Intended for
BHP Billiton Nickel West Pty Ltd

Date
April 2018

NICKEL WEST
MOUNT KEITH SATELLITE OPERATIONS - DUST MITIGATION

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Revision	**1**
Date	**5/4/2018**
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Ref	318000442

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1. INTRODUCTION

BHP Billiton Nickel West (Nickel West) is proposing to develop the Mt Keith Satellite Operations (MKSO) project (the Project). The Project involves the development of open pit mining operations at the Six-Mile Well and Goliath nickel deposits located approximately 25 km south of Nickel West's Mount Keith (NMK) operations in the north eastern Goldfields region of Western Australia.

The mine site is located adjacent to the Wanjarri Nature Reserve approximately 3 km from the Goldfields Highway. Waste rock will be disposed to a waste rock landform (WRL) located east of the two pits and road trains will transport the nickel ore from MKSO to the NMK operations along an unsealed transport corridor that passes through the Wanjarri Nature Reserve.

Ramboll Australia Pty Ltd (Ramboll) were requested by Nickel West to undertake air dispersion modelling of fugitive dust emissions from the proposed MKSO Project to assess the potential ambient air quality and deposition impacts associated with the mining and transport operations.

The air dispersion modelling assessment indicated that without watering controls employed on the transport corridor between MKSO and NMK, predicted concentrations are below applicable standards at the nominated receptors except at the NMK camp where exceedances of the 24 hour average TSP, PM_{10} and $PM_{2.5}$ standards and annual $PM_{2.5}$ standard are predicted to occur. Analysis of the source contributions at the NMK camp indicate that the exceedance of the TSP, PM_{10} and $PM_{2.5}$ standards are due to emissions from haulage of the ore along the transport corridor. The modelling also indicated that when watering controls are applied to the transport corridor the predicted concentrations at the NMK Camp fall below the nominated standards.

The modelling predicted the greatest daily depositional impacts within the Wanjarri Nature Reserve to occur at Wanjarri Nature Reserve 4 (WR4). Comparison of the predicted deposition rates with a guideline of 0.3 g/m^2/day for vegetation impacts indicates that the predicted deposition rates are not considered to be significant.

The modelling predicted monthly dust deposition at a number of Aboriginal heritage sites for all scenarios. The modelling indicated that the predicted levels of dust deposition for Scenario 1 at all nominated locations are above the NSW Environment Protection Authority (NSW EPA) dust deposition criteria (4 g/m^2/month) for amenity. For Scenario 2, the levels of were also above the NSW EPA dust deposition criteria except at Location 2. For Scenario 3, the NSW EPA dust deposition criteria were exceeded at only Locations 1 and 5. It should be noted that the criteria used was not designed to assess potential impacts at heritage locations but were designed to take into account potential amenity impacts, such as dust depositing on fabrics and buildings. The use of these guidelines serve as a reference as to the magnitude of the deposition resulting from MKO operations and should not be used as an indication of potential acceptability of these deposition levels.

The report noted that in considering the results, the prediction of ambient dust concentrations from fugitive sources by air dispersion modelling is difficult primarily due to the complexity and uncertainty in estimating dust emissions and the numerous factors that can affect the emissions. Modelling results have a degree of inherent uncertainty but are useful in prioritising management measures to control and reduce dust emissions.

In assessing the air dispersion modelling assessment, the Department of Water and Environment Regulation (DWER) notes the difficultly in quantifying the risk associated with generation of dust, and that dust modelling is better placed as a management guide rather than precise risk assessment tool.

DWER requested Nickel West provide further details regarding the uncertainty of the dust modelling, the sources of that uncertainty (e.g. meteorology, blasting and wind erosion), and include any further investigation actions, proposed monitoring programs and management measures that will be undertaken during construction/operation of the proposal to reduce potential impacts from dust.

This report outlines the main sources of uncertainty in modelling assessment and the recommended management actions for Nickel West to reduce the impacts from dust generation.

2. SOURCES OF UNCERTAINTY

There are three main general sources of error and uncertainty in dispersion modelling:

- input data;
- calibration of the model; and
- poor performance of the model itself.

The total uncertainty contained in the model results is the cumulative effect of these sources. Uncertainty can be characterised as either 'reducible' or inherent uncertainty. Reducible uncertainty includes the accuracy of the input data, and the way in which the model is run. The inherent uncertainty is the fundamental limitations in the way a model works. This is beyond the control of the model user but is an issue they must be aware of.

After input data uncertainty, the fundamental limitation for dispersion model accuracy is the way the model works. This includes the structure, physics and chemistry, and the way these are all parameterised and computed. This limitation is negated by the correct application of a suitable air dispersion model. The modelling was conducted using the USEPA AERMOD plume dispersion model (V14134). AERMOD is regularly used and accepted by regulatory agencies around Australia for assessing fugitive impacts from mining and industrial sites. The calibration of the model was undertaken using a methodology consistent with methodologies previously accepted by DWER.

As such this report will focus on the main source of uncertainty associated with the input data.

2.1 Input Data Uncertainty

There are three sets of input data needed for dispersion modelling:

- source or emissions characteristics,
- meteorological data, and
- terrain and local features.

The critical factor is to know the rate of emissions, in mass units (grams per second or kilograms per hour or tonnes per day), of in this instance particulates. This needs to be known for each time period of the model run (in this instance hourly timesteps over a period of a year). Only in very special cases is this constant and known accurately. There are several possible approaches. The most common (and conservative) method, is to use the maximum emission rate, which occurs when a source is operating at its upper limit. If the emissions are measured by an 'approved' method, this is ideal.

If actual emissions measurements are not available, then either a manufacturer's design specification or an emission factor can be used. Given actual emissions information was not available, emissions estimates were mainly derived from emissions factors presented in the National Pollutant Inventory's (NPI) emissions estimations manuals for mining (NEPC, 2012).

Most of the equations and factors presented in the NPI emissions estimation manual have been drawn from USEPA AP-42 studies, the National Energy Research, Development and Demonstration Council (NERDDC, 1988) and State Pollution Control Commission of NSW (SPCC, 1983) studies in the Hunter Valley. When information from both sources (i.e. the US and Australia) was available, the two were compared and, where possible, reconciled.

2.1.1 Emissions Estimates

Wheel Generated Dust

There remains some degree of uncertainty with emissions estimations. For example, the modelling assessment predicts that one of the main sources contributing to particulate impacts is wheel generated dust from the hauling of product from the satellite operations to the Mount Keith operations for processing. The emission factor used to derive haulage related PM_{10} emissions was based on a silt content of 4%. This figure was provided by Nickel West based on the haul roads being constructed with cap rock, a material associated with lower silt loadings than roads constructed with sand or gravel. The emission estimate is sensitive to the silt loading and the assumed silt loading may be conservative or could be an under estimate. There is also an assumption that the silt content of the road is constant along the entire length of the road and does not change with increased usage, material spills or maintenance of the road.

Blasting

Blasting emissions were determined from the NPI emissions estimation handbook which in turn was derived from the USEPA AP-42 emission factors (USEPA, 1980). The AP-42 emissions factors state that emissions from explosives detonation are influenced by many factors such as explosive composition, product expansion, method of priming, length of charge, and confinement. These factors are difficult to measure and control in the field and are almost impossible to duplicate in a laboratory test facility. With the exception of a few studies in underground mines, most studies have been performed in laboratory test chambers that differ substantially from the actual environment. Any estimates of emissions from explosives use must be regarded as approximations that cannot be made more precise because explosives are not used in a precise, reproducible manner.

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 (saltation). These larger particles can then dislodge the smaller (<50 µm) dust fraction 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 facilities in the Pilbara (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:

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

Where:
WST is the threshold for wind erosion in m/s, taken to be 7.5 m/s (SKM, 2003); and
Ewind is the PM_{10} emissions (g/m^2/s).

Estimates of emissions from wind erosion assume uniformity of product and therefore erodibility to the given meteorological conditions across all exposed areas and stockpiles. This assumption extends to the wind speed threshold at which wind erosion begins to occur. It would be almost impossible to accurately model the various interactions of every exposed area source within the modelling domain, and similar to wheel generated dust, generalisations are made to estimate the impact. There does exist the potential for estimated emissions from wind erosion to under or over represent actual emissions.

2.1.2 Meteorological data

Lack of appropriate meteorological information can sometimes be an important limiting factor in modelling accuracy. The ideal is to have at least one year of data, with at least hourly resolution, at the site of interest (usually within a few hundred metres). The minimum measurement requirements are for wind speed and direction, but some method of estimating stability and mixing height is also required as an input for steady-state modelling.

Often there are no suitable meteorological data at all. In this case, a prognostic meteorological data set can be generated and used. The use of prognostic data can assist in generating the worst-case meteorological scenarios, and show the highest concentrations that might occur, however there can be limitations in the use of this data. For example, there are known issues with using prognostic data generated by TAPM, which is known to under predict the frequency of light winds, often associated with increased concentrations from fugitive sources. DWER has previously issued guidance that the use of monitored data from larger distances is preferable to the use of prognostic data from TAPM when undertaking assessments of fugitive particulate sources (DEC, 2006).

The meteorological data used in this assessment was obtained from the nearest suitable meteorological station in Yeelirrie. Whilst this location is some distance from the satellite operations (XX km), it is thought to be indicative of regional meteorology and was therefore considered appropriate for use in the modelling assessment.

2.1.3 Background Data

In the absence of regional background data, the modelling assessment was not able to consider the cumulative impacts of regional dust sources (such as dust storms and bushfires) in combination with the predicted ambient air quality impacts associated with the modelled sources.

3. DUST MANAGEMENT AND MITIGATION MEASURES

The results of the air dispersion modelling indicate that the predicted TSP, PM_{10} and $PM_{2.5}$ GLCs associated with activity along the transport corridor could result in exceedances of the ambient air quality criteria at the NMK camp. Management of major dust sources is therefore imperative to ensuring impacts are minimised.

3.1 Potential Dust Controls Options

3.1.1 Haul Roads

Dust emissions from unpaved surfaces, including unsealed roads, are caused by the same factors as for paved surfaces, although the potential for dust emissions is usually much greater. Vehicles travelling over paved or unpaved surfaces tend to pulverise any surface particles and other debris. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents due to turbulent shear between the wheels and the surface. Dust particles are also sucked into the turbulent wake created behind the moving vehicles. The loads carried by trucks are a potential source of dust, either through wind entrainment or spillages. Mud and dust carry-out from unpaved surfaces is another potential problem.

Dust emissions can be controlled using the following procedures:

- Wet suppression of unpaved areas using a water cart and/or fixed sprinklers. It is important to check that the available water supplies and the application equipment are able to meet this requirement. For larger sites or those with a limited water supply, undertaking an assessment of the dust suppression water demand and supply is highly recommended.

  Wet suppression of unpaved areas can achieve dust emission reductions of about 70% or more, and this can sometimes be increased up to 95% through the use of chemical stabilisation.

- Chemical stabilisation, such as polymer additives, can also be used in conjunction with wet suppression. This involves the use of chemical additives with minimal water (as little as 0.1 % moisture addition with dry fog suppression systems), which help to form a crust on the surface and bind the dust particles together through particle agglomeration.

  Chemical stabilisation reduces watering requirements, but any savings are likely to be offset by the cost of the additives. The general consensus is that chemical additives can be successful, but they are costly and need to be applied regularly.

- Surface improvements. These include paving with concrete, asphalt or cobbles (for sites requiring hard-wearing surface for example, log yards), or the addition of gravel or slag to the surface. Paving can be highly effective, but is expensive and unsuitable for surfaces used by very heavy vehicles or subject to spillages of material in transport. In addition, dust control measures will usually still be required on the paved surfaces. The use of gravel or slag can be moderately effective, but repeated additions will usually be required. Paving can achieve up to 100% control efficiencies, but has a high associated cost and may not be suitable for use with heavy vehicles.

- Speed controls on vehicle movements. Speed controls on vehicles have an approximately linear effect on dust emissions. This means that a speed reduction from 30 to 15 kilometres per hour will achieve about a 50% reduction in dust emissions.

3.1.2 Blasting

There is no suitable control for blasting that will have a material impact on the emissions of particulates. However, scheduling of the blasting can be controlled to ensure that blasting occurs at times where meteorological conditions are such so as to minimise impacts at nearby sensitive receptor locations.

3.2 Recommendations

3.2.1 Monitoring

Ramboll recommends that an appropriate monitoring programme be established that has a meteorological monitoring component, an ambient air quality component and a depositional dust monitoring component.

Meteorological monitoring data can be used in back trajectory analyses to identify potential sources of dust emissions in the event that elevated concentrations are recorded. The monitoring data can also be used in conjunction with forecast data to assist in scheduling blasting to ensure that associated impacts are reduced at sensitive receptor locations.

Ambient air quality monitoring should be undertaken at the MKO camp to ensure compliance with the relevant air quality standards. Additional monitors should be installed at any sensitive receptor locations where there are concerns that ambient air quality may be impacted.

Nickel West has indicated that surveys monitoring impacts will be conducted within the Wanjarri Nature Reserve and at Aboriginal heritage sites. Dust deposition monitors should also be installed at these locations.

3.2.2 Controls

In order to mitigate the predicted dust impacts at the NMK camp, Ramboll recommends that Nickel West consider implementation of a number of controls along the transport corridor. Initially Ramboll would recommend that that the transport corridor is watered at a rate of greater than 2 litres/m^2/hour in the vicinity of the camp. If monitoring indicates that the impacts are still occurring at the campsite as a result of operations along the transport corridor further controls could be considered. Nickel West could consider the use of a chemical soil binding agent to further increase the control efficiency and reduce the amount and frequency of watering, reducing transport speeds, increased road maintenance or finally sealing of the road close to the campsite.

Based on the predicted depositional impacts in the Wanjarri Nature Reserve and at Aboriginal heritage sites, Ramboll does not believe the use of controls will initially be necessary along the transport corridor. However, we would recommend that Nickel West undertake vegetation monitoring in both the eastern and western section of the corridor that passes through the reserve. In the event that deleterious impacts are detected within the reserve, Ramboll Environ would recommend controls such as watering at rates starting at less than 2 litres/m^2/hour and then increasing as necessary. If further controls are required or watering is not possible within the reserve, Nickel West could consider other options including the use of a chemical binding agent, reducing transport speeds or finally sealing of the road be undertaken in the section of the transport corridor that passes within the reserve.

If monitoring indicates that impacts from blasting are of concern, Ramboll would recommend that scheduling be undertaken for blasting to ensure that it occurs when the meteorological conditions will not result in impacts at the sensitive receptor locations.

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