given as 75% control efficiency through regular water sprays.
Wind Erosion	$$E_{TSP} = 0.4\frac{\text{kg}}{\text{ha}}/\text{hr}$$ $$E_{PM10} = 0.2\frac{\text{kg}}{\text{ha}}/\text{hr}$$ Where, E = particulate emission factor for windblown dust from storage piles in kilogram per hectare per hour	NPI Section: Mining	The exposed construction area was taken to be 38.75 ha/month. The exposed topsoil storage pile was taken to be 8.38 ha/month. The exposed sand storage pile was taken to be 0.39 ha/month. The exposed aggregate storage pile was taken to be 0.79 ha/month No mitigation.

4.2 Qualitative Impact Assessment

The temporary nature of the construction activities, and the likelihood that these activities will be localised and on small areas at any given time, reduces 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 quarry type operations occur without blasting and a distance of 500 m when blasting will take place (AEPA, 2000).

Only the potential impacts from PM_{10} emissions on the surrounding environment and human health were assessed. Modelling was done using SCREEN3[1] to get an indication of the potential health impact distance and significance. The SCREEN3 model cannot simulate dust fallout rates and it was therefore not assessed.

The closest residential receptors are located approximately 21 km to the north-east (Achab Farm) and 14 km to the north (Aggeneys) from the proposed CSP 1 project location.

4.2.1 Potential impacts from the CSP 1 Construction site

The calculated PM_{10} emissions from the mining operations were combined for modelling. Emission rates were combined for scraping, grading, tipping, concrete batching and wind erosion and modelled as an area source. Modelled impacts are shown as a line graph – PM_{10} concentrations in relation to the distance from the construction site – for the unmitigated option (Figure 4-1) and the mitigated option (Figure 4-2). The applied mitigation measures and resulting controls are listed in Table 4-2.

The potential for PM_{10} impacts from the unpaved access routes road was assessed separately, and reported on in the subsequent subsection (Section 4.2.2).

The maximum impact from the construction operations are at a distance of 100 m from the CSP 1 site with 24-hour PM_{10} unmitigated ground level concentration of 41.7 µg/m³, falling within the NAAQ limit of 75 µg/m³. With the listed mitigation measures applied, the PM_{10} daily concentration reduces by 61% to 16.2 µg/m³ at 100 m from the site. From 5 km from the site, there are no impacts predicted.

The assessment could not account for dust fallout impacts from the construction operations and these are expected to be high on-site but also would reduce significantly with distance from the site. Larger particles of between 10 and 30 µm would typically settle within 500 m with coarse particles (greater than 30 µm) deposited within 100 m from the source.

[1] The South African Regulations on Dispersion Modelling (DEA, 2014) indicates that screening models, such as the US EPA SCREEN3, are adequate in Level 1 screening assessments which aim to reflect the worst-case air quality impacts. The purpose of these Level 1 assessments is to preliminary identify air quality issues associated with new sources and to determine if more detailed assessments are needed. SCREEN3, a Gaussian plume model that can provide maximum ground level concentrations for point, area, flare, and volume sources were used in this assessment (US EPA, 1992).

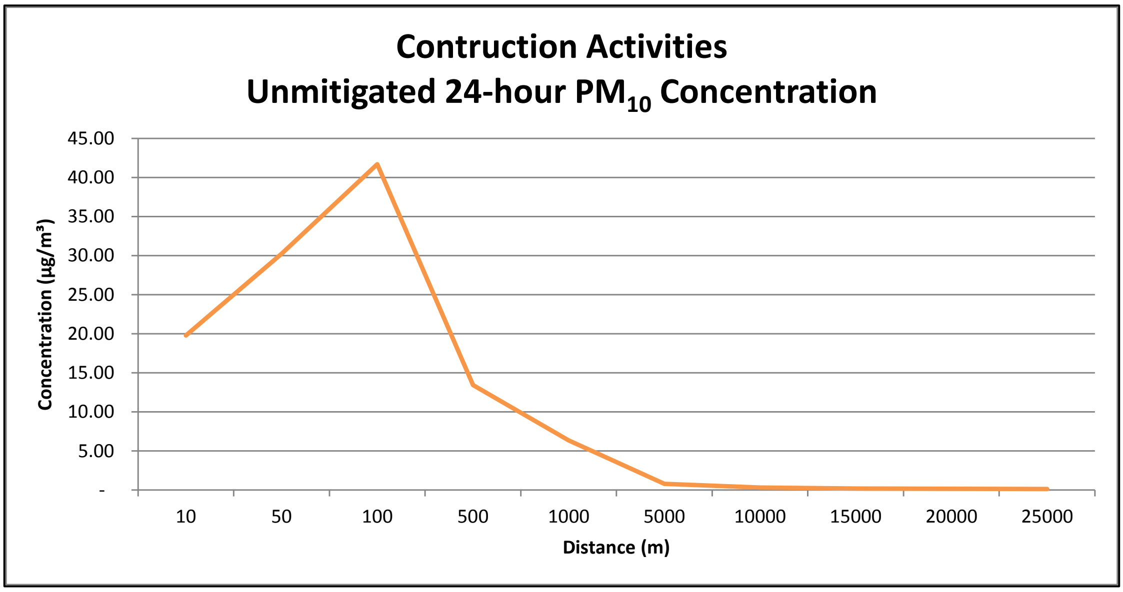

Figure 4-1: Predicted PM_{10} concentrations as a distance from the CSP 1 construction site – Unmitigated

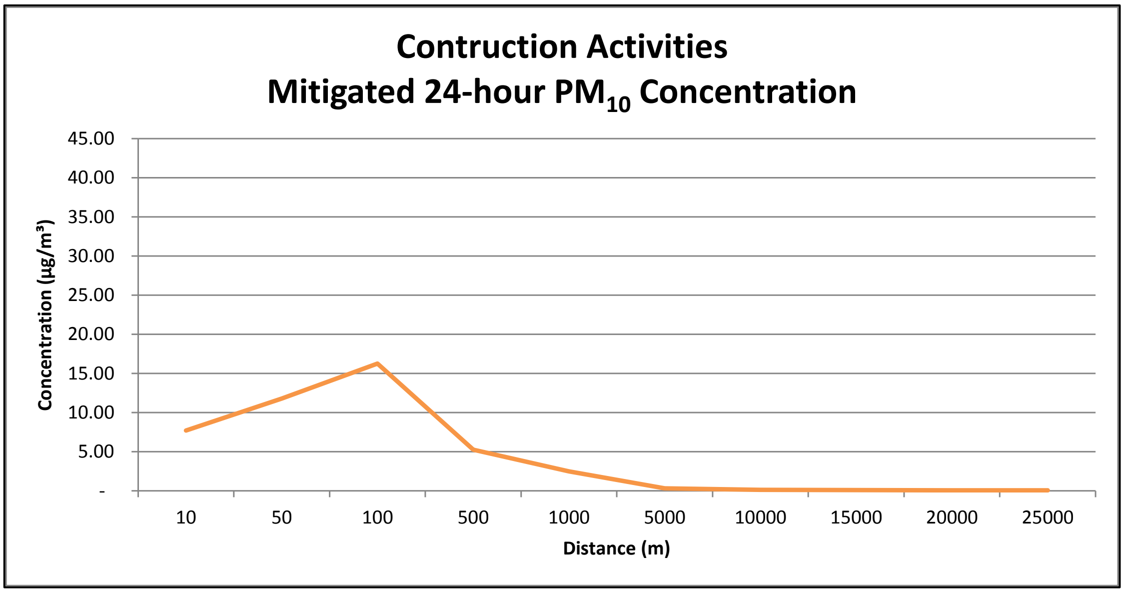

Figure 4-2: Predicted PM_{10} concentrations as a distance from the CSP 1 construction site – Mitigated

4.2.2 Potential impacts from Alternative Routes 1 and 2

Two access road alternatives were provided, with Alternative 1 (12.4 km long) and Alternative 2 (29.7 km long). The access road was modelled using SCREEN3 with the road as an area source, assuming a width of 6 m and a modelling length of 60 m (the model has an aspect ratio of 1:10). The predicted impacts are therefore a “snapshot” of what amount of PM_{10} concentrations would result from any 60 m portion of the road, at any given time. This would be the same for both routes since the number of truck trips would be the same. The only difference is that the impacts would be along a longer road for Alternative 2.

The PM_{10} 24-hour ground level concentrations for the unmitigated unpaved road are shown in Figure 4-3 and the mitigated, assuming 75% control efficiency due to water sprays, in Figure 4-4.

The maximum impact distance from the access road for the unmitigated scenario is between 50 m and 100 m with a 24-hour PM_{10} ground level concentration of 6.7 µg/m³ and 7.5 µg/m³, respectively. The impacts deplete rapidly within 500 m down to a concentration of less than 1 µg/m³. These are well below the selected ambient AQ PM_{10} limit of 75 µg/m³. With mitigation applied, the predicted impacts reduce by 77%, with no impacts from a distance of 500 m from the road.

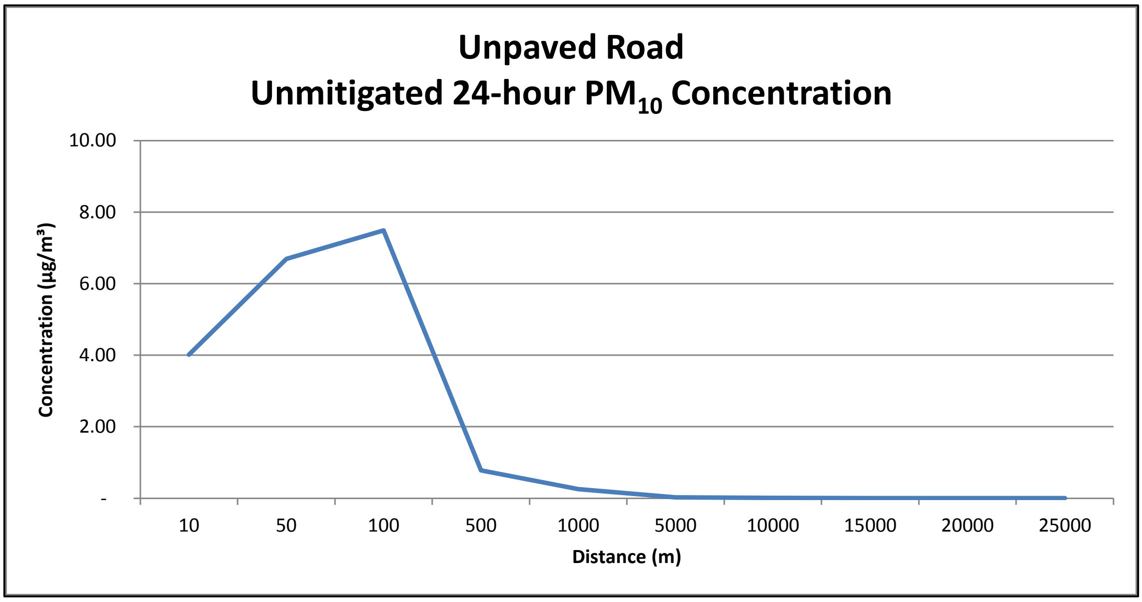

Figure 4-3: Predicted PM_{10} concentrations as a distance from the access road – Unmitigated

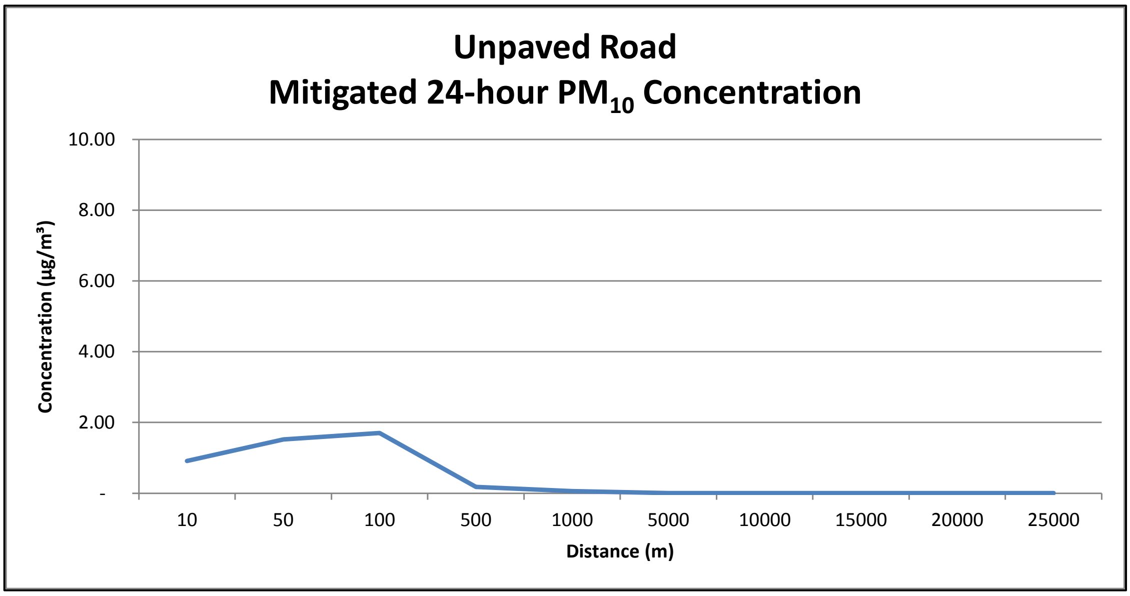

Figure 4-4: Predicted PM_{10} concentrations as a distance from the access road – Mitigated

4.3 Dust Management Plan

Based on the semi-quantitative evaluation of the proposed CSP Central Tower Project 1, generic management objectives are provided in Table 4-3. The management and monitoring of all operations at the proposed facility should be evaluated on a daily basis and appropriate actions taken to minimise particulate emissions and impacts.

Table 4-3: Air Quality Management Plan for the proposed Concentrating Solar Power (CSP) Central Tower Project 1 near Aggeneys

ASPECT	IMPACT	MANAGEMENT ACTIONS/OBJECTIVES	RESPONSIBLE PERSON(S)	TARGET DATE
Construction operations				
Land clearing activities such as dozing and scraping of vegetation and topsoil	PM_{10} and $PM_{2.5}$ concentrations and dustfall	Water sprays to be applied at the area to be cleared should significant amounts of dust be generated. Moist topsoil will reduce the potential for dust generation when tipped onto stockpiles. As much vegetation as possible should be retained, including patches and strips to minimise dust. Ensure travel distance between clearing area and topsoil piles to be at a minimum.	SM/EM Contractor(s)	Pre- and during construction
Material transfer points	PM_{10} and $PM_{2.5}$ concentrations and dustfall	Water sprays to be applied at all transfer points (I.e. loading and unloading of trucks, moving of topsoil and aggregates, etc.). Minimise the tip height as far as possible to reduce the potential for dust to be blown away. Ensure travel distance between clearing area and topsoil piles to be at a minimum.	SM/EM Contractor(s)	During construction
Concrete batching	PM_{10} and $PM_{2.5}$ concentrations and dustfall	The raw material should be stored in on-site silos with bag filters to control the dust emissions. A central mix hood would result in 98% control efficiency. All other fugitive sources (transfer of sand and aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion from sand and aggregate storage piles) can be controlled through the application of water sprays, enclosures, hoods, curtains, etc.,	SM/EM Contractor(s)	During construction
Vehicle entrainment on unpaved roads		Regular water sprays on unpaved roads to ensure at least 75% control efficiency. Conduct regular visual inspections to ensure the surface remains moist.	SM/EM Contractor(s)	Ongoing and post-operational
Wind erosion from exposed areas	PM_{10} and $PM_{2.5}$ concentrations and dustfall	Ensure exposed areas remain moist through regular water spraying during dry, windy periods. Vegetate topsoil stockpiles as soon as possible. Have an enclosed area (even if with netting to act as wind breaks) around the aggregate and sand stockpiles.	SM/EM Contractor(s)	Ongoing and post-operational

Notes:

SM = Site Manager / EM = Environmental Manager

(a) Non-residential dustfall limit (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.

(b) Residential dustfall limit (600 mg/m².day) not to be exceeded for two sequential months and not more than three exceedances in a year.

5 Conclusion

5.1 Main Findings

The main findings from the semi-quantitative assessment of the proposed CSP Central Power Project 1 are as follow:

- **Construction operations:** The screening assessment indicates that the area most likely to be impacted on by construction activities are at maximum 100 m from the proposed CSP 1 site, but with 24-hour PM_{10} ground level concentrations below the AQ limit of 75 µg/m³ and 61% lower with the application of the proposed mitigation measures. For the access road (both Alternative 1 and 2) the impacts are the highest between 50 m and 100 m but PM_{10} concentrations are well below the NAAQ limit of 75 µg/m³. With mitigation in the form of water sprays, the impacts are likely to reduce by 77%. Dust fallout rates could not be determined but the potential exists for exceedances of the residential dustfall limit (600 mg/m²/day) near the Construction site (up to 100 m away) and close to the road (within 50 m). With mitigation in place, primarily comprising of water sprays, these impacts would be limited.
- **Operational Phase operations:** Emissions to air associated with the operational phase would only result from maintenance vehicles. These are regarded as insignificant.
- **Decommissioning phase:** The decommissioning phase will mainly include materials handling activities, wind erosion and to a lesser extent vehicle and equipment movement on-site and on the access road.

5.2 Conclusion

From an air quality perspective the construction of the proposed Letsoai CSP Central Tower Project 1 is likely to have low impacts on the receiving environment and human health provided mitigation measures are in place. Alternative 2 is the preferred access road since it is shorter and would result in lower particulate emissions.

5.3 Recommendations

Construction should only be allowed with a mitigation and management plan in place, indicating mitigation measures the application frequency thereof. Mitigation measures as proposed in Section 17 should be applied during construction.

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