

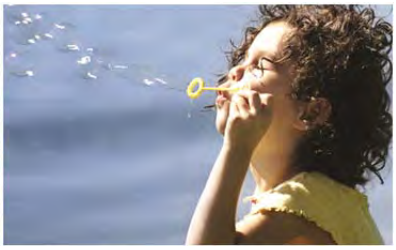

Kintyre Air Quality Assessment

Prepared for:
Cameco Australia Pty Ltd

Prepared by:
ENVIRON Australia Pty Ltd

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This document is issued in confidence to Cameco Australia Pty Ltd for the purposes of assessing the potential ambient air quality impacts associated with emissions of dust and other pollutants generated by mining, processing and power generation facilities at the proposed Kintyre Uranium Project site. It should not be used for any other purpose.

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Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

Cameco Australia Pty Ltd (Cameco) a wholly owned subsidiary of Cameco Corporation, is proposing to develop the Kintyre Uranium Project located approximately 1,250 km north-northeast of Perth in the Shire of East Pilbara, Western Australia. It is estimated that the Kintyre Project hosts potential mineral deposits ranging from 28 to 36 kilotonnes (kt) of uranium oxide (U_3O_8), with an average grade between 0.3% and 0.4% U_3O_8. The anticipated life of the Project including construction, production and closure is 13.5 years.

The proposed Kintyre Project will include a uranium mine and associated treatment facilities to extract the uranium from the ore. Ore would be mined from a single pit using a combination of selective and bulk open pit mining techniques and sorting to separate uranium-bearing ore from unmineralised overburden. The ore would be processed in a leach and precipitation treatment plant to produce the uranium oxide concentrate (UOC) for export. It is expected that under peak operations up to 4,400 tonnes of UOC will be produced per annum. The UOC would be transported via road from the mine site to the Port of Adelaide, South Australia.

Unmineralised overburden would be stored in a permanent above-ground Waste Rock Landform (WRL). Mineralised overburden would be stockpiled separately from the unmineralised overburden and may be blended with higher grade ore to ensure a consistent ore grade for processing. All tailings generated during the processing of the ore would be directed to an above-ground Tailings Management Facility (TMF). Additional infrastructure components required to support the mining and treatment plant include pit dewatering infrastructure; potable and process water supply borefields; lined evaporation pond for disposal of excess process, mine and tailings water; an electricity supply network based on an on-site diesel power generation; landfill for inert and putrescible waste; buildings, including offices, workshops and warehouses; and an accommodation village for a fly-in fly-out (FIFO) workforce, located approximately 1.3 km south of the on-site operations.

ENVIRON Australia Pty Ltd (ENVIRON) were engaged by Cameco to undertake air dispersion modelling of emissions of dust and other pollutants generated by the proposed mining, processing and power generation facilities at the Project site, to assess the potential ambient air quality impacts associated with the proposed Kintyre Project. The assessment focuses on fugitive dust emissions associated with mining operations, truck loading, stockpiling, reclaiming, primary and secondary crushing, radiometric sorting, vehicle movements on unpaved roads and wind erosion of unpaved surfaces including the ROM pad and WRLs; as well as point source emissions of pollutants such as oxides of nitrogen (NO_x) and sulphur dioxide (SO_2) from the diesel-generated power station.

Short-term and long-term ambient ground level concentrations (GLCs) of total suspended particulate (TSP), particulate matter less than 10 µm in equivalent aerodynamic diameter (PM_{10}) and particulate matter less than 2.5 µm in equivalent aerodynamic diameter ($PM_{2.5}$), have been predicted for a peak production scenario. Particulate deposition rates have been predicted to assess the impact of dust deposition on the surrounding environment. GLCs of pollutants associated with emissions from the power station have also been predicted to assess these impacts on ambient air quality.

The results of the air dispersion modelling show that the off-site impacts of TSP, PM_{10} and $PM_{2.5}$ concentrations are predicted to be below the ambient guidelines with exceedances of

these guidelines predicted to be localised to the immediate vicinity of the Project's operational areas and within Cameco's tenement boundaries. The incremental guideline for particulate deposition is also predicted to be exceeded within Cameco's tenement boundary. No exceedances of the ambient air quality objectives for SO_2, nitrogen dioxide, or carbon monoxide are predicted to occur as a result of the Project's proposed power station emissions.

A Dust Management Plan (DMP) has been prepared for the Project. The DMP will be reviewed and revised as required on a regular basis and includes ambient monitoring of PM_{10} concentrations and total deposition rates.

The air dispersion modelling results indicate that the proposed Kintyre Project is not expected to result in any significant issues with regards to potential ambient air quality impacts.

1 Introduction

1.1 Background

Cameco Australia Pty Ltd (Cameco) a wholly owned subsidiary of Cameco Corporation, is proposing to develop the Kintyre Uranium Project located approximately 1,250 km north-northeast of Perth in the Shire of East Pilbara, Western Australia (Figure 1). Kintyre is one of the largest known uranium occurrences in Western Australia. Uranium was first discovered in the area in 1985 and extensive exploration identified eight deposits. It is estimated that the Kintyre Project hosts potential mineral deposits ranging from 28 to 36 kilotonnes (kt) of uranium oxide (U_3O_8), with an average grade between 0.3% and 0.4% U_3O_8. The anticipated life of the Project including construction, production and closure is 13.5 years.

The proposed Kintyre Project will include a uranium mine and associated treatment facilities (Figure 2). Ore would be mined from a single pit using a combination of selective and bulk open pit mining techniques and sorted to separate uranium-bearing ore from barren material. The ore would be processed at a leach and precipitation treatment plant to produce the uranium oxide concentrate (UOC) for export. It is expected that under peak operations, up to 4,400 tonnes of UOC will be produced per annum. The UOC would be transported via road from the mine site to Port of Adelaide in South Australia.

Unmineralised overburden would be stored in permanent above-ground Waste Rock Landform (WRL) (Figure 2). Below ore-grade uranium overburden (mineralised overburden) would be stockpiled separately from the unmineralised overburden and may be blended with high grade ore to ensure a consistent ore grade for processing. All tailings generated during the metallurgical processing of the ore would be directed to an above-ground Tailings Management Facility (TMF) (Figure 2).

Additional infrastructure components required to support the mining and metallurgical operations include pit dewatering infrastructure; potable and process water supply borefields; lined evaporation pond for disposal of excess process, mine and tailings water; an electricity supply network using on-site diesel power generation; landfill for inert and putrescible waste; buildings, including offices, workshops and warehouses; and an accommodation village for a fly-in fly-out (FIFO) workforce, located approximately 1.3 km south of onsite operations (Figure 2).

ENVIRON Australia Pty Ltd (ENVIRON) were requested by Cameco to undertake air dispersion modelling of emissions of dust and other pollutants generated by the proposed mining, processing and power generation facilities at the Project site, to assess the potential ambient air quality impacts associated with the proposed Kintyre Uranium Project.

1.2 Purpose of this Report

The purpose of this air dispersion modelling study is to assess the potential ambient air quality impacts associated with emissions of dust and other pollutants from the proposed Kintyre Project site. The assessment focuses on fugitive dust emissions associated with mining operations, truck loading, stockpiling, reclaiming, primary and secondary crushing, radiometric sorting, vehicle movements on unpaved roads and wind erosion of unpaved surfaces including the Run Of Mine (ROM) pad and WRL; as well as point source emissions of pollutants such as sulphur dioxide (SO_2), oxides of nitrogen (NO_x) and particulate matter from the diesel-generated power station. Cameco has advised that water vapour is the primary emission from the process plant. The calciner stack will be fitted with a wet scrubber and dust collectors will be fitted to the grinding and milling circuits. Particulate emissions from the process plant are therefore expected to be negligible.

Air dispersion modelling has been completed to predict the short-term and long-term ambient ground level concentrations (GLCs) of total suspended particulate (TSP), particulate matter less than 10 µm in equivalent aerodynamic diameter (PM_{10}) and particulate matter less than 2.5 µm in equivalent aerodynamic diameter ($PM_{2.5}$), associated with a peak production scenario. Particulate deposition rates have been predicted to assess the impact of dust deposition on the surrounding environment. The air dispersion model has also been utilised to predict GLCs of pollutants associated with emissions from the power station to assess these impacts on ambient air quality.

2 Site and Process Description

2.1 Site Location and Facility Layout

The proposed Kintyre Project is located in a remote area in the East Pilbara Region of Western Australia, approximately 60 km south of Telfer and 260 km northeast of Newman (Figure 1).

The nearest sensitive receptor to the proposed site operations is the onsite accommodation camp, located approximately 1.3 km south of the TMF (Figure 2). The Telfer mine site and accommodation village is the nearest offsite receptor, followed by the local indigenous communities of Parnngurr, 80 km southeast of the Project; and Punmu, 113 km northeast of the Project. However, it is considered unlikely that fugitive dust emissions from the Kintyre Project site would have any significant impact on the ambient air quality at these receptors given their distance from the proposed operations.

A layout of the proposed mining operations is presented as Figure 2, highlighting the mining pit, WRL, TMF and processing plant. A conceptual layout of the metallurgical processing plant is presented in Figure 3, identifying the primary crusher, radiometric sorter, power station and other additional infrastructure required to support the mining and processing operations.

Process flow diagrams for the mining operations and metallurgical processing are presented in Figures 4 and 5 respectively and a brief overview of each component is provided below.

2.2 Production and Throughput

A summary of the proposed mining schedule provided by Cameco is presented in Table 1. This information indicates that the maximum mining rate for any one year would be up to 25.1 million tonnes per annum (Mtpa). This would occur during the second year of mining operations and would be comprised of approximately 0.7 Mtpa of ore, 23.9 Mtpa of waste rock and an additional 0.4 Mtpa of mineralised overburden. However, the maximum mining rate for mineralised overburden would be up to 1.9 Mtpa and would occur during the fourth year of mining activities, while the maximum mining rate for ore would be up to 1.1 Mtpa and would occur in the sixth and final year of mining activities.

Table 1: Summary of Proposed Mining Schedule

Material Type	Annual Material Movements (Mtpa)						Total
	Year 1[1]	Year 2	Year 3	Year 4	Year 5	Year 6[2]	
Ore	0.1	0.7	0.3	0.2	0.9	1.1	**3.4**
Mineralised Overburden	0.6	0.4	1.1	1.9	0.8	1.4	**6.3**
Waste Rock	13.1	23.9	23.5	5.7	19.0	10.0	**95.1**
Total	**13.8**	**25.1**	**24.9**	**7.8**	**20.7**	**12.5**	**104.7**

Notes:
1. Two active quarters.
2. Three active quarters.

All material from the pit would be classified into one of the three categories depending on the U_3O_8 content, with ore being material above the economic cut-off grade of 1,500 ppm.

The metallurgical plant would operate at a peak throughput rate of around 0.6 Mtpa, based on a maximum feed rate to the primary crushing circuit of up to 1.1 Mtpa. The crushed ore would be passed through a radiometric sorter with the reject material sent to the WRL.

The mineralised overburden (estimated to be approximately 6 Mt over the life of the mine) would be stockpiled separately in a lined facility adjacent to the WRL and may be used to blend with high grade ore or processed during periods of production shortfall. If not processed, the mineralised overburden would be encapsulated to minimise radon emanation and mitigate the potential for hazardous stormwater runoff.

2.3 Ore Moisture Content

The National Pollutant Inventory (NPI) classifies any ore (with the exception of bauxite) with a moisture content of greater than 4% by weight, either naturally or as a result of added water, as a ‘high’ moisture ore (NPI, 2011). For the purposes of this assessment (and in the absence of site specific information), it has been assumed that the moisture content of the ore from the proposed Kintyre Project will remain ‘high’ as water sprays will be used to control dust emissions throughout the mining process.

2.4 Mining and Process Operations

2.4.1 Mining Operations

The Kintyre deposit would be mined using a single open pit mine encompassing various individual ore zones. A combination of selective and bulk open pit mining techniques would be used with a conventional excavator and truck fleet. The mining pit would ultimately extend 1 km by 1.5 km and would be excavated to a depth of around 250 m below ground.

Traditional drill and blast methods would be utilised to break and loosen the material for extraction, using a combination of ammonium nitrate fuel oil (ANFO) and emulsion-based explosives and electric detonators in the ore areas and the adjacent mineralised overburden. Non-electric detonators would be used in the remaining mineralised overburden and in the unmineralised overburden.

Excavators would load the ore and waste rock into 133 t capacity haul trucks for transport to the ROM stockpiles and WRL. Mineralised overburden would be stockpiled within a dedicated facility adjacent to the WRL. The overburden would be directed to either the northern section or western section of the WRL based on the location of extraction of the material from the pit, in order to minimise haulage distances. Mining operations are expected to be carried out 24 hours per day, 365 days per year.

A process flow diagram of the mining operations is presented as Figure 4.

2.4.2 Onsite Processing

A metallurgical plant suitable for the production of up to 4,400 tpa of U_3O_8 would be established to treat ore extracted from the open pit using a conventional acid leaching process followed by conventional uranium extraction processes to produce a final UOC product for export. A flow diagram of the proposed metallurgical process is presented as Figure 5.

Ore reclaimed from the ROM pad would be loaded into a primary feed bin and a vibrating sizing grill (called a grizzly) would separate smaller material not requiring crushing from those larger rocks which would be fed to a primary jaw crusher. Material from the jaw crusher would be sorted using radiometric sorting to sort low grade materials from ore based on a defined uranium cut-off grade. Material rejected at this stage would be transported to the WRL or to the TMF for use as construction material.

Ore from the radiometric sorter would be conveyed to the secondary crusher feed bin, mixed with water and ground in a semi-autogenous grinding (SAG) milling circuit, with oversized material passed to a pebble crusher prior to recirculating to the SAG mill. The resultant slurry would be pumped to a thickener and the thickened slurry passing to the acid leach circuit.

The leaching of uranium would be carried out in a series of cascade overflow leach tanks, with manganese dioxide and sulphuric acid added to the tanks to facilitate the leaching process. The leached pulp (containing uranium in solution and gangue materials as a slurry) would pass from the last leaching tank to the solid liquid separation circuit, where the solids would be separated from the uranium-bearing solution (termed pregnant liquor solution (PLS)). The dewatered solids would pass to a neutralisation tank and the PLS would be filtered using ultrafiltration membranes to remove any remaining solids before being pumped to the PLS storage tank.

A conventional uranium solvent extraction process would be used for the purification and concentration of uranium in solution. A solvent extraction system would be used to recover uranium from the PLS to an organic phase (termed 'loaded organic') with the addition of extractant, modifier and diluent reagents, leaving a raffinate solution containing the majority of the iron, silica and sulphate impurities. The loaded organic solution would be scrubbed to remove any entrained raffinate and silica, and the scrubbed solution would subsequently pass to a stripping circuit where the uranium would be extracted using a stripping agent to form a uranium-bearing loaded strip solution. The barren organic solution, stripped of its uranium, would be regenerated using sodium carbonate and recycled through the process plant.

The loaded strip solution would be treated with either ammonium or hydrogen peroxide to produce a uranium precipitate. The uranium precipitate would be calcined in a rotary calciner, producing a 99% U_3O_8 product (also known as UOC). This would be discharged to a UOC product bin, before being loaded into 210 L steel drums, each of which would be sampled, sealed, washed, weighed and labelled in preparation for dispatch. Off-gas from the calciner would be scrubbed prior to discharge to the atmosphere, with the captured material pumped back to the uranium precipitation circuit. A separate baghouse system would be installed to provide scrubbing of the calcining and packaging building ventilation gases.

2.4.3 Tailings Management

The tailings from the proposed development, consisting of acid leach wastes in the form of slurry, would be deposited in an above-ground TMF at a rate of around 600,000 tpa. The TMF would be constructed adjacent to and integrated with the WRL, to create an Integrated Waste Landform (IWL) (Figure 2).

The TMF would have a nominal final height of around 20.5 m and would be designed to store approximately 7 Mt of tailings material over the life of the operation. The TMF embankments would be constructed from unmineralised material using a combination of mine overburden and material extracted during pond construction and during land clearing.

2.5 Emission Sources and Controls

Dust emissions from the proposed Kintyre Project are expected to be primarily generated from the following sources:

- Drilling and blasting;
- Material handling (i.e. excavating and in-pit loading, stockpiling, bulldozing, reclaiming, conveyor transfers);
- Primary and secondary crushing circuits;
- Radiometric sorting and associated material handling;
- Vehicle generated dust on unpaved surfaces (i.e. heavy vehicle movements along the haul roads); and
- Wind erosion of unpaved surfaces including the ROM pad and WRL.

Fugitive dust emissions are not expected to be generated from the TMF as the tailings will be deposited as a slurry and maintained in a damp state. The processing circuit is similarly not expected to generate fugitive dust emissions. The primary and secondary crushing circuits will be enclosed, as will conveyors and transfer stations within the processing circuit and ventilation gases from buildings will be scrubbed before release to the atmosphere. Fugitive dust emissions from these sources are subsequently expected to negligible.

Brief descriptions of the potential dust sources included in the modelling are provided in the following sections, along with details of dust control measures proposed by Cameco. The efficiency of the dust control measures is also described, based on the National Pollutant Inventory (NPI)'s estimated control factors for mining activities (NPI, 2011).

2.5.1 Drilling and Blasting

A combination of selective and bulk open pit mining techniques and a conventional excavator and truck fleet will be used to mine the Kintyre deposit. Drill and blast techniques will be employed to break and loosen the ore and overburden. In order to maintain production rates, blasting will be required to be carried out once every four days. For the purpose of this assessment it has been assumed that blasting will occur at 13:00 hours.

Information from Cameco indicates that an average of 100 holes will be drilled per day (400 holes per blast). For the purpose of this assessment it has been assumed that drilling activities will occur continuously throughout the modelled year. It has also been assumed that water sprays will be used during drilling and blasting operations to control dust emissions. A control efficiency of 50% was adopted for this measure, in line with the suggested NPI (2011) emission reductions for water sprays.

2.5.2 Excavation and Truck Loading

Excavation of blasted rock will proceed along pre-defined benches within the pit. Blasted rock will be recovered with a top loading excavator which will sit on top of the blasted bench and load material down into trucks positioned on a lower bench. Up to three hydraulic excavators will be in use at any one time. Ore and waste rock will be loaded into 133 t capacity haul trucks.

The mining schedule provided by Cameco indicates that peak mining movements will occur during the second year of operation. Up to 23.9 Mt of waste rock, 0.7 Mt of ore and 0.4 Mt of mineralised overburden will be excavated from the mining pit during this period, totalling 25.1 Mt (Table 1). The emission estimates associated with excavation and truck loading activities were conservatively based on this peak throughput rate. It was also assumed that excavation and truck loading would occur continuously throughout the modelled year.

Water sprays are expected to be used to minimise fugitive dust emissions generated during these activities and a control efficiency of 50% was adopted for this measure, in line with the suggested NPI (2011) emission reduction for water sprays.

2.5.3 Truck Unloading

Haul trucks will be used to transport ore and waste rock from the mining pit to the ROM pad, WRL and mineralised overburden stockpile. Emission estimates associated with truck unloading at the ROM pad were based on the peak ore throughput rate of 1.1 Mtpa, as advised by Cameco (Table 1). For modelling purposes it has been assumed that the ore will be stockpiled evenly across the ROM pad.

The placement of waste rock within the WRL will be controlled to conform to the WRL design plan. Emission estimates associated with truck unloading within the northern and western sections of the WRL were based on peak throughput rates of 3.4 Mtpa and 20.0 Mtpa respectively, the latter including an additional 0.55 Mtpa of rejected material from the primary crushing circuit, as advised by Cameco. For modelling purposes it has been assumed that stockpiling activities within the northern section of the WRL will occur in the area immediately adjacent to the north of the pit, while stockpiling activities within the western section of the WRL were conservatively assumed to be focused within the southernmost section of the landform, as this area is closest to the nearest sensitive receptor (i.e. onsite accommodation camp). The size of the active areas was determined by calculating a ratio of tonnes per square metre, based on the total amount of waste rock going to the WRL.

A proportion of the waste rock will be used as backfill and transported directly from the blast face and deposited in areas of the pit where mining activities have been completed. Emission estimates associated with the unloading of this material were based on a peak throughput rate of 15.6 Mtpa (as advised by Cameco) and for modelling purposes it has been assumed that the backfill will be deposited evenly throughout the mining pit.

It has been conservatively assumed that stockpiling activities at the ROM pad and WRL, as well as backfilling within the mining pit, occurs continuously throughout the modelled year. It is also assumed that water sprays will be used at each of these locations to minimise fugitive dust emissions. A control efficiency of 50% has been adopted for this measure, in line with the suggested NPI (2011) control factor for water sprays.

2.5.4 Bulldozing

Bulldozers will be used on the ROM pad, mineralised overburden stockpile and WRL for material handling purposes. Emission estimates associated with bulldozing activities at each location were conservatively calculated assuming the bulldozers were operating continuously throughout the modelled year. Water sprays were also assumed to be in use when bulldozing to minimise associated dust emissions and a control efficiency of 50% has been adopted for this measure, in line with the recommended NPI (2011) control factor for use of water sprays.

2.5.5 Reclaiming

Front end loaders will be used to reclaim ore from the ROM pad and feed it into the primary crusher ore feed bin. For modelling purposes it was assumed the rate of reclaim operations would match the maximum throughput rate for the primary crusher (i.e. 127 tph, based on peak ore movements of 1.1 Mtpa), which in turn assumes continuous operation throughput the modelled year.

Water sprays are expected to be in use at the ROM pad to minimise dust emissions during reclaiming operations and a control efficiency of 50% has been adopted for this measure, in line with the recommended NPI (2011) control factor for use of water sprays.

2.5.6 Primary and Secondary Crushing Circuits

2.5.6.1 Primary Crushing

Ore reclaimed from the ROM pad would be fed into a primary feed bin and a vibrating grizzly would separate smaller material not requiring crushing from larger rocks which would be fed to a primary jaw crusher.

Emission estimates associated with primary crushing operations have been based on an hourly throughput rate of 127 tph, which in turn has been based on the maximum ore throughput rate of 1.1 Mtpa and calculated assuming continuous operations throughout the modelled year. The primary crushing circuit will be fitted with scrubbers and water sprays will also be used to minimise fugitive dust emissions. A control efficiency of 88% has been adopted for these measures, in line with NPI (2011) recommendations.

2.5.6.2 Radiometric Sorting

Material from the primary jaw crusher would pass through a radiometric sorter to sort low-grade ore from ore at a defined uranium cut-off grade (nominally 200 ppm of uranium). Emission estimates associated with the processing of material through the radiometric sorter have been based on the peak ore throughput rate of 1.1 Mtpa (Table 1). The radiometric sorter will be enclosed and a control efficiency of 99% has been adopted for this measure. This is less than the 100% recommended by the NPI (2011) for a totally enclosed system to allow for dust emissions which may escape through the entry and exit openings and to ensure that the emissions estimates remain conservative.

2.5.6.3 Material Transfers

It is anticipated that up to 50% of the material passing through the radiometric sorter will be rejected as below the defined cut-off grade and transported to the WRL. Emission estimates associated with the loading of this material into haul trucks have been based on an annual throughput rate of 0.55 Mtpa. For modelling purposes it has been assumed a single 133 t capacity haul truck would be loaded over the course of an hour and that up to 11 trucks would be loaded in any one day.

2.5.6.4 Secondary Crushing

Material above the cut-off grade (nominally 0.55 Mtpa) would be conveyed to the secondary crusher feed bin, mixed with water and ground in a SAG milling circuit, with oversized material passed to a pebble crusher prior to recirculating to the SAG mill.

Emission estimates associated with secondary crushing operations have been based on a total throughput rate of 0.55 Mtpa and an hourly throughput rate of 63 tph has been calculated assuming continuous operation. The secondary crushing circuit will also be fitted with scrubbers to minimise fugitive dust emissions, in addition to the crushed material being mixed with water. A combined control efficiency of 88% has been adopted to account for these measures, in line with NPI (2011) recommendations.

2.5.7 Vehicle Movements

Vehicles travelling on unwatered, unpaved roads can generate dust. Under normal site conditions, haul trucks generally have the greatest potential for dust generation, although this is highly dependent on road conditions. Fugitive dust emissions generated from haul trucks travelling from the pit to the ROM pad, WRL and mineralised overburden stockpile, as well as from the radiometric sorter load-out to the WRL, have been included in the modelling assessment. An average round trip distance of 1.3 km was used to calculate fugitive dust emissions associated with the ore haulage between the pit and ROM and average round trip distances of 0.8 km were used to calculate fugitive dust emissions associated with the haulage of waste rock to both the western and northern sections of the WRL. An average round trip distance of 2.6 km was used to calculate fugitive dust emissions associated with haulage of mineralised overburden to the mineralised overburden stockpile and a distance of 1.0 km was used to calculate fugitive dust emissions associated with the haulage of sorting rejects to the WRL.

Based on a haul truck capacity of 133 t and the total amount of ore deposited at the ROM pad over the modelled year (1.1 Mt,), it is estimated that over 8,000 return trips between the pit and ROM will be made during peak operations. Approximately 158,000 return trips between the pit and western section of the WRL, 25,000 return trips between the pit and northern section of the WRL and 14,000 return trips between the pit and mineralised overburden stockpile were similarly estimated, based on peak waste movements of 21.0 Mt, 3.4 Mt and 1.9 Mt respectively (as advised by Cameco). Approximately 4,000 return trips are estimated to be made annually between the sorting rejects load-out and the WRL, based on peak waste movements of 0.55 Mt.

Water carts will be used to wet down unsealed roads and a control factor of 75% was adopted for this measure, in line with the NPI (2011) recommended emission reduction for Level 2 watering (>2 litres/m^2/hour).

2.5.8 Power Generation

Cameco is proposing to install an onsite power plant consisting of six 1.6 MW Caterpillar 3516B engines and one 1.6 MW Caterpillar 3512 engine in order to meet the power requirements of the process plant, mining operations and accommodation village. The total installed power load will be 11.2 MW, although the operating power load is expected to be 8 MW during the first 6.5 years of mine life and 8.9 MW during the final year of mine life. The six 1.6 MW 3516B engines will be used to meet the power demand during the first 6.5 years of mine life, with the additional 1.6 MW 3512 engine installed in the final year in order to accommodate the anticipated increase in demand. Cameco has advised that while the initial operating load can be accommodated by five of the six generators, it is likely that all six will be operating at part load at any one time to ensure there is sufficient spinning reserve in the event that one generator were to go offline. A similar operating configuration is expected for the final year of mine life. For the purposes of this assessment it has been conservatively assumed that all seven generators will be operating continuously at 100% load.

Emissions of the criteria pollutants carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$) are expected to be generated from the power plant as a result of diesel fuel combustion. Emission estimates for these compounds have been calculated using emission factors published by the NPI for combustion engines (NPI, 2008) and typical fuel usage rates as specified by the manufacturer. For the purpose of estimating SO_2 emissions, it has been assumed that the diesel fuel used will meet the current Australian Diesel Fuel Quality Standard sulphur content of 10 ppm.

In determining the predicted 1-hour average NO_2 GLCs, the ozone limiting method was applied assuming that 10% of the NO_x emissions are in the form of NO_2. A consistent ambient ozone concentration of 63 ppb (highest 1-hour concentration measured in the Pilbara region between 1998 and 2000) was further used to ensure that the predicted concentrations were conservative (the highest ambient ozone concentrations recorded in the Pilbara region were associated with regional bushfires).

3 Ambient Air Quality Criteria

3.1 Ambient Particulate Standards

Dust is generally defined as particles that can remain suspended in the air by turbulence for a period of time and can consist of a range of matter including crustal material, pollens, sea salts and smoke from combustion products. Dust or particulate matter is commonly defined by the size of the particles, measured as:

- TSP, which refers to all particulate matter with an equivalent aerodynamic particle size below 50 µm diameter. 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 below 10 µm in equivalent aerodynamic diameter; and
- $PM_{2.5}$, particulate matter below 2.5 µm 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 soiling of washing. PM_{10} and $PM_{2.5}$ are associated with the potential for health impacts as finer particle fractions can enter deeper into the lungs.

The National Environment Protection Council (NEPC) has produced national ambient air quality standards for the protection of human health relevant to particulates. These include the National Environment Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 1998), which sets national air quality standards for criteria pollutants including particulate (as PM_{10}), and the Variation to the National Environment Protection (Ambient Air Quality) Measure (NEPC, 2002) which sets an advisory reporting standard for $PM_{2.5}$ particulate. These standards have been derived from health studies in major urban centres where the particulate matter primarily consisted of combustion products from vehicles, industry and smoke from various burning activities. The purpose of the $PM_{2.5}$ advisory standard is to gather sufficient data to facilitate a review of the Standard as part of the review of the ambient air quality NEPM that is currently underway. The Western Australian State Government has adopted the NEPM standards for ambient air quality as part of the State Environmental (Ambient Air) Policy 2009 (EPA, 2009) and the NEPM standards for PM_{10} and $PM_{2.5}$ have subsequently been applied in this assessment.

In addition to the NEPC NEPMs, the Western Australian Environmental Protection Authority (EPA) has established an Environmental Protection Policy (EPP) which provides ambient air quality standards for TSP and sulphur dioxide (EPA, 1999) for Kwinana. These standards were established in order to maintain acceptable air quality within and around the Kwinana Industrial Area. The Kwinana EPP defines three regions which are covered by the policy; the industrial zone (Area A), the buffer zone surrounding heavy industry (Area B) and the rural and residential zone (Area C). In the absence of national ambient air quality standards for TSP, the EPA's standard for TSP within the industrial zone (Area A) has been applied within operating areas at the mine site and the standard for TSP within rural and residential areas (Area C) has been applied at sensitive receptors, namely the onsite accommodation camp.

The NEPC and Kwinana EPP ambient air quality standards for particulates relevant to this study are provided in Table 2.

<table>
<tr><th colspan="5">Table 2: Particulate Ambient Air Quality Standards</th></tr>
<tr><th>Pollutant</th><th>Averaging Period</th><th>Standard (µg/m3)</th><th>Goal</th><th>Reference</th></tr>
<tr><td rowspan="3">TSP</td><td rowspan="3">1 day</td><td>Area A – 150[1]</td><td rowspan="3">NA</td><td rowspan="3">EPA (1999)</td></tr>
<tr><td>Area B – 90[2]</td></tr>
<tr><td>Area C - 90[3]</td></tr>
<tr><td>Particles as PM_{10}</td><td>1 day</td><td>50</td><td>5 days a year</td><td>NEPC (1998)</td></tr>
<tr><td rowspan="2">Particles as $PM_{2.5}$[4]</td><td>1 day</td><td>25</td><td rowspan="2">To gather sufficient data to facilitate a review of the standard</td><td rowspan="2">NEPC (2002)</td></tr>
<tr><td>1 year</td><td>8</td></tr>
<tr><td colspan="5">Notes:
1. Kwinana EPP Area A (Industrial Zone) standard.
2. Kwinana EPP Area B (Buffer Zone) standard.
3. Kwinana EPP Area C (Residential and Rural Zone) standard.
4. $PM_{2.5}$ standards listed are advisory reporting standards.</td></tr>
</table>

3.2 Particulate Deposition Guidelines

The New South Wales Department of Environment and Climate Change (NSW DECC) has defined dust deposition criteria which are presented in Table 3. 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/m^2/month, the NSW DECC 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.

<table>
<tr><th colspan="3">Table 3: Dust Deposition Criteria</th></tr>
<tr><th>Pollutant</th><th>Averaging Period</th><th>Criteria (g/m^2/month)</th></tr>
<tr><td rowspan="2">Deposited Dust[1]</td><td>Annual (increase)[2]</td><td>2</td></tr>
<tr><td>Annual (total)[3]</td><td>4</td></tr>
<tr><td colspan="3">Notes:
1. Dust is assessed as insoluble solids as defined by AS 3580.10.1-1991 (AM-19).
2. Maximum increase in deposited dust level.
3. Maximum total deposited dust level.</td></tr>
</table>

3.3 Other Air Quality Criteria

The NEPC's (1998) national air quality standards for the criteria pollutants CO, NO_2 and SO_2 are presented in Table 4. As noted above, the NEPM standards for ambient air quality have been adopted by the State Government as part of the draft State Environmental (Ambient Air) Policy 2009 (EPA, 2009).

Table 4: Ambient Air Quality Criteria

Pollutant	Averaging Period	Standard ($\mu g/m^3$)	Maximum Allowable Exceedences	Source
CO	8-hour	11,100	1 day per year	NEPC, 1998
NO_2 [1]	1-hour	246	1 day per year	
	Annual	62	none	
SO_2 [1]	1-hour	571	1 day per year	
	24-hour	228	1 day per year	
	Annual	60	none	

Notes
1. NEPM standards for NO_2 and SO_2 have been converted from ppm to $\mu g/m^3$ at STP.

4 Existing Environment

4.1 Climate

The Kintyre Project Area has an arid climate with hot summers and warm dry winters. Since the inception of the Kintyre Uranium Project, a series of meteorological monitoring programmes have been undertaken within the region in order to define the existing environmental characteristics of the Project Area.

Meteorological monitoring programmes commenced in 1987 and continued until 1992 when the Project was put into care and maintenance. Monitoring recommenced in 1996 with the advancement of a full feasibility study and ended in 1998 as the Project was once again placed under care and maintenance. While an on-site meteorological monitoring program was established in 2010, there have been a number of ongoing problems relating to the provision of a stable power supply that has impacted on data recovery.

A summary of the site's climate is summarised below:

- The prevailing winds originate from the southeast quadrant and dominate the autumn, winter and late-summer months. Winds during spring and early-summer exhibit a greater degree of variability and the frequency of west-north-westerly winds increases.

- The average monthly wind speed is around 3.5 m/s. Peak wind speeds are generally experienced during the summer months and tend to correspond with winds from the southeast. The maximum 15-minute average wind speed reported for the monitoring periods was 18.5 m/s in February 1997.

- The annual average temperature measured at Kintyre is around 25ºC. The highest maximum daily temperatures are generally recorded during the summer months and can reach over 40ºC. Lower temperatures are recorded during the winter months, the monthly averages tending around 10ºC. Higher evaporation rates are also associated with higher temperatures during the summer months and lower rates with the cooler winter months.

- Total annual rainfall varies between years. However, the highest monthly rainfalls tend to occur in the summer months, indicative of the influence of cyclonic conditions in the region.

- Higher measurements of relative humidity and lower measurements of barometric pressure also tend to coincide with wetter summer months, which may experience some cyclonic effects. Lower humidity and higher pressures are more common during the drier winter months (Dames & Moore, 1990; 1998).

Meteorological monitoring undertaken by the Bureau of Meteorology (BoM) at Telfer shows that Telfer experiences similar meteorological conditions to those experienced within the Project Area. Figure 6 presents the annual wind rose derived from the Telfer data for 2009 and shows the predominance of south easterly and north westerly winds that are characteristic of the region.

4.2 Ambient Air Quality

Monitoring of dust deposition levels was undertaken at five monitoring sites in and around the Kintyre Project Area between June 1996 and July 1998. The monthly deposition data collected at these sites showed that the natural dust deposition level in the area were relatively high and regularly approached or exceeded the guideline of 4 g/m^2/month listed in Table 3.

Cameco commenced meteorological and particulate monitoring in July 2010. The monitoring network consists of a meteorological monitoring station to measure wind speed and direction, temperature, solar radiation, relative humidity, barometric pressure and rainfall; a continuous Beta Attenuation Monitor (BAM) to measure PM_{10} and five dust deposition gauges. A second BAM monitoring station is proposed to be installed by late 2012.

The average monthly deposition rates measured during the current monitoring program are generally well below those measured between 1996 and 1998, with the average deposition rate over the first 12 months of the monitoring program being less than 2 g/m^2/month with a maximum deposition rate of 2 g/m^2/month. The lower dust deposition rates currently being recorded may be attributable to higher rainfall during 2010/2011 than occurred between 1996 and 1998. It is also possible that greater levels of vegetation cover were present during 2010/2011 than between 1996 and 1998 due to the higher rainfall that has occurred in the region.

The maximum 24-hour average PM_{10} concentration recorded at the Kintyre Project site between August 2010 and June 2011 was 39 µg/m^3 and was recorded under moderate (4 m/s) south-westerly winds. Although there were no recorded exceedances of the PM_{10} 24-hour average NEPM standard (50 µg/m^3), compliance with the standard cannot be demonstrated reliably due to the low data recovery rates throughout the monitoring period. The low data recovery rates have occurred due to difficulties providing a stable power supply to the monitors and the remote location. Work on rectifying these issues is ongoing and performance is expected to be improved before the end of 2012.

5 Modelling Methodology

5.1 Air Dispersion Model

Air quality impacts from the proposed Kintyre Uranium Project have been modelled using the Victorian Environmental Protection Agency (VEPA)'s Gaussian plume dispersion model Ausplume (Version 6.0). Ausplume is regularly used for assessing impacts from industrial sites within Australia and has been used for a number of dust modelling assessments at mine sites and port operations throughout Western Australia, including a Department of Mines and Petroleum (previously Department of Industry and Resources) funded study that included cumulative particulate modelling of the Port Hedland area (SKM, 2007).

5.2 Meteorological Data

The Ausplume model requires time series meteorological data, including hourly averaged values of:

- wind speed and direction;
- ambient air temperature;
- Pasquill-Gifford stability class; and
- atmospheric mixing height.

As noted in Section 4.1, Cameco has experienced significant issues with the continuity of power at its meteorological and PM_{10} monitoring site that has resulted in the loss of data. While work is ongoing to improve the power supply and data recovery at the on-site monitoring station, there were not sufficient on-site data available to use in the air dispersion modelling. Therefore, observational data recorded at the BoM's Telfer monitoring station, located 60 km north of the Project site, were sourced in order to compile the required data set for this assessment.

Surface monitoring data recorded at the Telfer site between December 1995 and August 2011 were obtained from the BoM. Wind speed, wind direction and ambient temperature data collected over the 2009 calendar year were selected from the dataset to compile the required meteorological data file. The 2009 calendar year was chosen as these data were considered to be representative of the long term averages recorded over the 1995 to 2011 period and had the highest data availability. Further details of this comparison are presented in Appendix A.

The annual wind rose derived from the meteorological data file indicates that the most commonly occurring winds are from the southeast (Figure 6). Analysis of the seasonal wind roses indicates that wind direction is most variable during the summer months, while during autumn, spring and winter southeasterlies tend to dominate (Figure 7). Stronger winds are most common during the spring months, with 18% of winds greater than 7.5 m/s (Figure 7). The annual average wind speed for the monitoring period is 4.9 m/s. These data are consistent with the site specific meteorological data collected at the Kintyre site.

In the absence of upper air observations, vertical temperature profiles were predicted for the 2009 calendar year at the Telfer monitoring site using the meteorological component of The Air Pollution Model (TAPM). These data were used in conjunction with the surface temperature data to determine mixing height. Solar radiation and cloud cover data were also sourced from TAPM for use in the determination of stability class.

A summary of the stability class distribution is presented in Table 5. Moderate wind speeds resulted in low frequencies of unstable (Class A and Class F) conditions and higher frequencies of slightly stable and unstable (i.e. Classes E and C) and neutral (Class D) conditions. Further details of the methodology used in the compilation of the meteorological data file are presented in Appendix A.

Table 5: Pasquill-Gifford Stability Class Distribution

A	B	C	D	E	F
2.6%	15.2%	22.0%	22.5%	27.4%	10.2%

5.3 Model Setup and Parameterisation

For this study, Ausplume was set up with the following parameters and input data:

- A model domain of 20 km by 20 km, centred on 404,253 mE and 7,529,437 mN (GDA 94) and using a 200 m grid spacing;
- Terrain data extracted from the US National Aeronautics and Space Administration's (NASA) Shuttle Radar Topography Mission (SRTM) for the region from Mapmart Global Mapping Solutions (www.mapmart.com) in the form of three arc-second digital elevations. These data were interpolated (using Surfer Version 8.0) to provide terrain elevations for each of the model grid points (Figure 8);
- Dry depletion to model particle settling; and
- A surface roughness of 0.4 m to simulate the average roughness length.

The mining pit has been modelled as an area source, while the WRL, mineralised overburden stockpile, ROM pad, haul roads, primary crushing, radiometric sorting and secondary crushing facilities have been modelled as volume sources.

A sample of one of the Ausplume configuration files used in this assessment is included as Appendix B.

5.4 Particle Size Distribution

The USEPA's particle size distributions for batch drop, wind erosion and vehicle emissions (USEPA, 2004a and b; USEPA, 2006) are presented in Table 6. The distribution data for batch drop and wind erosion are similar, while the particle size distribution for vehicle emissions contains a lower percentage of $PM_{2.5}$ particulate. The distribution data for batch drop also indicates that dustiness is proportional to the silt content of the ore.

In the absence of site specific particle size distribution data for the TSP, PM_{10} and $PM_{2.5}$ fractions specific to Cameco's operations, a composite distribution was derived from the USEPA's three emissions categories (Table 6). It is noted that adoption of a composite distribution represents a simplification as different particulate emission sources will have different particle size distributions (e.g. wind erosion versus vehicular dust) and there may also be differences between particle size distributions between different ore types and process stages.

Table 6: Particle Size Distributions

<table>
<tr><th rowspan="3">Particle Size Range (µm)</th><th rowspan="3">Representative Particle Size (µm)</th><th colspan="5">Percentage of Particulate (%) in Various Size Ranges</th></tr>
<tr><th rowspan="2">USEPA Batch Drop</th><th rowspan="2">USEPA Wind Erosion</th><th rowspan="2">USEPA Unpaved Road</th><th colspan="2">This Study</th></tr>
<tr><th>TSP</th><th>PM_{10}</th></tr>
<tr><td><2.5</td><td>1.3</td><td>11</td><td>14.8</td><td>3.3</td><td>9</td><td>30</td></tr>
<tr><td>2.5 - 5.0</td><td>3.8</td><td>9</td><td rowspan="3">22.2</td><td rowspan="3">18.7</td><td>8</td><td>27</td></tr>
<tr><td>5.0 - 7.5</td><td>6.3</td><td rowspan="2">15</td><td>7</td><td>23</td></tr>
<tr><td>7.5 – 10</td><td>8.7</td><td>6</td><td>20</td></tr>
<tr><td>10 – 15</td><td>12.5</td><td>13</td><td>7</td><td rowspan="3">52</td><td>14</td><td>-</td></tr>
<tr><td>15 – 23</td><td>19</td><td rowspan="2">26</td><td rowspan="2">30</td><td>15</td><td>-</td></tr>
<tr><td>23 – 30</td><td>26</td><td>15</td><td>-</td></tr>
<tr><td>30 – 40</td><td>35</td><td rowspan="2">26</td><td rowspan="2">26</td><td rowspan="2">26</td><td>15</td><td>-</td></tr>
<tr><td>40 – 50</td><td>45</td><td>11</td><td>-</td></tr>
</table>

Notes

1. Particle sizes are equivalent aerodynamic size and not the physical size. The equivalent aerodynamic size relates to the aerodynamic properties of the particle as is used in dust sampling. For example PM_{10} samplers measure the dust below 10 µm equivalent aerodynamic size and not the physical size.
2. Wind erosion and vehicle emission size distributions are given for below 30 µm only, but have been adjusted here to less than 50 µm based on assuming 74% of the particulate is less than 30 µm as per the batch drop distribution.
3. The distribution of $PM_{2.5}$ has been modelled assuming a single representative particle size of 1.3 µm.

The USEPA particle size diameters are given in equivalent aerodynamic particle diameters which assume a particle density of 1 g/cm^3.

5.5 Fugitive Particulate Emission Estimates

To predict dust concentrations in a realistic manner, hourly dust emissions are required from all major sources. Factors which are important for dust generation include:

- the ore type being handled;
- moisture content;
- operational activities;
- quantity of ore being moved and the number of movements;
- size of stockpiles and level of activity;
- level of vehicle traffic;
- rainfall;
- evaporation;
- ambient wind speed; and
- management controls.

The throughput rates, emission factors, control factors and resultant particulate emission estimates for operations at the proposed Kintyre Project site are presented in Table 7. The emission factors are primarily based on the default emission rates recommended by the NPI (2011) for ‘high’ moisture ores (i.e. those with a moisture content of 4% or more). The control efficiencies adopted for each dust control measure are also primarily based on factors recommended by the NPI (2011).

For the purpose of this assessment it has been assumed that the moisture content of the ore at the Kintyre Project site will remain above the NPI threshold of 4%, as water sprays will be used to control dust emissions at each stage of the process. It is noted that the classification of ores into ‘high’ and ‘low’ moisture groups does not reflect the variation that can occur in dust emissions and is considered conservative.

The emission estimates for excavating, truck loading, stockpiling, reclaiming, crushing, sorting and associated handling activities are based on annual throughput rates provided by Cameco. It has been assumed that both mining and processing activities will occur on a continuous basis, throughout the modelled year.

For modelling purposes it has been assumed that stockpiling activities within the northern section of the WRL will occur in the area immediately adjacent to the north of the pit, while stockpiling activities within the western section of the WRL were conservatively assumed to be focused within the southernmost section of the landform, as this area is closest to the nearest sensitive receptor (i.e. onsite accommodation camp). The size of the active area was determined by calculating a ratio of tonnes per square metre, based on the total amount of waste rock going to the WRL.

It should be noted that dust emission estimates for fugitive dust sources contain a degree of uncertainty due to the complexity of characterising emission rates and control efficiencies.

Table 7: Emission Factors, Control Factors and Particulate Emission Estimates for Fugitive Dust Emissions

Activity	Emission Factor		Emission Factor Variable		Dust Control		PM_{10} Emission Rate	Comments
	PM_{10}	Unit	Rate	Unit	Measure	Efficiency	g/s	
Drilling								
Mining Pit	0.31	kg/hole	100	Holes per day	Water Sprays	50%	0.2	An average of 400 holes per blast (as advised by Cameco) was used to calculate the PM_{10} emission rate for drilling. Drilling operations were assumed to occur continuously throughout the modelled year.
Blasting								
Mining Pit	143	kg/blast	91	Blasts per year	Water Sprays	50%	20	A blast area of 11,600 m^2 (as advised by Cameco) was used to calculate the PM_{10} emission factor for blasting. Blasting was assumed to occur once every four days between the hours of 13:00 and 14:00.
Excavating								
Mining Pit	0.0006	kg/t	25,072,000	tpa	Water Sprays	50%	0.2	The annual average wind speed of 4.9 m/s and an assumed moisture content of 4% were used in the calculation of the PM_{10} emission factor for excavating. Excavating was assumed to occur continuously throughout the modelled year.
Truck Loading								
Mining Pit	0.0006	kg/t	25,072,000	tpa	Water Sprays	50%	0.2	The annual average wind speed of 4.9 m/s and an assumed moisture content of 4% were used in the calculation of the PM_{10} emission factor for truck loading by excavator. Truck loading was assumed to occur continuously throughout the modelled year.
Sorting Rejects	0.002	kg/t	555,900	tpa	NA	NA	0.07	The PM_{10} emission rate was based on the NPI emission factor for general handling and the assumption that a 133 t capacity haul truck would be loaded with the radiation sorter reject material over the course of an hour. On this basis, truck loading was assumed to occur for 11 hrs/day.
Truck Unloading								
Mining Pit (Backfilling)	0.0006	kg/t	15,614,500	tpa	Water Sprays	50%	0.1	The annual average wind speed of 4.9 m/s and an assumed moisture content of 4% were used in the calculation of the PM_{10} emission factor for truck. Total material unloaded at the western section of the WRL includes an additional 555,900 tpa of rejected material from the radiometric sorter. Truck unloading was assumed to occur continuously throughout the modelled year, at each source location.
Waste Rock Landform (Northern Section)	0.0006	kg/t	3,416,300	tpa	Water Sprays	50%	0.03	
Waste Rock Landform (Western Section)	0.0006	kg/t	21,045,800	tpa	Water Sprays	50%	0.2	

Table 7: Emission Factors, Control Factors and Particulate Emission Estimates for Fugitive Dust Emissions

Activity	Emission Factor		Emission Factor Variable		Dust Control		PM_{10} Emission Rate	Comments
	PM_{10}	Unit	Rate	Unit	Measure	Efficiency	g/s	
Mineralised Overburden Stockpile	0.0006	kg/t	1,914,600	tpa	Water Sprays	50%	0.02	
ROM Pad	0.0006	kg/t	1,111,800	tpa	Water Sprays	50%	0.01	
Reclaiming								
ROM Pad	0.0006	kg/t	1,111,800	tpa	Water Sprays	50%	0.01	It was conservatively assumed all ore will be reclaimed from the ROM pad prior to crushing, although a proportion is expected to be delivered directly from the pit to the plant feed bin, via haul truck.
Bulldozing								
Mining Pit	1.5	kg/hr	8,760	hrs	Water Sprays	50%	0.4	An assumed silt content of 10% and moisture content of 4% were used in the calculation of the PM_{10} emission rate for bulldozing overburden and ore. Bulldozing was conservatively assumed to occur continuously throughout the modelled year, at each source location. The PM_{10} emission rate for bulldozing within the mining pit was doubled to account for two bulldozers being in use at any one time. Single bulldozers will be in use at the ROM pad and northern and western WRL.
Waste Rock Landform (Northern Section)	1.5	kg/hr	8,760	hrs	Water Sprays	50%	0.2	
Waste Rock Landform (Western Section)	1.5	kg/hr	8,760	hrs	Water Sprays	50%	0.2	
Mineralised Overburden Stockpile	1.5	kg/hr	8,760	hrs	Water Sprays	50%	0.2	
ROM Pad	1.5	kg/hr	8,760	hrs	Water Sprays	50%	0.2	
Crushing								
Primary Crushing	0.004	kg/t	1,111,800	tpa	Hooding with Scrubbers/Water Sprays	88 %	0.02	An automated fogging system will be used at the feed hopper to minimise dust emissions and the crushing facilities will be hooded and fitted with wet scrubbers. A multiplicative control efficiency of 88% was adopted for these measures, as recommended by the NPI (2011). Crushing operations were assumed to occur continuously throughout the modelled year.
Secondary Crushing	0.012	kg/t	555,900	tpa	Hooding with Scrubbers/Water Sprays	88%	0.03	
Radiometric Sorting								
Radiometric Sorting	0.002	kg/t	1,111,800	tpa	Enclosed	99%	0.001	Emission estimates have been based on the assumption that two handling points will be required as part of the sorting process. A control efficiency of 99% has been adopted as the facility will be enclosed. This is less than the 100% recommended by the NPI (2011) for a totally enclosed system to ensure that the emissions estimates remain conservative.

Table 7: Emission Factors, Control Factors and Particulate Emission Estimates for Fugitive Dust Emissions								
Activity	**Emission Factor**		**Emission Factor Variable**		**Dust Control**		**PM_{10} Emission Rate**	**Comments**
	PM_{10}	**Unit**	**Rate**	**Unit**	**Measure**	**Efficiency**	**g/s**	
Wheel Generated Dust Emissions								
Haulage of Waste Rock to WRL/ Mineralised Overburden Stockpile	2.3	kg/VKT	2,371	VKT/day	Water Sprays (>2 L/m^2/hr)	75%	15.6	The emission factors for wheel generated dust are based on the recommended NPI (2011) equation for wheel dust from unpaved roads, assuming a silt content of 10% and an average vehicle weight of 183.5kg for haulage trucks. Total VKT for waste rock to the WRL was based on an average round trip distance of 830 m between the pit and both the northern and western sections of the WRL. Total VKT for haulage of mineralised overburden to the mineralised overburden stockpile was based on an average round trip distance of 2.7 km. Total VKT for ore to the ROM pad was based on an average round trip distance of 1.0 km and total VKT for haulage of sorting rejects to the WRL was based on an average round trip distance of 1.0 km. The average payload was assumed to be 133 t. Haul trucks were also assumed to operate continuously throughout the modelled year.
Haulage of Ore to ROM Pad	2.3	kg/VKT	101	VKT/day	Water Sprays (>2 L/m^2/hr)	75%	0.7	
Haulage of Sorting Rejects to WRL	2.3	kg/VKT	11	VKT/day	Water Sprays (>2 L/m^2/hr)	75%	0.1	

Hourly variable PM_{10} emissions were defined for each source based on the emission factors and dust control measures presented in Table 7. The effects of wind and rainfall on emission estimates were also taken into consideration, as per the methodologies described in Sections 5.5.1, 5.5.2 and 5.5.3. Hourly variable emission files for TSP and $PM_{2.5}$ were created for each source by multiplying the PM_{10} emissions estimates by 3.33 and 0.3 respectively, in accordance with the assumed particle size distribution in Table 6 (i.e. PM_{10} is 30% of TSP and $PM_{2.5}$ is 30% of PM_{10}). Operations across the site were assumed to occur continuously throughout the modelled year.

Each emission source was individually modelled in Ausplume using a fixed emission rate and the particle size distribution data detailed in Table 6. A particle size density of 1 g/cm^3 was adopted in line with the assumption upon which the USEPA particle size distributions are based. The resultant outputs for each source were scaled against the corresponding hourly variable emissions for TSP, PM_{10} and $PM_{2.5}$ to generate predicted GLCs for each hour of the year, at each model grid point. The predicted GLCs for each source were then combined to produce the overall TSP, PM_{10} and $PM_{2.5}$ GLCs predicted for the modelled scenario.

5.5.1 Wind Speed Dependence for Material Handling

For all material handling processes exposed to the wind, increasing wind speed acts to increase dust emissions through winnowing of the particles from the falling ore. The USEPA batch drop equations (USEPA, 2004a) specify that the dust emission increases with the wind speed to the power of 1.3, as follows:

$$E_{Actual} = E_{2.2}\,(WS/2.2)^{1.3}$$

Where:

WS is the wind speed at the drop height;

$E_{2.2}$ is the dust emission given, assumed to be at 2.2 m/s; and

E_{Actual} is the final emission rate.

The average source height was assumed to be 5 m above the surface, with the 10 m wind speeds reduced using the 1/7 power law given by:

$$WS_5 = WS_{10}\,(5/10)^{(1/7)}$$

Where:

WS_{10} is the wind speed at 10m.

5.5.2 Wind Erosion

Dust emissions generated by wind are generally negligible below a wind speed threshold, but increase rapidly when wind speeds exceed the threshold. Dust emissions from wind erosion are also dependent on the erodibility of the material which in turn is dependent on the size distribution of the material and whether a crust has developed. In general, material with a large (>50%) fraction of non-erodible particles (generally particles greater than 1 mm to 2 mm) will not erode as the erodible fraction is protected by these particles. Fine ores are generally much more erodible by wind erosion, particularly if they have a large fraction of particles in the range from 0.1 mm to 0.25 mm which can be dislodged by wind and then rolled and skipped along the surface dislodging other particles which can remain suspended in the air.

The NPI Emission Estimation Technique (EET) Manual for Mining (NPI, 2011) specifies a wind erosion factor of 0.2 kg/ha/hr for all sources with the exception of coal stockpiles. However, this factor is considered approximate as it does not take into account variations in the climate of an area or the soil or ore type. Previous studies investigating the impact of dust emissions from mining and export facilities (e.g. ENVIRON, 2004) have used the Shao (2000) equation to parameterise PM_{10} emissions for live stockyards and surrounding roads. The same method was also adopted to estimate the wind erosion factor for this assessment, as follows:

$$E_{wind} = 5.2E\text{-}07 * WS^3 * (1 - (WS_T/WS_{10})^2))$$

Where:

WS_T is the threshold for wind erosion in m/s, taken to be 7.5 m/s (SKM, 2003); and

E_{wind} is the PM_{10} emissions (g/m^2/s).

Dust emissions generated by wind erosion were considered in this assessment for all exposed surface areas, including the mining pit, WRL, mineralised overburden stockpiles, TSF and unsealed haul roads.

5.5.3 Rainfall Dependence

To account for the effects of rainfall suppressing dust, a simple scheme was adopted. With regards to wind erosion, rainfall was assumed to not only suppress dust at the time rain was occurring, but to also result in a suppression of the dust emissions that gradually decreases over time as surface areas as the areas dry out. Without stockpile activity, material can form a strong crust and be resistant to wind erosion for extended periods.

Dust emissions were taken to linearly return to a rainfall unaffected state within 400 hours of the rainfall evaporating if the rainfall event was greater than 25 mm. During the period when it was raining or if the rainfall had not evaporated, emissions were set to zero. The evaporation rate at the surface was assumed to be 1.25 times the Class A pan evaporation rate with a limit to the amount of water on/near the surface of 75 mm. In the absence of site specific data for the Kintyre Project site, Class A pan evaporation rates for the modelled year were obtained from the Bureau of Meteorology's Telfer monitoring station.

These time scales have been adopted from previous dust assessments (i.e. ENVIRON, 2004) and were originally based on observations of the time taken for high dust levels to return following a large rainfall event in the Pilbara region. It is noted that the return to dusty conditions is not just a function of the evaporation of the water, but is determined from the activity level within the stockpile area, as surfaces are disturbed and fresh surfaces are created as a result of reclaiming, stacking and vehicle movement.

6 Modelling Results

6.1 Predicted Ambient Particulate Concentrations

A summary of the maximum TSP, PM_{10} and $PM_{2.5}$ concentrations predicted at Cameco's tenement boundary and at the onsite accommodation camp for the proposed Kintyre Project in isolation from background concentrations, is presented in Table 8.

Table 8: Summary of Predicted TSP, PM_{10} and $PM_{2.5}$ GLCs

Particulate Fraction	Averaging Period	Standard (µg/m³)	Predicted GLC (µg/m³)	
			Tenement Boundary	Onsite Camp
TSP	24-hour	150[1]/90[2]	87	40
	Annual	NA	5.5	1.8
PM_{10}	24-hour	50	47	29
	Annual	NA	3.7	1.2
$PM_{2.5}$	24-hour	25	20	9.5
	Annual	8	1.3	0.4

Notes
1. Kwinana EPP Area A (Industrial Zone) standard.
2. Kwinana EPP Area C (Residential and Rural Zone) standard.

Contours of the maximum 24-hour average TSP GLCs presented as Figure 9 indicate that peak impacts are expected to occur in and around the mining pit and WRL. Exceedences of the 24-hour TSP EPA Area A (Industrial Zone) standard are predicted to occur within close proximity of onsite operations (Figure 9). The maximum 24-hour average TSP GLC predicted at Cameco's tenement boundary is 87 µg/m³ and remains below the EPA Area C (Residential Zone) standard of 90 µg/m³ (Table 8). At the proposed accommodation camp the maximum predicted 24-hour TSP concentration is 40 µg/m³ and also remains below the EPA Area C standard.

Contours of the predicted annual average TSP concentrations presented as Figure 10 also show that the highest predicted concentrations are localised to the mining pit and WRL. The highest annual average TSP concentration predicted at the tenement boundary is 40 µg/m³, while at the onsite accommodation camp the predicted annual average TSP GLC is 40 µg/m³ (Table 8).

Contours of the maximum 24-hour PM_{10} concentrations (Figure 11) indicate that exceedences of the 24-hour PM_{10} NEPM standard are predicted to occur within 2.5 km of Cameco's proposed operations, although remain within the tenement boundary. Furthermore, exceedences of the NEPM goal (i.e. no more than five exceedences of the 24-hour PM_{10} NEPM standard per annum) are only expected to occur in close proximity of the mining operations (Figure 12). The maximum 24-hour PM_{10} concentration predicted to occur at the tenement boundary is 47 µg/m³ and is below the 24-hour PM_{10} NEPM standard of 50 µg/m³ (Table 8). At the onsite accommodation camp, the maximum predicted 24-hour PM_{10} GLC is 29 µg/m³ and is also below the 24-hour PM_{10} NEPM standard.

Contours of the predicted annual average PM_{10} concentrations presented as Figure 13 also show that the highest predicted concentrations are localised to the mining pit. The predicted annual average concentrations at the onsite accommodation camp are significantly lower.

Contours of the predicted maximum 24-hour average $PM_{2.5}$ GLCs indicate that peak impacts are expected to occur in and around the mining pit and WRL (Figure 14). Exceedences of the 24-hour $PM_{2.5}$ NEPM advisory reporting standard are predicted to occur within the tenement boundary (Figure 14). At the nearest sensitive receptor (the proposed accommodation camp) the maximum predicted 24-hour average PM_{25} GLC is 9.5 µg/m^3 and is well below the applicable guideline value of 25 µg/m^3 (Table 8).

Contours of the predicted annual average $PM_{2.5}$ concentrations illustrate a similar pattern of distribution as predicted for TSP and PM_{10}, where peak concentrations are localised in and around the onsite operations (Figure 15). Exceedences of the annual average $PM_{2.5}$ NEPM advisory reporting standard are predicted to occur within close proximity of the mining pit and WRL (Figure 15). At the tenement boundary, the predicted annual average $PM_{2.5}$ GLC is 1.3 µg/m^3 and remains well below the annual average $PM_{2.5}$ NEPM advisory reporting standard of 8 µg/m^3 (Table 8). The annual average $PM_{2.5}$ GLC predicted at the onsite accommodation camp is 0.4 µg/m^{3}and is less than 5% of the applicable standard (Table 8).

A summary of the source contributions to the maximum 24-hour average TSP, PM_{10} and $PM_{2.5}$ GLCs predicted at the onsite accommodation camp is presented in Table 9. The analysis of these data indicate that wheel generated dust emissions from the haul roads is predicted to contribute the greatest proportion of the maximum predicted 24-hour average TSP, PM_{10} and $PM_{2.5}$ GLCs at the camp site, with respective contributions of 92%, 96% and 96% (Table 9). Fugitive dust emissions associated with activities within the mining pit (i.e. drilling, blasting, excavation and truck loading) are predicted to contribute 5.6%, 2.3% and 2.1% to the maximum predicted 24-hour average TSP, PM_{10} and $PM_{2.5}$ GLCs respectively. The maximum 24-hour average TSP, PM_{10} and $PM_{2.5}$ concentrations predicted at the accommodation camp are associated with moderate, north-northwesterly winds.

Table 9: Summary of Source Contributions to Maximum Predicted 24-hour Average GLCs at Accommodation Camp

Maximum Predicted 24-hour Average GLC (μg/m^3)	Mining Pit	Northern WRL	Western WRL (Stockpiling)	Western WRL (Wind Erosion)	Mineralised Overburden Stockpiles	ROM Pad	Crushing Circuit[1]	Truck Loading (Sorting Rejects)	Haul Roads
TSP									
40	5.6%	0.3%	0.8%	0%	0.7%	0.6%	0.1%	0.1%	92%
PM_{10}									
29	2.3%	0.2%	0.6%	0%	0.4%	0.6%	0.1%	0.1%	96%
$PM_{2.5}$									
9.5	2.1%	0.2%	0.5%	0%	0.4%	0.6%	0.1%	0.1%	96%

Notes
1. Crushing circuit includes primary and secondary crushing and radiometric sorting.

6.2 Predicted Particulate Deposition Rates

A summary of the monthly average TSP deposition rates predicted at Cameco's tenement boundary and at the onsite accommodation camp for the proposed Kintyre Project is presented in Table 10. Contours of the average monthly TSP deposition rates are presented as Figure 16.

Table 10: Summary of Predicted TSP Deposition Rates – 115 Mtpa

Particulate Fraction	Dust Deposition Criteria ($g/m^2/month$)	Predicted Average Deposition Rate ($g/m^2/month$)	
		Tenement Boundary	**Onsite Camp**
TSP	2 (increase)[1]	1.5	0.7
	4 (total)[2]		

Notes
1. Maximum annual increase in deposited dust level.
2. Maximum annual total deposited dust level.

Contours of the highest monthly average TSP deposition rate indicate that peak impacts are expected to occur in close proximity of the mining pit (Figure 16). Exceedences of the NSW DECC incremental guideline of 2 g/m^2/month are predicted within the tenement boundary, although the average TSP deposition rate predicted at the onsite accommodation camp is 0.7 g/m^2/month, which is well below the incremental dust deposition guideline of 2 g/m^2/month (Table 10). The maximum average monthly TSP deposition rate predicted at Cameco's tenement boundary is 1.5 g/m^2/month and is also below the incremental guideline (Table 10).

Wind erosion from the WRL is the primary source contributing to the maximum predicted deposition rates predicted to the north-west of the Project site and at the onsite accommodation camp.

6.3 Other Atmospheric Emissions

Cameco has advised that the atmospheric emissions from the processing plant are expected to be very small although these have not be quantified in detail at this stage of the Project's engineering. The atmospheric emissions from the Project's diesel fired power station have been modelled using Ausplume to predict the ground level concentrations of CO, NO_2, SO_2 and particulate matter (PM_{10} and $PM_{2.5}$) and the results are presented in Table 11. The results in Table 11 show that only the predicted 1-hour average GLCs of NO_2 approach the ambient guidelines. Contours of the maximum predicted 1-hour average concentrations of NO_2 are presented as Figure 17, showing that the highest GLCs are predicted to occur to the south west of the plant site but remain below the NEPM standard.

Table 11: Summary of Predicted CO, NO_2, SO_2 and PM GLCs as a Result of the Power Station Emissions

Pollutant	Averaging Period	Standard (µg/m^3)	Maximum Predicted GLC (µg/m^3)	
			Tenement Boundary	Onsite Camp
CO	8-hour	11,100	13	7.0
SO_2	1-hour	571	0.003	0.002
	24-hour	228	0.0003	0.0002
	Annual	60	0.00003	0.00001
PM_{10}	24-hour	50	1.1	0.8
$PM_{2.5}$	24-hour	25	1.1	0.8
	Annual	8	0.1	0.03
NO_2	1-hour	246	180	159
	Annual	62	4.0	0.8

Notes
1. Maximum predicted GLC across the modelled domain including the Project Area.

7 Dust Management and Mitigation Measures

The Kintyre Project has been designed with a strong focus on minimising dust emissions. Within the mining and WRL areas, traditional dust management techniques, including the use of water sprays 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.

A Dust Management Plan (DMP) has been developed for the site and this will be implemented and reviewed on a regular basis. The DMP includes ambient monitoring of PM_{10} concentrations and total dust deposition rates.

8 Conclusions

Air dispersion modelling of emissions from the proposed Kintyre Project has been completed to assess the potential ambient air quality impacts associated with the Project. The air dispersion modelling assessment focused on fugitive dust emissions associated with mining operations, truck loading, stockpiling, reclaiming, primary and secondary crushing, radiometric sorting, vehicle movements on unpaved roads and wind erosion of cleared surfaces including the ROM pad, WRL and haul roads; as well as point source emissions of pollutants such as NO_x and SO_2 from the diesel-fired power station.

The results of the air dispersion modelling show that the off-site impacts of TSP, PM_{10} and $PM_{2.5}$ concentrations are predicted to be below the ambient guidelines, with exceedances of these guidelines predicted to be localised to the immediate vicinity of the Project Area. The TSP, PM_{10} and $PM_{2.5}$ concentrations predicted at the onsite accommodation camp are also below the applicable guidelines. The incremental guideline for particulate deposition is predicted to be exceeded within the boundary of the Project Area, although the predicted deposition rate at the onsite accommodation camp remains below the applicable guideline. No exceedances of the ambient air quality objectives for SO_2, NO_2, or CO are predicted to occur as a result of the Project's proposed power station emissions.

A Dust Management Plan (DMP) has been prepared for the Project. The DMP will be reviewed and revised as required on a regular basis and includes ambient monitoring of PM_{10} concentrations and total deposition rates.

The air dispersion modelling results indicate that the proposed Kintyre Project is not expected to result in any significant issues with regards to potential ambient air quality impacts.

9 References

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10 Limitations

ENVIRON Australia prepared this report in accordance with the scope of work as outlined in our proposal to Cameco Australia Pty Ltd dated 13 September 2011 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent ENVIRON's professional judgment based on information made available during the course of this assignment and are true and correct to the best of ENVIRON's knowledge as at the date of the assessment.

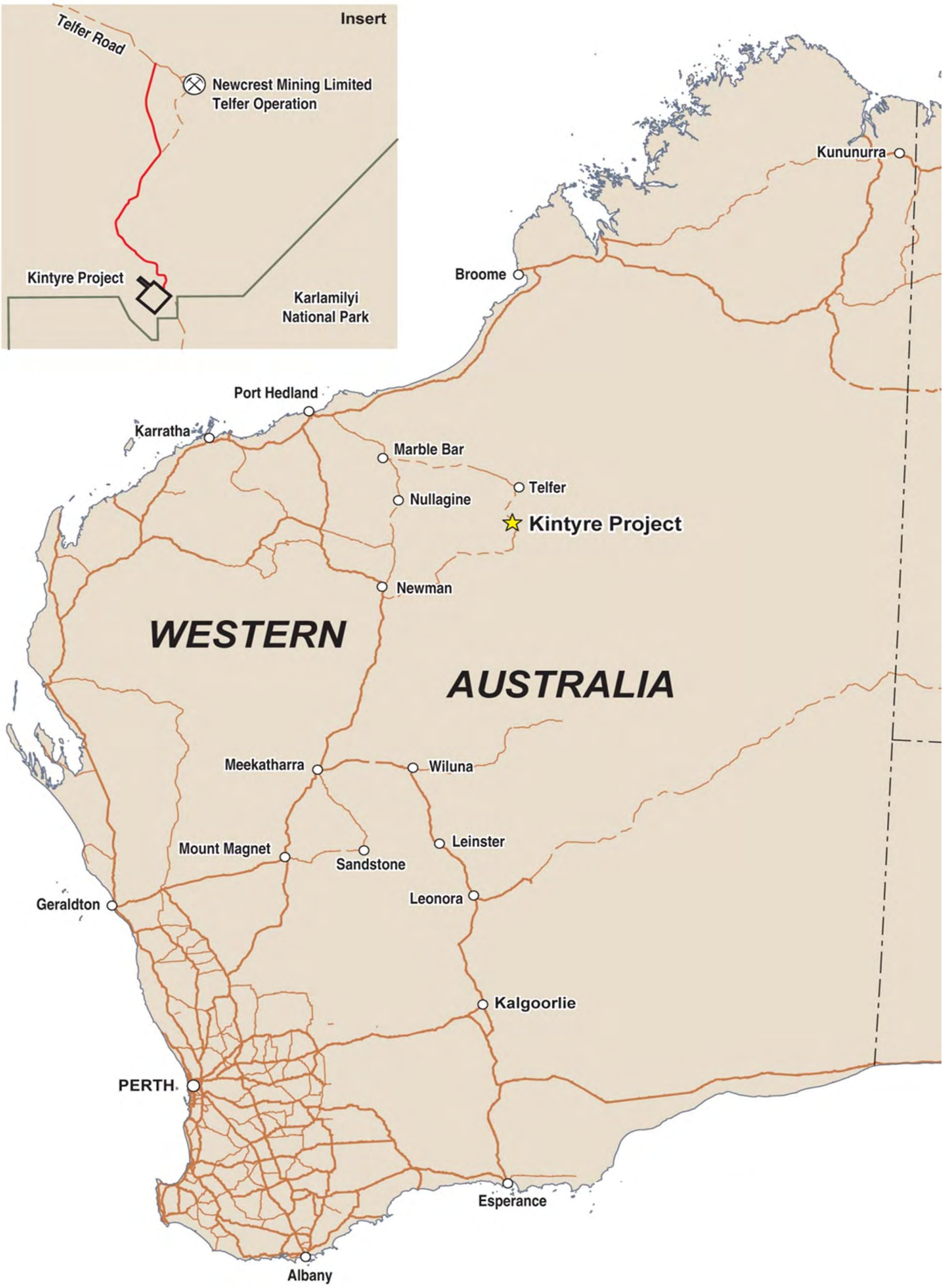
ENVIRON did not independently verify all of the written or oral information provided to ENVIRON during the course of this investigation. While ENVIRON has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to ENVIRON was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

10.1 User Reliance

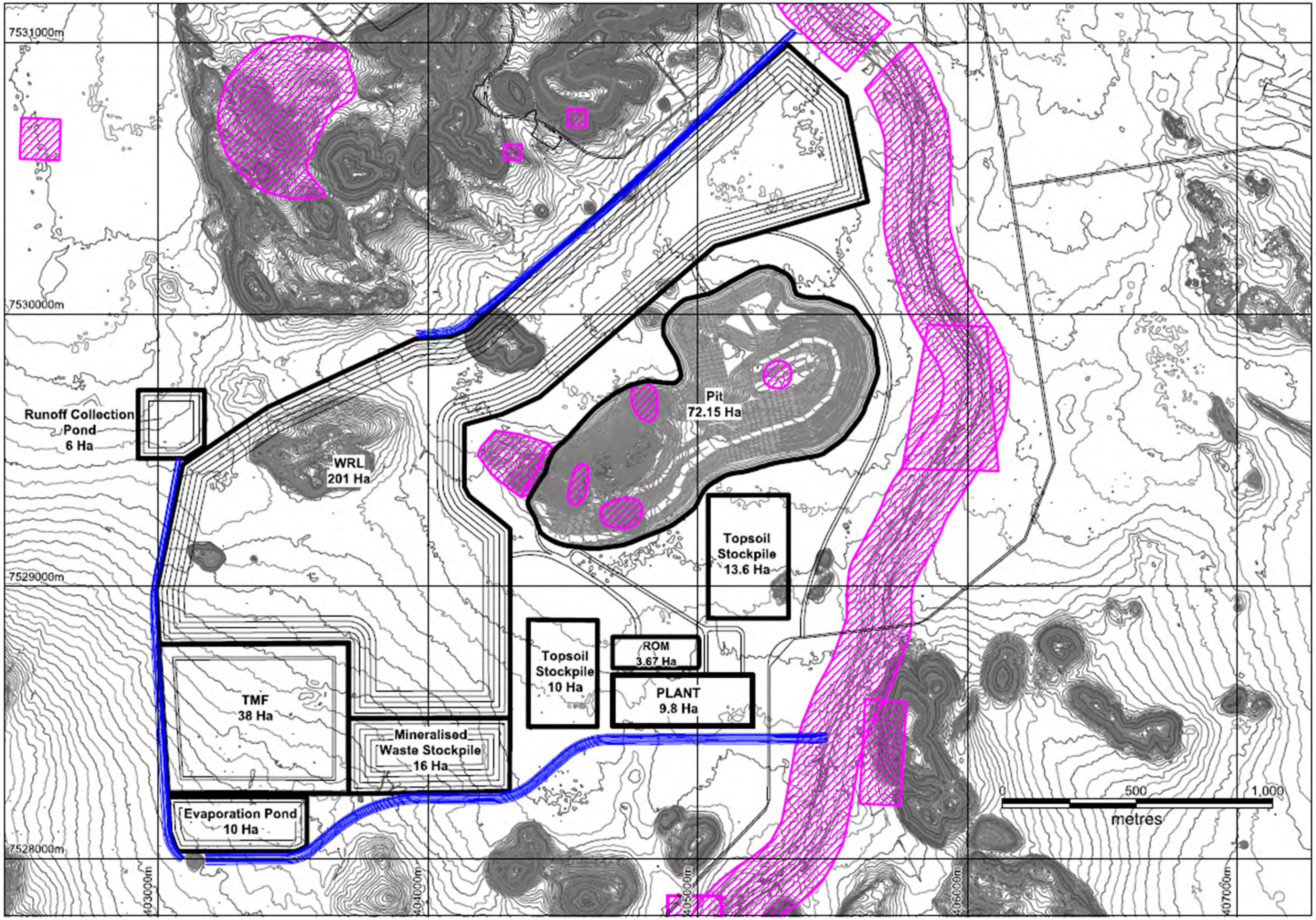
This report has been prepared exclusively for Cameco Australia Pty and may not be relied upon by any other person or entity without ENVIRON's express written permission.

Figures

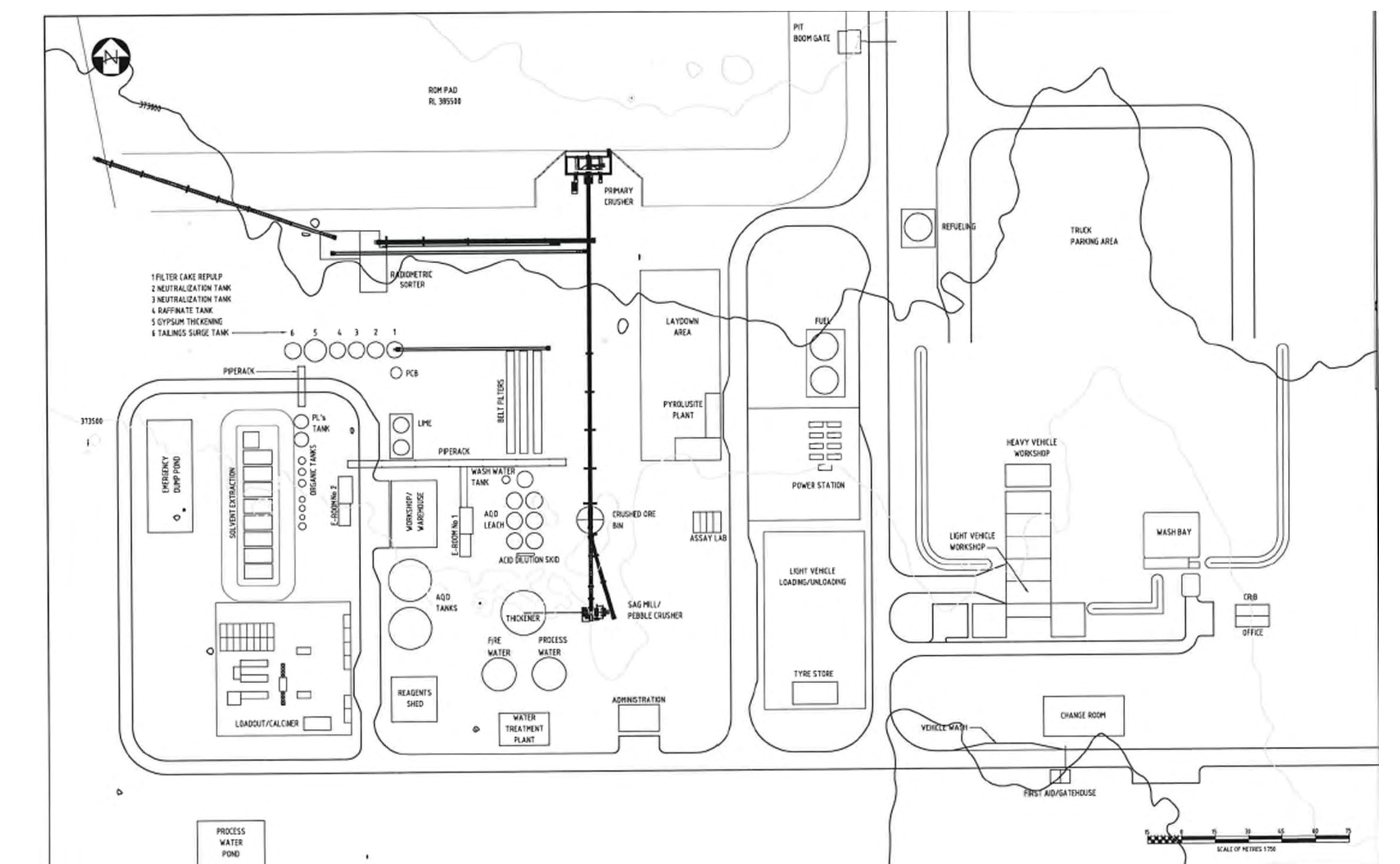


Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Kintyre Project – Project Location

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 1

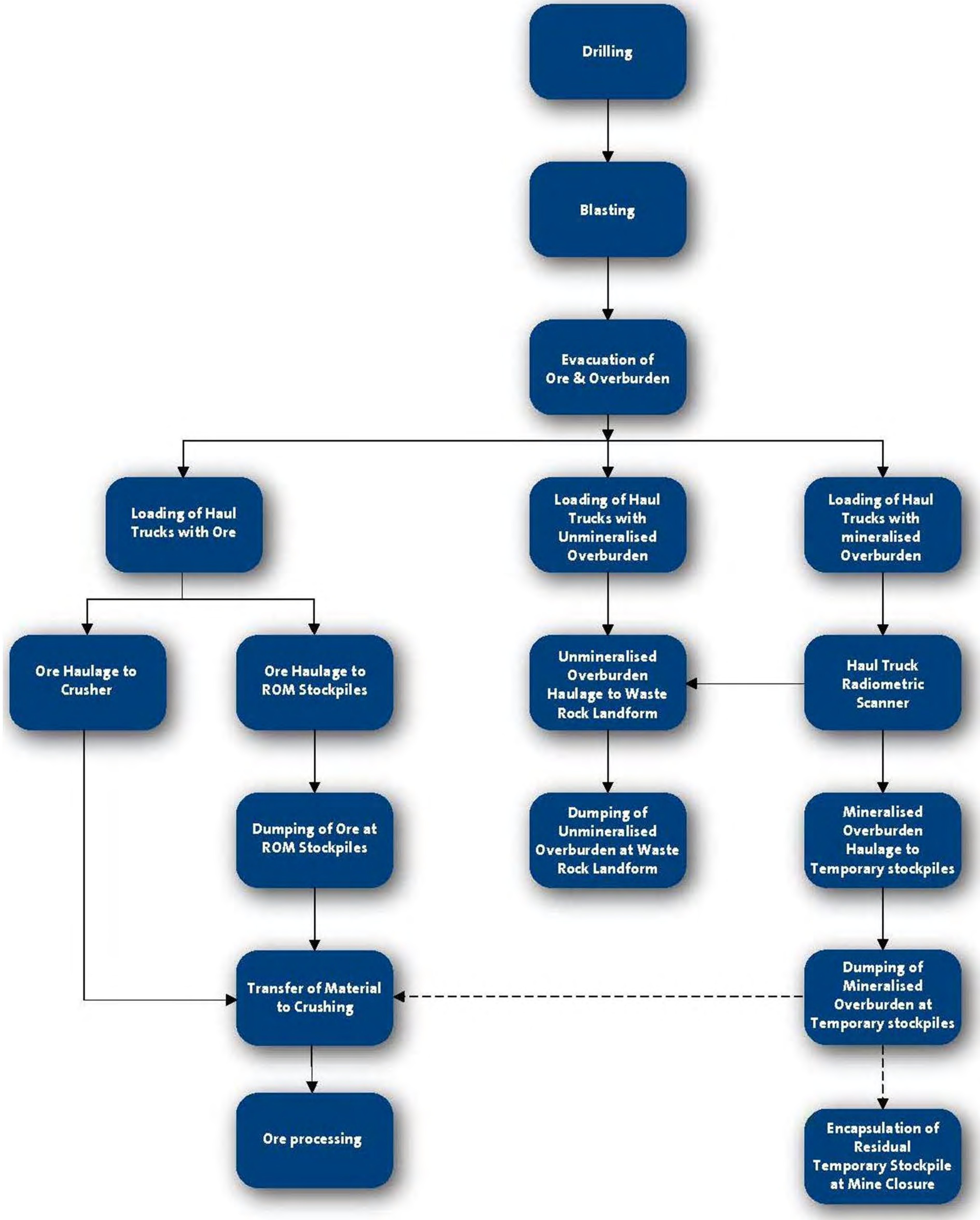


Cameco Australia Pty Ltd	Kintyre Air Quality Assessment	Kintyre Project – Site Layout
ENVIRON	JOB NO: AS110500C	DATE: May 2013	FIGURE 2



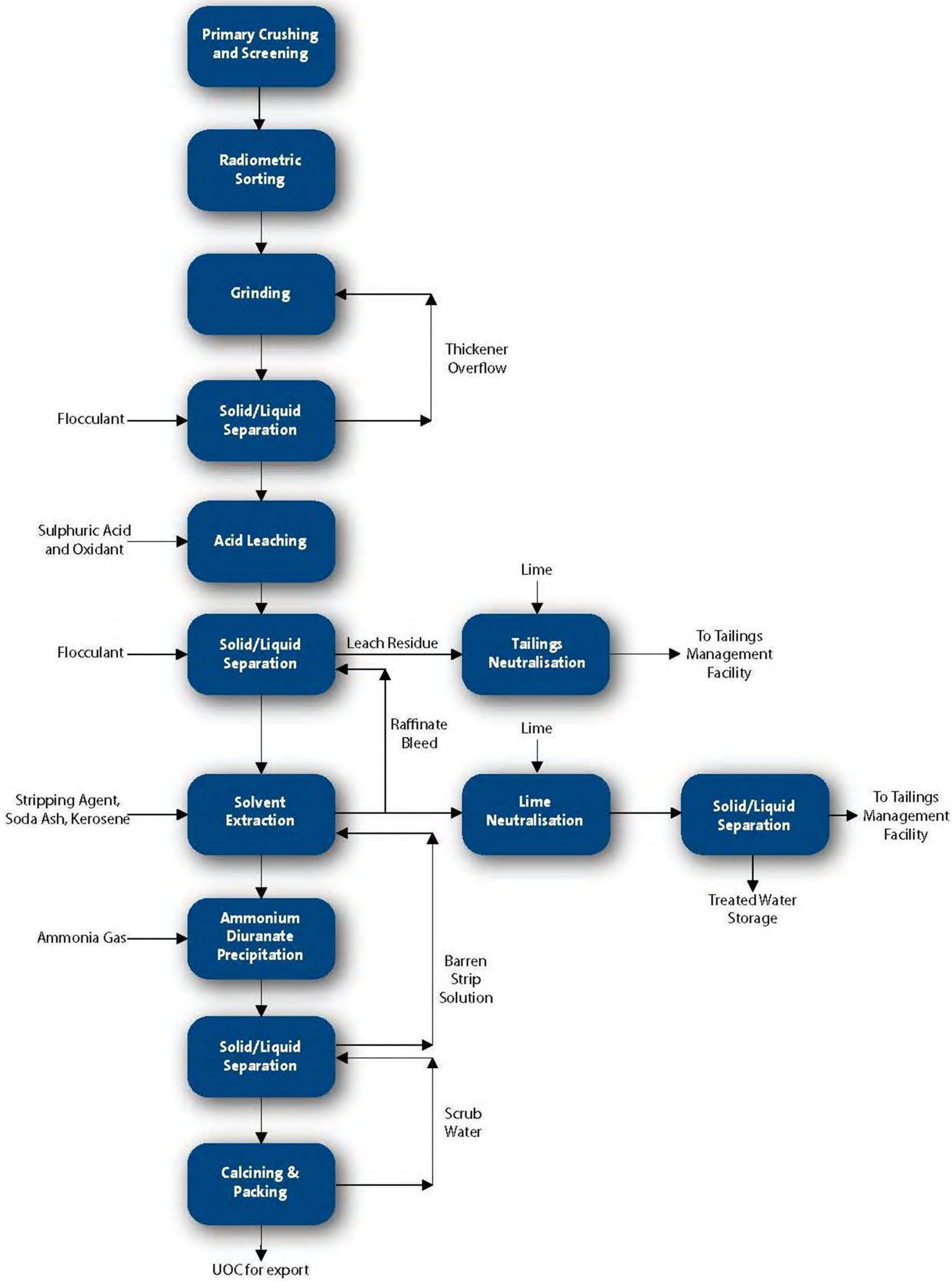
Cameco Australia Pty Ltd | Kintyre Air Quality Assessment | Metallurgical Plant – Conceptual Layout

ENVIRON | JOB NO: AS110500C | DATE: May 2013 | FIGURE 3

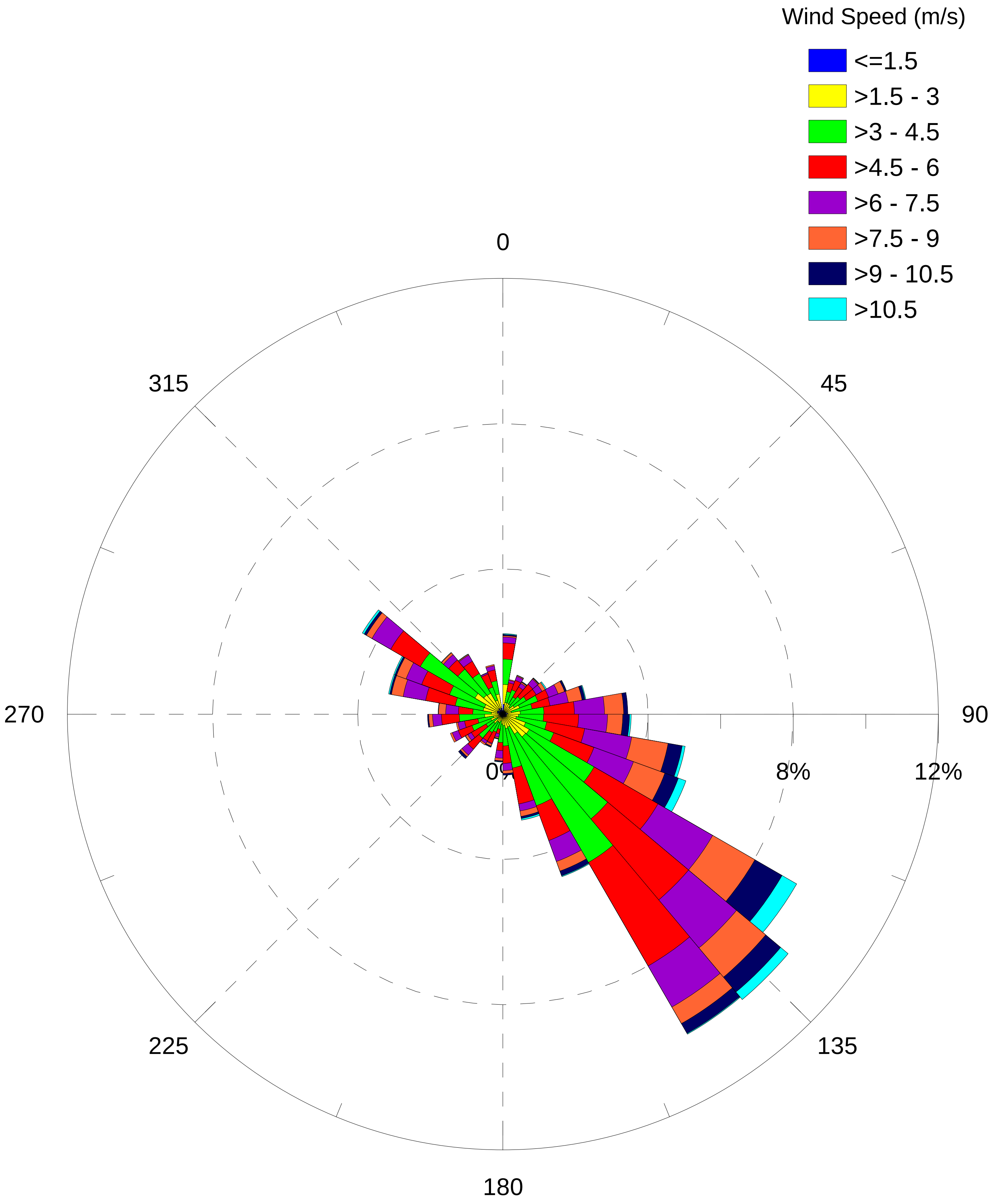


Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Process Flow Diagram – Mining Operations

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 4

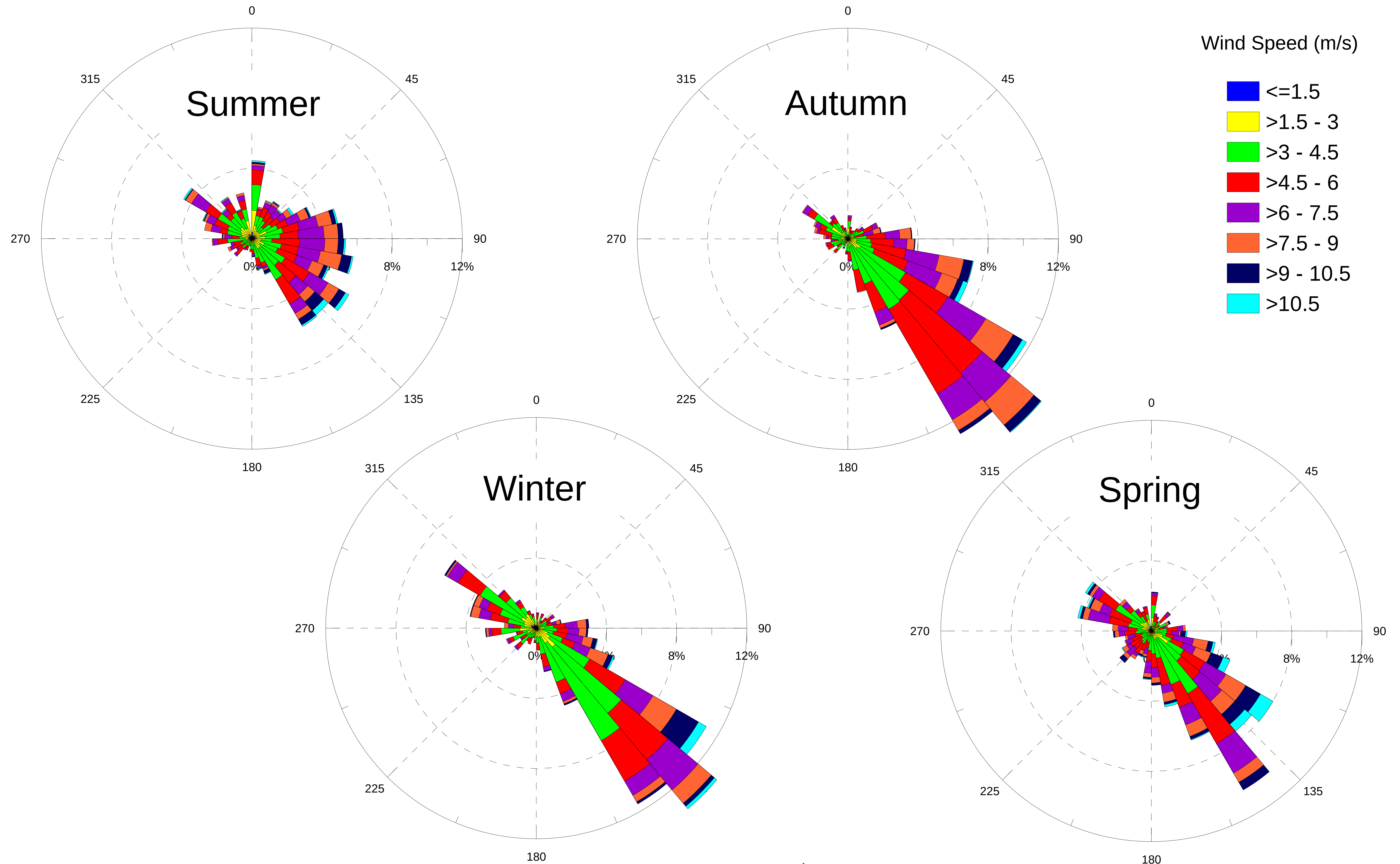


Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Process Flow Diagram – Metallurgical Processing

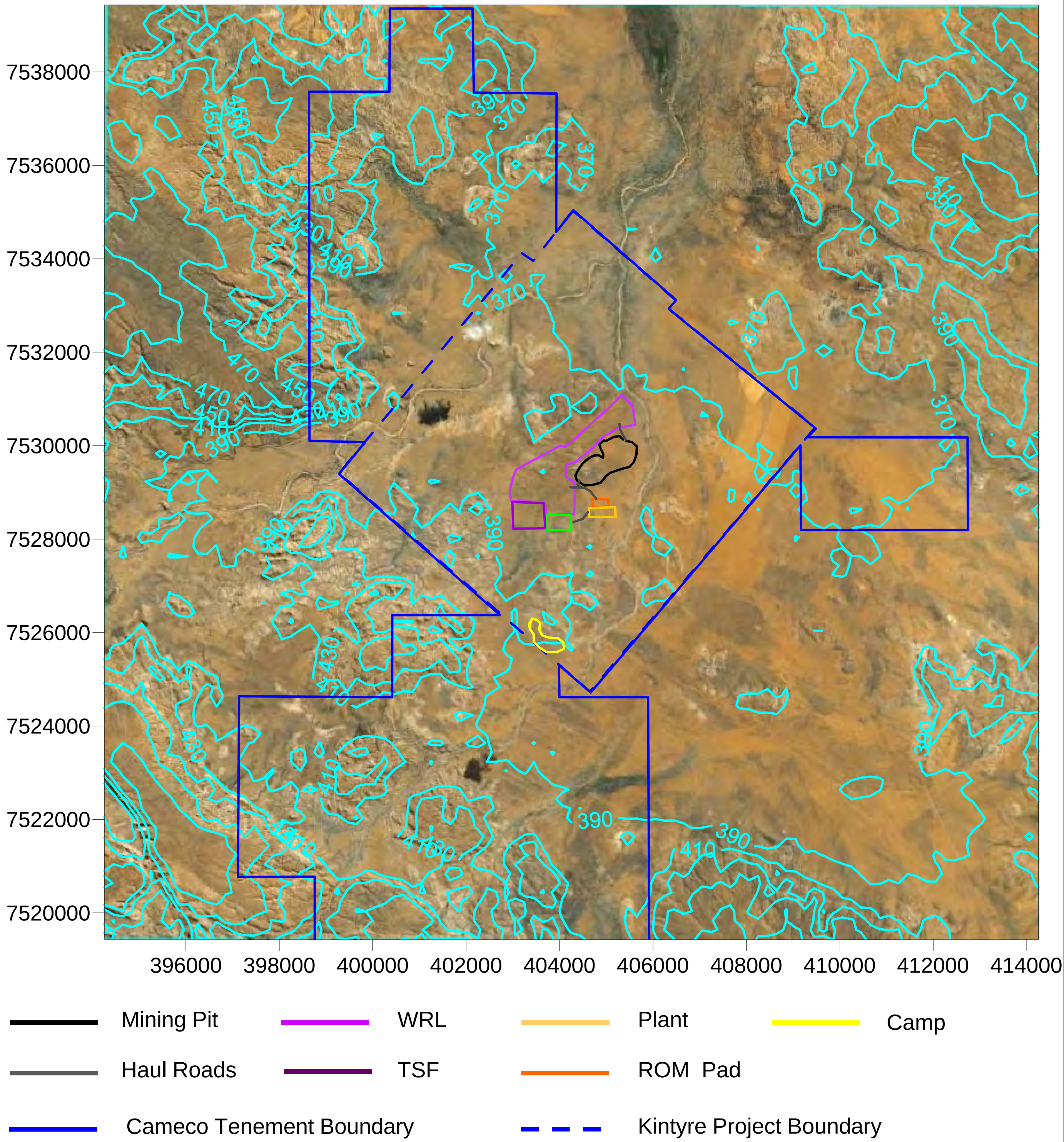


Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Telfer 2009 Annual Wind Rose

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 6



Cameco Australia Pty Ltd	Kintyre Air Quality Assessment	Telfer 2009 Seasonal Wind Roses
ENVIRON	JOB NO: AS110500C DATE: May 2013	FIGURE 7



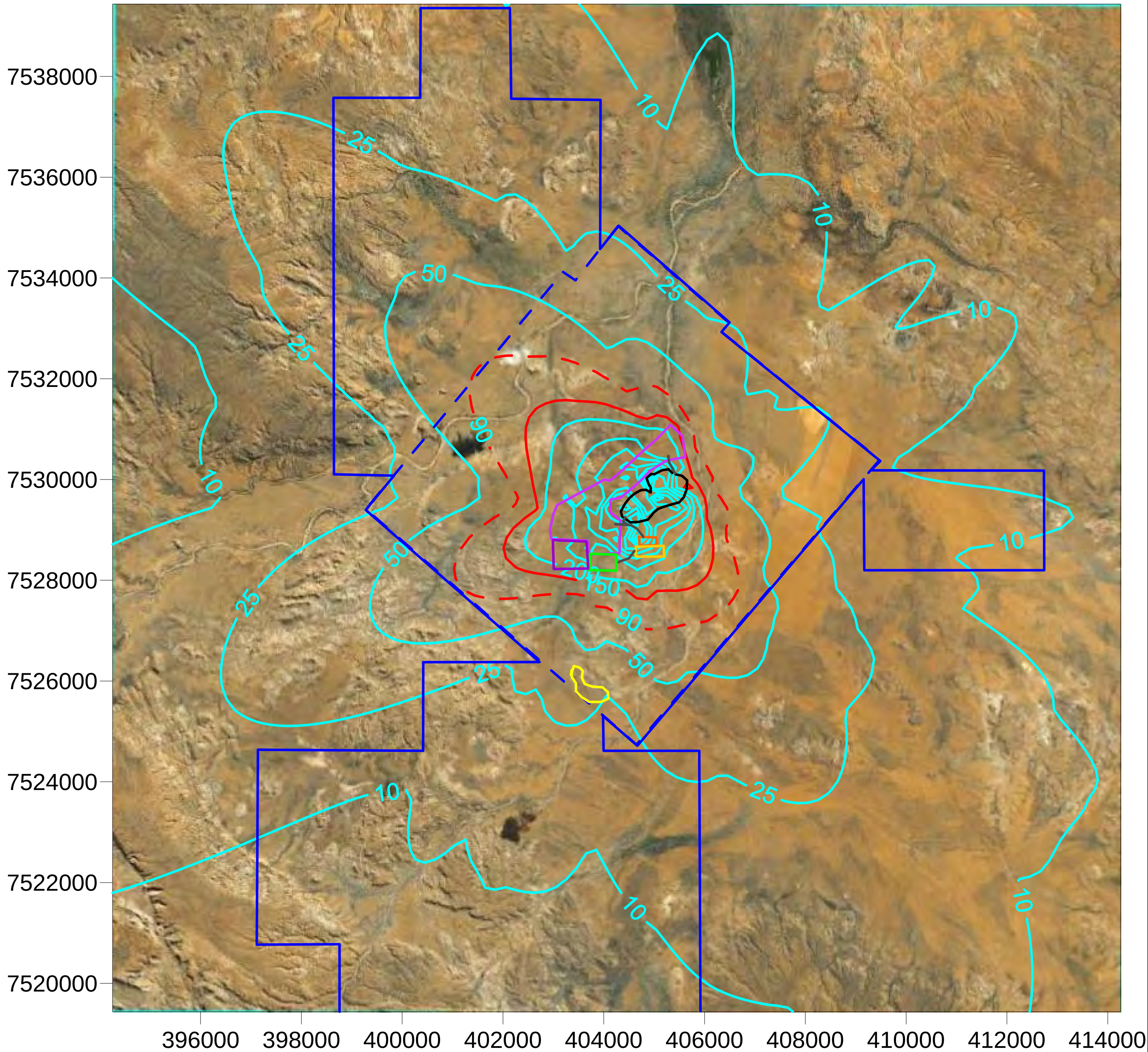
Cameco Australia Pty Ltd

Kintyre Air Quality Assessment

Kintyre Project Site – Terrain Elevations (metres)

Source: Mapmart

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 8



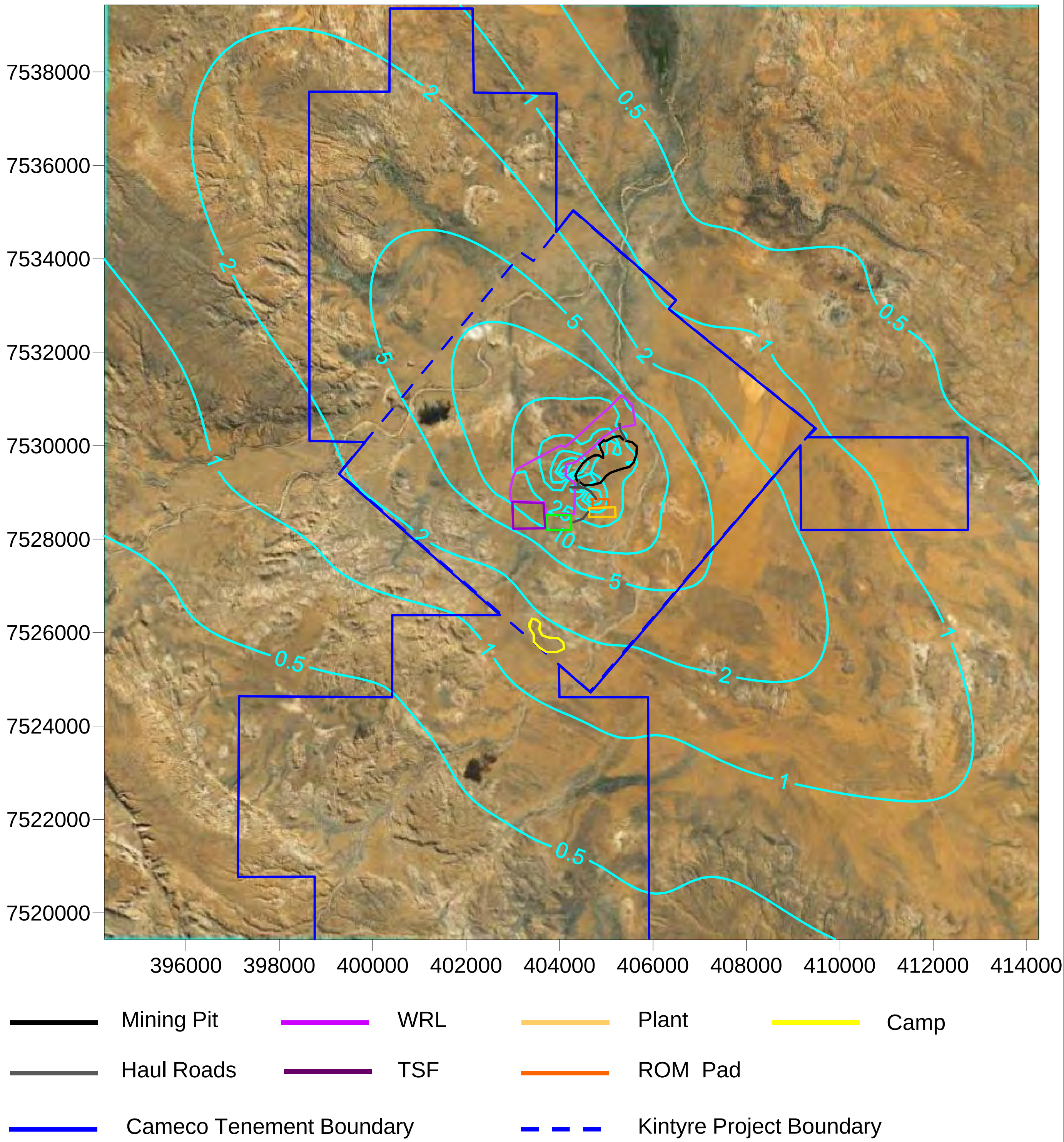
Mining Pit | WRL | Plant | Camp
Haul Roads | TSF | ROM Pad
Cameco Tenement Boundary | Kintyre Project Boundary
24-hour Average TSP EPA Area A Standard (150 µg/m³) | 24-hour Average TSP EPA Area C Standard (90 µg/m³)

Cameco Australia Pty Ltd

Kintyre Air Quality Assessment

Maximum Predicted 24-hr Average TSP GLCs (µg/m³)

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 9

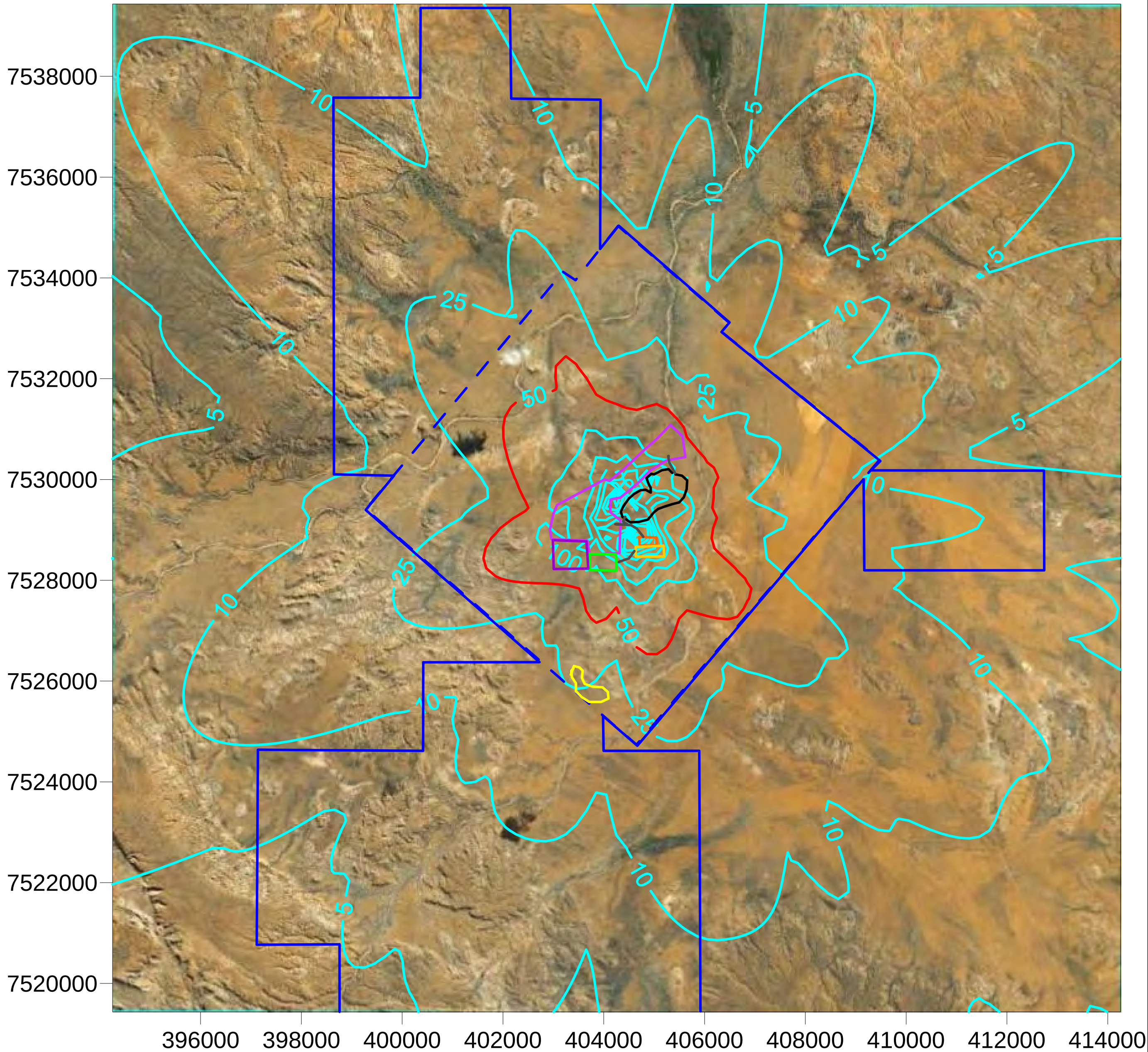


Cameco Australia Pty Ltd

Kintyre Air Quality Assessment

Predicted Annual Average TSP GLCs ($\mu g/m^3$)

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 10



Mining Pit

WRL

Plant

Camp

Haul Roads

TSF

ROM Pad

Cameco Tenement Boundary

Kintyre Project Boundary

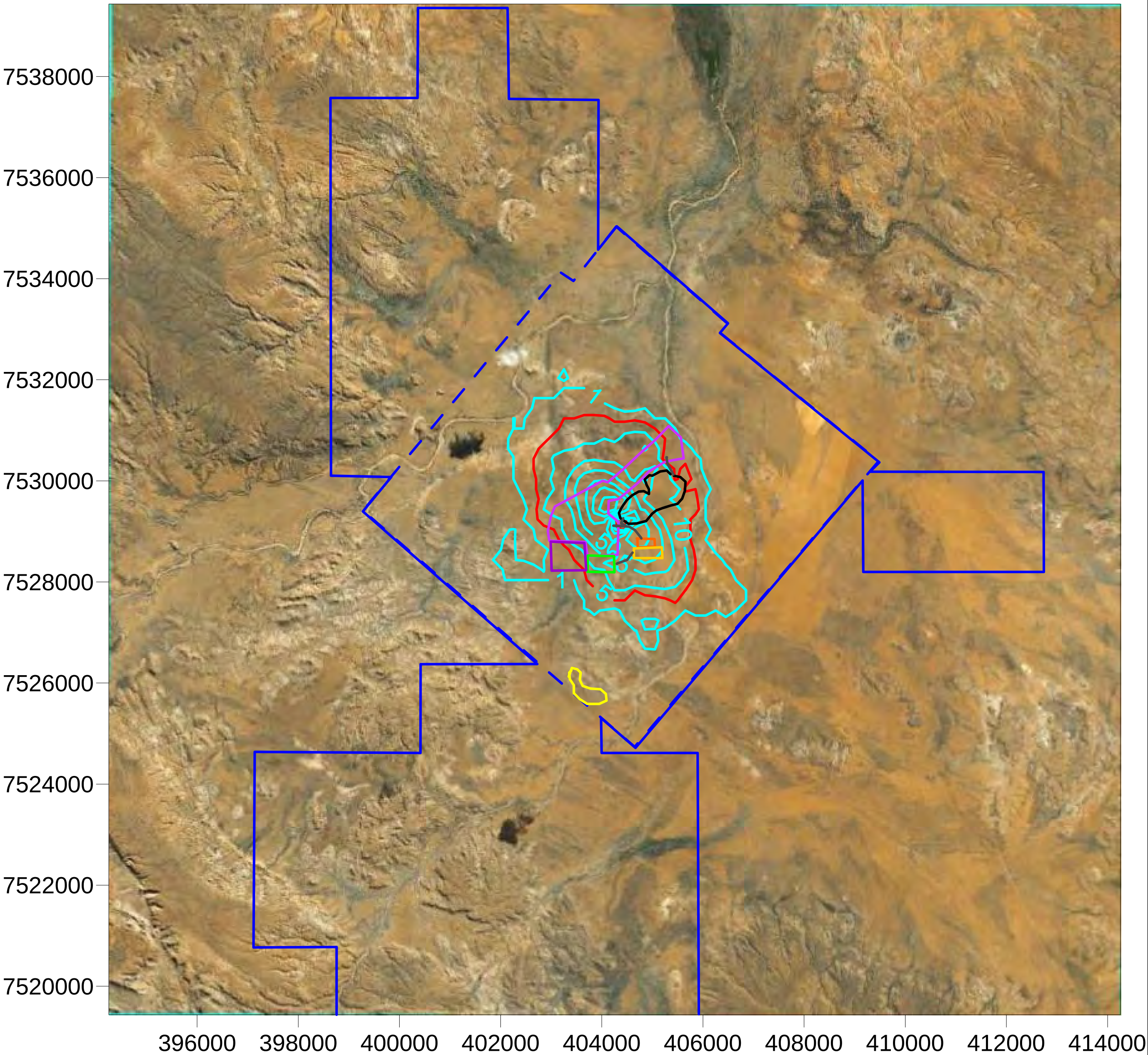
24-hour Average PM_{10} NEPM Standard (50 µg/m^3)

Cameco Australia Pty Ltd

Kintyre Air Quality Assessment

Maximum Predicted 24-hr Average PM_{10} GLCs (µg/m^3)

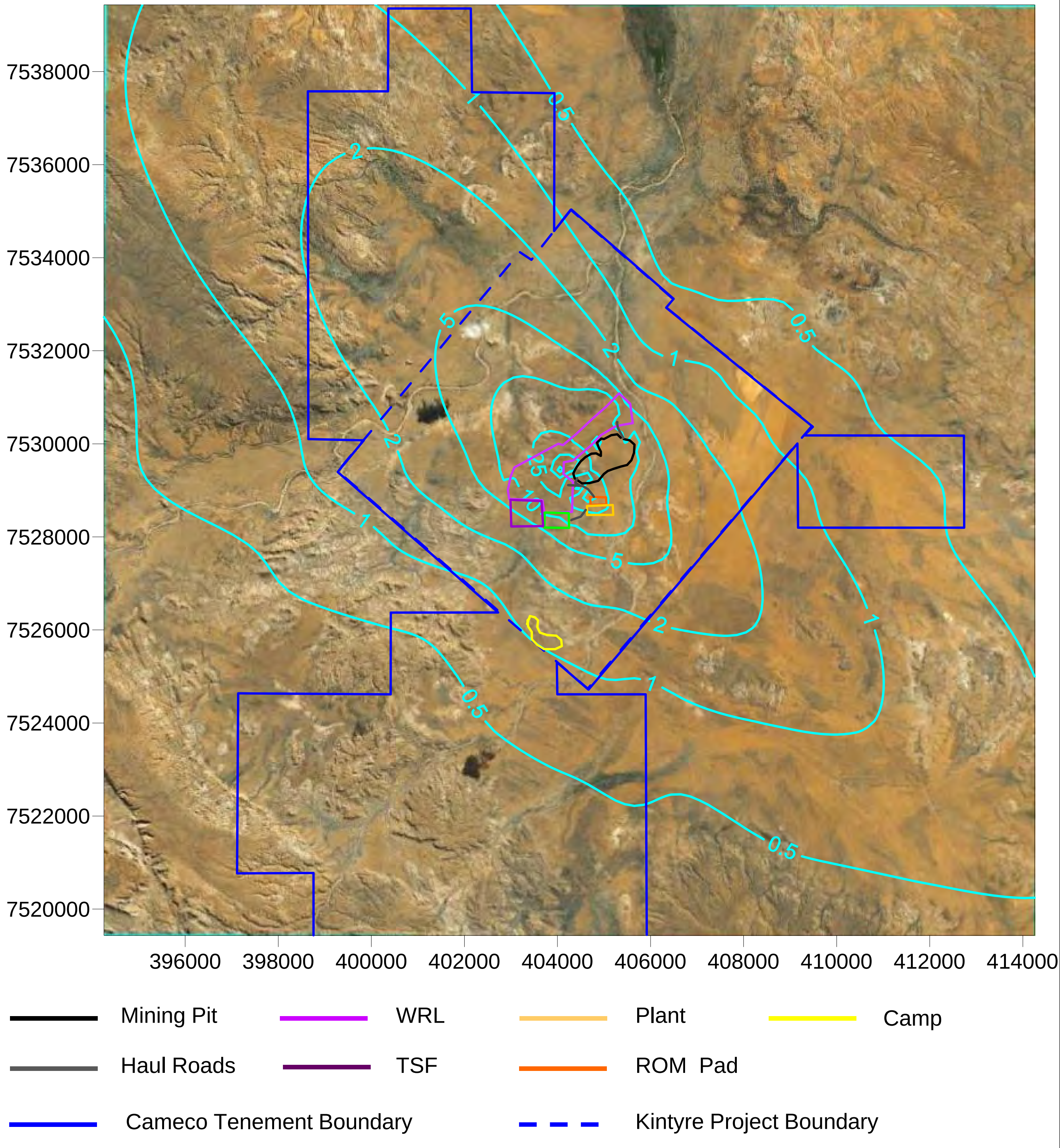
ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 11



Mining Pit
WRL
Plant
Camp
Haul Roads
TSF
ROM Pad
Cameco Tenement Boundary
Kintyre Project Boundary
NEPM goal for number of exceedences per year (5)

Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Number of Predicted Exceedences of the 24-hour PM_{10} NEPM Standard

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 12

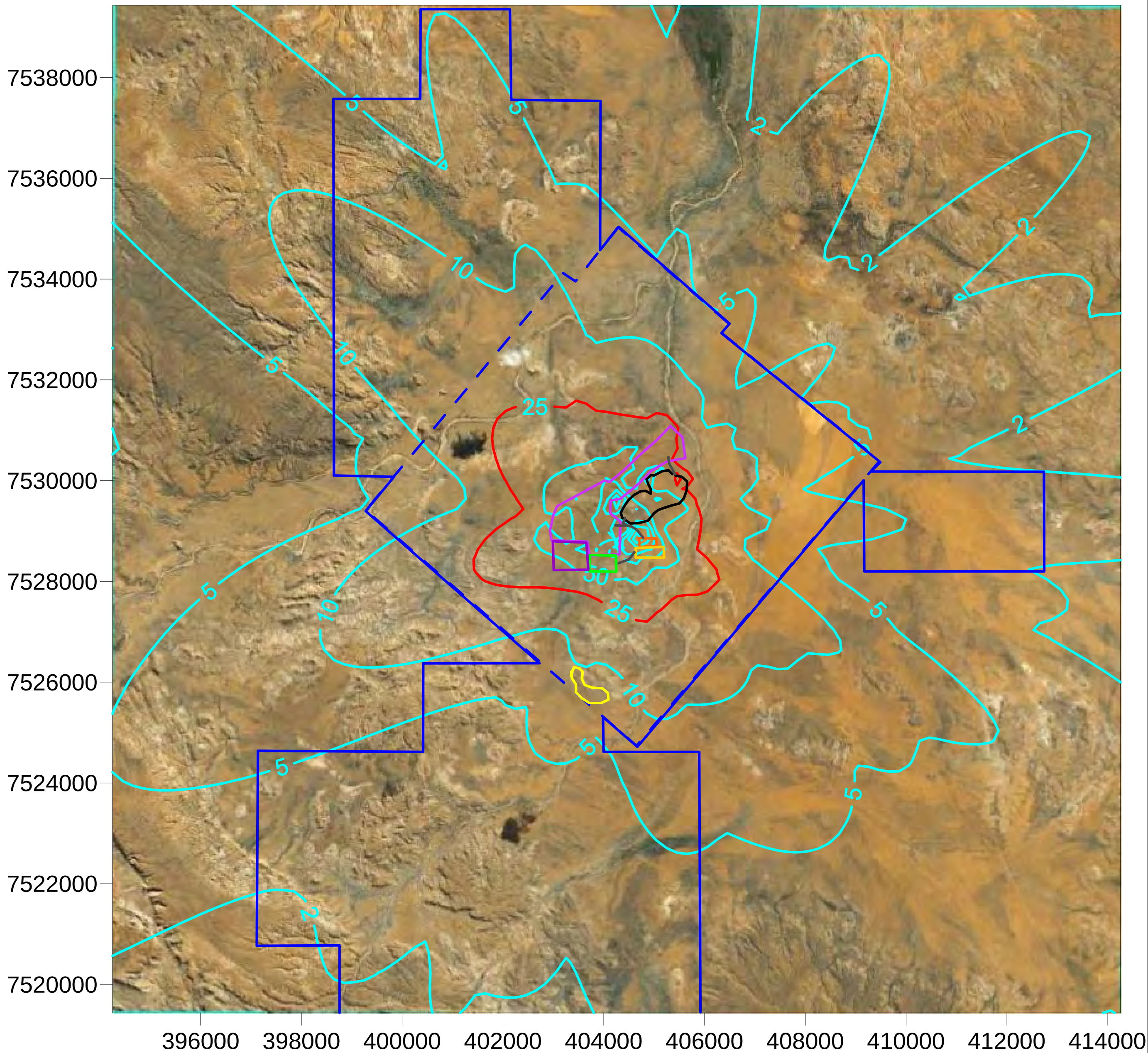


Cameco Australia Pty Ltd

Kintyre Air Quality Assessment

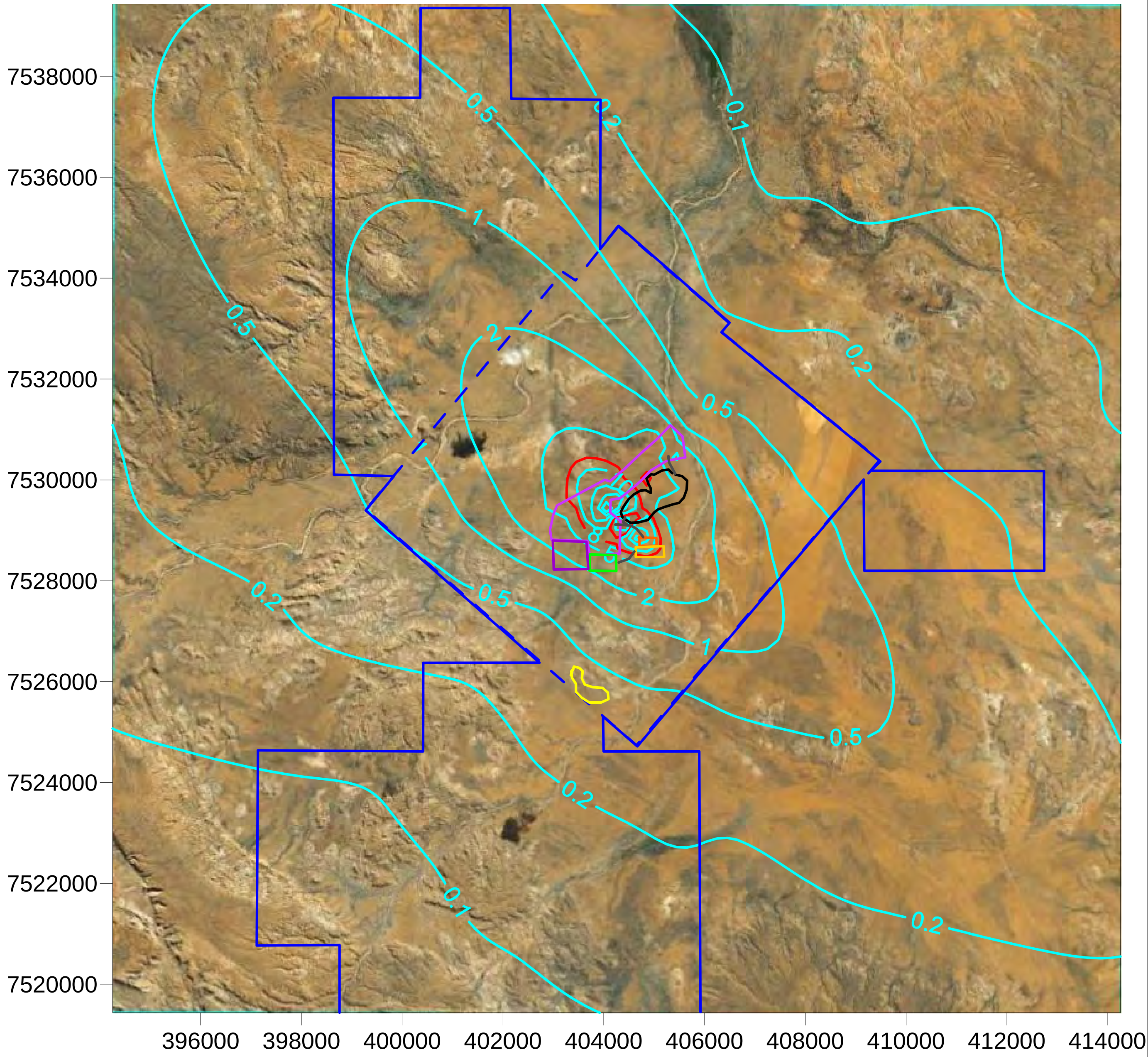
Predicted Annual Average PM_{10} GLCs ($\mu g/m^3$)

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 13



Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Maximum Predicted 24-hr Average $PM_{2.5}$ GLCs (µg/m³)

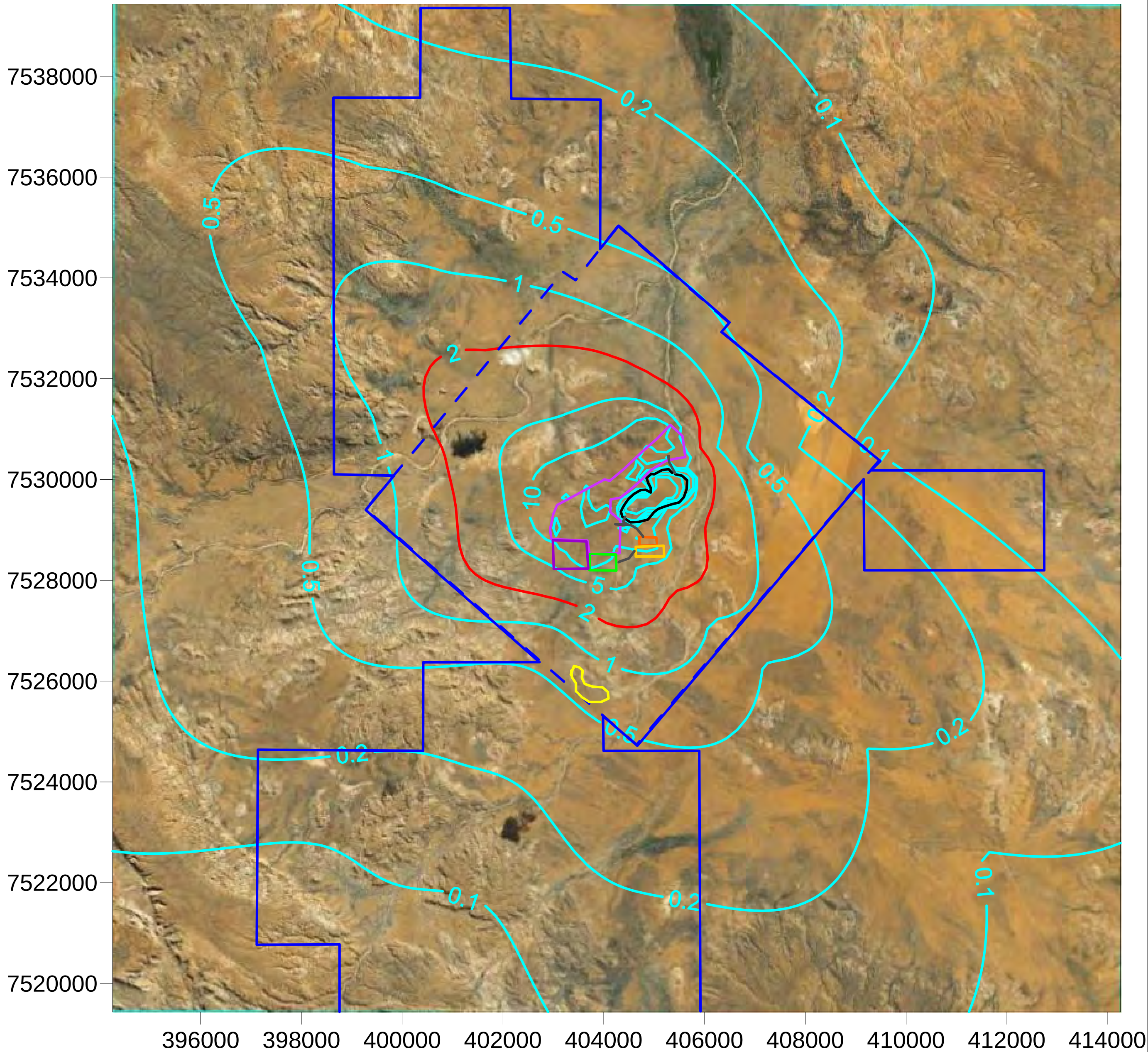
ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 14



Mining Pit | WRL | Plant | Camp
Haul Roads | TSF | ROM Pad
Cameco Tenement Boundary | Kintyre Project Boundary
Annual Average $PM_{2.5}$ NEPM Advisory Reporting Standard (8 µg/m³)

Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Predicted Annual Average $PM_{2.5}$ GLCs (µg/m³)

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 15



Mining Pit | WRL | Plant | Camp

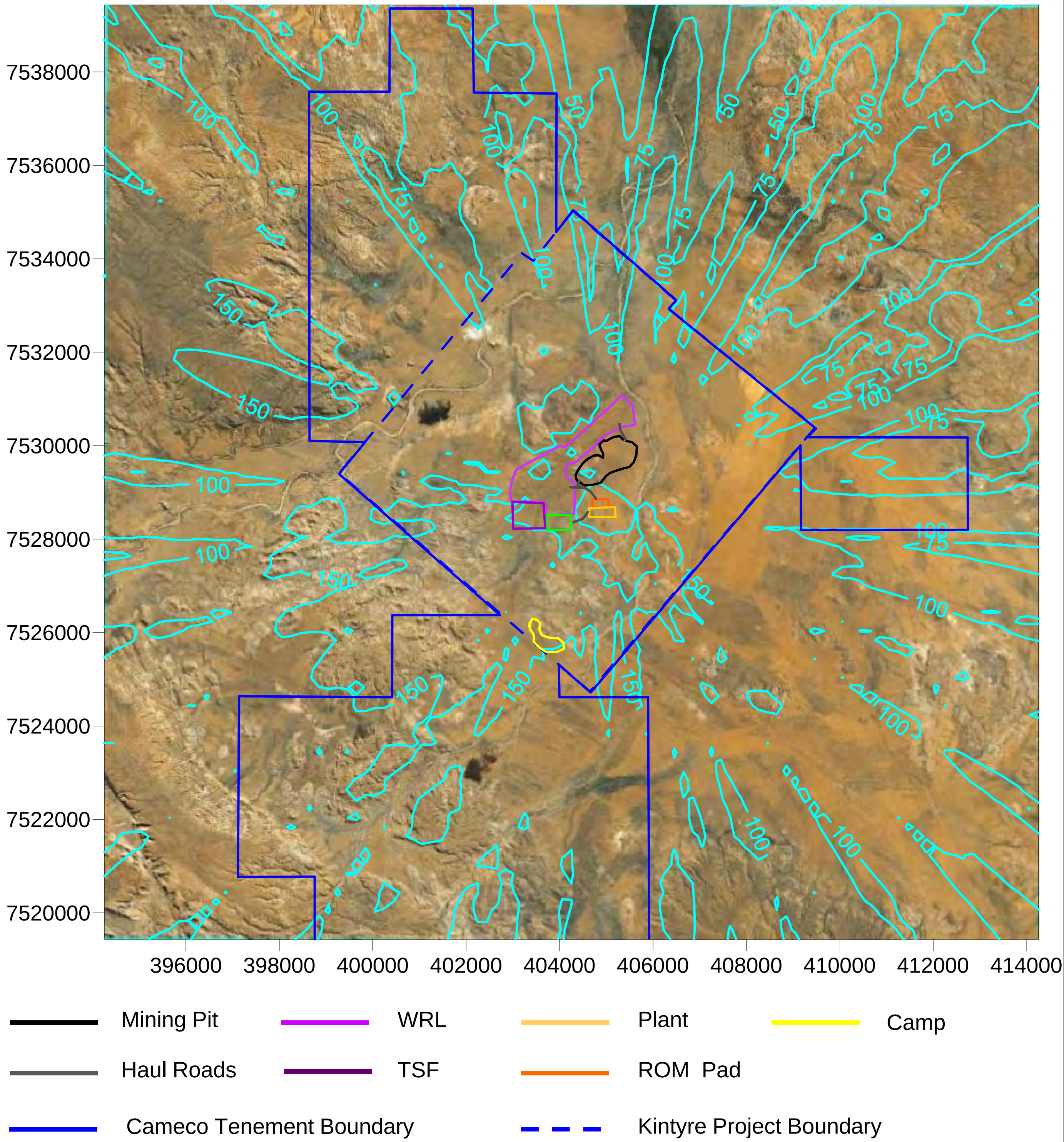
Haul Roads | TSF | ROM Pad

Cameco Tenement Boundary | Kintyre Project Boundary

NSW DECC Monthly (Increase) Dust Deposition Criteria (2 g/m²/month)

Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Predicted Average Monthly TSP Deposition rate ($g/m^2/month$)

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 16



Cameco Australia Pty Ltd Kintyre Air Quality Assessment	Predicted Maximum 1-Hour Average Ground Level Concentrations of NO_2 ($\mu g/m^3$)

ENVIRON JOB NO: AS110500C DATE: May 2013 FIGURE 17

Appendix A

Creation of Ausplume Meteorological Data File

Creation of Ausplume Meteorological File

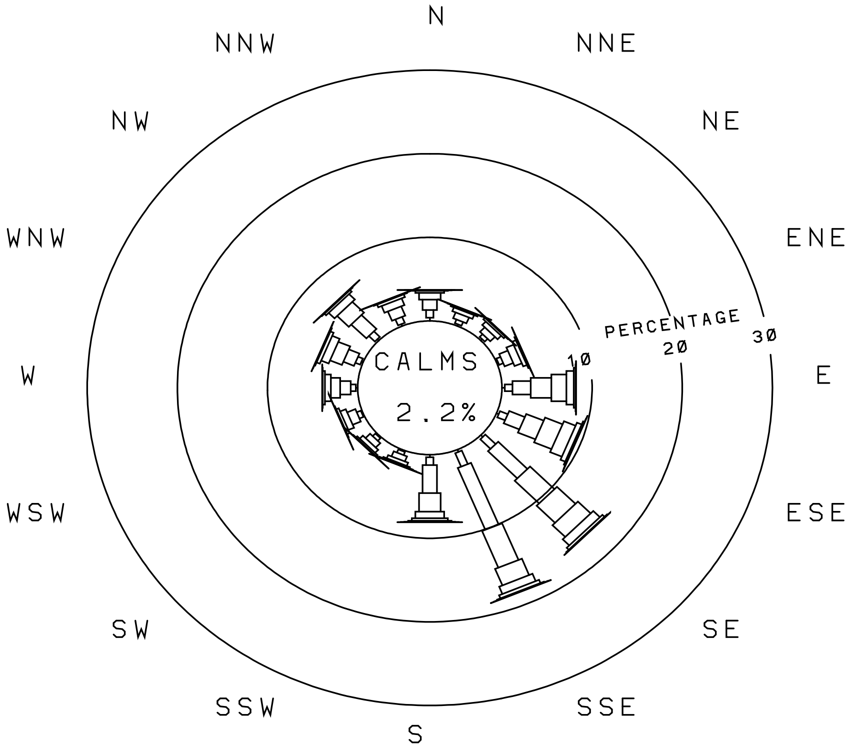
A1. Surface Meteorological Data

Cameco recently established a meteorological and ambient dust monitoring program to provide climactic data for use in project infrastructure design, future air quality studies, and ongoing environmental review of the Project; and to provide data on the existing dust concentrations and monitor the fugitive particulate emissions resulting from the potential development and operation of the Project in the future. The meteorological component includes a monitoring station to measure wind speed and direction, temperature, solar radiation, relative humidity, barometric pressure and rainfall. Monitoring began in mid-2010, however significant issues associated with the continuity of power at the site have resulted in the loss of data. Work is ongoing to improve the continuity of the power supply and data recovery at the site and is expected to be installed by late 2012.

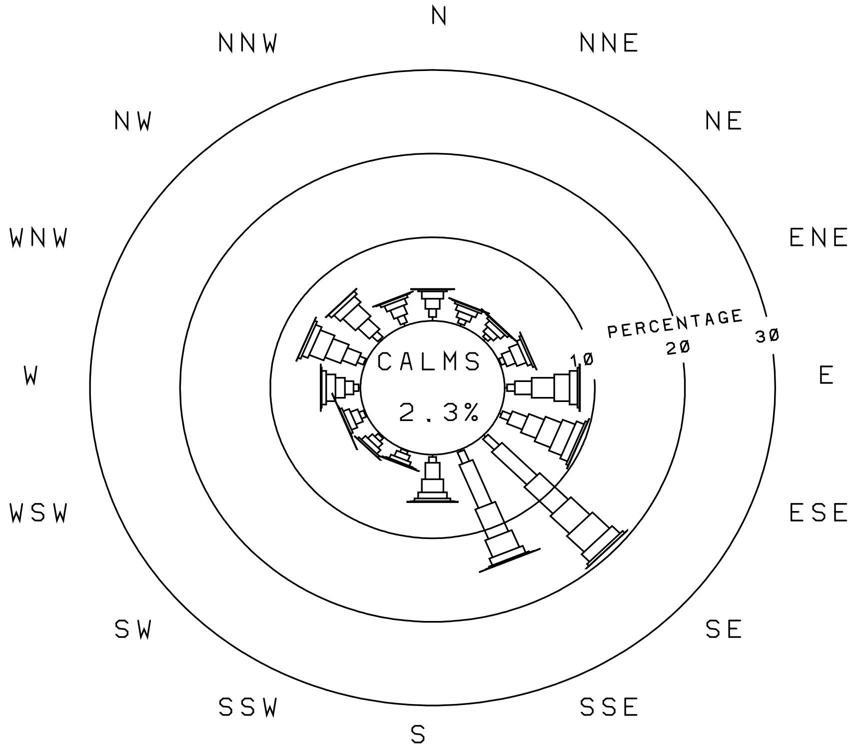
In the absence of suitable site specific meteorological data, surface monitoring data collected between December 1995 and August 2011 were obtained from the Bureau of Meteorology (BoM) Telfer monitoring station, located 60 km north of the Kintyre Project site. Annual wind roses for the calendar years 2008, 2009 and 2010 were compared to the long-term wind rose derived from the data collected between January 2000 and December 2010 (Figure A1). The 2009 data were considered most representative of the long-term averages and as such, were used to compile the meteorological data file required for the modelling assessment. Seasonal wind roses derived from the 2009 data (Figure 7) also compare reasonably well against the long-term seasonal wind roses (Figure A2).

As described in Section 5.2, the annual wind rose derived from the meteorological data file indicates that the most common winds are from the southeast (Figure A1). Analysis of the seasonal wind roses indicates that stronger winds are most common during the spring months, with 18% of winds greater than 7.5 m/s (Figure 7). The annual average wind speed for the monitoring period is 4.9 m/s.

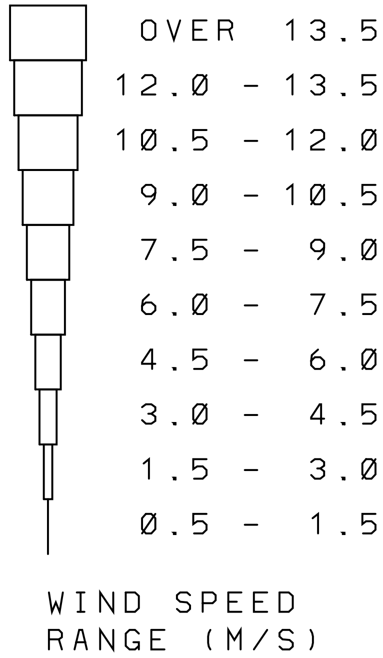
For the purposes of modelling, the minimum wind speed was set at 0.5 m/s.

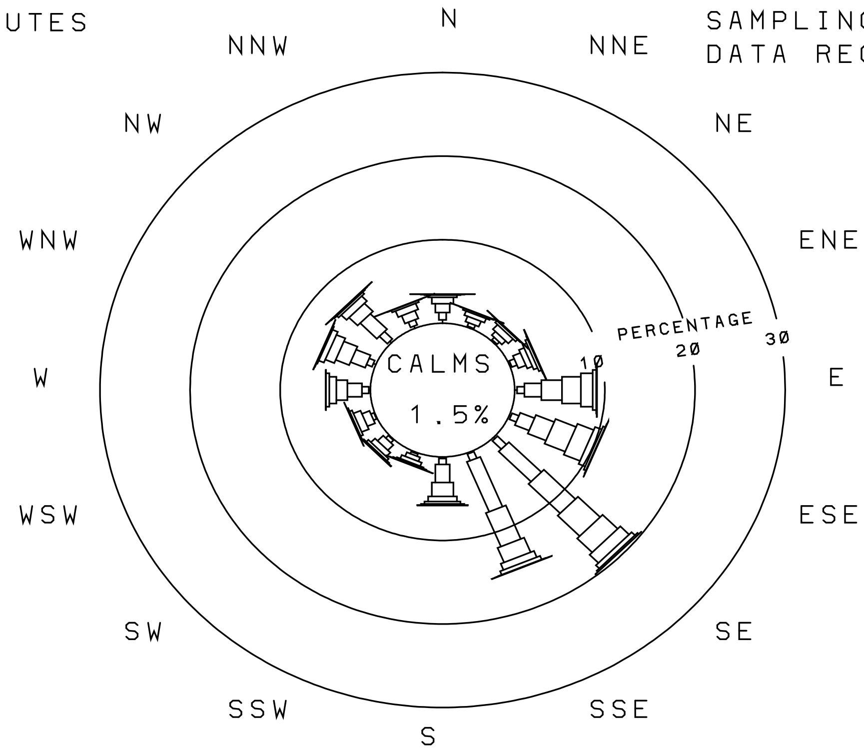


WIND ROSE FOR BoM Telfer, WA
DATA PERIOD: 01/01/2000 TO 31/12/2010
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 97.0%

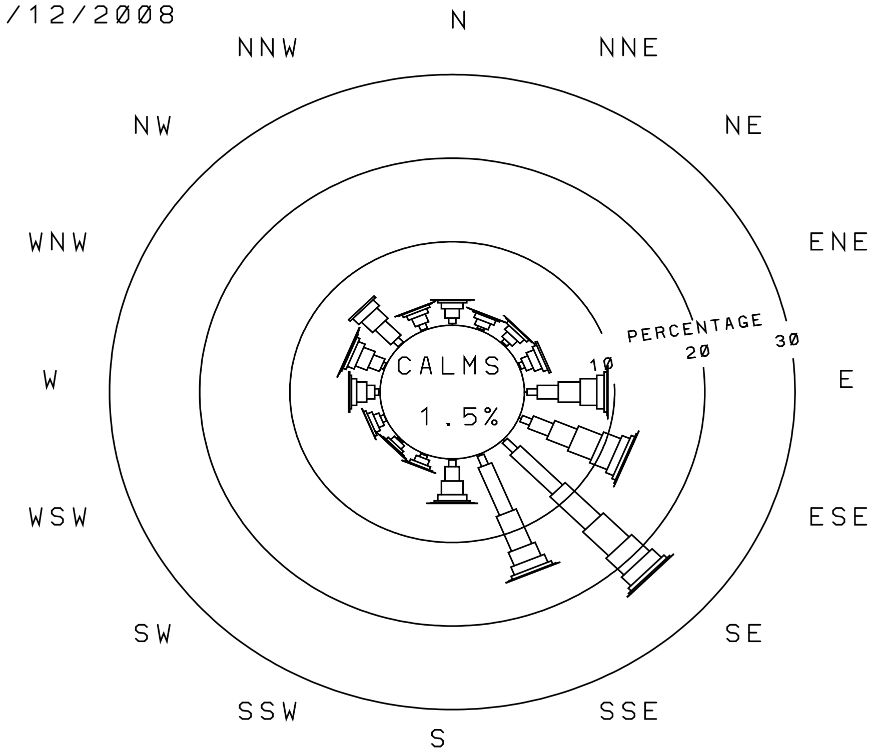


WIND ROSE FOR BoM Telfer, WA
DATA PERIOD: 01/01/2008 TO 31/12/2008
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 99.7%





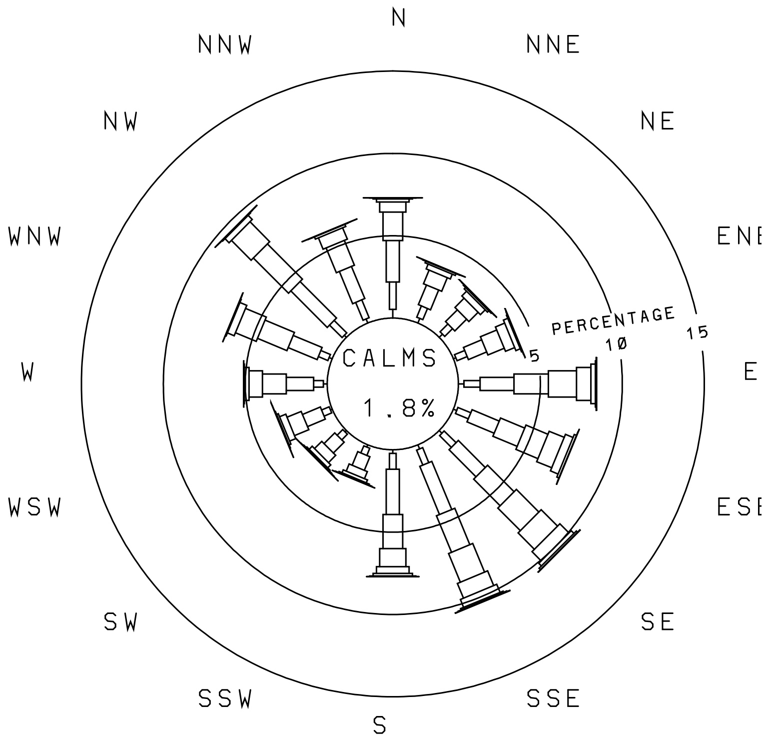
WIND ROSE FOR BoM Telfer, WA
DATA PERIOD: 01/01/2009 TO 31/12/2009
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 99.6%



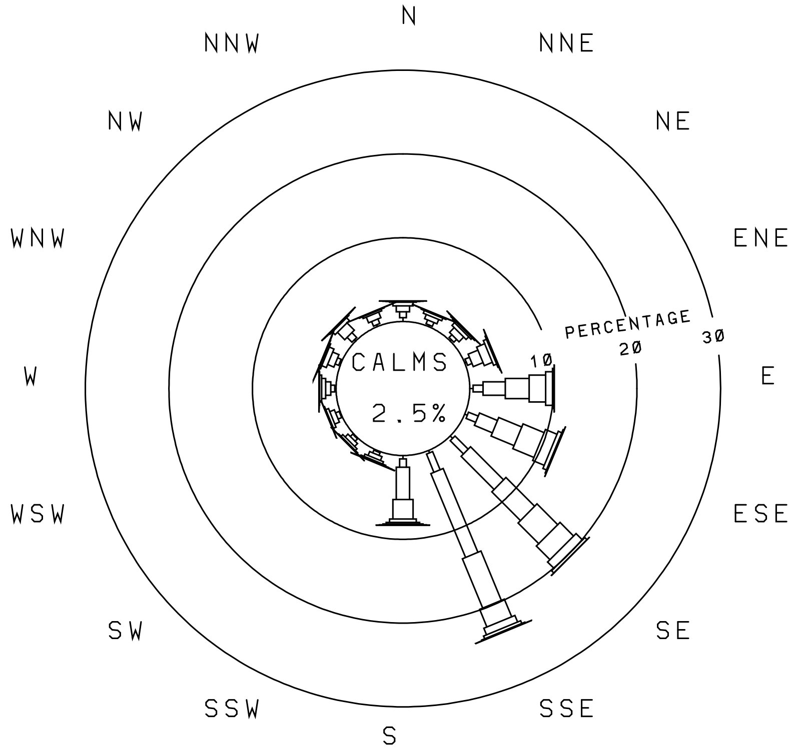
WIND ROSE FOR BoM Telfer, WA
DATA PERIOD: 01/01/2010 TO 31/12/2010
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 99.9%

Cameco Australia Pty Ltd	Kintyre Air Quality Assessment	Telfer Monitoring Site Comparison of Long-Term (2000-2010) and Annual (2008, 2009, 2010) Wind Roses
ENVIRON	JOB NO: AS110500C	DATE: May 2013

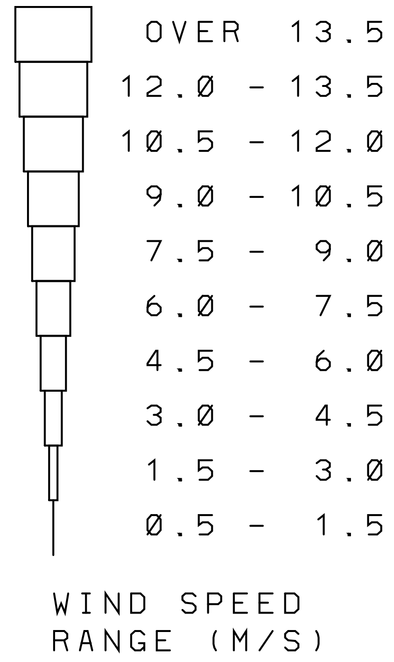
FIGURE A1

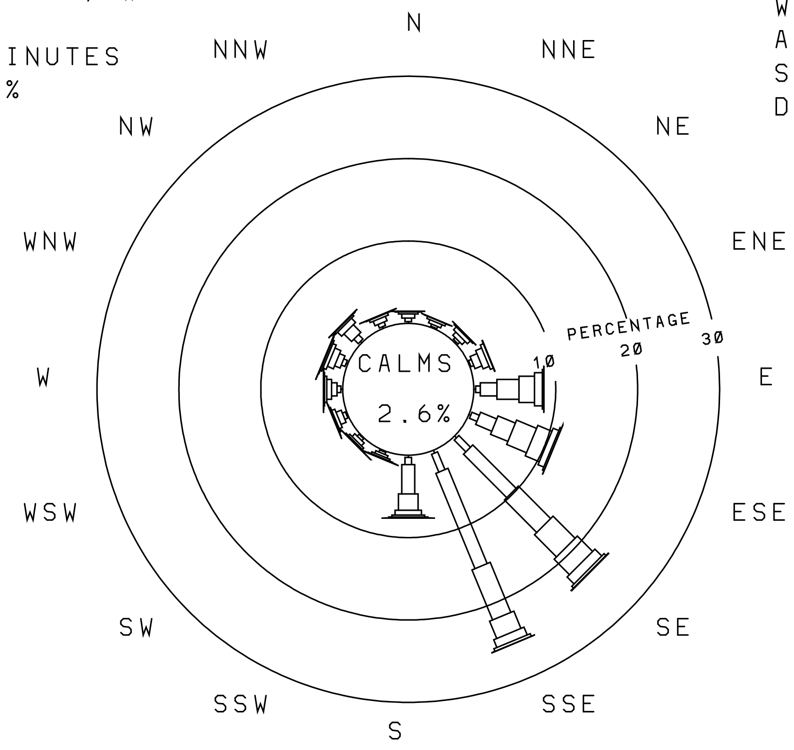


WIND ROSE FOR BoM Telfer, WA
SUMMER
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 95.5%

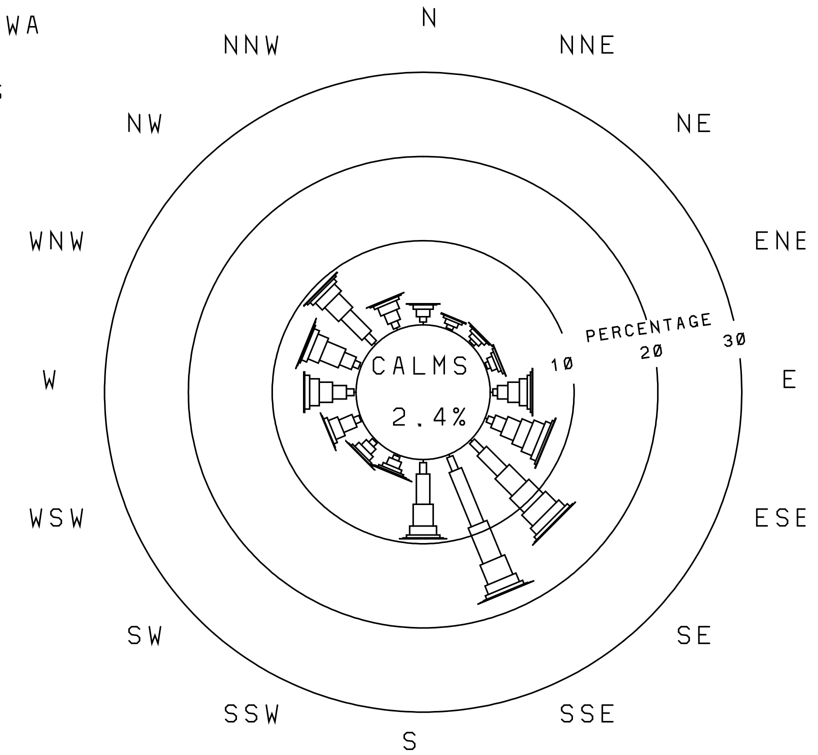


WIND ROSE FOR BoM Telfer, WA
AUTUMN
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 96.8%





WIND ROSE FOR BoM Telfer, WA
WINTER
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 97.0%



WIND ROSE FOR BoM Telfer, WA
SPRING
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 98.9%

Cameco Australia Pty Ltd	Kintyre Air Quality Assessment	Telfer Monitoring Site Long-Term Seasonal Wind Roses (2000 to 2010)
ENVIRON	JOB NO: AS110500C	DATE: May 2013 — FIGURE A2

A2. Atmospheric Stability Class

Atmospheric stability is required by Ausplume for each modelled hour and has been determined using the ‘Turner method’ (USEPA, 2001). This method requires solar radiation, cloud cover and wind speed data. In the absence of suitable solar radiation data from either the Telfer or Kintyre monitoring sites, the meteorological component of The Air Pollution Model (TAPM) was used to generate solar radiation data for the determination of atmospheric stability. TAPM was also used to generate cloud cover data for the modelling period, in the absence of monitored data.

The methodology used to determine atmospheric stability class for each hour is summarised in Table A1.

Table A1: Determination of Pasquill-Gifford Atmospheric Stability Class

Wind Speed (m/s)	Day			Night	
	Solar Radiation			Cloud Cover	
	Strong	Moderate	Low	≤3/8ths	>3/8ths
<2	A	A	B	F	D
2-3	A	B	C	F	E
3-5	B	B	C	E	D
5-6	C	C	D	D	D
>6	C	D	D	D	D

Based on the recommendation of Smith (1972), the following values for solar radiation were used:

- Strong: Greater than 600 W/m^2
- Moderate: Greater than 310 W/m^2 and less than 600 W/m^2; and
- Weak: Less than 310 W/m^2.

A3. Atmospheric Mixing Depth

Vertical temperature profiles are often used in conjunction with surface temperatures to define mixing heights, the depth through which pollutants released to the atmosphere are typically mixed by dispersive processes (NSW EPA, 2001). Mixing heights can be determined from the intersection between the vertical potential temperature profile and the surface temperature for each hour.

In the absence of monitored upper air data for Telfer or the Kintyre monitoring sites, TAPM was used to predict the hourly average vertical temperature profiles for the modelled period. The mixing depth was then determined as the intersection between the vertical potential temperature profile and the surface temperature for each hour. At night-time, the mixing height was set to 999 m.

As the majority of the Kintyre Project emission sources are low level non-buoyant sources, mixing height is not likely to be a significant factor in terms of the air dispersion modelling.

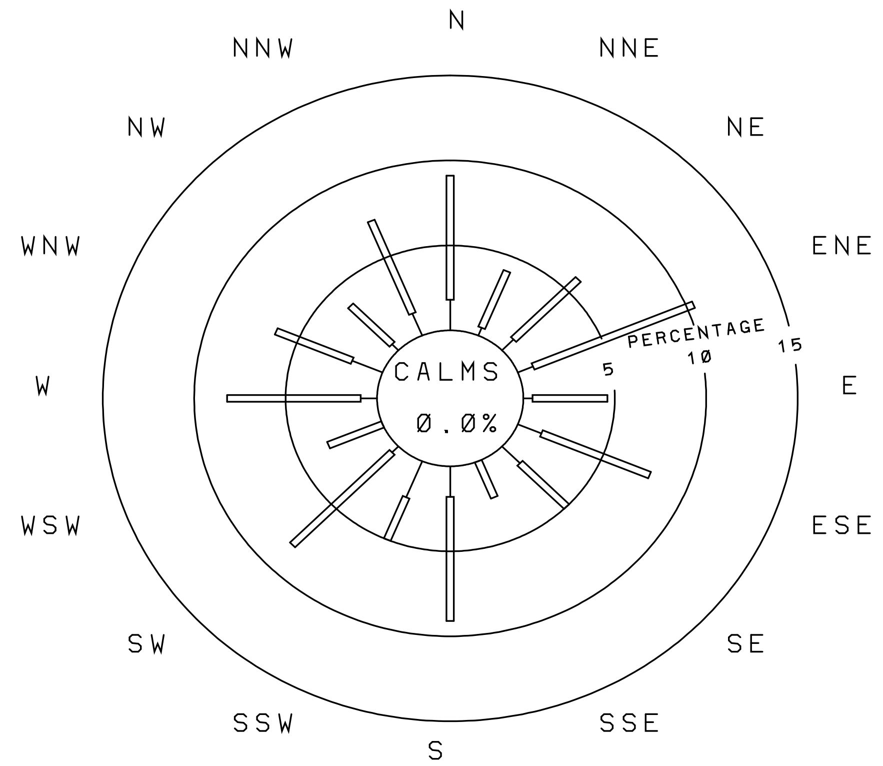
A.4 Analysis of the AUSPLUME Meteorological Data

Table A2 presents a summary of the frequency occurrence of the atmospheric stability classes determined for the Telfer monitoring site for the 2009 calendar year.

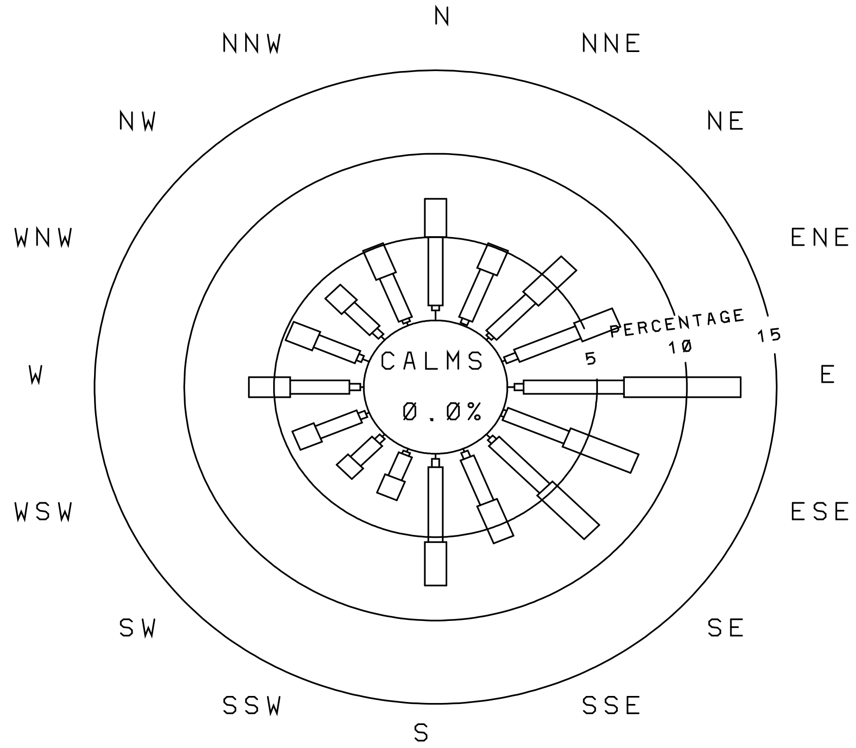
Table A2: Frequency Occurrence of Atmospheric Stability Class

Hour	Frequency Occurrence of Stability Class					
	A	B	C	D	E	F
1				1.26%	2.22%	0.68%
2				1.27%	2.17%	0.72%
3				1.16%	2.16%	0.85%
4				1.18%	2.21%	0.78%
5				1.11%	2.09%	0.97%
6		0.05%	0.43%	1.21%	1.75%	0.72%
7		0.25%	2.14%	1.79%		
8	0.07%	0.92%	0.97%	2.21%		
9	0.22%	1.31%	1.34%	1.30%		
10	0.35%	1.26%	2.17%	0.39%		
11	0.34%	1.30%	2.44%	0.09%		
12	0.37%	1.67%	2.05%	0.07%		
13	0.35%	1.70%	2.08%	0.04%		
14	0.34%	1.81%	1.89%	0.13%		
15	0.32%	1.81%	1.68%	0.36%		
16	0.19%	1.72%	1.31%	0.96%		
17	0.02%	1.13%	1.37%	1.65%		
18		0.14%	1.93%	1.04%	0.77%	0.29%
19		0.02%	0.42%	0.65%	2.16%	0.91%
20				0.65%	2.67%	0.84%
21				0.69%	2.59%	0.89%
22				0.98%	2.40%	0.78%
23				1.10%	2.22%	0.85%
24				1.23%	2.19%	0.75%
Total	2.6%	15.1%	22.2%	22.5%	27.6%	10.0%

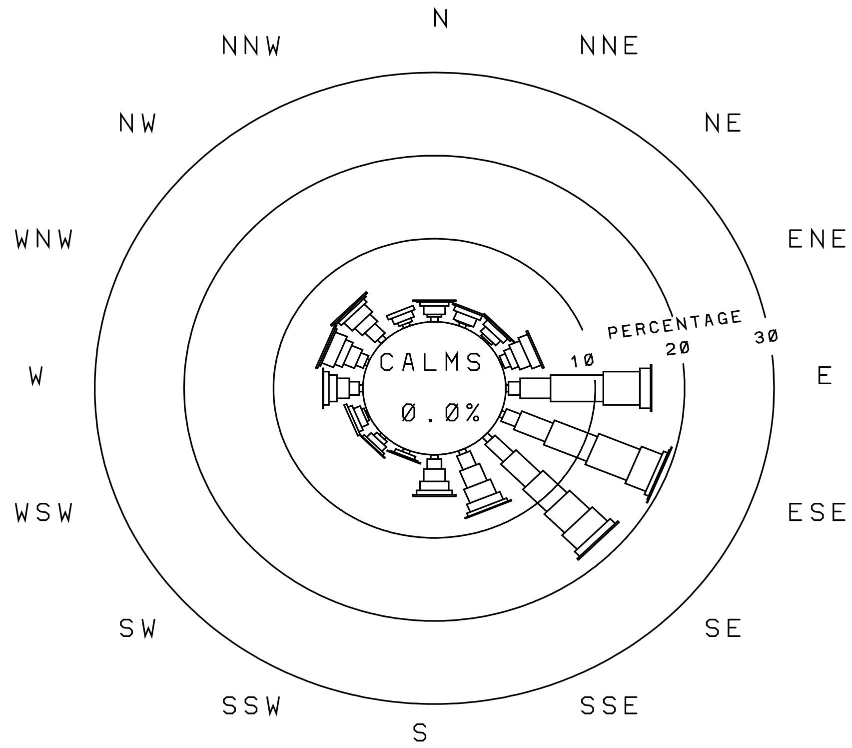
The stability dependant wind roses were also produced for the data set (Figure A3) and the tabular versions of these are presented as Table A3 to A8 for A to F class stability respectively.



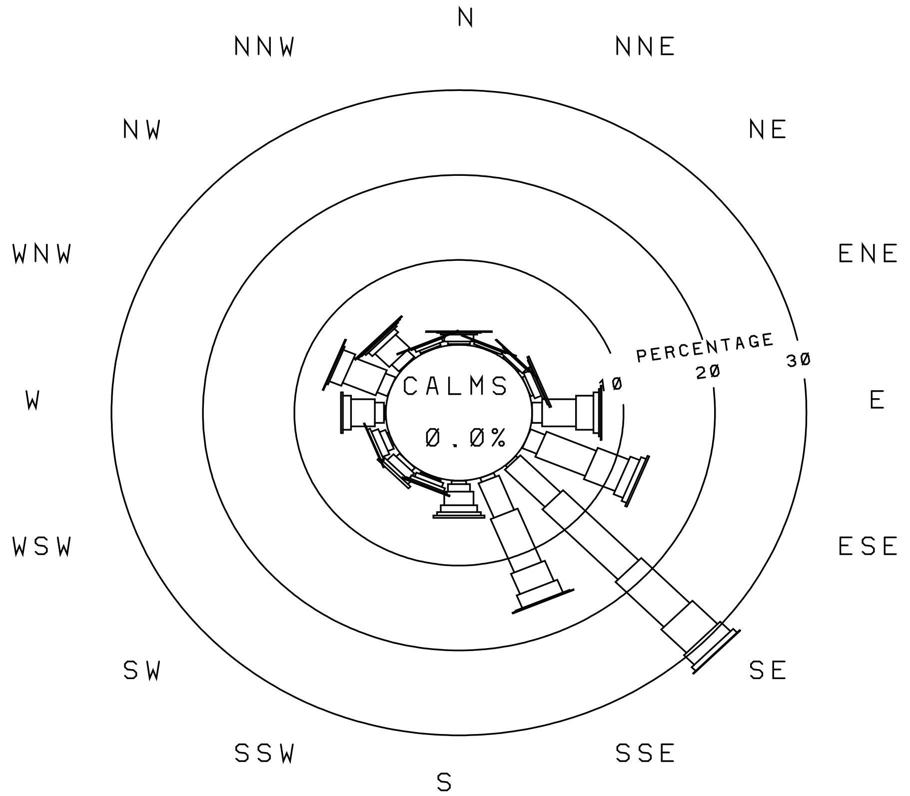
A Class Stability



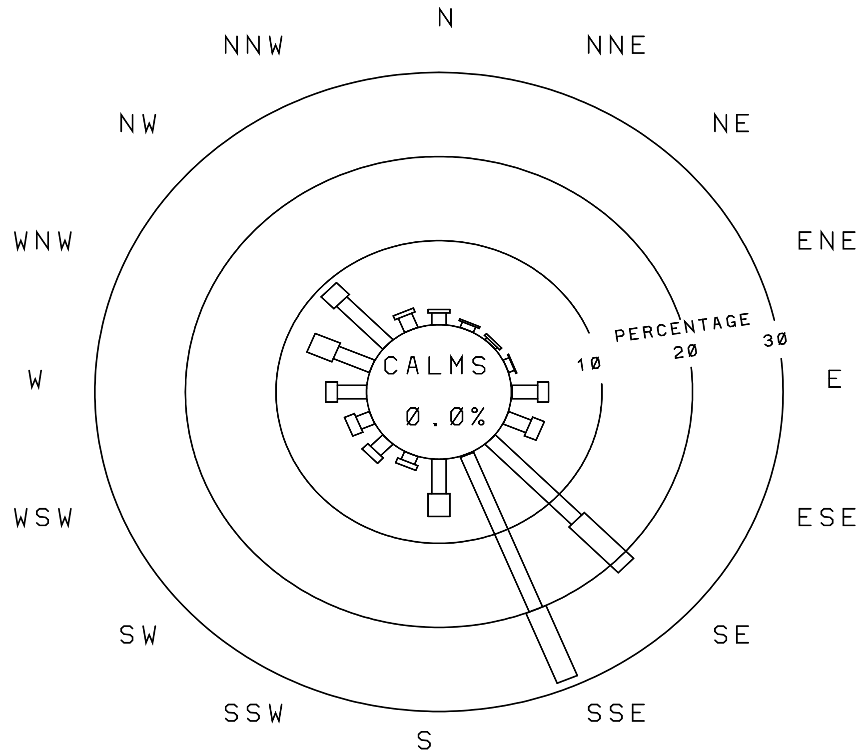
B Class Stability



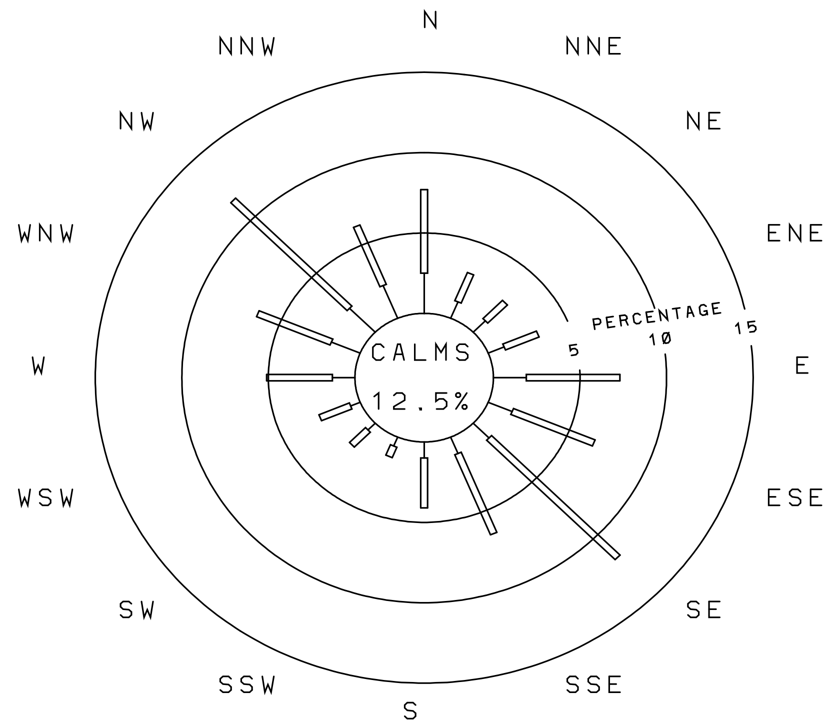
C Class Stability



D Class Stability



E Class Stability



F Class Stability

Cameco Australia Pty Ltd	Kintyre Air Quality Assessment	Telfer Monitoring Site 2009 Stability Dependent Wind Roses
ENVIRON	JOB NO: AS110500C	DATE: May 2013	FIGURE A3

Table A3: A Class Stability Dependent Wind Rose

SITE - Telfer PASQUILL STABILITY CLASS A
DATA PERIOD: 1. 1. 9 TO 31.12. 9 INCLUSIVE.

*** WIND SPEED - WIND DIRECTION PERCENTAGE OCCURRENCE MATRIX ***

WIND SPEED RANGE (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
OVER 13.5																	0.0
12.0 - 13.5																	0.0
10.5 - 12.0																	0.0
9.0 - 10.5																	0.0
7.5 - 9.0																	0.0
6.0 - 7.5																	0.0
4.5 - 6.0																	0.0
3.0 - 4.5																	0.0
1.5 - 3.0	7.3	3.6	5.0	9.5	4.1	6.4	3.6	2.3	7.3	2.7	7.7	3.2	7.3	4.5	3.2	5.9	83.6
0.5 - 1.5	1.8	0.5	0.9	0.9	0.5	1.4	1.4		1.8	2.3	0.5		0.9	1.8	0.5	1.4	16.4
TOTALS	9.1	4.1	5.9	10.5	4.5	7.7	5.0	2.3	9.1	5.0	8.2	3.2	8.2	6.4	3.6	7.3	

CALMS (LESS THAN 0.5 M/S): 0.0%
DATA RECOVERY: 97.5%
SAMPLING TIME: 60 MINUTES

*** PERCENTAGE OF ALL DATA IN THIS STABILITY CLASS: 2.57% ***

*** SUMMARY STATISTICS ***

	MEAN (M/S)	STD. DEV. (M/S)	MAX. (M/S)
SCALAR WIND SPEED	2.2	0.4	2.5
NORTHERLY COMPONENT	0.1	1.6	2.5
EASTERLY COMPONENT	0.1	1.6	-2.5

Table A4: B Class Stability Dependent Wind Rose

SITE - Telfer PASQUILL STABILITY CLASS B
DATA PERIOD: 1. 1. 9 TO 31.12. 9 INCLUSIVE.

*** WIND SPEED - WIND DIRECTION PERCENTAGE OCCURRENCE MATRIX ***

WIND SPEED RANGE (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
OVER 13.5																	0.0
12.0 - 13.5																	0.0
10.5 - 12.0																	0.0
9.0 - 10.5																	0.0
7.5 - 9.0																	0.0
6.0 - 7.5																	0.0
4.5 - 6.0	2.3	1.6	3.0	2.3	6.5	4.1	3.7	2.4	2.6	1.2	0.9	1.3	2.3	1.6	1.3	1.9	39.1
3.0 - 4.5	4.1	3.1	3.1	3.7	5.6	3.7	4.0	2.9	4.5	1.5	1.7	2.5	3.3	2.5	2.0	2.8	51.0
1.5 - 3.0	0.3	0.3	0.2	0.7	0.5	0.2	0.3	0.4	0.5	0.2	0.4	0.4	0.6	0.3	0.5	0.2	6.1
0.5 - 1.5	0.6	0.1	0.2	0.2	0.4		0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.4	0.3	0.2	3.8
TOTALS	7.4	5.1	6.4	7.0	13.0	8.0	8.4	5.8	8.0	3.0	3.2	4.4	6.4	4.7	4.1	5.1	

CALMS (LESS THAN 0.5 M/S): 0.0%
DATA RECOVERY: 97.5%
SAMPLING TIME: 60 MINUTES

*** PERCENTAGE OF ALL DATA IN THIS STABILITY CLASS: 15.06% ***

*** SUMMARY STATISTICS ***

	MEAN (M/S)	STD. DEV. (M/S)	MAX. (M/S)
SCALAR WIND SPEED	4.0	0.9	5.0
NORTHERLY COMPONENT	-0.1	2.7	5.0
EASTERLY COMPONENT	0.8	2.9	-5.0

Table A5: C Class Stability Dependent Wind Rose

SITE - Telfer PASQUILL STABILITY CLASS C
DATA PERIOD: 1. 1. 9 TO 31.12. 9 INCLUSIVE.

*** WIND SPEED - WIND DIRECTION PERCENTAGE OCCURRENCE MATRIX ***

WIND SPEED RANGE (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
OVER 13.5						0.1											0.1
12.0 - 13.5						0.1	0.2										0.3
10.5 - 12.0					0.1	0.5	0.8	0.1						0.2	0.2		1.8
9.0 - 10.5	0.1		0.1	0.2	1.2	2.5	2.4	0.4	0.2				0.1	0.2	0.2		7.4
7.5 - 9.0	0.1	0.2	0.2	1.1	4.1	5.0	3.2	1.0	0.5	0.1	0.1	0.3	0.6	1.4	0.5		18.3
6.0 - 7.5	0.5	0.6	0.7	1.3	5.9	5.2	3.8	1.8	1.1	0.1	0.3	0.5	0.9	0.9	1.3	0.5	25.2
4.5 - 6.0	1.0	1.0	0.8	0.8	3.4	3.8	3.9	2.2	1.5	0.4	0.7	0.8	1.4	1.3	1.2	0.8	25.1
3.0 - 4.5	0.3	0.1	0.3	0.7	1.3	1.7	2.9	1.8	1.2		0.5	0.3	1.1	0.9	1.6	0.4	15.4
1.5 - 3.0	0.6	0.4	0.2	0.2	0.3	0.4	0.8	0.5	0.5	0.4	0.3	0.2	0.4	0.3	0.6	0.4	6.4
0.5 - 1.5																	0.0
TOTALS	2.5	2.2	2.4	4.4	16.2	19.3	18.0	7.9	5.0	0.8	1.9	2.1	4.4	5.2	5.5	2.2	

CALMS (LESS THAN 0.5 M/S): 0.0%
DATA RECOVERY: 97.5%
SAMPLING TIME: 60 MINUTES

*** PERCENTAGE OF ALL DATA IN THIS STABILITY CLASS: 22.25% ***

*** SUMMARY STATISTICS ***

	MEAN (M/S)	STD. DEV. (M/S)	MAX. (M/S)
SCALAR WIND SPEED	6.2	2.1	14.4
NORTHERLY COMPONENT	-1.3	3.5	-11.0
EASTERLY COMPONENT	2.8	4.6	13.5

Table A6: D Class Stability Dependent Wind Rose

SITE - Telfer PASQUILL STABILITY CLASS D
DATA PERIOD: 1. 1. 9 TO 31.12. 9 INCLUSIVE.

*** WIND SPEED - WIND DIRECTION PERCENTAGE OCCURRENCE MATRIX ***

WIND SPEED RANGE (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
OVER 13.5	0.1						0.1	0.1							0.1	0.1	0.4
12.0 - 13.5		0.1	0.1	0.2	0.1	0.2	0.6	0.1						0.1	0.1		1.4
10.5 - 12.0				0.1	0.2	0.6	1.6		0.3	0.1		0.1			0.1		2.9
9.0 - 10.5	0.1				0.6	1.1	3.9	1.6	0.4	0.2	0.3		0.2	0.2	0.2		8.6
7.5 - 9.0	0.2	0.1	0.1	0.2	1.9	3.7	7.5	2.6	0.8	0.4	0.4	0.3	0.9	1.4	0.6	0.1	21.1
6.0 - 7.5	0.8	0.3	0.6	0.8	3.7	5.9	11.7	6.8	1.6	0.5	1.0	0.8	2.6	3.9	2.2	0.4	43.6
4.5 - 6.0	0.3	0.1	0.2	0.3	1.1	1.7	6.2	4.4	0.9	0.2	0.5	0.7	1.0	1.2	1.1	0.3	20.2
3.0 - 4.5	0.1						0.3	0.5	0.4	0.1		0.2	0.2		0.1	0.1	1.8
1.5 - 3.0																	0.0
0.5 - 1.5																	0.0
TOTALS	1.5	0.5	1.0	1.5	7.5	13.1	31.9	16.0	4.4	1.4	2.2	2.0	4.9	6.8	4.3	1.0	

CALMS (LESS THAN 0.5 M/S): 0.0%
DATA RECOVERY: 97.5%
SAMPLING TIME: 60 MINUTES

*** PERCENTAGE OF ALL DATA IN THIS STABILITY CLASS: 22.48% ***

*** SUMMARY STATISTICS ***

	MEAN (M/S)	STD. DEV. (M/S)	MAX. (M/S)
SCALAR WIND SPEED	7.2	1.6	15.8
NORTHERLY COMPONENT	-3.0	4.0	15.8
EASTERLY COMPONENT	2.5	4.9	12.0

Table A7: E Class Stability Dependent Wind Rose

SITE - Telfer PASQUILL STABILITY CLASS E
DATA PERIOD: 1. 1. 9 TO 31.12. 9 INCLUSIVE.

*** WIND SPEED - WIND DIRECTION PERCENTAGE OCCURRENCE MATRIX ***

WIND SPEED RANGE (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
OVER 13.5																	0.0
12.0 - 13.5																	0.0
10.5 - 12.0																	0.0
9.0 - 10.5																	0.0
7.5 - 9.0																	0.0
6.0 - 7.5																	0.0
4.5 - 6.0	0.4	0.2	0.3	0.1	1.2	1.4	7.6	9.0	2.8	0.6	0.9	1.2	1.3	3.0	2.0	0.5	32.6
3.0 - 4.5	1.4	0.7	0.3	0.7	2.9	2.7	13.5	19.8	4.2	1.0	1.9	1.6	3.1	4.3	7.1	1.8	67.0
1.5 - 3.0					0.1			0.1									0.4
0.5 - 1.5																	0.0
TOTALS	1.8	0.9	0.6	0.9	4.2	4.1	21.1	28.9	6.9	1.6	2.8	2.8	4.5	7.3	9.1	2.3	

CALMS (LESS THAN 0.5 M/S): 0.0%
DATA RECOVERY: 97.5%
SAMPLING TIME: 60 MINUTES

*** PERCENTAGE OF ALL DATA IN THIS STABILITY CLASS: 27.55% ***

*** SUMMARY STATISTICS ***

	MEAN (M/S)	STD. DEV. (M/S)	MAX. (M/S)
SCALAR WIND SPEED	4.0	0.7	5.0
NORTHERLY COMPONENT	-1.6	2.6	-5.0
EASTERLY COMPONENT	0.5	2.7	-5.0

Table A8: F Class Stability Dependent Wind Rose

SITE - Telfer PASQUILL STABILITY CLASS F
DATA PERIOD: 1. 1. 9 TO 31.12. 9 INCLUSIVE.

*** WIND SPEED - WIND DIRECTION PERCENTAGE OCCURRENCE MATRIX ***

WIND SPEED RANGE (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
OVER 13.5																	0.0
12.0 - 13.5																	0.0
10.5 - 12.0																	0.0
9.0 - 10.5																	0.0
7.5 - 9.0																	0.0
6.0 - 7.5																	0.0
4.5 - 6.0																	0.0
3.0 - 4.5																	0.0
1.5 - 3.0	5.6	2.3	2.0	2.4	5.7	5.6	11.6	5.8	3.5	1.0	1.5	3.0	4.4	5.6	10.1	4.8	74.9
0.5 - 1.5	3.0	1.7	1.2	1.5	2.1	1.6	1.3	1.4	1.2	0.6	0.7	0.6	1.5	2.1	2.2	2.4	25.1
TOTALS	8.6	4.1	3.1	3.9	7.8	7.2	12.9	7.2	4.6	1.6	2.2	3.6	5.9	7.7	12.3	7.2	

CALMS (LESS THAN 0.5 M/S): 0.0%
DATA RECOVERY: 97.5%
SAMPLING TIME: 60 MINUTES

*** PERCENTAGE OF ALL DATA IN THIS STABILITY CLASS: 10.08% ***

*** SUMMARY STATISTICS ***

	MEAN (M/S)	STD. DEV. (M/S)	MAX. (M/S)
SCALAR WIND SPEED	2.1	0.6	2.9
NORTHERLY COMPONENT	0.1	1.5	2.8
EASTERLY COMPONENT	0.1	1.5	2.9

Appendix B

Sample Ausplume Model Input File

```
  6.0 version
*************************************************************
* WARNING - WARNING - WARNING - WARNING - WARNING - WARNING *
*                                                           *
* This is a generated file. Please do not edit it manually. *
* If  editing  is  required, under any circumstances do not *
* edit information enclosed in curly braces.  Corruption of *
* this information or changed order of data blocks enclosed *
* in curly braces may render the file unusable.             *
*                                                           *
*************************************************************

Simulation Title
{Cameco Air Dispersion Modelling - Kintyre ROM Rev2 PM12.5}
Concentration(1)/Deposition(0), Emission rate units, Concentration/Deposition units,Background
Concentration, Variable Background flag,Variable Emission Flag
{True grams/second microgram/m3 0 False False }

Terrain influence tag, 0-ignore, 1 - include
{2}
Egan coefficients
{0.5 0.5 0.5 0.5 0.7 0.7 }
Number of source groups
{1}
Total number of sources (Stack + Area + Volume sources)
{1}

Source Group information
Total Number of Sources in Group 1
{1}
Sources in Source Group 1
{ROM    }
BPIP Run (1-True, 0-False)
{0 }
Total number of buildings
{0 }

Source Information

Source ID, Source Type (1 - stack, 2 - area, 3- volume) and X, Y, Z coordinates
{ROM 3 404647 7528676 376 }
Source height
{2.5 0 }
Side length, Effective Radius
{60 5 }
Emission type (1-constant, 2-monthly, 3-hours of the day, 4-wind and stability, 5-hour and
season, 6-temperarture), Position in Array, Number of particle fractions
{1 1 }
Constant emission rate
{1}
Deposition fraction proportions
{1 }
Particle sizes
{12.5 }
Particle densities
{1 }
Water scavenging
{0 }
Ice scavenging
{0 }

Receptor information

Discrete receptors
Receptor coordinates type (1-Cartesian,0-Polar),Number of Receptors
{1 0 }

Gridded receptors
Receptor coordinates type (1-Cartesian, 0-Polar), Number of X and Y coordinates, Receptor
height
{1 101 101 0 }

X grid coordinates
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396252.6 396452.6 396652.6 396852.6 397052.6 397252.6 397452.6 397652.6 397852.6 398052.6
398252.6 398452.6 398652.6 398852.6 399052.6 399252.6 399452.6 399652.6 399852.6 400052.6
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400252.6 400452.6 400652.6 400852.6 401052.6 401252.6 401452.6 401652.6 401852.6 402052.6
402252.6 402452.6 402652.6 402852.6 403052.6 403252.6 403452.6 403652.6 403852.6 404052.6
404252.6 404452.6 404652.6 404852.6 405052.6 405252.6 405452.6 405652.6 405852.6 406052.6
406252.6 406452.6 406652.6 406852.6 407052.6 407252.6 407452.6 407652.6 407852.6 408052.6
408252.6 408452.6 408652.6 408852.6 409052.6 409252.6 409452.6 409652.6 409852.6 410052.6
410252.6 410452.6 410652.6 410852.6 411052.6 411252.6 411452.6 411652.6 411852.6 412052.6
412252.6 412452.6 412652.6 412852.6 413052.6 413252.6 413452.6 413652.6 413852.6 414052.6
414252.6 }

Y grid coordinates
{7519436.6 7519636.6 7519836.6 7520036.6 7520236.6 7520436.6 7520636.6 7520836.6 7521036.6
7521236.6 7521436.6 7521636.6 7521836.6 7522036.6 7522236.6 7522436.6 7522636.6 7522836.6
7523036.6 7523236.6 7523436.6 7523636.6 7523836.6 7524036.6 7524236.6 7524436.6 7524636.6
7524836.6 7525036.6 7525236.6 7525436.6 7525636.6 7525836.6 7526036.6 7526236.6 7526436.6
7526636.6 7526836.6 7527036.6 7527236.6 7527436.6 7527636.6 7527836.6 7528036.6 7528236.6
7528436.6 7528636.6 7528836.6 7529036.6 7529236.6 7529436.6 7529636.6 7529836.6 7530036.6
7530236.6 7530436.6 7530636.6 7530836.6 7531036.6 7531236.6 7531436.6 7531636.6 7531836.6
7532036.6 7532236.6 7532436.6 7532636.6 7532836.6 7533036.6 7533236.6 7533436.6 7533636.6
7533836.6 7534036.6 7534236.6 7534436.6 7534636.6 7534836.6 7535036.6 7535236.6 7535436.6
7535636.6 7535836.6 7536036.6 7536236.6 7536436.6 7536636.6 7536836.6 7537036.6 7537236.6
7537436.6 7537636.6 7537836.6 7538036.6 7538236.6 7538436.6 7538636.6 7538836.6 7539036.6
7539236.6 7539436.6 }

Model settings and parameters
Emission conversion factor, Averaging Time
{1000000 0 }

Land use (surface roughness)
{0.4}

Averaging time flags (1,2,3,4,6,8,12,24 hrs, 7, 90 days, 3 month, All hrs
{1 0 0 0 0 0 0 0 0 0 0 0 0 }

Statistical output options
{0 0 }

Output options (All meteodata, Every concentration/deposition, Highest/2nd highest, 100 worst
case table, Save all calculations
{0 1 0 0 0 0 }
Write concentration (1-yes, 0-no), Concentration rank, Write frequency, Frequency Level
{0 1 0 -1 }

Disregard exponents (1-yes, 0-no), Exponent Scheme (1-Irvin urban, 2-Irvin rural, 3-ISCST, 4-
User Defined
{0 2 }
Dispersion exponents
{0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.15 0.2 0.2 0.2 0.2 0.2 0.2 0.25 0.25
0.25 0.25 0.25 0.25 0.4 0.4 0.4 0.4 0.4 0.4 0.6 0.6 0.6 0.6 0.6 0.6 }

Building wake effects (1-include,0-not) , Default decay coefficient, Anemometr height, Sigma-
theta averaging period, Roughness at vane site, Smooth stability changes, ConvectivePDF)
{1 0 10 60 0.3 0 0 }

Deposition options, Depletion options
{False False False False True False }

Stability class adjustments (0-None, 1-Urban1, 2-Urban2)
{0}
Building wake algorithms (1-Huber-Sneider, 2-Hybrid, 3-Schulman-Scire)
{4}

Gradual plume rise (1-yes,0-no), Stack tip downwash (1-yes,0-no), Disregard Temperature
Gradient (1-yes,0-no), Partial Penetration, Temp Gradient,  Adiabatic Entrainment, Stable
Entrainment
{1 1 0 0 0.004 0.6 0.6 }
Temperature Gradients for Wind and Stability categories
{0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.02 0.02 0.02 0.02 0.02 0.02 0.035 0.035
0.035 0.035 0.035 0.035 }

Dispersion curves (1-Pasquill Gifford, 2- Briggs rural,  3-Sigma theta) horizontal < 100 m,
ditto vertical < 100 m, ditto horizontal > 100 m, ditto vertical > 100 m
{3 1 2 2 }
Adjust PG curves for roughness - Horizontal, Vertical (1-yes,0-no)
{1 1 }
Enhance plume for buyoancy - Horizontal, Vertical (1-yes,0-no)
{1 1 }
```

```
Adjust for wind direction shear
{0}
Shear rates
{0.005 0.01 0.015 0.02 0.025 0.035 }

Wind Speed categories
{1.54 3.09 5.14 8.23 10.8 }

Output file
{'C:\Cameco\Revision_3\ROM_Rev3\ROM_Rev3_PM12.5.txt'}
Meteorological file
{'C:\Cameco\Tel2009_Rev3.met'}
Receptor file
{'C:\Cameco\Kintyre_DEM.ter'}
```