9.8 Air Quality

9.8.1 EPA Objective

The EPA's objective with regards to air quality is:

- To maintain air quality for the protection of the environment, human health and amenity and to minimise atmospheric gases through the application of best practice.

9.8.2 Relevant Legislation and Policy

The key air emissions of concern for the Project are:

- dust (or particulates) from land clearing, mining, haulage, stockpiling, processing (including crushing and milling); and
- sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulates from diesel-fired power generation.

Dust is generally defined as particles that can remain suspended in the air by turbulence for a period of time. Dust or particulate matter is commonly defined by the size of the particles, measured as:

- total suspended particulates (TSP), which refers to all particulate matter but typically associated with particles that have an equivalent aerodynamic diameter below 50 µm. (The term equivalent aerodynamic particle is used to reference a spherical shaped particle and a density of 1 g/cm^3);
- PM_{10}, particulate matter of 10 µm or less in equivalent aerodynamic diameter; and
- $PM_{2.5}$, particulate matter of 2.5 µm or less in equivalent aerodynamic diameter.

TSP, which contains both the PM_{10} and $PM_{2.5}$ fractions, is normally associated with nuisance impacts such as dust fallout and impacts on amenity. PM_{10} and $PM_{2.5}$ are associated with the potential for health impacts as finer particle fractions can enter deeper into the lungs.

Air quality in WA is assessed against the standards specified in the National Environment Protection (Ambient Air Quality) Measure 1998 (Air NEPM) (National Environmental Protection Council, 1998). The Air NEPM standards for the most significant air pollutants that may arise from the Project are presented in Table 9-65.

Table 9-65: Air quality standards relevant to the Yeelirrie Uranium Project

Pollutant	Averaging Period	Air NEPM standard (µg/m^3)[a]	Air NEPM goal – maximum allowable exceedances
PM_{10}	24-hour	50	5 days per year
NO_2	1-hour	246	1 day per year
	Annual	62	None
SO_2	1-hour	571	1 day per year
	24-hour	229	1 day per year
	Annual	57	None
CO	8-hour	11,000	1 day per year

Note: a. Expressed at Standard Temperature and Pressure (i.e. 0 degrees Celsius and an absolute pressure of 101.325 kilopascals)

For impact assessment purposes, where air pollutants are not covered by the Air NEPM, the DER typically adopts the World Health Organisation's (WHO) Guidelines for Air Quality, or air quality guidelines from other jurisdictions where appropriate (Department of Environment and

Conservation 2004). For example, the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999 (Kwinana EPP) specifies a 24-hour average standard for total suspended particulates (TSP) of 90 µg/m³ (limit of 150 µg/m³) for a residential dwelling outside of the buffer zone (Area B). This standard has been applied in the air quality assessment undertaken for the Project by Katestone Environmental Pty Ltd (Katestone) (Katestone 2014a; Appendix L1).

In addition, the New South Wales Office of Environment and Heritage (NSW OEH) has defined dust deposition criteria. These guidelines are based on studies undertaken on coal dust deposition in the Hunter Valley in NSW by the National Energy Research and Demonstration Council (NERDC 1988) and take into account potential amenity impacts. While the dust deposition guideline is expressed as g/m²/month, the NSW OEH has indicated that the monthly average deposition (to be compared against the guideline value) is to be determined from data spanning no less than one year, so as to account for seasonal variations.

Other relevant air quality assessment criteria that are not covered by the Air NEPM are summarised in Table 9-66.

Table 9-66: Relevant air quality guidelines

Pollutant	Averaging period	Air quality guideline	Units [d]	Source
Total suspended particulates (TSP)	24-hour	90	µg/m³	Kwinana EPP
	Annual	90	µg/m³	NSW EPA
PM_{10}	Annual	25	µg/m³	WHO Guideline
$PM_{2.5}$	24-hour	25	µg/m³	Air NEPM advisory reporting standard
	Annual	8	µg/m³	Air NEPM advisory reporting standard
Dust deposition rate	Annual	2 [a]	g/m²/month	NSW EPA [c]
		4 [b]		

Notes:

[a] Maximum increase in deposited dust levels

[b] Maximum total deposited dust level

[c] Amenity dust guideline

[d] Concentrations expressed at Standard Temperature and Pressure (i.e., 0 degrees Celsius and an absolute pressure of 101.325 kilopascals)

Other relevant policies are:

- DEC (2006) Guidance Notes: Air Quality and Air Pollution Modelling, Perth, Western Australia.
- DEC (2010) A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities, Perth, Western Australia.

9.8.3 Studies and Investigations

An air quality assessment of the Project was undertaken by Katestone for Cameco's Project design. The complete air quality assessment report is provided as Appendix L1 (Katestone, 2014a).

The purpose of the air quality assessment as outlined in the report was to:

- characterise baseline air quality and describe the climate, local meteorology and existing air environment in the development area;

- quantify particulate emissions (TSP, PM_{10} and $PM_{2.5}$) from all Project related sources;
- quantify emissions of other air pollutants from all Project related sources, including onsite power generation;
- conduct air dispersion modelling using accepted techniques;
- evaluate the incremental and cumulative air quality impacts of the proposed project on the air environment;
- present the results in relation to relevant ambient air criteria; and
- recommend dust management and mitigation strategies where applicable.

The key air pollutants that were considered were dust from the project operations and SO_2, NO_2 and CO from power generation. Atmospheric dispersion modelling was carried out using the CALPUFF Version 6.4 dispersion model to predict the ground-level concentrations of SO_2, CO, NO_2, particulate matter (TSP, PM_{10}, $PM_{2.5}$) and dust deposition rates at sensitive receptors as well as contours across the modelling domain.

The results of dispersion modelling to predict radionuclide activities in airborne and deposited dust and radon emissions have been considered separately in Section 9.6 under Health Impacts (Dust and Radiation).

The assessment was generally conducted in accordance with the DER's Air Quality Modelling Guidance Notes (DER, 2006). Meteorological data for the assessment was generated by coupling TAPM (a prognostic mesoscale model) to CALMET (a diagnostic dispersion model). Data from the on-site automatic weather station was also assimilated into the TAPM model to improve the model's predictions. Katestone evaluated the performance of the TAPM model in simulating wind speed, wind direction and other meteorological parameters against meteorological measurements at the Yeelirrie Automatic Weather Station (AWS). The model was shown to accurately simulate the distribution of light and strong winds at the Yeelirrie AWS. Statistically the TAPM model performed well in regards to accurately reproducing wind speeds at the Yeelirrie AWS.

Dust emissions from the project were estimated based on representative emission factors from the National Pollutant Inventory (NPI) mining handbook, USEPA AP-42 documents and source characteristics and operational activity data provided by Cameco (refer to Katestone 2014a [Appendix L1]). Emissions from power generation were estimated based on engine manufacturer's specifications.

The ESD has requested that Cameco undertake physical and geochemical characterisation of process residues, waste rock and overburden including an assessment of the 'dustiness' of bulk materials to the relevant standards, with an early version of the ESD directing Cameco to undertake the assessment using EN150541 Workplace exposure - Measurement of the dustiness of bulk materials:

- Part 1: requirement and choice of test methods' and/or Workplace exposure - Measurement of dustiness of bulk materials.
- Part 2: rotating drum method.

Cameco has reviewed the European Standards associated with EN150541. Based on a review of the Standard, Cameco considers that it is not applicable as the test methods (rotating drum and continuous drop) do not apply to the mechanical handling of ore and waste at Yeelirrie.

Further the Standard is not applicable to dust releases during mechanical reduction of solid bulk materials (e.g. cutting or crushing) or to wheel generated dust, excavation of material or wind erosion. As these mechanisms (crushing, wheel generated dust, excavation of material or wind erosion) account for approximately 80% of the dust producing processes modelled at Yeelirrie, further testing pursuant to the Standard is unlikely to provide any additional information or improve the existing estimates.

9.8.4 Existing Environment

The Project is located in the East Murchison region in an area which is sparsely populated. The Project is located on the Yeelirrie pastoral lease and is located more than 10 km from the nearest receptors, which have been identified as the Yeelirrie Pool, Yeelirrie Homestead and the proposed Accommodation Village, located approximately 10.2 km, 16.9 km and 14.4 km, respectively, from the ore body.

The nearest sensitive receptors to the Project are presented in Table 9-67.

Table 9-67: Nearest sensitive receptors to the Project

Receptor	Distance and direction from ore body
Accommodation Village	14.4 km SE
Yeelirrie Homestead	16.9 km SE
Ululla Homestead	28.8 km N
Albion Downs Homestead	45 km WSW
Youno Downs	62.1 km WNW
Yeelirrie Pool	10.2 km NE
Palm Springs	50.4 km ESE

The National Pollutant Inventory (NPI) database identifies 15 emission sources within a 100 km radius of the Project. The reported emissions from these sources for the 2012-2013 reporting year are presented in the Katestone report (Appendix L1). The closest mining activity to the Project is at Mount Keith, approximately 70 km east of the proposed Yeelirrie Uranium Project.

The main regional and local dust source is wind erosion of exposed soil surfaces particularly during dry periods. Air quality in the vicinity of the site is also affected by occasional bush fires and scrub fires. Anthropogenic dust sources are primarily from pastoral activities and vehicular activity on unsealed roads. Daily background-levels of dust are expected to be low and will vary significantly depending on location, topography, meteorological conditions and proximity to sources. There are no significant anthropogenic gaseous emissions sources that could affect air quality in the vicinity of the Project.

9.8.4.1 Climatic Conditions

The inland areas of the Western Australian region show a predominance of east to southwest winds during spring and summer, shifting to a distinct alternating westerly and easterly flow during autumn and winter. The climate of the Project Area is described as arid with rainfall occurring mostly in winter. A detailed description of the climatic conditions is presented in Appendix L1.

The most important aspect of the Yeelirrie climate in terms of air quality is the frequency and intensity of hot, dry north-easterly winds as these are most likely to generate dust from the erosion of stockpiles and disturbed areas. Also of importance is the frequency and intensity of night-time inversions particularly in winter characterised by a stable atmosphere and the formation of a low level jet (Lyons *et al.*, 1981). These conditions can cause pollutants to remain suspended in the atmosphere for long periods of time (Katestone 2014a).

The meteorological modelling found that stable boundary layer conditions (Pasquil-Gifford F class) were likely to occur frequently (39% of hours in the period from February 2010 to January 2011). These conditions occur at night and are more prominent during the winter months when surface cooling is at a maximum (Katestone 2014a).

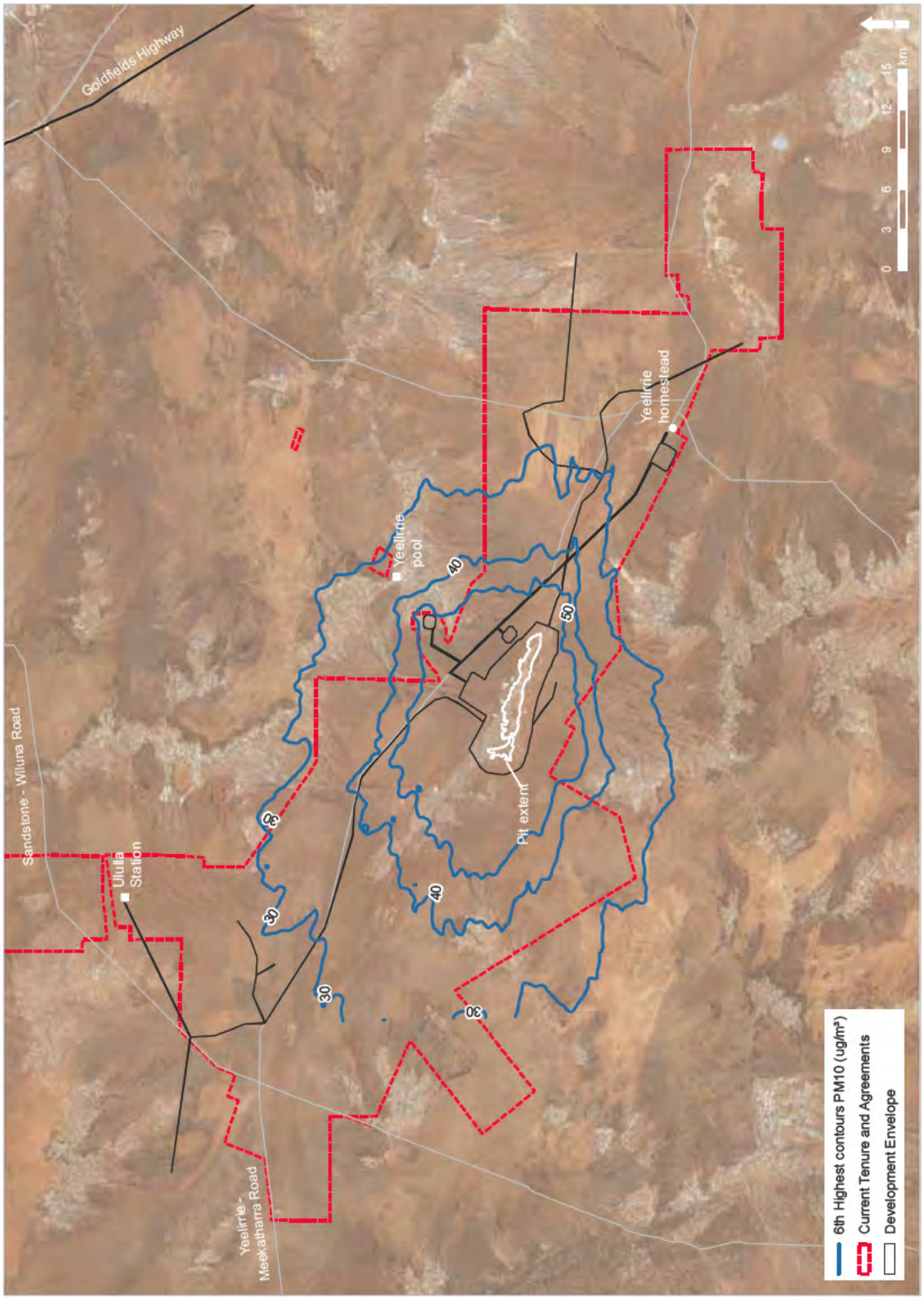

Figure 9-59: Predicted 6th highest 24 hour average ground level concentration of PM_{10}

9.8.5 Potential Impacts

The predicted maximum 24-hour average and annual average ground-level concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition from the Project at the nearest sensitive receptor locations are presented in Table 9-68. The maximum predicted ground level concentrations of these pollutants as a result of the Project are presented in Plates 1 – 13 of the Katestone report (Appendix L1).

These results indicate that:

- the predicted maximum 24-hour average ground-level concentrations of TSP, PM_{10} and $PM_{2.5}$ at the nearest sensitive receptors due to the Project comply with the relevant air quality criteria;
- the predicted annual average ground-level concentrations of TSP, PM_{10} and $PM_{2.5}$ at the nearest sensitive receptors due to the Project comply with the relevant air quality criteria; and
- incremental dust deposition rates outside the mining lease area boundary due to mine operations are predicted to comply with the air quality criterion of 2 g/m^2/month.

Figure 9-59 shows the predicted sixth highest 24-hour average ground level concentrations of PM_{10} with ambient background levels included (as noted in Table 9-68).

Figure 9-60 and Figure 9-61 show the predicted maximum 24-hour and annual average ground level concentrations of $PM_{2.5}$ respectively with ambient background levels included.

The predicted annual average dust deposition rate from the Project is presented in Figure 9-62.

Air emissions from on-site diesel power generators will principally consist of NO_2, CO, SO_2 and particulates. The predicted maximum and annual average ground-level concentrations for these pollutants at the nearest sensitive receptor locations are presented in Table 9-68.

The results of dispersion modelling of pollutants show:

- The maximum 1-hour average NO_2 concentration at Yeelirrie Pool is predicted to be greater than the Air NEPM criterion of 250 $\mu g/m^3$ (Figure 9-63) However, one exceedance day is allowed for by the Air NEPM. As the maximum 1-hour average concentration on the 2nd highest day is 157.5 $\mu g/m^3$, concentrations at this receptor comply with the Air NEPM criterion.
- The ground-level concentrations of 1-hour average NO_2 at all other sensitive receptors comply with the air quality criterion.

The ground-level concentrations of CO, SO_2, PM_{10}, and annual average NO_2 at all nearest sensitive receptors due to on-site power generation are predicted to comply with the relevant air quality criteria (Katestone, 2014a, Appendix L1).

The predicted maximum 1-hour average ground level concentration of NO_2, assuming no reduction of generator NO_x emissions, is shown in Table 9-69.

Table 9-68: Predicted ground-level concentrations (µg/m³) of TSP, PM_{10} and $PM_{2.5}$ and dust deposition rate (g/m²/month) due to the Yeelirrie Uranium Project

Pollutant	Averaging Period	Criteria	Accommodation village / Yeelirrie Homestead		Yeelirrie Pool		Ululla Homestead		Palm Springs	
			From operations	With background	From operations	With background	From operations	With background	From operations	With background
TSP	24-hour max	90	4.7	24.7	14.4	64.4	5.6	55.6	0.4	50.4
	Annual	90	0.1	25.1	1.14	26.1	0.2	25.2	0.01	25.0
PM_{10}	24-hour (6^{th} highest)[1]	50	1.3	26.3	10.9	35.9	1.7	26.7	0.1	25.1
	Annual	25	0.1	12.6	1.0	13.5	0.2	12.7	0.01	12.5
$PM_{2.5}$	24-hour max	25	1.1	11.9	3.5	14.3	0.9	11.7	0.1	10.9
	Annual	8	0.01	7.7	0.2	7.9	0.04	7.7	0.002	7.7
Dust deposition	Annual	2 [2]	0.002	n/a	0.013	n/a	0.006	n/a	0.0004	n/a

Notes:

[1] 6^{th} Highest 24-hour concentration presented for PM_{10} in accordance with the Air NEPM

[2] Dust deposition criterion of 2 g/m²/month (as an annual average) is maximum increase in deposited dust level above background

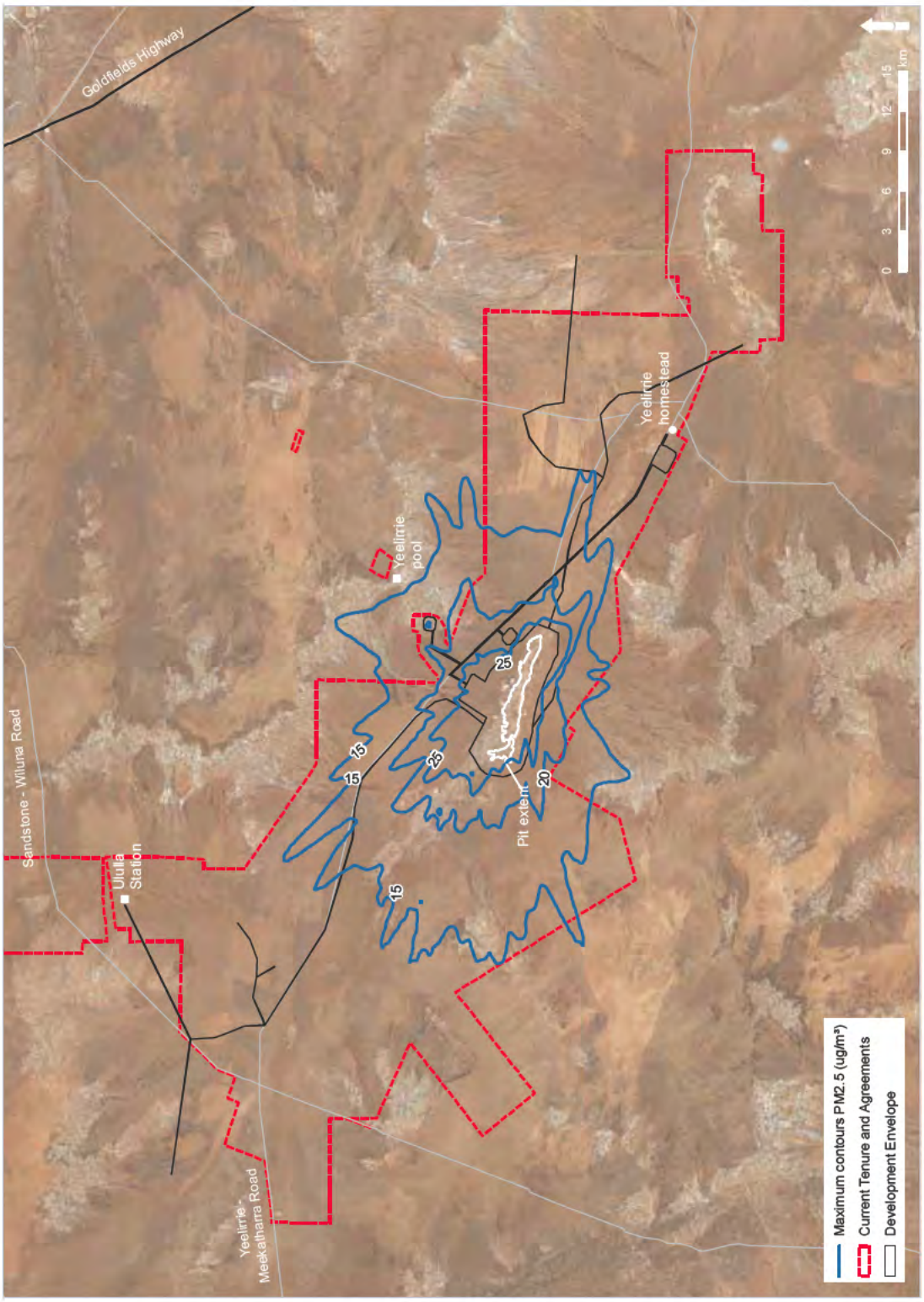

Figure 9-60: Predicted max 24 hour average ground level concentration of $PM_{2.5}$

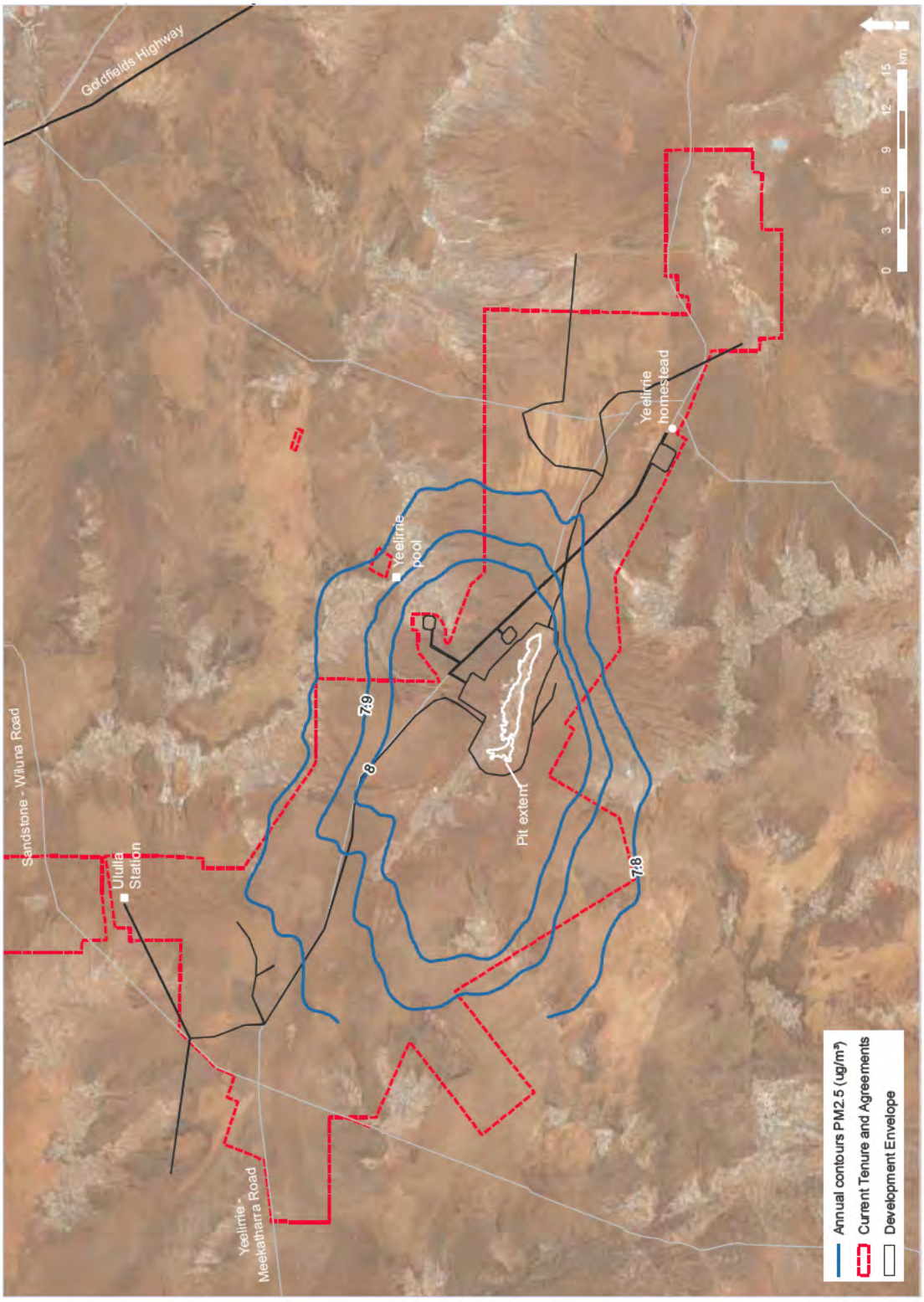

Figure 9-61: Predicted annual average ground level concentration of $PM_{2.5}$

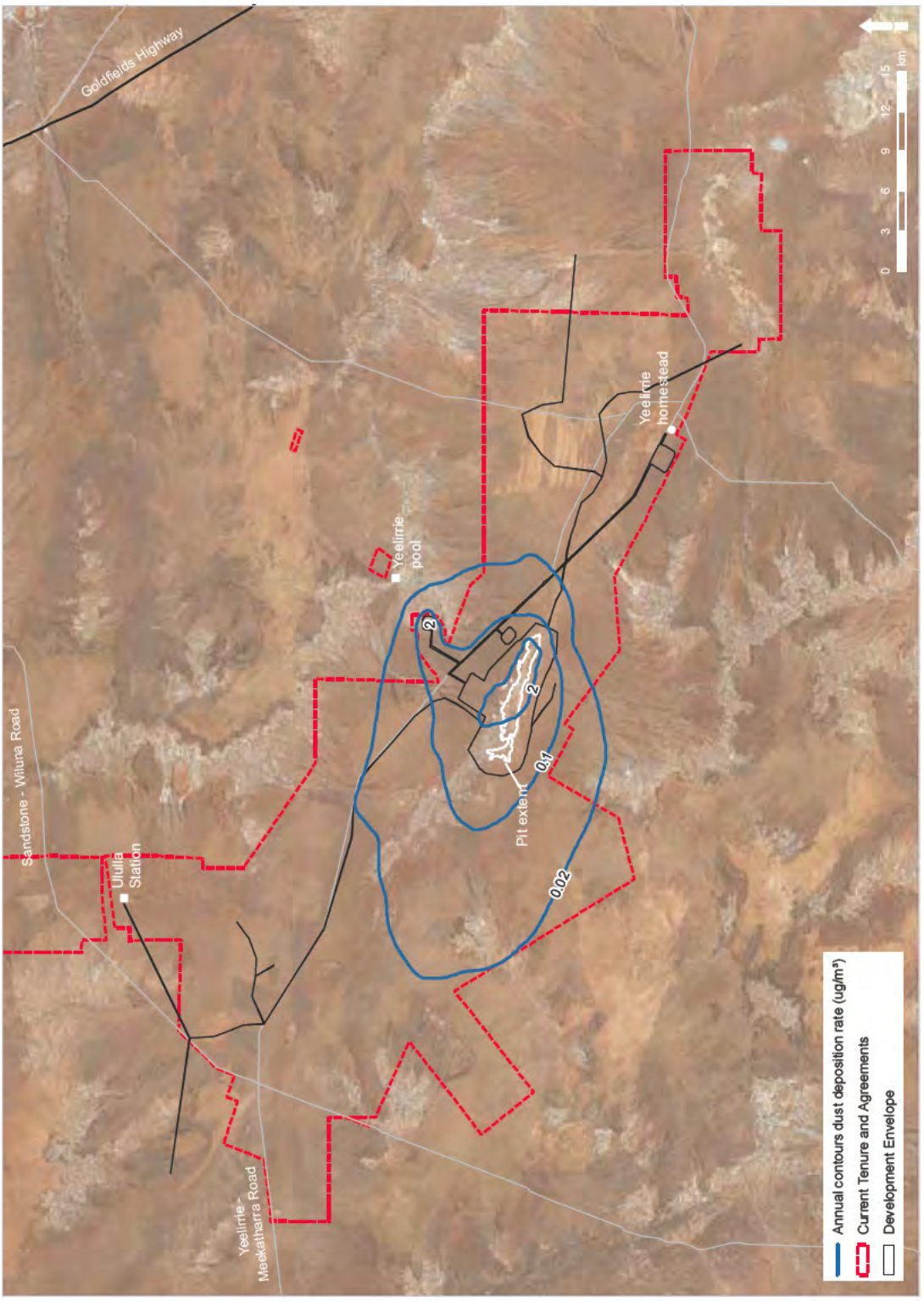

Figure 9-62: Predicted operationally contributed annual average dust deposition rate

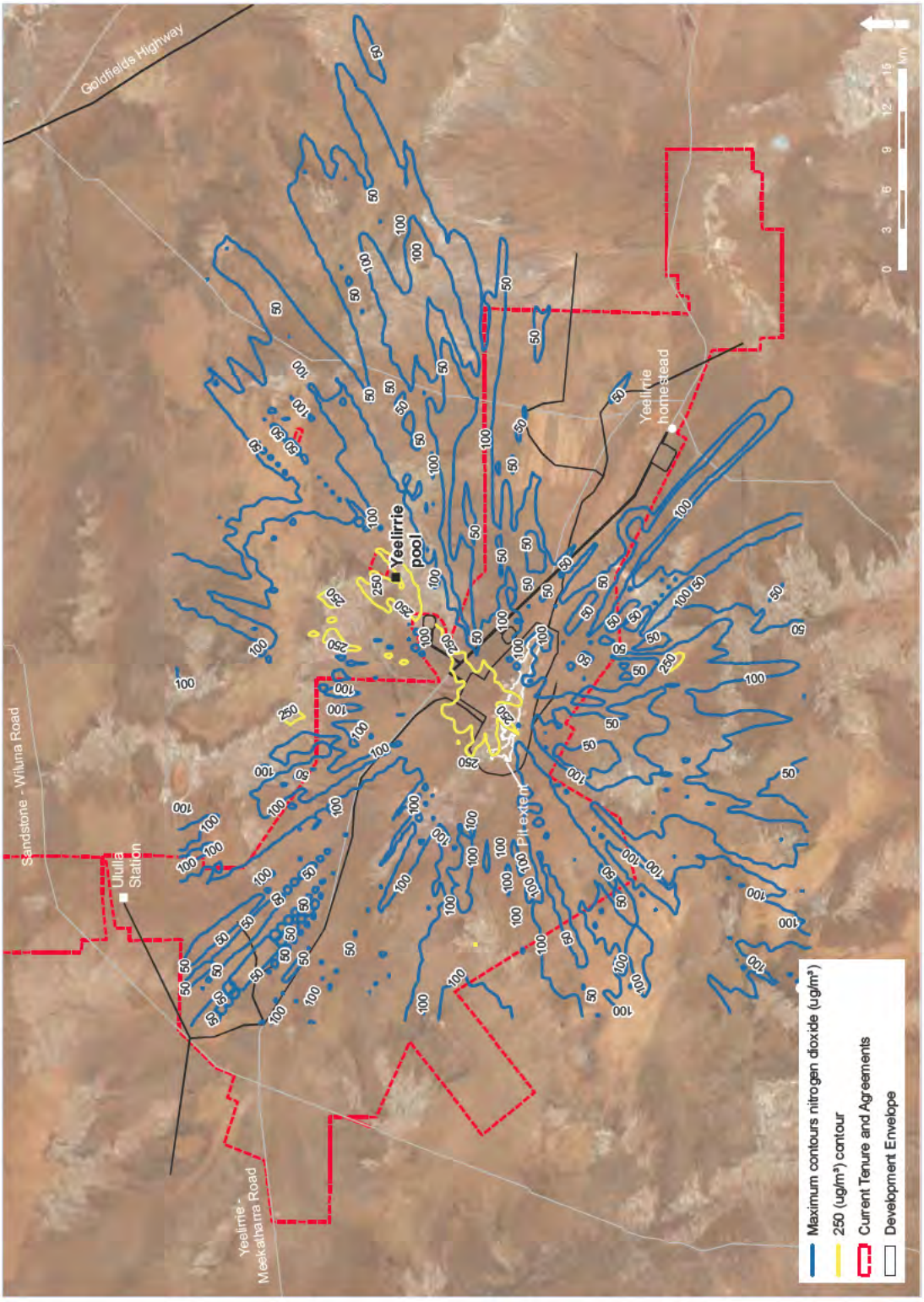

Figure 9-63: Predicted operationally contributed maximum 1-hour average ground-level concentration of nitrogen dioxide (assumes no capture of generator emissions)

Table 9-69: Predicted operationally contributed ground-level concentrations (µg/m³) due to diesel generators (Assume zero capture of generator emissions)

Pollutant	Averaging Period	Criteria	Accommodation village/ Yeelirrie Homestead	Yeelirrie Pool	Ululla Homestead	Palm Springs
NO_2	1-hour max	250	42.2	157.5 [1]	82.6	10.6
	Annual	62	0.02	0.6	0.2	0.03
CO	8-hour max	11,000	0.7	10.1	4.2	0.6
SO_2	1-hour max	570	1.7	17.0	3.6	0.5
	24-hour max	230	0.1	1.6	0.7	0.1
	Annual	57	0.001	0.024	0.01	0.001
PM_{10}	24-hour (6^{th} highest)[2]	50	<0.01	0.07	0.02	<0.01
	Annual	25	<0.01	<0.01	<0.01	<0.01
$PM_{2.5}$	24-hour max	25	0.02	0.3	0.1	0.02
	Annual	8	<0.01	<0.01	<0.01	<0.01

Notes:

[1] Maximum 1-hour concentration on 2^{nd} highest day in accordance with the Air NEPM

[2] 6^{th} Highest 24-hour concentration presented for PM_{10} in accordance with the Air NEPM

The results of the dispersion modelling indicate that fugitive dust emissions from the Project are not likely to result in unacceptable air quality impacts at the sensitive receptors. The maximum predicted 24-hour and annual average TSP, PM_{10} and $PM_{2.5}$ ground-level concentrations and the monthly incremental dust deposition rates will comply with the relevant air quality criteria at each of the sensitive receptors. The air dispersion modelling results also indicate that emissions from the on-site diesel power generators will not result in unacceptable air quality impacts and the associated maximum and annual predicted ground-level concentrations of NO_2, CO, SO_2 and particulates will comply with the relevant air quality criteria at each of the sensitive receptors.

9.8.6 Management

A Dust Management Plan will be prepared for the Project. The Project has been designed with a strong focus on minimising dust emissions. Within the mining and stockpile areas traditional dust management techniques, including the use of water sprays, dust suppressants and progressive rehabilitation (where practicable), will be used to manage dust emissions associated with the Project. Similarly, a high level of control has been included within the plant design to minimise the particulate emissions (Section 9.6.6). Dust management measures are discussed further in Appendix L.

The Dust Management Plan will include ambient monitoring of PM_{10} concentrations and dust deposition rates. The results of the ambient monitoring program will be used to develop management targets for PM_{10} concentrations to allow an adequate response time to reduce the risk that concentrations greater than the 24 hour NEPM PM_{10} standard occur as a result of Project operations. In the event that target concentration criteria are not met, Cameco will investigate the likely causes and assess possible contributions from the Project's operations. If these are deemed to be significant then Cameco will implement remedial actions and contingencies targeting the identified Project related sources using actions that will be identifi ed in the Dust Management Plan.

General - Avoid and Minimise

- The Project has been designed to minimise atmospheric emissions as a result of its operations and comply with all relevant air quality standards and guidelines.
- The Dust Management Plan will be prepared for the Project. The plan will include ambient monitoring of PM_{10} concentrations and dust deposition rates. The results will be used to develop management targets for PM_{10} concentrations to allow adequate response time to reduce the risk of exceeding the NEPM standard.
- Within the mining and stockpile areas conventional dust management techniques, including the use of water sprays, dust suppressants and progressive rehabilitation, will be used to manage dust emissions.
- The process plant uses wet processing and the plant has been designed to minimise particulate emissions.
- Tailings will be deposited to the in-pit TSF as a slurry and kept moist throughout operations to prevent dust generation at the surface.
- The power station will be maintained to operate efficiently.
- Comply with all relevant air quality standards and guidelines.
- Developing limits and management targets for the Project by using the Ambient Air Quality NEPM.

9.8.7 Commitments

Cameco will:

- Develop and implement the Dust Management Plan.

9.8.8 Outcomes

Taking into account the Project design and proposed management measures to be implemented, Cameco believes that the Proposal will meet the EPA's objective with regards to Air Quality.