Arrowsmith North Silica Sand Project

Air Emissions Desktop Assessment

Final Report

Version 3

Prepared for VRX Silica Limited

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Arrowsmith North Silica Sand Project

Final Report

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Signature

Karla Hinkley

Executive Summary

VRX Silica Limited (VRX) is seeking to develop the Arrowsmith North Silica Sand Project (the Proposal), located in the Mid-West region of Western Australia (WA), approximately 270 kilometres (km) north of Perth. The Proposal is in the Geraldton Sandplain bioregion of WA, in an area of high biodiversity.

The Proposal involves the development of a sand mine that will produce a high-grade silica sand via extraction and mechanical upgrading. An important feature of the Proposal is the use of sequential block mining and Vegetation Direct Transfer (VDT) rehabilitation methods, which minimises the total of all cleared areas within the Development Envelope to no more than 10 hectares (ha) at any time (i.e. excluding rehabilitation areas).

The life of the Proposal is estimated to be 30 years, with additional reserves available that could extend this mine life (pending approval).

A desktop air quality assessment has been conducted for the Proposal to determine the potential air quality impacts posed by the Proposal. Referencing the Environmental Protection Authority's (EPA, 2021) determination of the level of assessment, this assessment specifically addressed:

- dust emissions from the various stages of project development
- combustion emissions from the project's power station
- vehicle exhaust emissions.

Overview of assessment

The potential air quality impacts of the Proposal were determined based on consideration of:

- nature and scale of the Proposal
- key pollutants of concern and potential emission sources
- separation distance to surrounding sensitive receptors (residences)
- proposed dust controls incorporated into the design of the Proposal and management practices that will be available to minimise dust generation
- results of a screening model for emissions of products of combustion (NOx, SO_2 and CO) from the gas fired power station and from diesel vehicle usage on site
- other relevant factors that could potentially influence the extent of impacts, such as terrain, prevailing meteorology, and dust characteristics (physical properties, particle size, composition).

Key findings

The key findings of the assessment are:

Separation Distance

- The area surrounding the Project site is very sparsely populated, within just three residential developments (residences) located within a 5 km radius.

- The separation distance between the Proposal and the surrounding sensitive receptors (residences) far exceeds the recommended generic buffer distance of 300 m to 500 m for an 'Extractive Industry - sand and limestone extraction' (EPA, 2005):
  - at least 3,300 m from the processing plant
  - at least 3,200 m from the mining operation
  - at least 1,700 m from the proposed haulage road (to the Brand Highway).
- As the separation distances provide a considerably larger buffer around the Proposal, the potential for emissions to impact upon the air quality at sensitive receptors or to cause adverse amenity impacts are minimised.

Dust Characteristics

- The physical properties of silica sand (hardness, specific gravity) generally make it less susceptible to dust generation from particle attrition and wind erosion, however low porosity can act to reduce the effectiveness of wetting down of surfaces for dust abatement.
- Dust is of a similar colour to the underlying soils in the area, and therefore less likely to be of concern in terms of adverse amenity impacts from dust deposition.
- The impurity level of silica sand is very low and very stable, therefore any trace metals and other elements are not expected to be leeched during processing, and rather will remain bound within the silica sand as occurs naturally.
- The Particle Size Distribution (PSD) testing shows the fraction of PM_{10} is relatively low in the various materials handled:
  - 0.1% in commercial grade silica sand product
  - 1.8% in raw (in-situ) silica sand
  - 4.6% in reject material.
- The in-situ content of Respirable Crystalline Silica (RCS) in the materials handled is extremely low and unlikely to present a potential health risk at sensitive receptors (residences).

Dust Sources and Controls

- A key feature of the Proposal is the use of sequential block mining and VDT rehabilitation techniques which limit the extent of open areas susceptible to wind erosion through staged clearing and progressive rehabilitation.
- The Processing Plant uses gravity and magnetic separation (wet processes) to upgrade to a commercial grade silica sand. There is no crushing, grinding or dry screening involved in the processing of silica sand.
- Various other conventional design features and management practices will also be employed to ensure dust generation can be maintained within acceptable levels.

Combustion Emissions

- Combustion emissions from the power station and diesel vehicle exhausts have been shown, using a screening model, not to be significant in terms of their potential to cause adverse air quality impacts at sensitive receptors (residences).

- Detailed (refined) air dispersion modelling of combustion emissions from the Proposal is not considered to be warranted.

Vegetation Impacts

- In terms of ecologically sensitive receptors in the area, the closest conservation reserves are located at least 5 km away. The separation distance between the Proposal and the closest conservations reserves far exceeds the recommended generic buffer distance established for protection of amenity (EPA, 2005), considered in the context of this Proposal to be a suitable proxy for the assessment of potential effects upon vegetation from dust deposition.

- Native vegetation in the Midwest region is expected to be reasonably tolerant to dust deposition and at minimal risk of physiological impacts.

Having regard to the key findings of the desktop air emissions assessment it is considered unlikely that the Proposal will have a significant impact on air quality. The nature and scale of the Proposal, and the separation distance to surrounding sensitive receptors (residences) is such that adverse impacts to human health and amenity are not expected to occur. Similarly, the Proposal is not expected to adversely impact native vegetation as a result of dust deposition. Additionally, through the implementation of the proposed dust controls airborne dust generation can be maintained within acceptable levels.

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1 Introduction

1.1 Background

VRX Silica Limited (VRX) is seeking to develop the Arrowsmith North Silica Sand Project (the Proposal) located in the Mid-West region of Western Australia (WA), approximately 270 kilometres (km) north of Perth (Figure 1-1). The Proposal is in the Geraldton Sandplain bioregion of WA, in an area of high biodiversity. The Proposal involves the development of a sand mine that will produce a high-grade silica sand via extraction and mechanical upgrading.

The Proposal lies primarily within mining lease M70/1389. There are two sites which make up the Arrowsmith Silica Sand Project, Arrowsmith North (M70/1389) and Central (M70/4987). The Proposal is for the Arrowsmith North Silica Sand Project only. The Development Envelope for the Proposal covers an area of 1,025 hectares (ha), of which no more than 360 ha will be cleared to establish the mine, processing plant and other infrastructure. The life of the Proposal is estimated to be 30 years, with additional reserves available that could extent this mine life (pending approval).

An important feature of the Proposal is the use of sequential block mining and Vegetation Direct Transfer (VDT) rehabilitation methods. Sequential block mining of silica sand is performed in relatively small areas (blocks covering an area of typically 150 metres (m) x 150 m) and VDT, as the name suggests, involves the direct transfer of topsoil and vegetation to rehabilitation areas (refer to Section 2.1). In this way, the total of all cleared areas within the Development Envelope is to be no more than 10 ha at any time (i.e. excluding rehabilitation areas).

Mined sand is processed through the Mine Feed Plant (MFP), comprised of a hopper, conveyor and trommel screen, before being piped as a slurry to the Processing Plant that uses gravity and magnetic separation to produce the commercial grade silica sand product (refer to Section 2.1). Dry product is stockpiled on site, prior to being transported using haul trucks to the Geraldton Port for export. Reject material (slime) will be deposited into a dewatered tailings stack before being packaged for sale in the local market.

Other elements of the Proposal include a moveable surface conveyor, slurry pipeline, freshwater supply bore, site access corridors and natural gas fired power station. Associated infrastructure includes water storage, laydown areas, workshop and administration buildings.

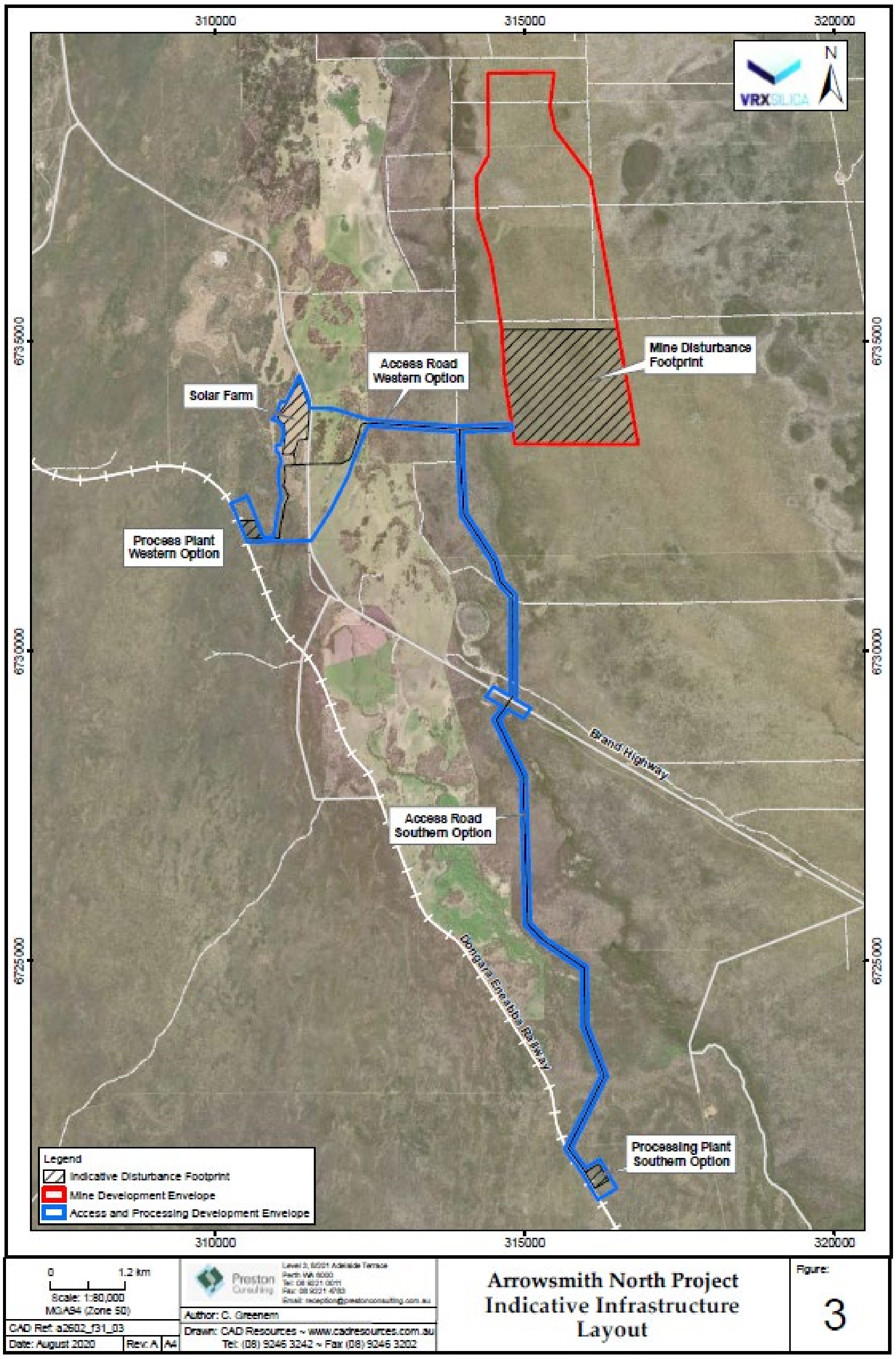


Figure 1-1: Project location and setting (Preston, 2021)

1.2 Regulatory context

The Environmental Protection Authority (EPA) has determined that the Proposal is to be assessed under Part IV of the *Environmental Protection Act 1986* (EP Act) as a Public Environmental Review (PER). Air Quality has been identified as a preliminary key environmental factor, based upon the potential impacts from the power station and vehicle exhaust emissions, and dust (inclusive of clearing, construction, and operation) (EPA, 2021).

The following key regulatory policy and guidance has been referenced:

- Guidance on Separation Distances between Industrial and Sensitive Land Uses (EPA, 2005)
- Environmental Factor Guideline – Air Quality (EPA, 2020)
- Guideline - Dust Emissions, draft for external consultation (DWER, 2021)
- Guideline - Air Emissions, draft for external consultation (DWER, 2019)

It is noted that while the guidelines for Dust Emissions (DWER, 2021) and Air Emissions (DWER, 2019) are in draft they are subject to change as an outcome of public consultation. Nevertheless, these guidelines have been adopted to inform the assessment approach.

1.3 Scope of work

VRX commissioned Environmental Technologies and Analytics (ETA) to conduct a desktop assessment into the potential air quality impacts posed by the Proposal, specifically in relation to:

- dust emissions from the various stages of project development
- combustion emissions from the power station
- vehicle exhaust emissions.

This independent technical advice has been based on consideration of:

- distance to sensitive receptors compared to generic separation distances recommended for sand extraction (no grinding or milling) and screening or sieving of sand
- description of major dust sources associated with the Project development and proposed controls, corrective and contingency actions, including (but not limited to);
    - rehabilitation using Vegetation Direct Transfer to minimise areas prone to wind erosion
    - design features and dust control measures for dry material handling and storage
    - measures to limit wheel-generated dust from truck haulage on unsealed roads
- potential characteristics of the dust emitted that will influence the potential health or amenity impacts, drawing on the characteristics of the raw silica sand, silica sand product and dewatered tailings in terms of particle size, density, composition and colour
- prevailing meteorology and topographic influences in the context of nearest sensitive receptors and other areas of interest such as nature reserves
- significance of estimated combustion emissions from the natural gas power station and vehicle exhaust, assessed in accordance with a recognised screening analysis approach.

2 Project Overview

2.1 Project Description

The Proposal is to develop a high-grade silica sand mine located approximately 270 km north of Perth in the Geraldton Sandplain bioregion of WA. The Proposal will produce a high-grade silica sand via extraction and mechanical upgrading.

The Proposal includes the sequential block mining of silica sand, development of a mine feed plant, moveable surface conveyor, pipeline, processing plant, freshwater supply bore, access corridor, laydown, administration, water storage and associated infrastructure including: natural gas fired power station, communications equipment, offices, workshop and laydown areas.

The life of the Proposal is estimated to be 30 years, with additional reserves available that could extend this mine life (pending approval).

For the purpose of this assessment, the critical aspects of the Proposal that are significant in terms of potential to generate emissions include:

Sequential block mining of silica sand:	This will involve sequentially mining 8 – 15 m of sand from below the surface of the soil profile. Mining will be performed in sections by removing blocks (typically 150 m x 150 m), with an estimated five blocks being mined per year. Conventional dry mining methods will be employed using front end loaders.
Vegetation Direct Transfer (VDT)	The rehabilitation technique VDT, or community translocation, is the practice of salvaging and replacing sods of vegetation with the underlying soil intact for direct transfer to rehabilitation areas. There are numerous advantages to utilising VDT as a rehabilitation technique, including faster re-vegetative process thereby minimising the disturbed area susceptible to wind erosion. As such, the Proposal has a relatively small annual mining footprint (a maximum of 12 ha per year). The complete mining sequence using the VDT process is shown in a video prepared by VRX and is accessible via the following link: https://www.vrxsilica.com.au/miningandrehabilitationmethodology/
Mine Feed Plant (MFP)	Mined sand is processed through the MFP comprised of a hopper, conveyor and trommel screen. The hopper and conveyor components will be relocatable according to the mining area sequencing. Dry silica sand extracted from the mine face will be tipped across a dump hopper with static grizzly bars to remove oversize rocks and large organic material. The bin will meter feed out to a feed conveyor which will transfer feed to the mouth of a rotating trommel (wet screening/washing process), prior to transfer via the slurry pipeline to the Processing Plant.
Processing Plant	The Processing Plant uses gravity and magnetic separation (wet processes) to upgrade to a commercial grade silica sand. Upgraded sand is pumped to a dewatering screen for drying, and clean dry product is stockpiled using a radial stacker conveyor in preparation for export.

Product Load Out	Dry, commercial grade silica sand will be reclaimed from the final product stockpile by front-end loaders, loaded onto trucks and transported to the Geraldton port via the proposed haulage road (5.6 km unsealed) connecting to the Brand Highway (sealed).
Reject Material	Reject material (slimes) will report to a thickener tank with flocculant addition to create a single plant tail. The thickener will utilise a pressure sensor activated underflow pump which will deposit densified tails into a dewatered tailings stack before being packaged for sale in the local market.
Power Supply	Power will be generated from a 5 MW natural gas fired base load power station that will be established at the Processing Plant site.

2.2 Key Pollutants

Based on the project description and referencing the EPA advice on the preliminary key environmental factors for the Proposal (refer to Section 1.2), the key pollutants of interest are summarised in Table 2-1.

Table 2-1: Key air pollutants of interest

Pollutant	Description	
Particulate Matter (PM)	Airborne particles are a broad class of diverse substances that may be solid or liquid (liquid particles are often called aerosols) and are produced by a wide range of natural and human activities. Airborne particles are commonly classified by their size as total suspended particles (TSP), visibility reducing particles (PM_2), and inhalable particles (coarse fraction PM_{10} and fine fraction $PM_{2.5}$). **Project mining and processing activities that involve the handling of dry materials are a potential source of PM. Periodically, windblown dust from exposed areas and stockpiles and wheel-generated dust truck haulage will also be sources of PM. Combustion emissions from the natural gas-fired power station and vehicle exhaust emissions from the mining and truck haulage fleet are expected to be minor contributing sources.**	
	PM_{10}	Inhalable particles are grouped into two size categories: those with a diameter of up to 10 µm (PM_{10}) and those with a diameter of up to 2.5 µm ($PM_{2.5}$). Inhalable particles are associated with increases in respiratory illnesses such as asthma, bronchitis and emphysema, with an increase in risk related to their size, chemical composition and concentration. Particles in the PM_{10} size fraction have been strongly associated with increases in the daily prevalence of respiratory symptoms, hospital admissions and mortality.
	$PM_{2.5}$	Particles in the $PM_{2.5}$ size fraction can be inhaled more deeply into the lungs than PM_{10}, and have been associated with health effects similar to those of PM_{10}. There is some evidence to suggest that $PM_{2.5}$ might be more deleterious to health than other size fractions. No lower limit for the onset of adverse health effects has yet been observed.

Pollutant	Description	
	Deposited dust	Deposited PM is dust that, because of its aerodynamic diameter and density, falls from the air due to gravitational settling and deposits onto surfaces. The effects of deposited dust are primarily considered as an amenity issue. There is also the potential for deposited dust to have an effect upon the health of susceptible vegetation by adversely affecting photosynthesis and transpiration rates.
Products of Combustion	NO_2	Nitrogen dioxide (NO_2) is a brownish gas with a pungent odour. It exists in the atmosphere in equilibrium with nitric oxide. The mixture of these two gases is commonly referred to as nitrogen oxides (NOx). Nitrogen oxides are a product of combustion processes, and can arise when flame staging is non-ideal and nitrogen present in air is oxidised. Nitrogen dioxide can cause damage to the human respiratory tract, increasing a person's susceptibility to respiratory infections and asthma. Sensitive populations, such as the elderly, children, and people with existing health conditions are most susceptible to the adverse effects of nitrogen dioxide exposure. Nitrogen dioxide can also cause damage to plants, especially in the presence of other pollutants such as ozone and sulphur dioxide. Nitrogen oxides are also present in the reactions that lead to photochemical smog formation. **Combustion emissions from the natural gas-fired power station and vehicle exhaust emissions from the mining and truck haulage fleet are sources.**
	SO_2	Sulphur dioxide (SO_2) is a strong-smelling, colourless gas that can irritate the lungs, and can be particularly harmful for people with asthma. SO_2 and other sulphur oxides can react with compounds in the atmosphere to form fine particles that reduce visibility (haze formation). **Combustion emissions from the natural gas-fired power station and vehicle exhaust emissions from the mining and truck haulage fleet are sources.**
	CO	Carbon monoxide (CO) is a colourless, odourless gas. When inhaled, CO is rapidly absorbed into the bloodstream from the lungs. At extremely high exposures this can cause the formation of carboxyhaemoglobin which decreases the body's ability to carry oxygen. Long term (chronic) health effects from exposure to low levels of CO may produce heart disease and damage to the nervous system. **Combustion emissions from the natural gas-fired power station and vehicle exhaust emissions from the mining and truck haulage fleet are sources.**

2.2.1 Respirable Crystalline Silica

The commercial grade silica sand that will be produced from this Project is comprised of 99% quartz (Microanalysis Australia, 2021a), the most common crystalline silica polymorph. The minerals cristobalite and tridymite are other polymorphs of crystalline silica, with the same composition (SiO_2) but differ in the crystalline structure.

When material containing crystalline silica is crushed, cut or worked in some way, fine fractions of dust are released into the atmosphere. The respirable fraction of silica dust particles, commonly referred to as respirable crystalline silica (RCS), are small enough to penetrate deeply into the lungs and can cause irreversible lung damage. The International Agency for Research on Caner (IARC) classifies RCS as carcinogenic to humans (Group 1). The non-crystalline or amorphous forms of silica do not cause this kind of lung damage.

To upgrade the raw (in-situ) silica sand to a commercial grade silica sand product, wet processes involving gravity and magnetic separation are principally used (refer to Section 2.1), and there is no crushing, grinding or dry screening involved. As quartz is a relatively hard mineral it is not susceptible to attrition (refer to Section 4.2.1.1), and therefore the mining and processing of silica sand does not 'generate' RCS in the same way as drilling or crushing activities for example can generate RCS.

It is therefore only the in-situ content of RCS in the materials being handled that is of potential concern, which has been confirmed through analytical testing to be present at very low levels (refer to Section 4.2.1.4). Accordingly, RCS has not been identified as a key pollutant for the purpose of this assessment.

2.3 Emission Sources

Based on the description of the Proposal and referencing the EPA advice on the preliminary key environmental factors for the Proposal (refer to Section 1.2), the potential emission sources are summarised in Table 2-2.

The focus has been placed on emission sources from the operational phase of the Proposal, rather than the construction phase. Construction emissions from this Proposal does not represent a significant potential impact because of the sequential block mining approach that involves progressive clearing of very small areas (150 m x 150 m) over the life of mine. Further, the total footprint of the Processing Plant and associated infrastructure (8 ha) is relatively small, with construction related emissions expected to be short term and transient in nature.

Table 2-2: Potential emission sources

Source	Description of activities
Mining	• Material handling of dry silica sand during mining, including: ○ excavation by front end loader ○ tipping to dump hopper ○ conveyor. • Material handling of surface of the soil profile for VDT rehabilitation. • Wheel generated dust from front-end loader. • Wind erosion from open areas. • Exhaust emissions from diesel industrial vehicles.
Processing Plant	• Material handling of dry silica sand product, including: ○ stacking • Wind erosion from product stockpile.
Product Load Out	• Material handling of dry silica sand product, including: ○ Loading onto trucks by front end loader • Wheel generated dust from truck haulage. • Exhaust emissions from diesel industrial and road transport vehicles.

Source	Description of activities
Reject Material	• Material handling of dewatered reject material, including: ○ Loading/unloading by front end loader • Wind erosion from dewatered reject material stack. • Exhaust emissions from diesel industrial vehicles.
Power Supply	• Combustion emissions from on-site natural gas fired power station.

2.3.1 Mitigating Factors

The mitigating factors specific to this Proposal that limit the potential for emissions to air to be generated, as well as the proposed dust controls (refer to Section 4.2.2), are important to consider. These are discussed in further detail in this report, and include:

- Physical properties of silica sand - namely that is it very hard with a high density, tends to limit the potential for airborne particulates to be generated from mining activities. These physical properties also make silica sand less susceptible to wind erosion (i.e. higher wind speed threshold for dust lift-off).
- Sequential block mining and VDT rehabilitation techniques - limits the annual mining footprint for the Proposal to no more than 12 ha per year, such that the open areas susceptible to wind erosion are kept relatively small.
- Wet processing of silica sand – wet processes are principally used to upgrade to a commercial grade silica sand. There is no crushing or dry screening involved which limits the potential for dust generated from the MFP and Processing Plant.
- Properties of silica sand product - the product stockpile of commercial grade similar sand will be at 5% moisture, above the Dust Extinction Moisture (DEM) and have a particle size of between 150 µm and 600 µm, and therefore is not expected to generate significant dust.
- Diesel industrial vehicle fleet is small - three front end loaders and a water truck.
- Power requirement is small – 5 MW natural gas fired base load power station.

3 Site Characteristics

3.1 Climate

The climate at Arrowsmith is characterised, according to the Koppen-Geiger classification, as "Csa" (Mediterranean climate) indicating hot, dry summers with the majority of rainfall occurring during the winter (Kottek et al (2006)). The long-term climate data for this region are sourced from the Bureau of Meteorology (BoM) meteorological station at Eneabba (BoM station ID: 008225), located approximately 30 km to the south of Arrowsmith.

3.1.1 Temperature

The long-term temperature statistics from the BoM station at Eneabba are presented in Figure 3-1. From this figure it is apparent that the summer period has hot days and warm nights while the winter has cool days with cold nights.

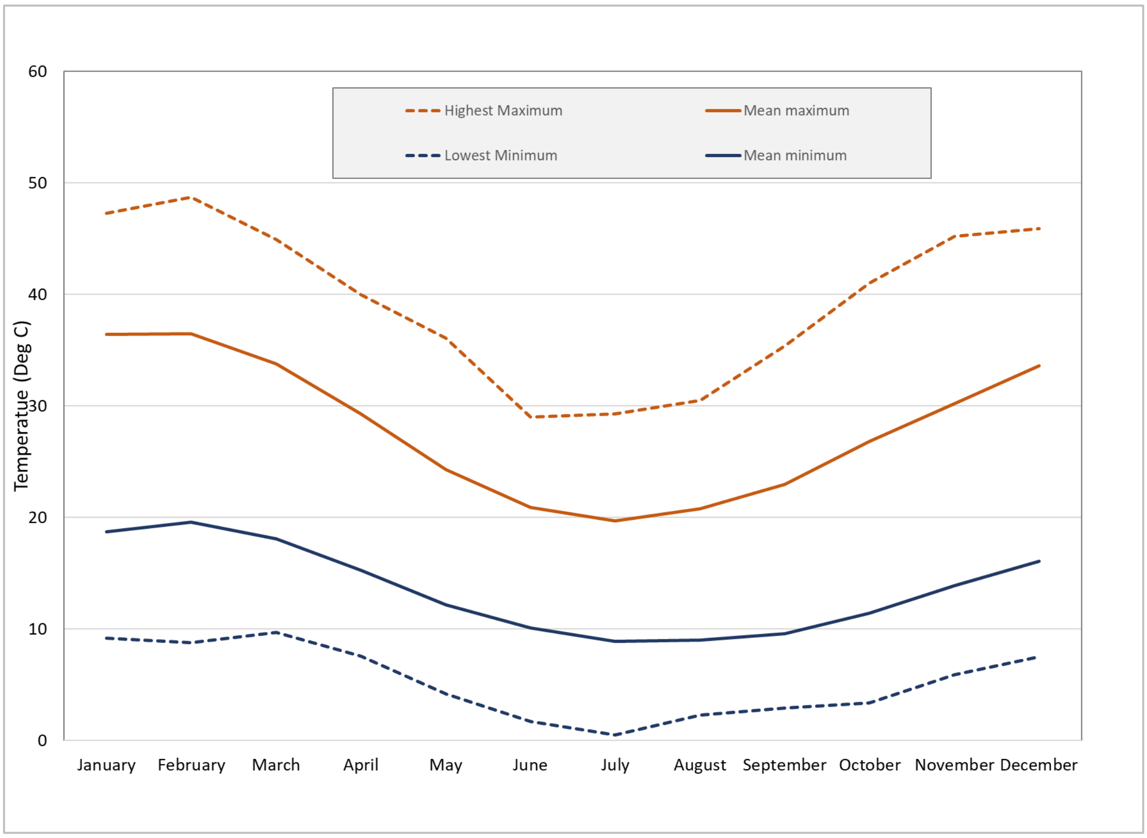


Figure 3-1: Long term temperature statistics (BoM, 2021)

3.1.2 Relative Humidity

The long-term relative humidity statistics from the BoM station at Eneabba are presented in Figure 3-2. Relative humidity varies seasonally with high levels of humidity during the winter months and low levels of humidity during the summer months.

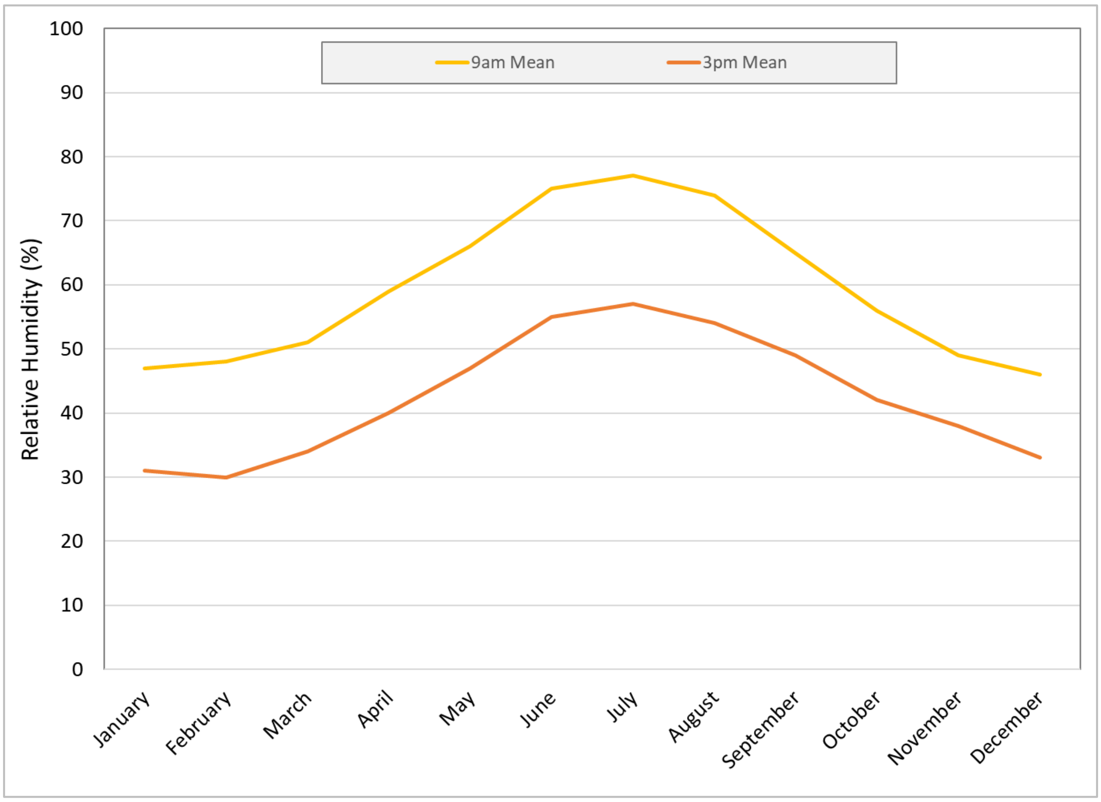


Figure 3-2: Long term relative humidity statistics (BoM, 2021)

3.1.3 Rainfall

The region has a mean annual rainfall of approximately 490 mm. Rainfall varies seasonally with significantly more rain during the winter months, as presented in Figure 3-3.

The amount, and seasonality, of rainfall is important for understanding the periods in which natural dust suppression occurs from windblown sources associated with surface mining and material handling activities. It is also important to understand periods in which there is the potential for elevated windblown dust emissions to occur. This would primarily be periods with high evaporation and low rainfall. For Eneabba the period January to March and November to December are most conducive to high windblown dust emissions.

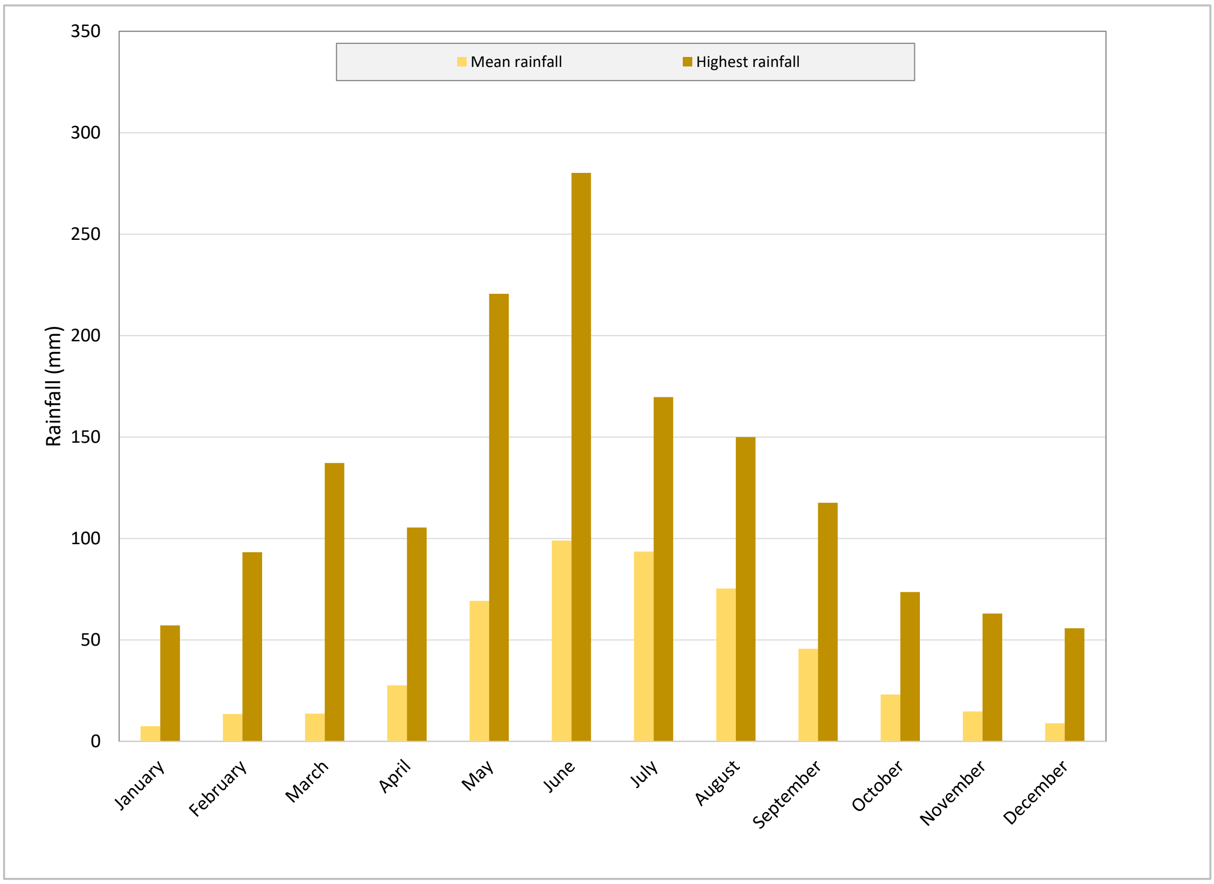


Figure 3-3 Long term rainfall statistics (BoM, 2021)

3.2 Meteorology

3.2.1 Prevailing winds

In the absence of wind measurements for the Proposal site and limitations in the wind measurement data available for the BoM's nearby weather stations at Eneabba and Mingenew[1], the prevailing winds at the site have been characterised using wind speed and direction measurements obtained from the BoM's Geraldton Airport station (BoM station ID: 008315). Whilst the Geraldton Airport station is located 90 km north of the Proposal site, it is a similar distance from the coastline and so has been used for indicative purposes only.

The annual and seasonal wind roses derived from wind speed and direction measurements obtained from the BoM's Geraldton Airport station over a period of approximately ten years (July 2011 to March 2021) is presented in Figure 3-4.

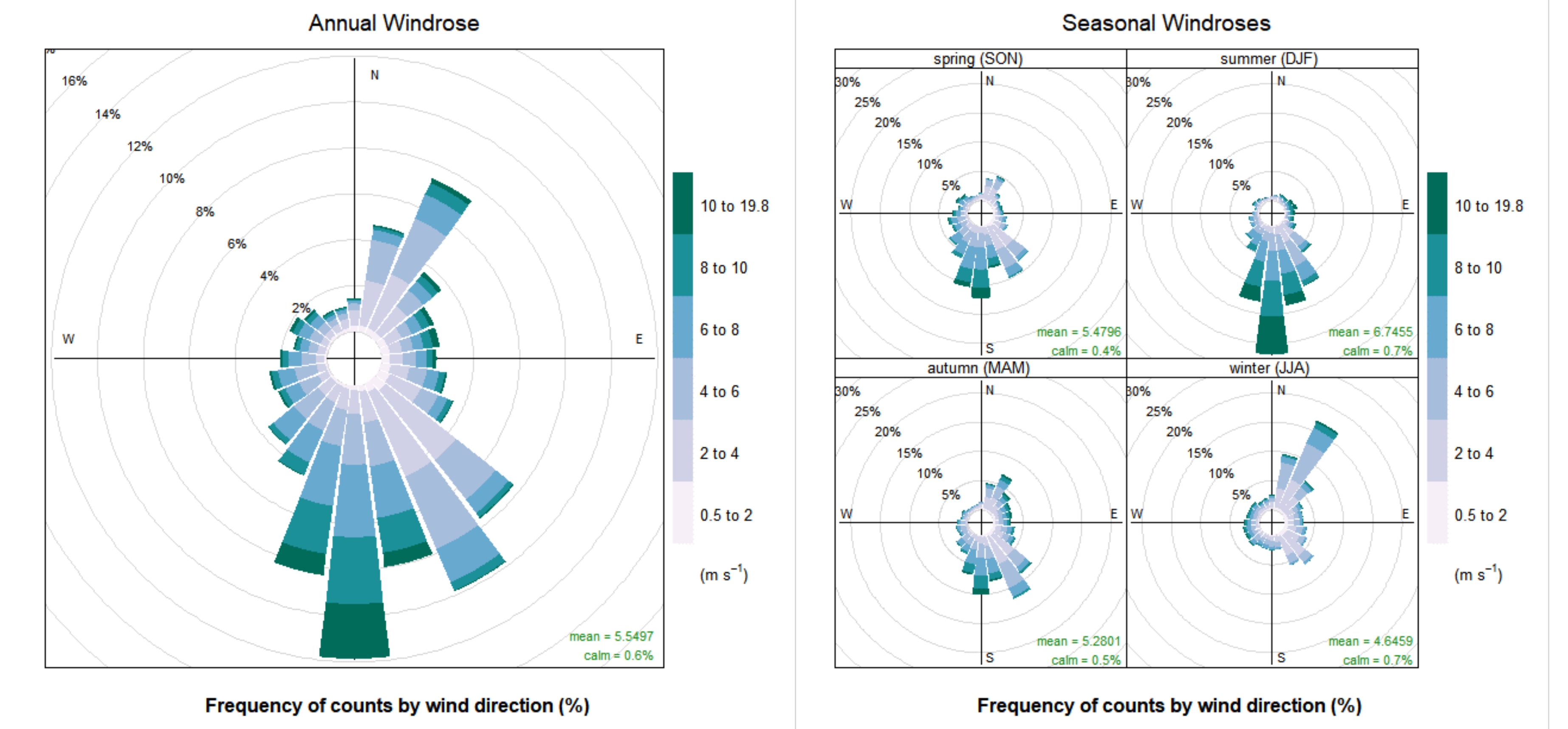
[1] Wind speed and direction observations at some BoM weather stations are only performed twice a day, at 9 am and 3 pm. The corresponding wind roses that are produced showing only 9 am and 3 pm average conditions are not a reliable indicator of average wind conditions for daily periods, or for periods when emissions occur, and are not used in regulatory assessments (DWER, 2021).

The major features of these wind roses, particularly those that are critical in terms of potential to generate wind-blown dust emissions, are as follows:

- The predominance of moderate to strong southerly winds is evident, particularly during summer and spring.
- During winter, moderate to strong north easterly winds occur more often than at other times of the year.
- Light to moderate south easterly winds is also predominant throughout the year, although tending to occur less often during winter.
- The average wind speed is 5.5 m/s. During summer the average wind speed is higher (6.7 m/s), and for the remainder of the time the average wind speed is similar: 5.5 m/s in spring, 5.3 m/s in autumn and 4.6 m/s in winter.
- Calm conditions (<0.1 m/s) occur infrequently (0.6 %).

Summer is expected to be the more critical time of the year for the management of dust. Owing to the higher strength of winds and the lower rainfall and relative humidity, the potential for the generation of wind-blown dust emissions is increased and tends to reduce the effectiveness of conventional dust abatement controls (wetting down of surfaces).

The location of sensitive receptors in the area relative to the prevailing winds is discussed in Section 4.1.



Note a different scale is used for annual and seasonal wind roses.

Figure 3-4: Geraldton wind roses, 2011 - 2021

3.3 Terrain

The Proposal is in the Geraldton Sandplain bioregion of Western Australia, characterised by the sandy earths of an extensive undulating sandplain. The Proposal site and surrounding landscape is relatively flat with terrain induced effects on local winds not expected to be significant. Figure 3-5 presents contours of terrain height for the area surrounding the Proposal site, derived from 1 second (approximately 30 m) resolution Shuttle Radar Topography Mission (SRTM) obtained elevation data.

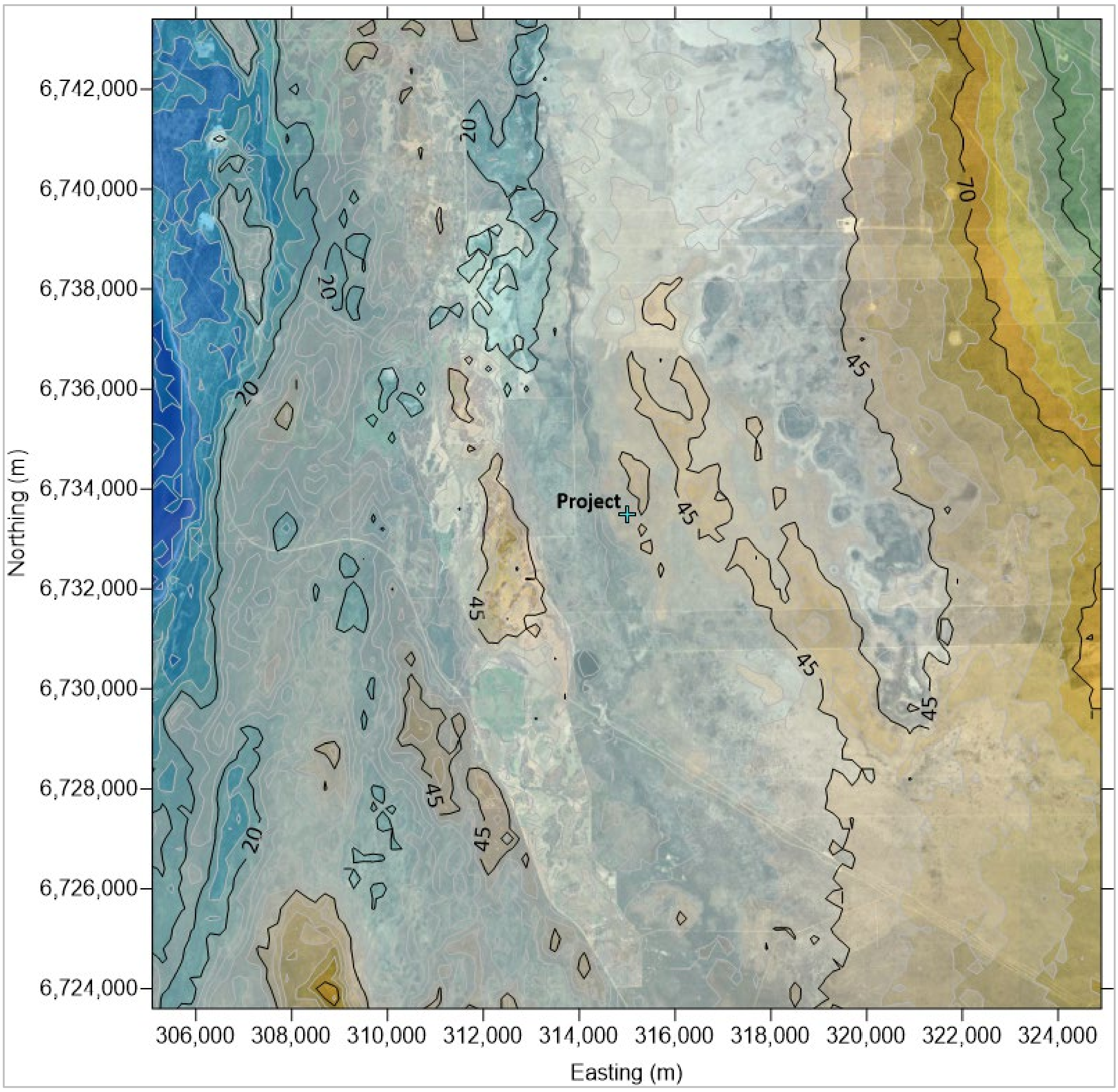


Figure 3-5: Terrain height contours (m)

3.4 Surrounding Land Use

The dominant land use in the surrounding area is dry-land agriculture, with lesser areas of conservation and unallocated crown land and crown reserves (Desmond & Chant, 2001). Tenure, land use and management for the Proposal and surrounds are shown in Figure 3-6.

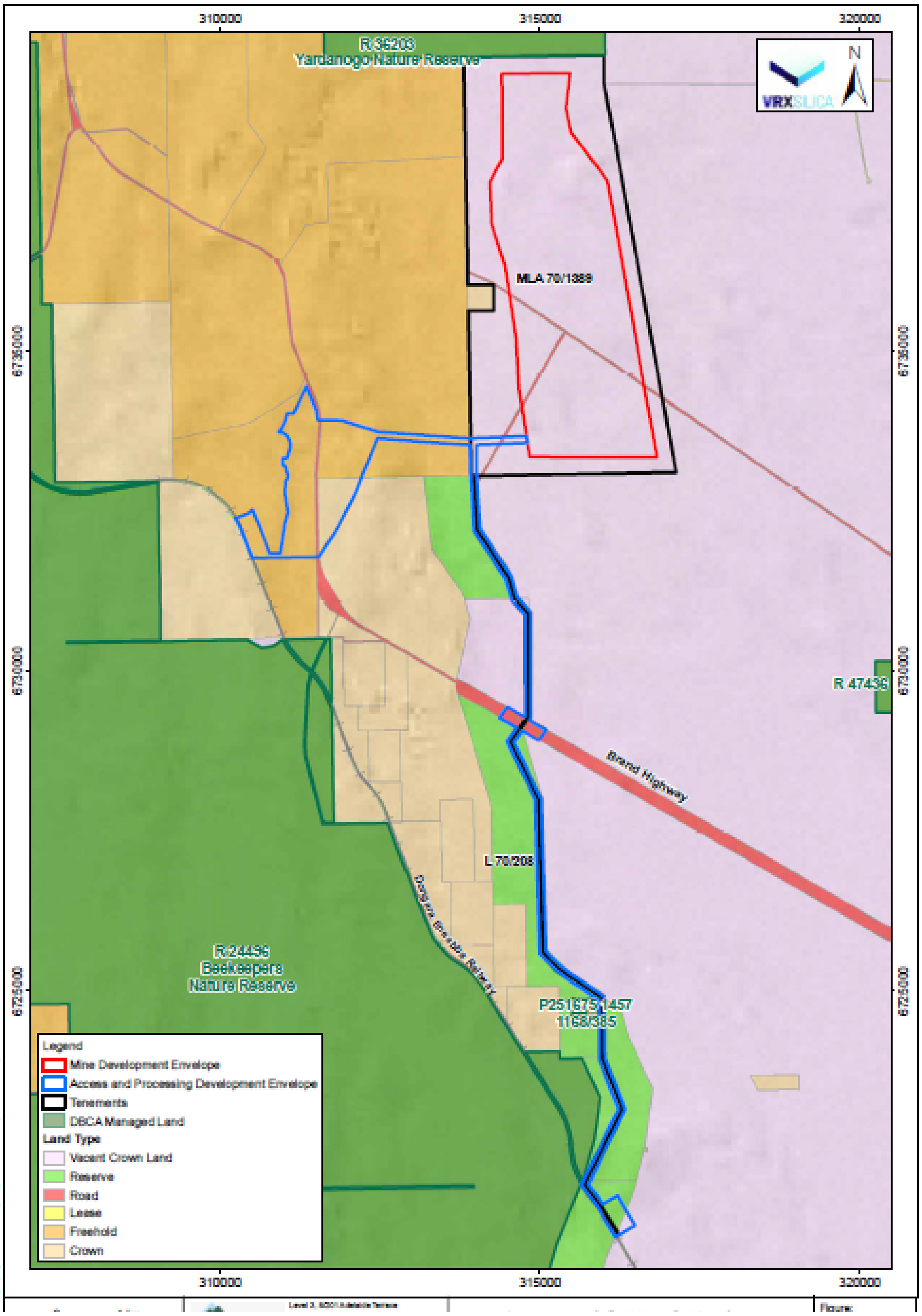


Figure 3-6: Surrounding land use (Preston, 2021)

The freehold land to the west of the Proposal site is very sparsely populated, with just three residential developments (residences) located within a 5 km radius. Refer to Section 4.1 for further description of sensitive receptors (human receptors) in the local area.

In terms of ecologically sensitive receptors in the area, the closest conservation reserves are the Beekeepers Nature Reserve (R24496) located approximately 7 km to the west and Yardanogo Nature Reserve (R 36203) located 5 km to the north. These Nature Reserves are managed by the Department of Biodiversity, Conservation and Attractions (DBCA) for the conservation of flora and fauna. More generally, the extent of native vegetation within a 20 km radius of the Proposal site is high (more than 80% of native vegetation remaining) (Preston, 2021).

The dominant soil type in the area comprises deep white to pale yellow sand. Descriptions and extents of the Vegetation and Substrate Associations (VSAs) within the area surveyed for the Proposal are outlined in Preston (2021). Kwongan Heath, described as low, dense, proteaceous/myrtaceous shrubland on yellow and pale sands, occurs across the majority of the survey area.

4 Assessment

4.1 Separation Distance

The Environmental Protection Authority (EPA) Guidance Statement No. 3 (EPA, 2005) provides advice on the use of generic separation distances (buffers) between industrial and sensitive land uses to avoid conflicts between incompatible land uses. The generic separation distances are a tool to assist in the determination of suitable distances between industry and sensitive land uses where industry may have the potential to affect the amenity of a sensitive land use. Where the separation between the industrial and sensitive land uses is greater than the generic distance, there will not usually be a need to carry out site-specific technical analyses to determine the likely area of amenity impacts due to emissions from the industry.

These generic separation distances are also referenced in the Guideline for Dust Emission, release as a draft for external consultation by the Department of Water and Environment Regulation (DWER) in July 2021 (DWER, 2021).

Consistent with the EPA (2005) definition for sensitive land use – land use sensitive to emissions from industry and infrastructure[2], have been identified in the vicinity of the Proposal. This includes residential development - any permanent structure whose primary use is as a dwelling place, and various other locations where people are residing either on a temporary or permanent basis.

The location of sensitive land uses (sensitive receptors) in the area is presented in Figure 4-1, and summarised in Table 4-1.

Table 4-1: Summary of Sensitive Receptors

Sensitive Receptor	Land Use Type	Separation Distances (m)	
		Processing Plant	Activity Boundary
1	Residence	4,000	3,200 (mining area)
2	Residence	4,300	1,900 (haulage road)
3	Gas Plant	7,400	5,100 (mining area)
4	Residence	3,300	1,700 (haulage road)

[2] Sensitive land uses include residential development, hospitals, hotels, motels, motels, hostels, caravan parks, schools, nursing homes, childcare facilities, shopping centres, playgrounds and some public buildings. Some commercial, institutional and industrial land uses which require high levels of amenity or are sensitive to particular emissions may also be considered "sensitive land uses". Examples include some retail outlets, offices and training centres, and some types of storage and manufacturing. (EPA, 2005).

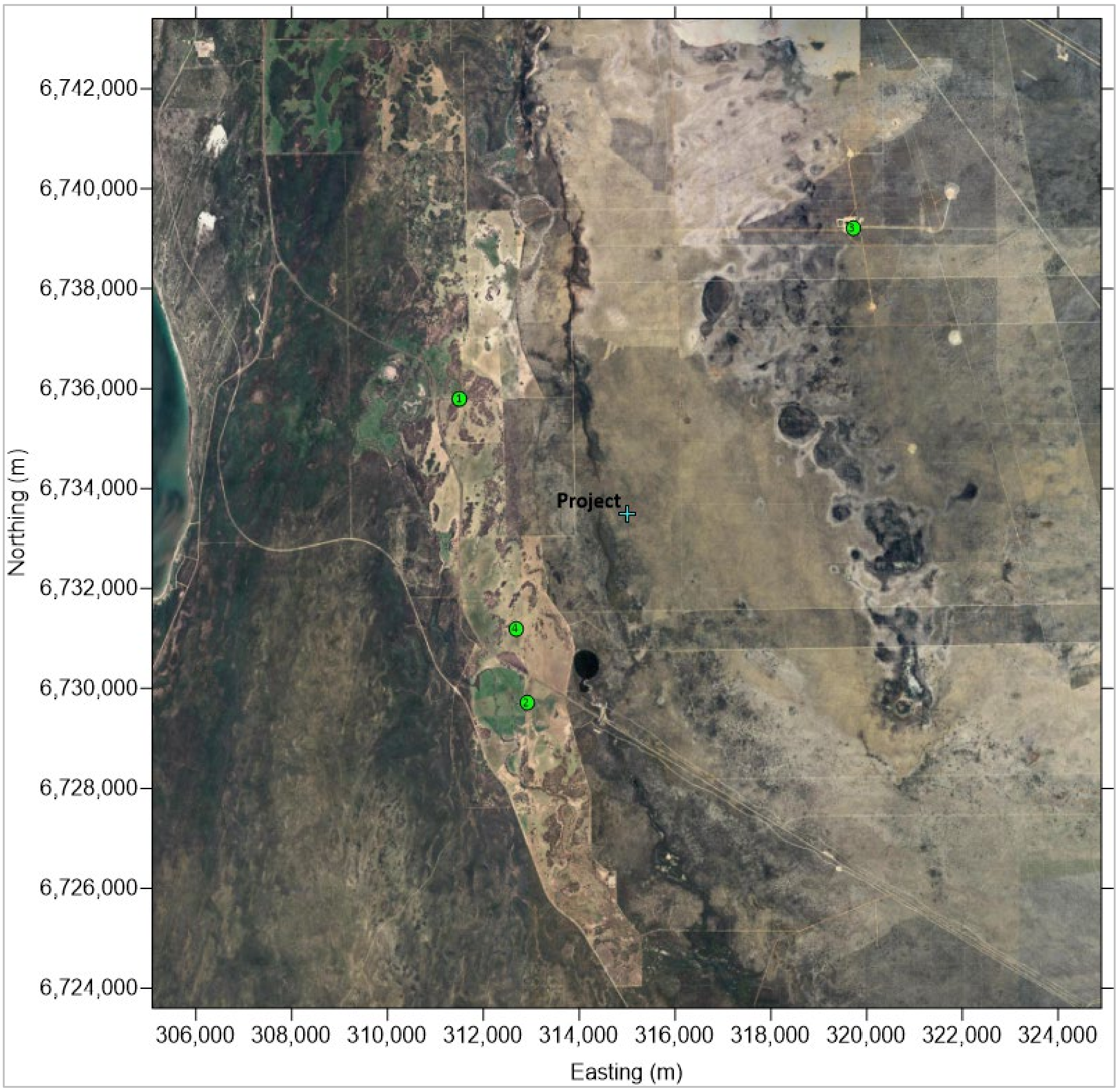


Figure 4-1: Location of sensitive receptors

Under the separation distances guidance (EPA, 2005), the Proposal is best described as an ‘Extractive Industry – sand and limestone extraction’, involving no grinding or milling works. The corresponding generic buffer distance that is recommended is 300 m to 500 m, depending on size. All sensitive receptors are located more than 500 m away, the recommended generic separation distance for a Proposal of this type.

The closest sensitive receptor to the processing plant is the residence to the southwest (Receptor 4), located 3,300 m away. The closest sensitive receptor to the mining operation is the residence to the northwest (Receptor 1), located 3,200 m away. The closest sensitive receptor to the proposed haulage road (to the Brand Highway) is the residence to the southwest (Receptor 4), located 1,700 m away.

These separation distances provide a considerably larger buffer around the Proposal, far exceeding the recommended generic buffer distance of 300 m to 500 m, thereby minimising the potential for emissions to impact upon the air quality at sensitive receptors or to cause adverse amenity impacts.

Receptor 1 is downwind of the proposed site under south easterly winds. Based on the wind speed and wind direction measurements obtained for Geraldton Airport, south easterly winds are predominant throughout the year and tend to be light to moderate in strength, noting this is considered indicative only of the Proposal site (refer to Section 3.2.1). Receptors 2 and 4 are downwind of the Proposal site under north easterly winds, which are more predominant during winter when rainfall is higher and therefore the potential for wind-blown dust emissions is reduced, although do also occur during autumn and spring albeit less frequently (refer to Section 3.2.1).

Receptor 3 is downwind of the Proposal site under south westerly winds, which tend to be moderate to strong in strength. However, as this receptor is located a considerable distance (> 7 km) away, it is very unlikely to be adversely impacted by the Proposal.

In terms of the ecologically sensitive receptors in the area, the closest conservation reserves are the Beekeepers Nature Reserve (7 km away) and Yardanogo Nature Reserve (5 km away) (refer to Section 3.4). Although ecologically sensitive receptors fall outside the EPA (2005) definition for sensitive land use, the separation distance guidance is considered in the context of this Proposal to be a suitable proxy for the assessment of potential effects upon vegetation from dust deposition (refer also to Section 4.4). The separation distance to these surrounding nature reserves far exceeds the recommended generic duffer distance of 300 m to 500 m, thereby minimising the potential for adverse impacts arising from dust deposition upon native vegetation.

4.2 Particulate Matter

4.2.1 Dust characteristics

The potential dust emission sources are described in Section 2.3, and fall into three categories:

- Raw (in-situ) silica sand (mined material)
- Commercial grade silica sand (product)
- Reject material (slimes) produced as the by-product of processing

Comprehensive testing has been undertaken by VRX to characterise the properties of the above-mentioned materials, including (but not limited to):

- Dust Extinction Moisture (DEM)
- Particle Size Distribution (PSD)
- Compositional analysis - elemental, trace metal leach testing, Respirable Crystalline Silica (RCS).

The results of this material testing have been used to determine the likely characteristics of dust emitted (including particle size, composition, and colour) that influence the potential health or amenity impacts.

4.2.1.1 Physical properties

Silica sand is most commonly found as quartz – a crystalline silica polymorph composed of silicon and oxygen in the form of silicon dioxide (SiO_2). Quartz is a relatively hard mineral, and although it is very brittle, because it does not exhibit cleavage, it is relatively strong to mechanical stress. It has a specific gravity of between 2.6 and 2.7 depending on the type of quartz, with a low porosity. As a result of these properties, silica sand is not susceptible to the generation of dust from particle attrition and less susceptible to wind-blown dust owing to the higher wind speed threshold at which dust lift-off is expected to occur. The low porosity can act to reduce the effectiveness of wetting down of surfaces for dust abatement, however.

In its purest form quartz is a translucent or white colour, but different impurities can cause the colour to change. The Proposal's reserves of silica sand are made up of translucent to transparent colourless quartz with some light yellow to orange-brown translucent quartz discolouration. Dust that may be generated would be a similar colour to the underlying soils in the area, and therefore is less likely to be of concern in terms of adverse amenity impacts from dust deposition.

Quartz is very stable and will not dissolve unless treated with very strong acids. The use of gravity and magnetic separation (wet processes) to upgrade to a commercial silica sand within the Processing Plant involves the use of water only (refer to Section 2.1). Notwithstanding the low impurity level of the silica sand (refer to Section 4.2.1.4), any trace metals and other elements will not be leeched during processing, and rather will remain bound within the silica sand as occurs naturally.

4.2.1.2 Dust Extinction Moisture

DEM testing in accordance with AS 4156.6–2000 has been conducted of commercial grade silica sand product (Microanalysis Australia, 2021b). The DEM test result of 3.7% will be used as a guide for the moisture level required to minimise dust when storing and handling of the product.

The graph of dust versus moisture level of the product is also useful as it illustrates the impact of adding moisture to the materials, for purposes of design and implementation of dust control measures (Figure 4-2).

The proposed use of water cannons for wetting down of the product stockpile and during product load out (refer to Section 4.2.2) is a suitable dust control measure provided moisture levels are maintained above the DEM level.

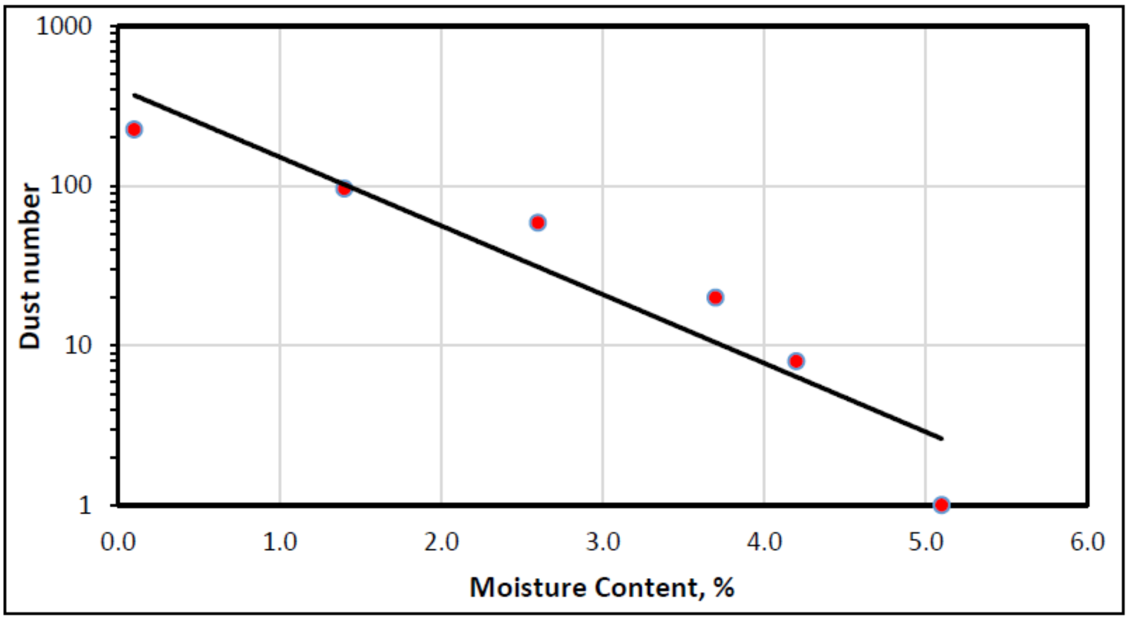


Figure 4-2: Dust Extinction Moisture (DEM) - Commercial Grade Silica Sand Product (Microanalysis Australia, 2021b)

4.2.1.3 Particle size

PSD testing using laser diffraction size distribution analysis following ISO 13320-1:2009 has been conducted of bulk samples of commercial grade silica sand, raw (in-situ) silica sand and reject material, summarised in Table 4-2. These results are of the bulk material samples and should not be misinterpreted as the anticipated particle size distribution of dust emissions from the Proposal.

The very high percentages of the large particles that fall into the non-inhalable fraction (> 100 µm), particularly in commercial grade silica sand product (99.8%) and raw (in-situ) silica sand (97.1%), indicates much of the material will not become readily airborne during material handling or due to wind erosion.

The relatively higher percentage of thoracic (PM_{10}) and respirable (PM_4) particulate matter contained in the reject material indicates this material may become more readily airborne if allowed to dry out. Maintaining the moisture content of the reject material and ensuring immediate covering once returned to the mine are the proposed measures to control dust (refer to Section 4.2.2).

The respirable fraction of the bulk samples is used to evaluate the potential health risk associated with exposure to Respirable Crystalline Silica (RCS) (refer to 4.2.1.4).

Table 4-2: Particle Size Distribution

Sample ID	Description	Size fraction (by aerodynamic diameter) volume percent				Analytical Report
		Non-inhalable	Inhalable, PM_{100}	Thoracic, PM_{10}	Respirable, PM_4	
Sample 1	Commercial grade silica sand product	99.8	0.2	0.1	0.03	Microanalysis Australia, 2021c
Arrowsmith North Raw Sand	Raw (in-situ) silica sand	97.1	2.9	1.8	1.43	Microanalysis Australia, 2021d
LF/MF Bulk Final Tails	Reject material	72.6	27.4	4.6	1.94	Microanalysis Australia, 2021e

4.2.1.4 Composition

Analytical testing of the commercial grade silica sand product, raw (in-situ) silica sand and reject material has been conducted to characterise the RCS content of these materials, to evaluate the potential public health risk to sensitive receptors from exposure to RCS in ambient air (i.e. excludes consideration of occupational health risk).

Bulk samples were collected by VRX and analysis for respirable (PM_4) silica content was undertaken by X-ray diffraction (XRD) and scanning electron microscope (SEM) using the modified size-weighted respirable fraction (SWeRF) method (Pensis et al, 2014). The results are summarised in Table 4-3.

Table 4-3: Respirable Crystalline Silica (RCS) Material Content

Sample ID	Description	Respirable (PM_4) of the bulk material ($\%_{wt}$)			Analytical Report
		α-Quartz	Crystobalite	Tridymite	
Sample 1	Commercial grade silica sand product	0.001	<0.001	<0.001	Microanalysis Australia, 2021c
Arrowsmith North Raw Sand	Raw (in-situ) silica sand	0.103	<0.001	<0.001	Microanalysis Australia, 2021d
LF/MF Bulk Final Tails	Reject material	0.290	<0.001	<0.001	Microanalysis Australia, 2021e

Assuming that PM_4 concentrations associated with dust emissions from the Proposal approached the relevant national air quality standards for PM_{10} (NEPC, 2021) at the surrounding sensitive receptor locations, which is highly unlikely (overly conservative), a screening-level assessment can be conducted that compares the estimated concentrations of RCS derived from the results of the bulk material content, to relevant ambient air assessment criteria for RCS sourced from the DWER (2019) and the Californian Office of Environmental health Hazard Assessment (OEHHA) (2005). This is summarised in Table 4-4.

Table 4-4: Respirable Crystalline Silica (RCS) Screening Assessment

RCS Content ($\%_{wt}$)	Description	24-hour Average (µg/m^3)		Annual Average (µg/m^3)	
		PM_{10}	RCS	PM_{10}	RCS
< 0.290	Screening Concentrations	50	< 0.15 [1]	25	< 0.07 [2]
	Assessment Criteria		10 [3]		3 [4]
	% of Criteria		< 1.4%		< 2.3%

Notes:

1. 0.29% of 50 µg/m^3 = 0.15 µg/m^3
2. 0.29% of 25 µg/m^3 = 0.07 µg/m^3
3. Acute exposure (24-hour average) assessment criteria for silica sourced from DWER (2019).
4. Chronic exposure (annual average) assessment criteria for RCS sources from OEHHA (2005).

Despite the very conservative nature of such a screening assessment approach, the analysis shows that the estimated concentrations of RCS in ambient air at sensitive receptor locations is not expected to be equivalent to more than 2.3% of the relevant assessment criteria. This confirms the in-situ content of RCS in the materials being handled is extremely low and does not present a potential public health risk to sensitive receptors from exposure to dust emissions from the Proposal.

4.2.2 Emission Controls

The dust controls that have been incorporated into the design of the Proposal and management practices that will be available to minimise dust generation, are detailed below.

- There is a considerable buffer around the Proposal, far exceeding the recommended generic buffer distance of 300 m to 500 m (refer to Section 4.1).
- Sequential block mining and VDT rehabilitation techniques limits the open areas susceptible to wind erosion through staged clearing and progressive rehabilitation.
- An open conveyor will be used to transfer dry silica sand from the mine to the MFP. The transfer of material via conveyor is preferred to truck haulage, eliminating wheel generated dust generated with truck haulage on unsealed roads.
- A radial stack conveyor will be used to stockpile commercial grade silica sand prior to export.
- Water cannons will be installed in the Product Load Out area to wet down the product stockpile, as required.
- The moisture content of the reject material will be relatively high (~10%) and will be packaged for sale in the local market.
- A dedicated watering truck will operate at the site for wetting down the haulage road (unsealed section) and open areas susceptible to wind erosion.
- The surface of the haulage road will be regularly maintained to retain surface integrity.
- Vehicle speeds will be limited on unsealed roads to minimise wheel generated dust.

Through the implementation of these dust controls it is expected that any generated airborne dust will be maintained within acceptable levels.

4.3 Combustion Products

4.3.1 Emissions

The primary emission sources of combustion products (NOx, CO and SO_2) emitted from the Proposal include:

- natural gas fired power station – CAT G3520E or similar gas engine
- exhaust emissions from diesel industrial vehicles, comprised of:
  - Front end loader (x3) – CAT 988K or similar
  - Water truck
  - Road trains.

Credible emission estimates have been derived for these emission sources, presented in Table 4-5. The manufacturer specification sheet for a representative gas engine (G3520E) (Caterpillar, 2021) was used as the basis for the emission estimates for the power station. Projected diesel fuel consumption information (*Pers Comm.* Preston Consulting, 28 October 2021) was used as the basis for the emission estimates from vehicle exhausts. The methodology used to estimate emissions is outlined in further detail in Appendix A.

Table 4-5: Emission Estimates – Combustion Sources

Source	NOx	CO	SO_2
	kg/y		
Power generation	160,660	370,483	492
Front end loader	45,043	12,826	29
Water truck	8,181	3,528	6
Road transport	14,038	5,357	11
Total	**227,923**	**392,193**	**537**

Emissions from the power station is the primary source of combustion products estimated for the Proposal, representing 70% (NOx), 94% (CO) and 92% (SO_2) of total emissions on an annual basis.

The significance of the emissions of combustion products from the Proposal has been evaluated using a screening model (refer to Section 4.3.2).

4.3.2 Screening analysis

The screening air dispersion model, SCREEN3, has been applied as a conservative approach to the assessment of the significance of emissions of combustion products estimated for the Proposal. SCREEN3 is a United States Environmental Protection Agency (USEPA) screening model, which provides maximum predicted concentrations for a range of 'worst case' meteorological conditions. Screening models are often applied to determine if the potential air quality impacts from a source warrants more detailed (refined) air dispersion modelling.

The use of a screening model is preferred over the draft DWER (2019) screening analysis approach in this case to account for the distance to sensitive receptors, an important aspect of the Proposal.

The maximum predicted 1-hour average concentrations of NO_2, CO and SO_2 expected to occur at sensitive receptors located more than 3,000m downwind of the Proposal, are summarised in Table 4-6. The maximum predicted concentrations were compared to relevant assessment criteria to provide an objective evaluation of the potential air quality impact of the Proposal.

Table 4-6: Screening Model Results

Pollutant	Avg. Time	Max. Concentration (µg/m^3)			Downwind Distance (m)	Assessment Criteria		% of Criteria
		Power Station	Vehicle Exhaust	Combined Emissions		µg/m^3 [1]	Reference	
NO_2 [2]	1-hour	29.1	0.3	29.4	3,000	151	NEPC (2021)	19%
CO	1-hour	227	140	366	3,000	35,000	WHO (2021)	1%
SO_2	1-hour	0.3	0.3	0.6	3,000	262	NEPC (2021)	0.2%

Notes:

1. Referenced at ambient conditions (25^{o}C, 101.3 kPa).
2. Empirically derived generic conversion factor (NOx to NO2) of 30% has been applied (Katestone, 2017).

The screening model results show the maximum predicted concentrations are well below the relevant assessment criteria at a downwind distance of 3,000m. As such, the emissions of combustion products from the Proposal are not considered to be significant in terms of their potential to cause adverse air quality impacts at the identified sensitive receptor locations. Detailed (refined) air dispersion modelling of combustion emissions from the Proposal is therefore not considered to be warranted.

4.4 Vegetation Impacts

There is the potential for deposited dust to affect the health of susceptible vegetation by adversely affecting photosynthesis and transpiration rates. As the Proposal is in an area of high biodiversity, the potential for deposited dust to have an effect upon the health of vegetation has been considered.

As discussed earlier in Section 4.1, the separation distance between the Proposal and the closest conservation reserves (at least 5 km away) far exceeds the recommended generic buffer distance established for protection of amenity (EPA, 2005), considered in the context of this Proposal to be a suitable proxy for the assessment of potential effects upon vegetation from dust deposition.

More generally, native vegetation in the Midwest region is expected to be reasonably tolerant to dust deposition and at minimal risk of physiological impacts (Eco Logical Australia, 2016), being adapted to high dust levels that occur naturally in summer under the combination of high winds and low rainfall. Dust deposition will be mitigated to some extent by periodic high rainfall events, which would remove built-up materials on foliage.

5 Conclusions

This desktop assessment has been conducted for the proposed Arrowsmith North Silica Sand Project, to determine the potential air quality impacts posed by the Proposal, specifically in relation to:

- dust emissions from the various stages of project development
- combustion emissions from the power station
- vehicle exhaust emissions.

The key findings of the air emissions desktop assessment completed for the Proposal are outlined in Table 5-1 below. Having regard to the key findings of the desktop air emissions assessment it is considered unlikely that the Proposal will have a significant impact on air quality. The nature and scale of the Proposal, and the separation distance to surrounding sensitive receptors (residences) is such that adverse impacts to human health and amenity are not expected to occur. Similarly, the Proposal is not expected to adversely impact native vegetation as a result of dust deposition. Additionally, through the implementation of the proposed dust controls airborne dust generation can be maintained within acceptable levels.

Table 5-1: Summary of key findings

Assessment Factor	Key Findings
Location	The Proposal is located in the Mid-West region of Western Australia, approximately 270 kilometres (km) north of Perth.
Surrounding land use	The area surrounding the Proposal site is very sparsely populated, within just three residential developments (residences) located within a 5 km radius. In terms of ecologically sensitive receptors in the area, the closest conservation reserves are located at least 5 km away.
Climate and meteorology	Summer is expected to be the more critical time of the year for the management of dust, owing to the higher strength of winds and the lower rainfall which increases the potential for the generation of wind-blown dust emissions. During summer, the predominance of moderate to strong southerly winds is evident.
Terrain	The Proposal site and surrounding landscape is relatively flat with terrain induced effects on local winds not expected to be significant.
Separation distance	The separation distance between the Proposal and the surrounding sensitive receptors (residences) far exceeds the recommended generic buffer distance of 300 m to 500 m for an 'Extractive Industry - sand and limestone extraction' (EPA, 2005): ○ at least 3,300 m from the processing plant ○ at least 3,200 m from the mining operation ○ at least 1,700 m from the proposed haulage road (to the Brand Highway). The separation distances provide a considerably larger buffer around the Proposal, thereby minimising the potential for emissions to impact upon the air quality at sensitive receptors or to cause adverse amenity impacts.

Assessment Factor	Key Findings
Dust characteristics	The physical properties of silica sand (hardness, specific gravity) generally make it less susceptible to dust generation from particle attrition and wind erosion, however low porosity can act to reduce the effectiveness of wetting down of surfaces for dust abatement. Similar colour to the underlying soils in the area, and therefore less likely to be of concern in terms of adverse amenity impacts from dust deposition. The impurity level of silica sand is very low and very stable, therefore any trace metals and other elements will not be leached during processing, and rather will remain bound within the silica sand as occurs naturally. The PSD testing shows the fraction of PM_{10} is relatively low in the various materials handled. This indicates much of the material will not become readily airborne during material handling or due to wind erosion. ○ 0.1% in commercial grade silica sand product ○ 1.8% in raw (in-situ) silica sand ○ 4.6% in reject material. The in-situ content of RCS in the materials handled is extremely low and does not present a potential health risk at sensitive receptors (residences).
Emission sources	Potential emission sources from mining, processing, product load out, reject material handling and power generation may be generated from: ○ material handling ○ wheel-generated dust on unsealed roads ○ wind erosion from open areas ○ vehicle exhaust emissions ○ fuel (natural gas and diesel) combustion The Processing Plant uses gravity and magnetic separation (wet processes) to upgrade to a commercial grade silica sand. There is no crushing, grinding or dry screening involved in the processing of silica sand.

Assessment Factor	Key Findings
Dust controls	Various design features and management practices will be employed to control dust. The key dust controls include: ○ Sequential block mining and VDT rehabilitation techniques limit the extent the open areas susceptible to wind erosion through staged clearing and progressive rehabilitation. ○ An open conveyor (preferred to truck haulage) to transfer dry silica sand from the mine to the MFP. ○ Water cannons will be installed in the Product Load Out area to wet down the product stockpile, as required. ○ The moisture content of the reject material will be relatively high (~10%) and will be packaged for sale in the local market.
Combustion emissions	Combustion emissions from the power station and diesel vehicle exhausts have been shown, using a screening model, to not be significant in terms of their potential to cause adverse air quality impacts at sensitive receptors (residences). Detailed (refined) air dispersion modelling of combustion emissions from the Proposal is not considered to be warranted.
Vegetation impacts	The Proposal is in an area of high biodiversity, and hence the potential for deposited dust to affect the health of vegetation has been considered. The separation distance between the Proposal and the closest conservation reserves (at least 5 km away) far exceeds the recommended generic buffer distance established for protection of amenity (EPA, 2005), considered in the context of this Proposal to be a suitable proxy for the assessment of potential effects upon vegetation from dust deposition. Native vegetation in the Midwest region is expected to be reasonably tolerant to dust deposition and at minimal risk of physiological impacts.

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7 Acronyms and Glossary

Acronym	Description
BoM	Bureau of Meteorology
C	Degrees Celsius (temperature)
CO	Carbon monoxide
DWER	Department of Water and Environmental Regulation
DBCA	Department of Biodiversity, Conservation and Attractions
DEM	Dust Extinction Moisture
EE	Emissions estimation
EET	Emissions Estimation Technique
EF	Emission factor
EPA	Environmental Protection Authority
ETA	Environmental Technologies& Analytics Pty Ltd
EP Act	Environmental Protection Act 1986
FEL	Front end loader
GLC	Ground Level Concentration
g/s	grams per second
ha	hectares
kg	kilogram
kg/yr	kilograms per year
kPa	kiloPascals
km	kilometre
MW	Mega watts
m	metre
m/s	metres per second
mm	millimetre
NOx	Oxides of nitrogen
NEPC	National Environment Protection Council
NEPM	National Environmental Protection Measure
NPI	National Pollutant Inventory
PSD	Particle Size Distribution
OEHHA	Office of Environmental health Hazard Assessment, Californian
PM	Particulate matter, small particles and liquid droplets that can remain suspended in air.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 10 µm or less.
PM_{10}	Particulate matter with an aerodynamic diameter of 2.5 µm or less.
PER	Public Environmental Review
RCS	Respirable Crystalline Silica
SO_2	Sulphur dioxide
SRTM	Shuttle Radar Topography Mission
SEM	scanning electron microscope
SWeRF	size-weighted respirable fraction
t	Tonnes
TSP	Total suspended particulates
$\mu g/m^3$	micro grams (one millionth of a gram) per cubic metre
µm	micrometre
USEPA	United States Environment Protection Agency
VDT	Vegetation Direct Transfer
XRD	X-ray diffraction

8 Appendices

Appendix A – Combustion Products

A.1: Emission Estimation

Emission estimates for all key sources of combustion products have been derived for use as inputs to the screening model assessment.

The manufacturer specification sheet for a representative gas engine (G3520E) (Caterpillar, 2021) was used as the basis for the emission estimates for the power station (Appendix Table 1).

Appendix Table 1 Power Station Emissions Specification – Indicative Only

Exhaust Concentration	Units	Specification (at 100% Load)
NOx (corr. to 5% O_2)	mg/Nm^3, dry	500
CO (corr. to 5% O_2)	mg/Nm^3, dry	1,153
SO_2 (corr. to 5% O_2)	mg/Nm^3, dry	4.6 [1]

Notes:

1. Calculated based on natural gas sulphur content of 20 mg/m^3, in accordance *with Gas Supply (Gas Quality Specifications) Regulations 2010*.

Projected diesel fuel consumption information was used as the basis for the emission estimates from vehicle exhausts (Appendix Table 2), with emissions estimated according to well established methods published in the relevant emission estimation technique (EET) manuals approved for use by industry for National Pollutant Inventory (NPI) reporting purposes (DAWE, 2008).

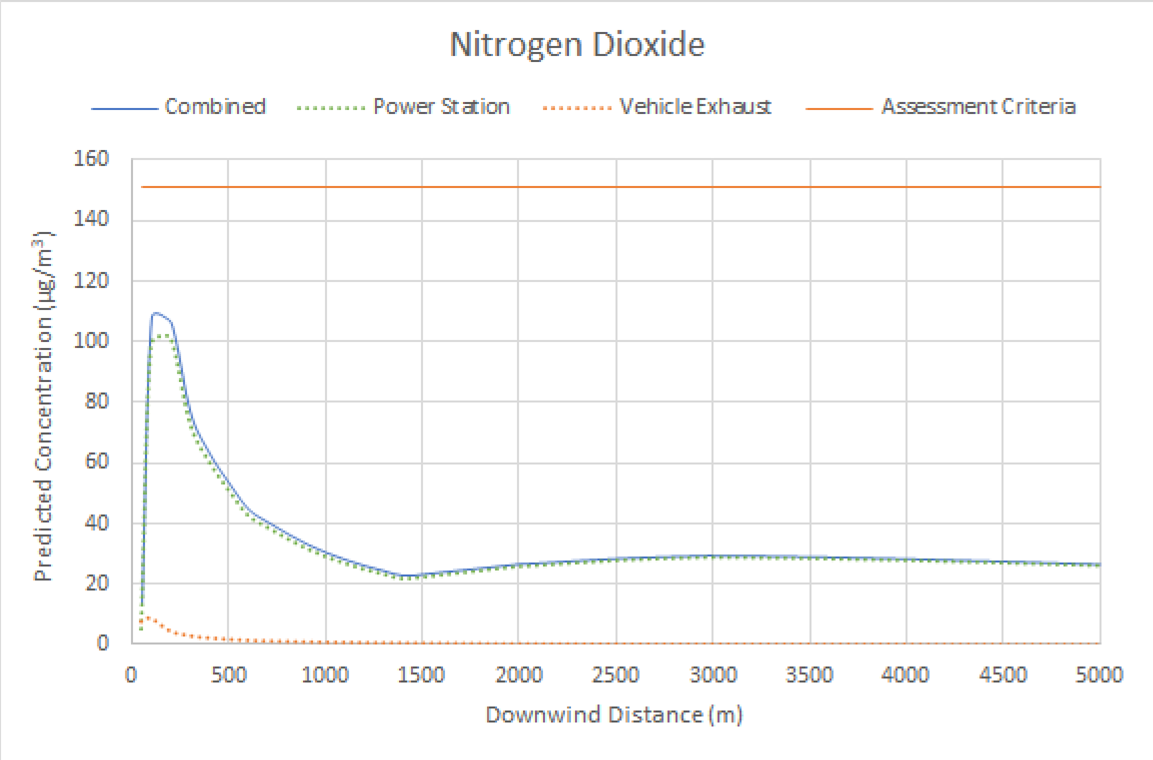
Appendix Table 2 Projected diesel vehicle fuel consumption

Source	Fuel Consumption [1]		Units
Front end loader	Diesel	3,817,222	kWh per year
Water truck	Diesel	750,555	kWh per year
Road transport	Diesel	4,277 [2]	m^3 per year

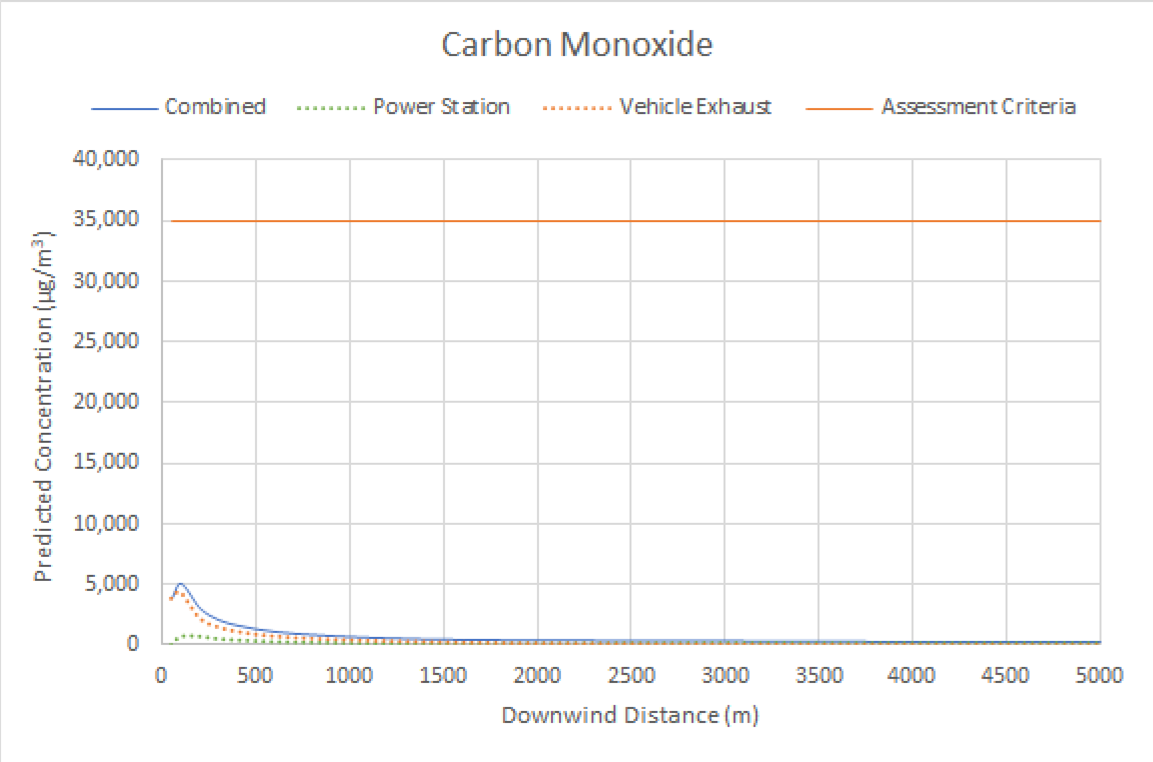
Notes:

1. Projected annual consumption (*Pers comm.* Preston Consulting, 28 October 2021).
2. Road transport fuel usage provided for distance from site to Geraldton Port. A reasonable assumption of 15% apportioned to on site emissions from road transport was applied to estimate emissions.

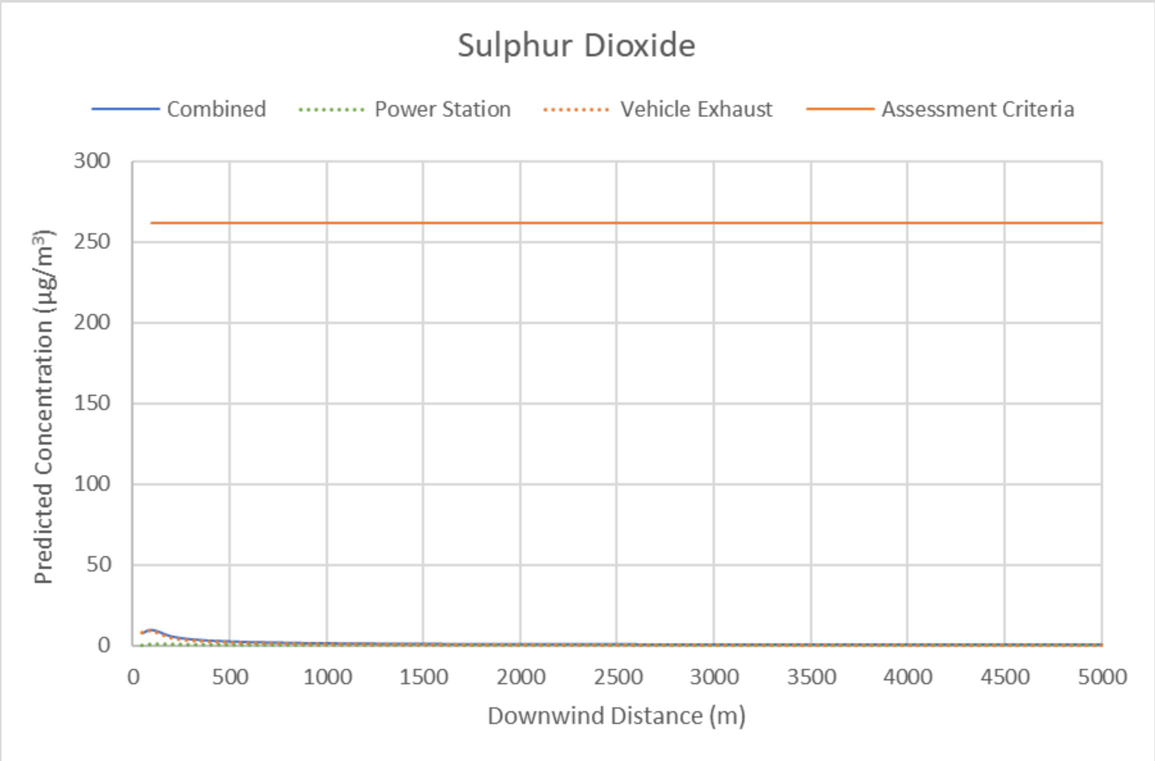
A.2: Screening Model Results



Appendix Figure 1 Maximum predicted NO_2 concentration (1-hour average) with downwind distance



Appendix Figure 2 Maximum predicted CO concentration (1-hour average) with downwind distance



Appendix Figure 3 Maximum predicted SO_2 concentration (1-hour average) with downwind distance