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FORMER HYDRO ALUMINIUM KURRI KURRI SMELTER DEMOLITION AND REMEDIATION
AIR QUALITY IMPACT ASSESSMENT

RAMBOLL ENVIRON

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GLOSSARY OF TERMS

AGL	Above ground level
BoM	Bureau of Meteorology
CO	Carbon monoxide
DA	Development Application
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	Environment Protection Authority
GADDC	Guidance on the Assessment of Dust from Demolition and Construction
Hydro	Hydro Aluminium Kurri Kurri Pty Ltd
ISC	Industrial Source Complex
NO_x	Oxides of nitrogen
NPI	National Pollution Inventory
OEH	Office of Environment and Heritage
PAHs	Polycyclic aromatic hydrocarbons
PM_{10}	Particulate matter less than 10microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5microns in aerodynamic diameter
RMS	Roads and Maritime Services
SO_2	Sulphur dioxide
The Project	Demolition of remaining buildings and structures at the Smelter; remediation of contaminated soils and groundwater; and the construction and management of Containment Cell to contain materials generated by demolition and remediation.
The Smelter	The former Hydro Aluminium Kurri Kurri Pty Ltd aluminium smelter at Hart Road, Loxford
TSP	Total Suspended Particulates
US-EPA	United States Environment Protection Agency
VOCs	Volatile organic compounds

EXECUTIVE SUMMARY

This Air Quality Impact Assessment has been prepared by Ramboll Environ Australia Pty Ltd (Ramboll Environ) on behalf of Hydro Aluminium Kurri Kurri Ltd to support an Environmental Impact Statement for submission to the Department of Planning and Environment prepared to assess for the Demolition and Remediation Project (the Project) at the former Hydro Aluminium Kurri Kurri aluminium smelter at Hart Road Loxford (the Smelter).

This his report has been prepared to address environmental impact assessment NSW Department of Planning and Environment's (NSW DPE) Secretary's Environmental Assessment Requirements (SEARs). The assessment was undertaken with consideration to the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005).

Emissions of particulate matter, individual metals and air toxics and diesel-combustion related air pollutants were quantified for peak Stage 2 operations. Ground level concentrations were predicted at selected sensitive receptor locations surrounding the Smelter site using the AERMOD dispersion model.

The assessment concluded that the Project would comply with the applicable NSW EPA assessment criterion at all sensitive receptors.

1. INTRODUCTION

This Air Quality Impact Assessment has been prepared by Ramboll Environ Australia Pty Ltd (Ramboll Environ) on behalf of Hydro Aluminium Kurri Kurri Pty Ltd (Hydro) to support an Environmental Impact Statement for submission to the Department of Planning and Environment prepared to assess for the Demolition and Remediation Project (the Project) at the former Hydro Aluminium Kurri Kurri aluminium smelter at Hart Road Loxford (the Smelter).

1.1 Background

The former Hydro Aluminium Kurri Kurri Smelter (the Smelter) is located on Hart Road, Loxford near Kurri Kurri in New South Wales, Australia. The area owned and managed by Hydro incorporates the former smelter area comprising approximately 60 hectares, and the surrounding Hydro owned lands, comprising approximately 1,940 hectares (the Hydro land).

Smelting activities ceased in September 2012, and in May 2014 Hydro formally announced the closure of the Smelter.

It is Hydro's strategic vision for the Hydro land to play a key role in allowing the Hunter Region to achieve the economic, employment and environmental objectives identified in the NSW Government NSW State Plan 2021 and the Hunter Regional Action Plan. Hydro aims to achieve this strategic vision by facilitating the rezoning and development of the Project site for significant employment, residential, rural and biodiversity conservation purposes.

Hydro has commenced a number of decommissioning activities to facilitate demolition and remediation of the Smelter. In addition Hydro has received Development Approval from Cessnock City Council for the demolition of the majority of the Smelter (Stage 1 Demolition) excluding buildings used for material storage, various workshops, offices and storage sheds, the three concrete stacks and the main water tower.

The remaining activities that would make the Smelter suitable for future employment and industrial land uses are the following:

- The Works. The Works are the activities required to make the Project site suitable for future use. The key element of the Works is the construction of a waste management facility, comprising a state of the art, modern and purpose built Containment Cell.

  Other ancillary elements of the Works are:

  – Demolition of the remaining Smelter buildings and structures.

  – Site remediation.

  – Leachate and groundwater treatment.

- Containment Cell Management. Following completion of the Works, the Containment Cell would be subject to a monitoring and management program.

These activities form the Project, which is the subject of the Environmental Impact Statement and this Air Quality Impact Assessment.

1.2 Objectives

The purpose of the air quality impact assessment is to assist the Department of Planning and Environment in assessing the Project in accordance with Section 79(c)(1) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report has been prepared to address environmental impact assessment NSW Department of Planning and Environment's (NSW DPE) Secretary's Environmental Assessment Requirements (SEARs). The specific air quality related SEARs for the Project are detailed in **Table 1**.

Table 1: Air Quality-related SEARs for the Project

Agency Requirement	Where addressed in the Assessment
NSW Department of Planning and Environment	
Details of all pollutants of concern	**Section 4** and **Section 5**
Details of the air emission inputs and outputs	**Section 4** and **Section 5**
Dispersion modelling, including adequate justification and validation (where appropriate) of all model inputs and outputs	**Section 4** and **Section 5**
A cumulative assessment of all existing and proposed emission sources	**Section 4** and **Section 5**
Details of the proposed management and monitoring measures	**Section 6**
NSW Environment Protection Authority	
1. Assess the risk associated with potential discharges of fugitive and point source emissions for all stages of the proposal. Assessment of risk relates to environmental harm, risk to human health and amenity.	**Section 5**
2. Justify the level of assessment undertaken on the basis of risk factors, including but not limited to: (a) proposal location; (b) characteristics of the receiving environment; and (c) type and quantity of pollutants emitted.	**Section 3**, **Section 4** and **Section 5**
3. Describe the receiving environment in detail. The proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to: (a) meteorology and climate; (b) topography; (c) surrounding land-use; receptors; and (d) ambient air quality.	**Section 3**
4. Include a detailed description of the proposal. All processes that could result in air emissions must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided.	**Section 2** and **Section 4**
5. Identification and location information of all fixed and mobile sources of dust/air emissions from the development. The EIS needs to identify all pollutants of concern and estimate emissions by quantity (and size for particles), source(s) and discharge point(s). Note: emissions can be classed as either: (a) point (e.g . emissions from stack or vent), or (b) fugitive (from wind erosion, leakages or spillages associated with loading or unloading, crushing/screening, conveyors, storage facilities, plant and yard operation, vehicle movements [dust from road, exhausts, loss from load], land clearing and construction works).	**Section 4**
6. Include a consideration of 'worst case' emission scenarios and impacts at proposed emission limits.	**Section 4.** Assessment addresses worst case combination of proposed operations.

Table 1: Air Quality-related SEARs for the Project

Agency Requirement	Where addressed in the Assessment
7. Account for cumulative impacts associated with existing emission sources as well as any currently approved developments linked to the receiving environment.	**Section 4** and **Section 5**
8. The Air Quality Impact Statement (AQIA) must prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005)	**Section 4**
9. The Air Quality Impact Assessment must also make appropriate reference to the *Assessment and Management of Odour from Stationary Sources in NSW: Technical Framework* (2006) and *Management of Odour from Stationary Sources in NSW: Technical Notes* (2006).	As per **Section 4**, odour emissions are anticipated to be negligible from the Project
10.1 The identification of the pollutants of concern, including Individual toxic air pollutants, dust and odours.	**Section 4**
10.2 The identification and assessment of all relevant fugitive and point source emissions.	**Section 4**
10.3 Appropriate coverage of all aspects of the remediation, including the excavation, storage, transport and treatment of contaminated material.	**Section 4**
10.4 Proposed air quality management and monitoring procedures during remediation.	**Section 6**
11. Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations Act 1997 (NSW) and the Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW).	**Section 4** and **Section 5**
12. Detail emission control techniques/practices that will be employed by the proposal and demonstrate that these are best management practice.	**Section 6**
13. Provide an assessment of the project in terms of the priorities and targets adopted under the NSW State Plan 2010 [now replaced by the NSW 2021 plan] and its implementation plan Action for Air [dated November 2009].	Through the quantification of emissions in **Section 4**, prediction of impacts in Section 5 and proposed mitigation measures in Section 6, it has been demonstrated in this assessment that the Project will have minimal air pollution impacts on the NSW environment.
NSW Health - Hunter New England Local Health District	
Air quality (particulates and cumulative impact of particulates)	**Section 3**, **Section 4** and Section 5

2. PROJECT DESCRIPTION

The Project would be located within the existing Hydro Aluminium Kurri Kurri Smelter site (the Smelter) at Hart Road Loxford. The Smelter location is shown in **Figure 1**. **Figure 2** shows the overall Project layout, including the locations of key activities.

Table 2.1 outlines the major elements of the Project and the key activities. A detailed description of the Project is provided in **Sections 8** and **9** of the Environmental Impact Statement.

Table 2: Outline of The Project

Element	Key Activities
The Works	
Project Site Establishment	• Establishment of environmental controls (erosion and sediment controls, water quality controls). • Construction of the Containment Cell haul road. • Continued use of Stage 1 Demolition compounds. • Continued use of Stage 1 Demolition stockpile and storage areas.
Containment Cell Construction	• Vegetation clearance. • Site preparatory works. • Establishment and implementation of environmental controls (erosion and sediment controls, water quality controls). • Construction of the Containment Cell base layers. • Construction of internal cell walls within the Containment Cell. • Transport and placement of remediation and demolition materials to the Containment Cell. • Leachate and stormwater management. • Construction of the final Containment Cell capping layers.
Stage 2 Demolition	• Completion of hazardous materials removal. • Establishment and implementation of environmental controls (dust mitigation and water quality management). • Demolition of three concrete stacks and a water tower using detonation. • Mechanical demolition of remaining buildings and structures. • Material collection, separation, processing and storage. • Transportation of recyclable metals offsite. • Transport non-recyclable demolition material to the Containment Cell. • Grading of former building footprints.
Demolition Material Management	• Operation of a concrete and refractory crushing plant processing of up to 140 tonnes per day. • Manage a large stockpile area in the west of the Smelter. • Ferrous (steel) and non-ferrous (predominantly aluminium and copper) metals would be sorted and sized before being transported off site for recycling. It is anticipated that there would be up to 20 truck movements per day.
Contamination Remediation	• Removal of the Capped Waste Stockpile. • Excavation of the contaminated soils within the Smelter (including stockpiled soils sourced from other Hydro land). • Transport to the Containment Cell. • Filling and grading following removal of contaminated materials.
Leachate and Groundwater Management	• Establish and operate (when required) water treatment plants (Capped Waste Stockpile and Containment Cell). • Groundwater monitoring.

Table 2: Outline of The Project

Element	Key Activities

Environmental Controls	• Dust controls during demolition would include:
	  • Accumulated fines from within the buildings would be removed where safe, reasonable and feasible to do so.
	  • Pre-wetting of buildings prior to undertaking the induced collapse and use of water sprays for dust suppression (as required due to wind conditions) during induced collapse.
	  • Ceasing activities that have the potential to generate significant dust that could have adverse impacts on sensitive receivers.
	• Watering of the demolition areas, unsealed access roads and other unsealed areas.
	• Vehicles would use (where possible) existing sealed roads.
	• Erosion and sediment controls would be installed, monitored and managed to reduce sediment run off entering the existing drainage system.
	• The existing site water management system would capture runoff.
	• Where possible, clean water would be diverted from Works areas.

Containment Cell Management	
Monitoring	• Monitoring of leachate generation within the Containment Cell.
Maintenance	• Mowing of the Containment Cell grass cover. • Maintenance (if required) of the capping layers.

The Works component of the Project would take approximately three years to complete.

Project traffic would predominantly travel to and from the Smelter via Hart Road and the Hunter Expressway (using the Hart Road interchange). A small number of vehicles (predominantly small vehicles used by Works personnel) are likely to continue to the intersection with Sawyers Gully Road, Gingers Lane and Government Road and along one of these roads.

Works activities that could generate an audible noise at the nearest sensitive receiver would be undertaken between 7:00 am to 6:00 pm, Mondays to Fridays and 7:00 am to 1:00 pm on Saturdays.

2.1 Concurrent Activities

In March 2016 Hydro received Development Consent from Cessnock City Council to undertake the following:

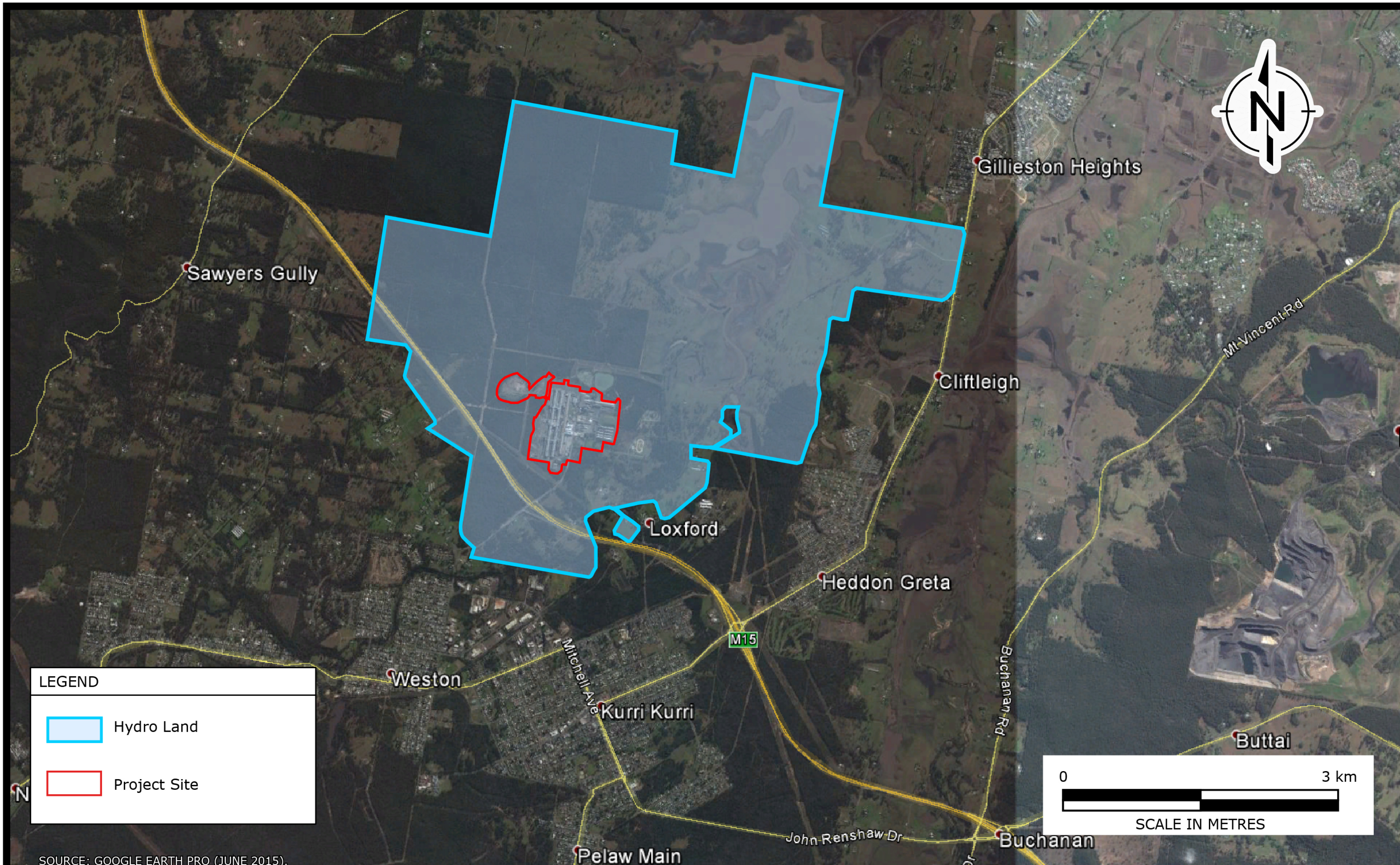
- Demolition of all buildings and structures at the Smelter excluding:
  - Buildings used for the storage of materials.
  - Three concrete stacks, and one concrete water tower (structures requiring the use of explosives for demolition).
  - The transformer yard and major power supply infrastructure in the north of the Smelter.
  - Administration buildings, amenities building and various workshops and storage sheds.
- Establishment of a contractor’s compound, either within an existing building located in the south of the Smelter (the former Building 77A Pot Rebuild building), or in the car park near the main entrance to the Smelter.
- A concrete and refractory crushing plant processing up to 28,000 tonnes per year or 140 tonnes per day.
- A demolition materials stockpile area.

- The sorting of recyclable metallic demolition materials and transportation to a metal recycling facility.

The activities approved under the Development Consent are known as Stage 1 Demolition.

It is proposed that the contractor's compound, the demolition materials stockpile area and the concrete and refractory crushing plant included in the Development Application to Cessnock City Council would continue to be used for the Project. It is anticipated that some Stage 1 Demolition activities would occur concurrently with the early stage of the Works.

So that the potential cumulative air quality impacts of Stage 1 Demolition activities are considered when assessing the Project, these activities have been included as appropriate in **Section 5** (Impact Assessment) of this report.



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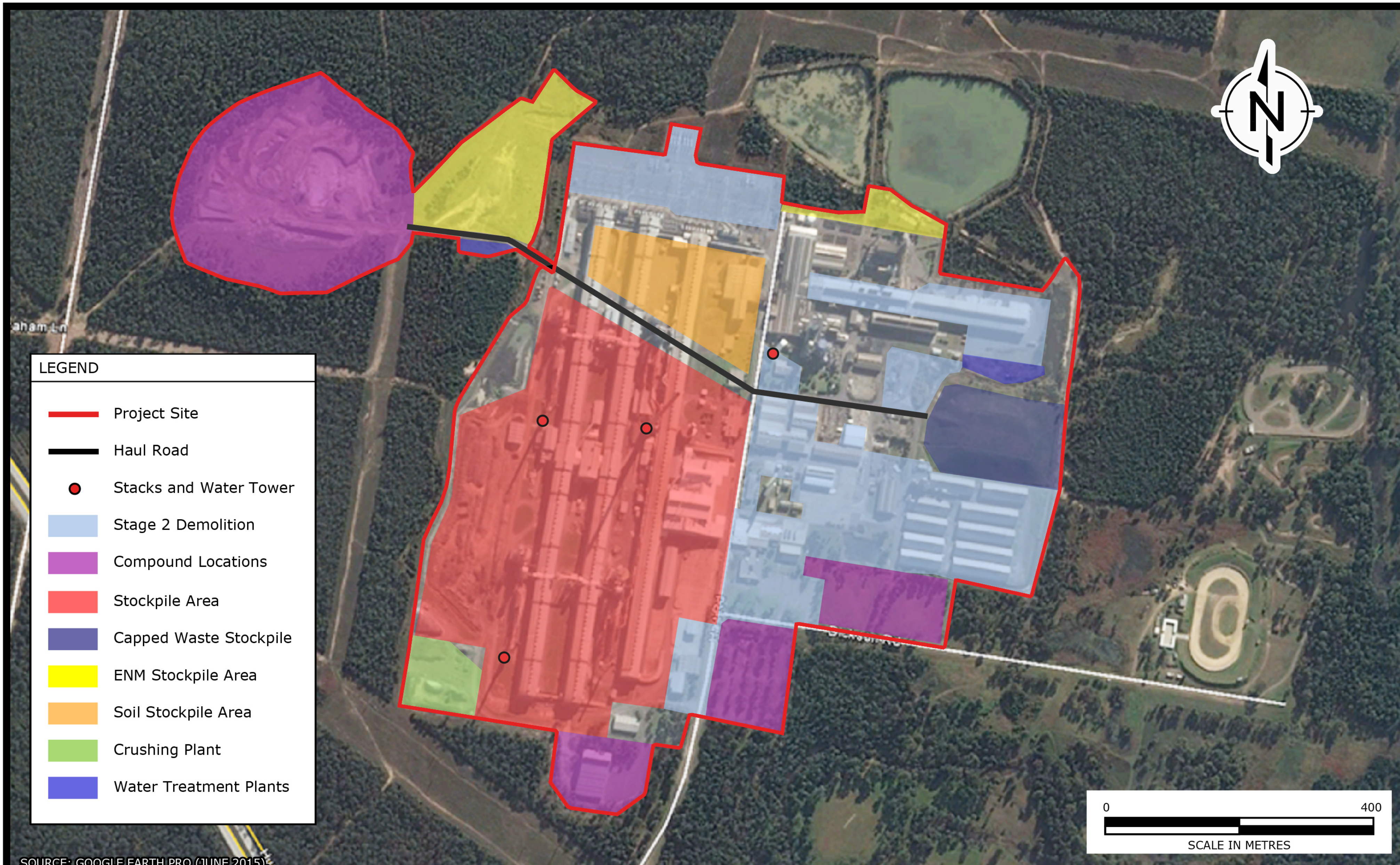
LOCATION PLAN

FORMER HYDRO ALUMINIUM KURRI KURRI SMELTER
DEMOLITION AND REMEDIATION

FIGURE 1

DRAFTED BY: KK | DATE: July 2016 | AS130401



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DRAFTED BY: KK | DATE: July 2016

PROJECT LAYOUT

FORMER HYDRO ALUMINIUM KURRI KURRI SMELTER
DEMOLITION AND REMEDIATION

FIGURE
2

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3. EXISTING ENVIRONMENT

3.1 General

As shown in **Figure 2**, the Project would impact the fenced Smelter footprint and the area currently known as the clay borrow pit to the immediate west.

Land uses in the vicinity of the Project include:

- Native vegetation: native ecological communities (with some cleared or disturbed areas) generally surround the Smelter and are within the Hydro owned land. Security fencing separates the Smelter from the vegetation.
- Electricity infrastructure: overhead power lines are located within easements to the north, west, southwest and northwest of the Smelter.
- Recreation: the Kurri Kurri Speedway and the Kurri Kurri Junior Motorcycle Club facility are approximately 500 metres to the east of the Project.
- Roads: The key roads in the vicinity of the Project are:
  - Hart Road is used to access the Smelter and is immediately adjacent to the western section of the Project.
  - Dickson Road intersects with Hart Road approximately 120 metres south of the Smelter security gate and immediately adjacent to the western section of the Project.
  - The Hunter Expressway is approximately 380 metres southwest of the Project.
- Residential: the Project is approximately 440 metres to the north of the nearest sensitive receiver, which is a rural residence owned by Hydro. The nearest rural residence not owned by Hydro is approximately 500 metres to the southeast, and the next nearest is approximately 750 metres to the southeast. There are approximately 24 rural residences within 1000 metres of the Project, of which 15 are on Hydro land.
  The nearest residential area to the Project is Weston, which is approximately 1800 metres to the southwest.
- Education: The Kurri Kurri TAFE is located approximately 1500 metres to the southeast of the Project and Kurri Kurri High School is approximately 1900 metres to the southeast of the Project.

Relevant details of the surrounding sensitive receptors are listed within **Table 3** and illustrated in **Figure 3**.

The topography of the local area surrounding the Smelter site is illustrated in **Figure 4**. The surrounding terrain is considered be uncomplicated and unlikely to have a significant effect on the dispersion of emissions from site. It can be seen that the elevation of the land decreases to the northeast of the site towards Wentworth Swamp. In all other directions, the elevation of the land increases gradually.

Table 3: Selected Surrounding Sensitive Receptor Locations

ID	Location (m, MGA56)		Distance (km) / Direction from Project Site	Name
	Easting	Northing		
R1	358,460	6,370,837	0.31 / E	Kurri Kurri Speedway
R2	357,882	6,370,489	0.27 / ESE	Cricket Pitch (Hydro owned)
R3	359,293	6,370,036	1.4 / SE	Hunter TAFE
R4	360,243	6,374,212	3.54 / NNE	Wentworth Swamp
R5	358,250	6,368,767	1.88 / SSE	Kurri Kurri High School
R6	358,094	6,375,224	3.73 / N	Resident – North
R7	361,051	6,373,839	3.79 / NE	Resident - Northeast
R8	360,241	6,373,230	2.78 / NE	Resident - Northeast (Hydro owned)
R9	359,090	6,370,765	0.92 / ESE	Resident – East
R10	358,089	6,370,343	0.5 / S	Resident – Southeast
R11	357,583	6,369,233	1.29 / S	Resident – South
R12	357,701	6,370,177	0.37 / SSE	Resident - South (Hydro owned)
R13	356,088	6,367,158	3.63 / SSW	Kurri Kurri Hospital
R14	357,043	6,369,948	0.7 / SW	Resident - Southwest
R15	356,552	6,370,704	0.66 / W	Resident - West
R16	355,734	6,371,675	1.63 / WNW	Resident - Northwest
R17	356,265	6,367,019	3.69 / SSW	RFBI Masonic Village Nursing Home
R18	358,155	6,368,039	2.55 / SSE	Kurri Early Childhood Centre
R19	357,903	6,368,035	2.51 / S	Church of Christ

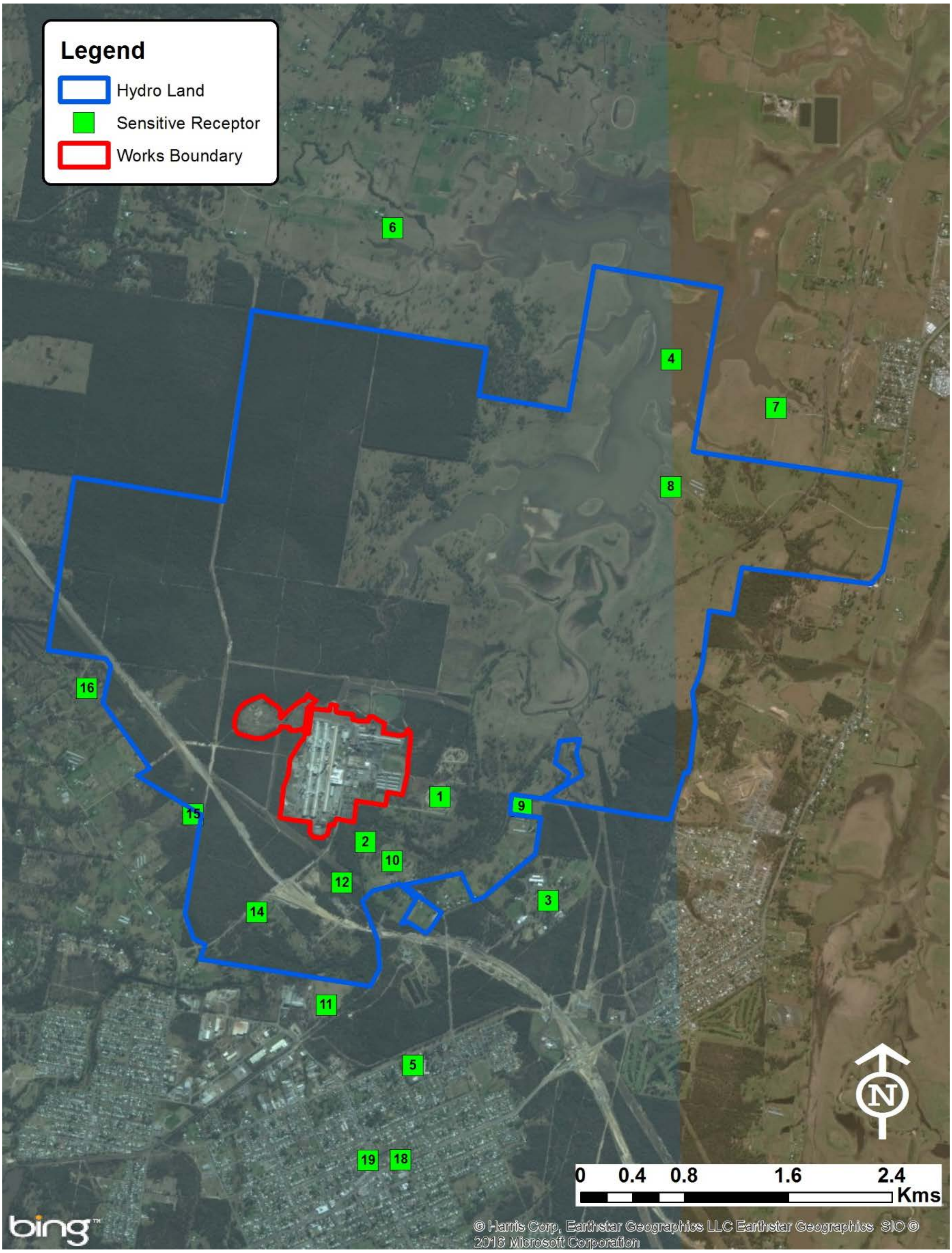

Figure 3: Surrounding Receptor Locations

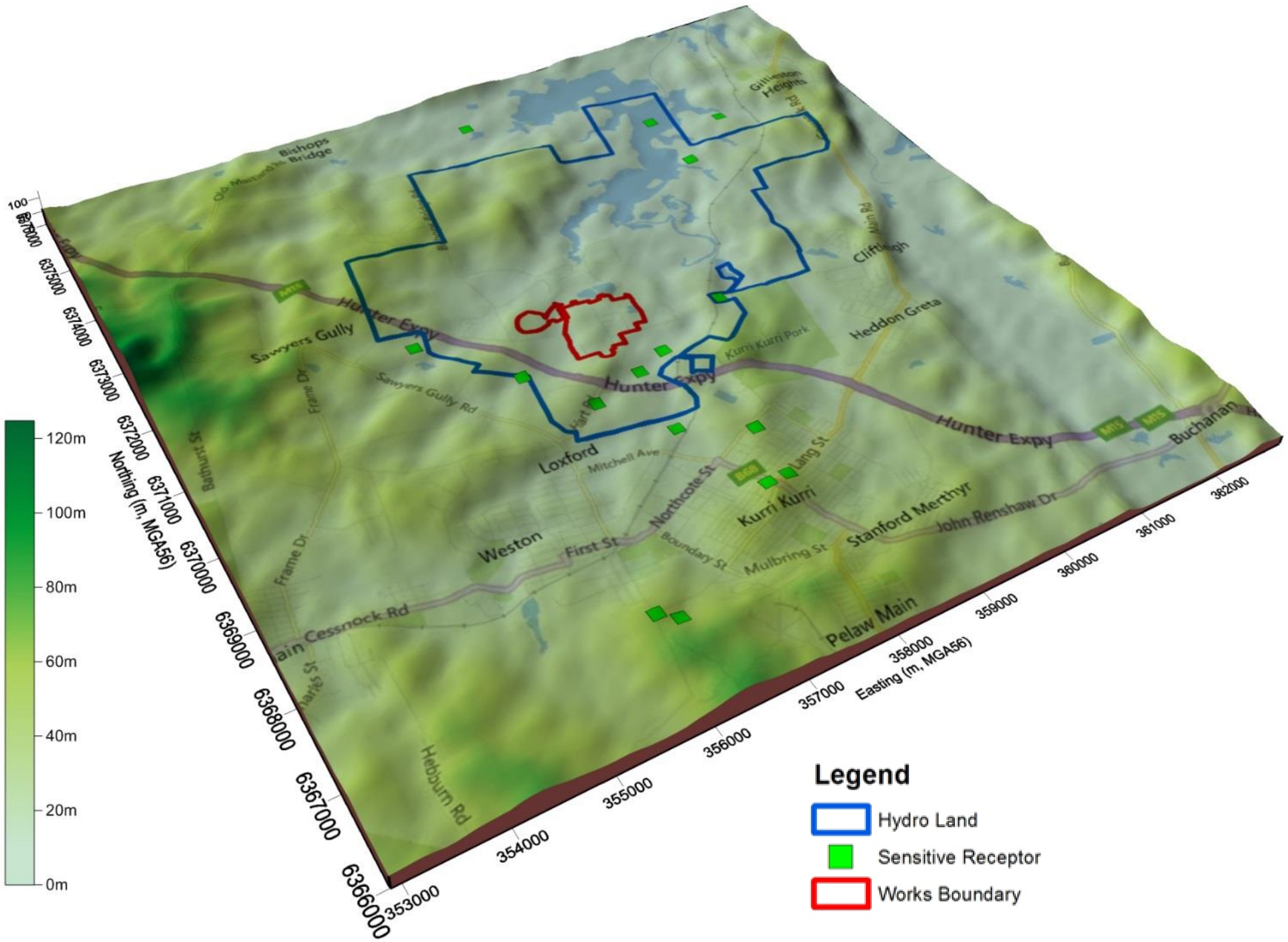

Figure 4: Topography surrounding the Project Site

Note: Vertical Exaggeration of 4 applied

3.2 Existing Meteorological Environment

3.2.1 Meteorological Modelling

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. Dust generation rates are particularly dependent on wind energy and on the moisture budget, which is a function of rainfall and evaporation rates.

The NSW EPA specifies in Section 4.1 of the *Approved Methods for Modelling* (DEC, 2005) that meteorological data representative of a site should be used in the absence of suitable on-site observations. Data should cover a period of at least one year with a percentage completeness of at least 90%. Site representative data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

A meteorological tower has been maintained at the Smelter since 1996 providing long term observations of wind speed, temperature, relative humidity and rainfall. Measurements at the tower are made at 10 metres and 30 metres above ground level (AGL). In order to describe the dispersion meteorology for the area surrounding the Smelter, analysis of data recorded between January 2010 and December 2014 is presented.

In addition to this meteorological observation dataset, TAPM was used to generate parameters not routinely measured, specifically the vertical temperature profile, and to substitute data gaps in the monitoring dataset.

TAPM was configured and run in accordance with the Section 4.5 of the *Approved Methods for Modelling* (DEC, 2005), with the following refinements:

- Modelling to 300 m grid cell resolution (beyond 1 km resolution specified).
- Inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data).

The TAPM vertical temperature profile for every hour was adjusted by first substituting the predicted 10 m and 30 m above ground temperature with hourly recorded temperature at 10 m and 30 m from the on-site station. The difference between the TAPM predicted temperature and the measured temperature was applied to the entire predicted vertical temperature profile. This modified vertical profile was used in combination with the ambient air temperature throughout the day to calculate convective mixing heights between sunrise and sunset.

3.2.2 Annual Wind Regime

Annual wind roses of recorded wind speed and direction data from the Smelter meteorological tower are presented in **Figure 6**. Wind roses are presented for the years 2010 to 2014 and for 10 metres and 30 metres AGL

There is reasonable consistency in wind speed and direction across the five years of data at both measurement heights. At 10 metres AGL, each year experiences a dominant southeasterly flow, with notable southwest and northwest components. At 30 metres AGL, the dominant wind direction is less defined from the southeast, with more even distribution between the east to southwest.

At both measurement levels, the highest wind speeds are most frequently experienced from the west to north quadrant. Recorded wind speeds are higher at 30 metres AGL than 10 metres AGL. The average recorded wind speed for all years is in the order of 1.5m/s at 10 metres AGL and 2.7m/s at 30 metres AGL. The frequency of calm conditions (wind speeds less than 0.5 m/s) is higher at 10m AGL than 30 metres AGL.

3.2.3 Ambient Temperature

Monthly mean minimum temperatures are in the range of 4°C to 17°C, with monthly mean maxima of 17°C to 30°C, based on the long-term average record from the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Cessnock Airport (Station Number 061242) (the Cessnock Airport AWS) located approximately 12 kilometres to the west of the Project site. Peak temperature occurs during summer months with the highest temperatures typically being recorded between November and February. The lowest temperatures are usually experienced between June and August.

Figure 5 presents the monthly variation in recorded regional mean, minimum and maximum temperatures at the Cessnock Airport AWS. Additionally, temperature data recorded by the on-site station at 10 metres AGL between 2010 and 2014 has been overlayed on the long-term temperature record trends from the Cessnock Airport AWS. There is good agreement between temperatures recorded between 2010 and 2014 and the recorded historical trends, indicating that the onsite data is representative of conditions experienced in the region.

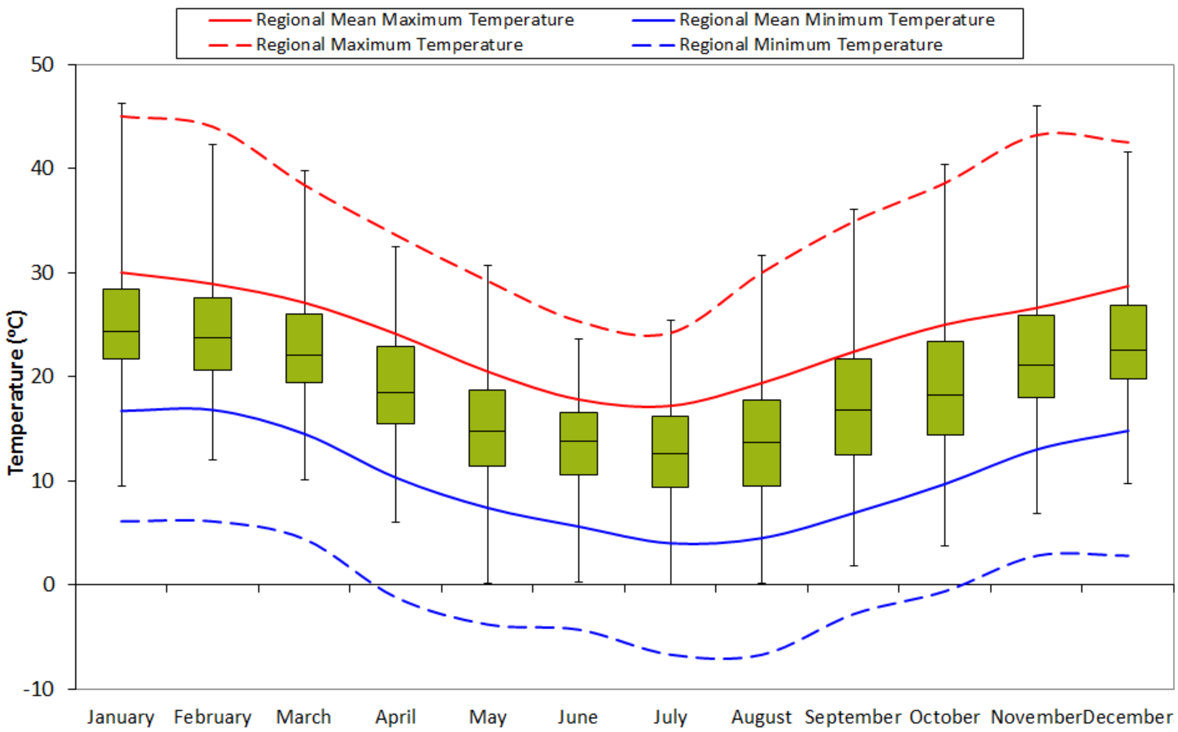

Figure 5: Temperature comparison between Smelter Site data and historical averages – BoM Cessnock Airport (1968 to 2013)

Note: Temperature recorded between 2010 and 2014 at the on-site weather station are illustrated by the 'box and whisker' indicators. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values. Maximum and minimum temperatures from long-term measurements at BoM Cessnock Airport are depicted as line graphs.

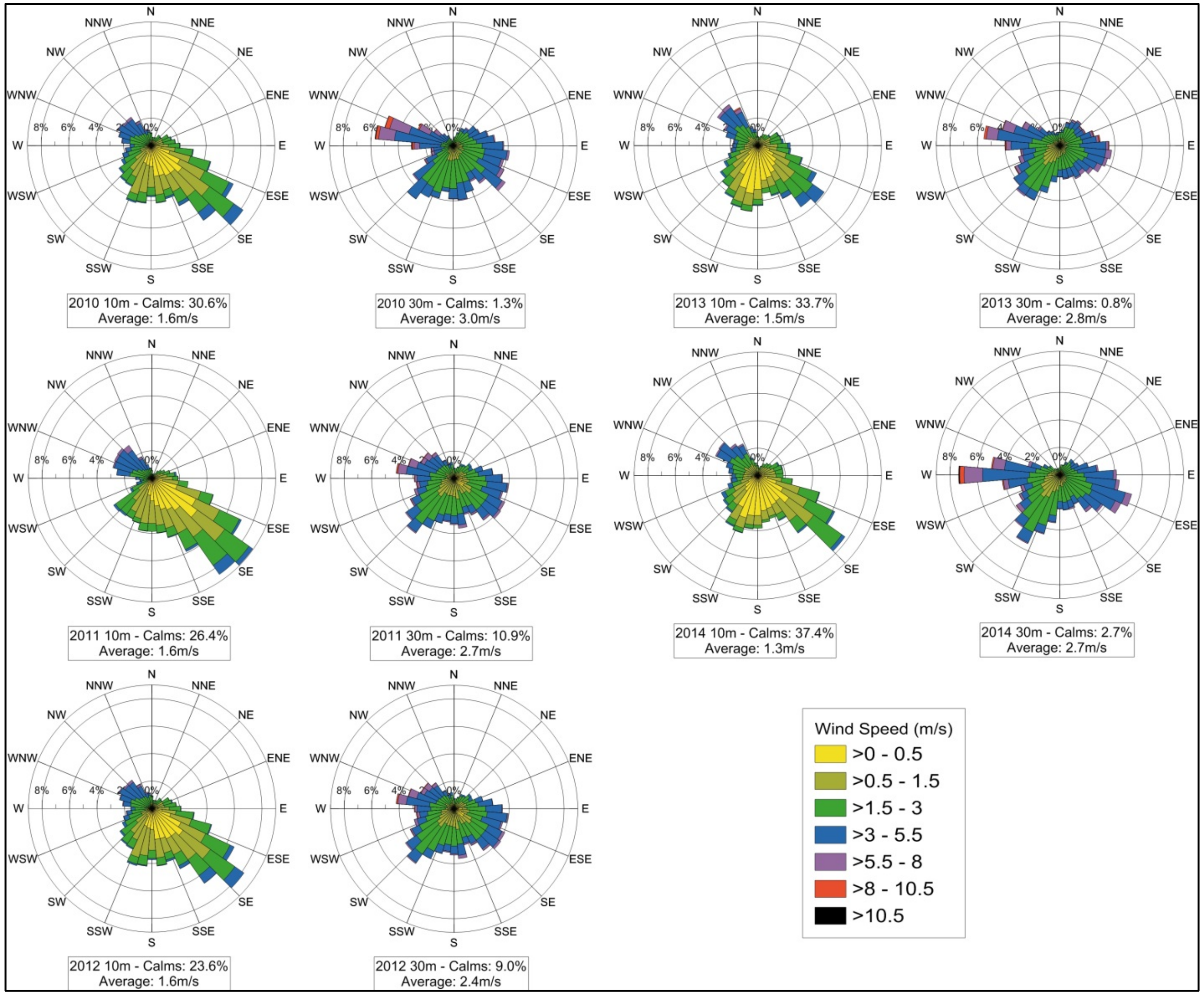

Figure 6: Interannual Comparison of Wind Speed and Direction – Smelter Station – 2010 to 2015

3.2.4 Precipitation and Evaporation

Precipitation is important to air pollution studies since it impacts on dust generation potential and represents a removal mechanism for atmospheric pollutants.

Based on historical data recorded since 1968 at Cessnock Airport AWS, the region is characterised by moderate rainfall, with a mean annual rainfall of approximately 730mm, and an annual rainfall range between 460mm and 1,040mm. Rainfall is most pronounced between November and March, with significantly lower rainfall during the colder months of the year. According to the records, an average of 112 rain days occur per year. Rainfall data recorded at the Smelter between 2010 and 2014 is comparable with the long-term rainfall recorded at the Cessnock Airport AWS.

Evaporation is a function of ambient temperature, wind and the saturation deficit of the air. The closest evaporation measurement station to the Smelter is the BoM Cessnock Nulkaba Station (Station Number 061242), which is located approximately 12 kilometres to the west-southwest of the Project site. On average, the region experiences an annual evaporation rate of 1,350mm/year, with greatest evaporation rates occurring during the summer months.

Mean monthly rainfall amounts recorded by the at Smelter between 2010 and 2014 were compared with mean monthly evaporation rates recorded at the Cessnock Nulkaba Station to determine the likely moisture budget at the site. The monthly variation in moisture budget is illustrated in **Figure 7**.

Figure 7 illustrates that a moisture deficit occurs (evaporation exceeds rainfall) throughout the majority of the year. The deficit is greatest during the summer months and near zero during winter (June experiences a slight surplus).

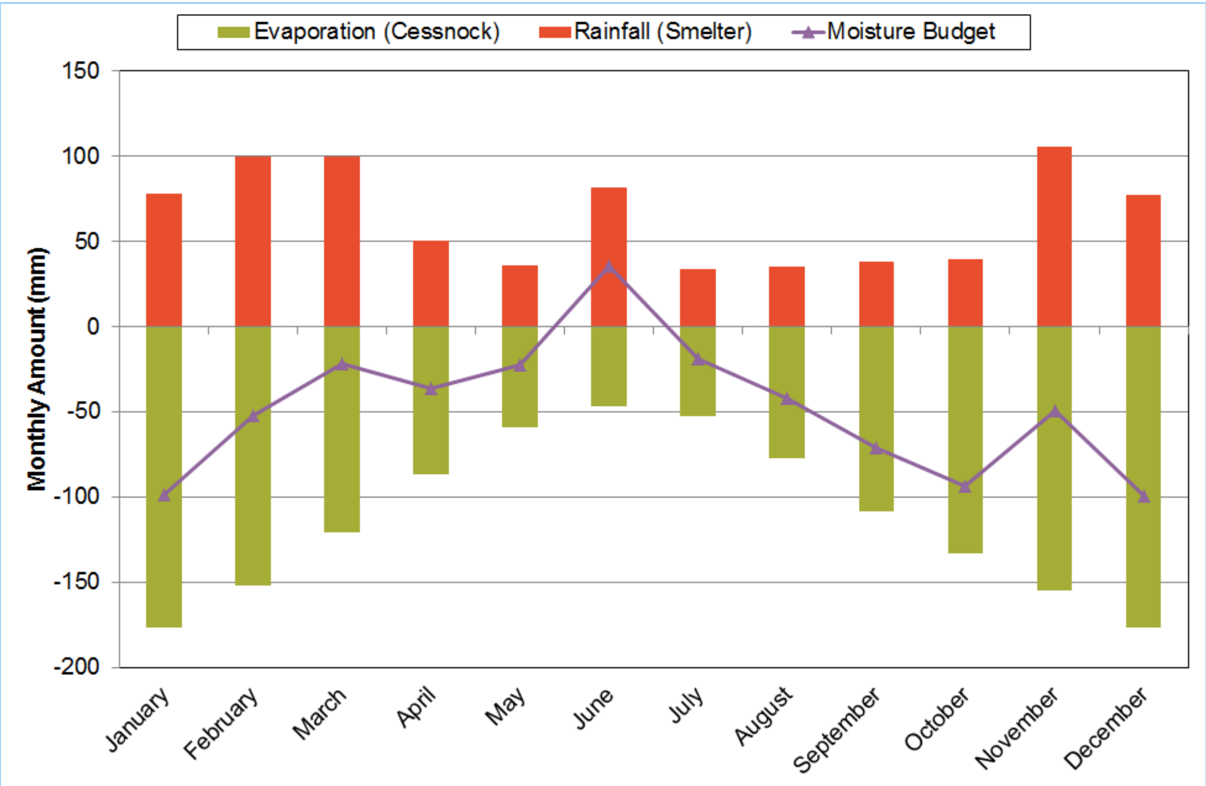

Figure 7: Monthly Moisture Budget – Smelter Site

To provide a conservative (upper bound) estimate of the airborne particulate matter concentrations occurring due to the Project, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report.

3.2.5 Atmospheric stability and boundary layer depth

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of air flow due to the frictional drag of the earth's surface (mechanical mechanisms), or as result of the heat and moisture exchanges that take place at the surface (convective mixing) (Stull, 1997; Oke, 2003).

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence and the passage of frontal systems. Due to radiative flux divergence, nights are typically characterised by weak to no vertical mixing and the predominance of stable conditions. These conditions are normally associated with low wind speeds and hence lower dilution potentials.

Hourly-varying atmospheric boundary layer depths were generated for the Project site by AERMET, the meteorological processor for the AERMOD dispersion model, using a combination of surface observations from the on-site weather station, sunrise and sunset times and adjusted TAPM-predicted upper air temperature profile. The variation in average boundary layer depth by hour of the day for the Project site is illustrated in **Figure 8**. It can be seen that greater boundary layer depths are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10% of the mixing height). Wharton and Lundquist (2010) provide typical value ranges for L for widely referenced atmospheric stability classes, as listed within **Table 4**.

Table 4: Monin-Obukhov length with respect to atmospheric stability

Monin-Obukhov length (L) range	Stability class
$-50 < L < 0$	Very Unstable
$-600 < L < -50$	Unstable
$\|L\| > 600$	Neutral
$100 < L < 600$	Stable
$0 < L < 100$	Very Stable

Source: Table 2, Wharton and Lundquist (2010)

Figure 9 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET for the Project site. The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during day time hours and lowest during evening through to early morning hours.

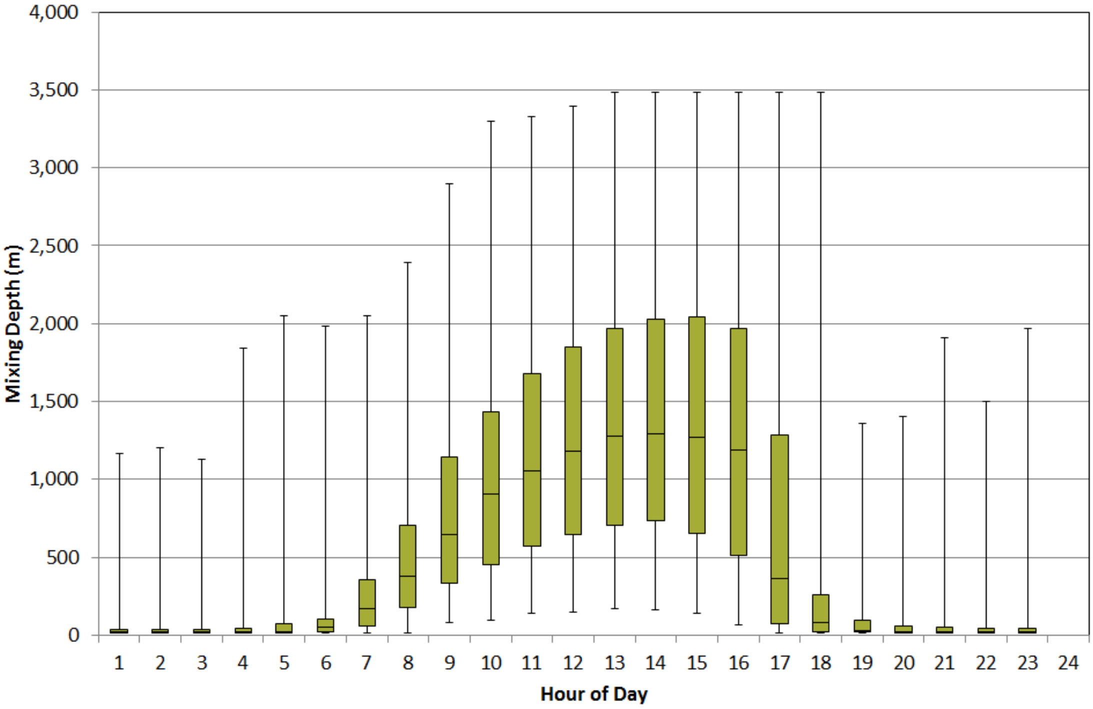

Figure 8: AERMET-generated diurnal variations in average boundary layer depth – Smelter Site

Note: Boxes indicate 25th percentile, Median and 75th percentile of AERMET-generated mixing height data while upper and lower whiskers indicate maximum and minimum values.

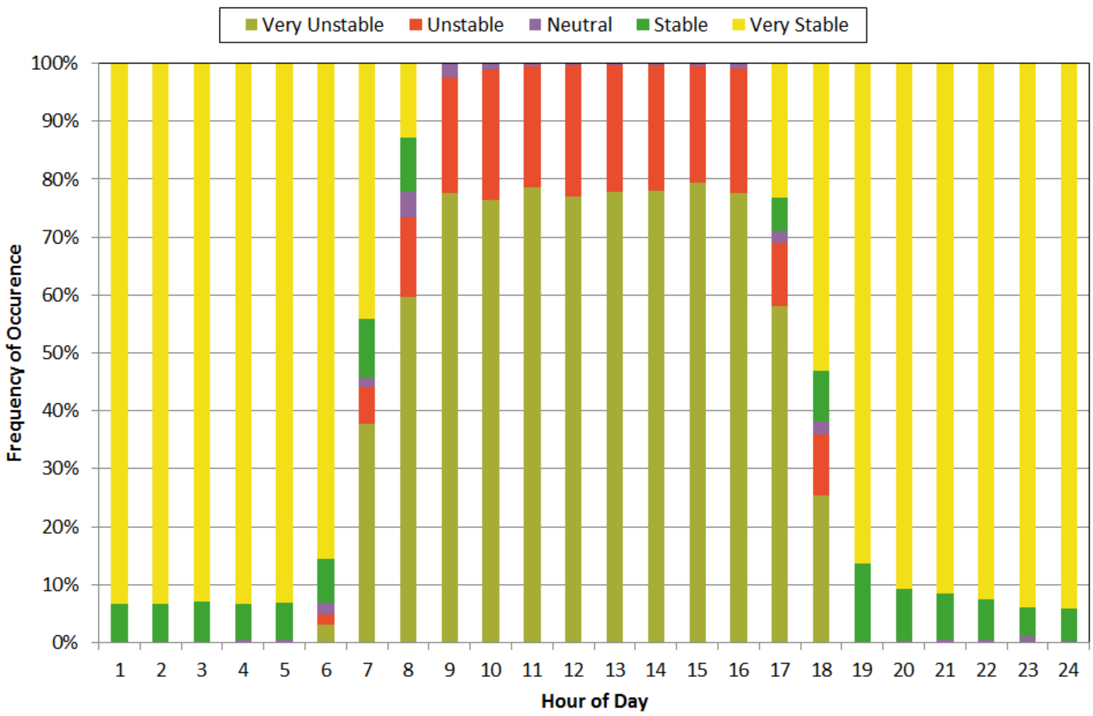

Figure 9: Diurnal variations in AERMET-generated atmospheric stability for Smelter Site – 2014

3.3 Existing Air Quality Environment

3.3.1 Sources of Air Emissions

Air quality in the Kurri Kurri area may be influenced by a number of air emission sources including:

- Open-cut and underground coal mining operations to the southeast and northwest, in particular the Bloomfield Open Cut, Donaldson Open Cut, Abel Underground and Tasman Underground mines located between 7km and 12km east to southeast of the Project site;
- Mobile sources, such as emissions from road and rail transport, in particular the Hunter Expressway to the immediate south of the Project site;
- Emissions from light industrial, commercial and residential activity;
- Wind entrained dust from exposed areas; and
- Biogenic (natural) sources, including the contribution of sea salt to airborne aerosol concentrations.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. Whereas dust storms generate primary particles from mechanical attrition, bushfires are a source of both primary and secondary fine particles, occurring from atmospheric gas to particle conversion processes. Long-range transport of emissions from power generation within the Upper Hunter Valley and on the Central Coast may also contribute to secondary fine particulate concentrations within the region.

3.3.2 Monitoring Data Available for Baseline Air Quality Characterisation

No particulate matter air quality monitoring has been conducted by Hydro in the area surrounding the Smelter. The NSW Office of Environment and Heritage (OEH) maintains a network of air quality monitoring stations across NSW. The three closest OWH stations are located at:

- Beresfield – established in 1993, approximately 16km east of the Project site;
- Wallsend – established in 1992, approximately 21km southeast of the Project site; and
- Singleton South – established in 2011, approximately 33km northwest of the Project site.

All available daily-varying particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) and particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$) monitoring data from these three OEH stations recorded between January 2010 and December 2014 was obtained in order to analyse existing ambient particulate matter concentrations in the Kurri Kurri region. It is noted that only the Beresfield and Wallsend stations record $PM_{2.5}$ concentrations.

3.3.3 PM_{10}

A time-series of 24-hour average PM_{10} concentrations recorded by the three surrounding OEH stations between 2010 and 2014 is presented in **Figure 10**.

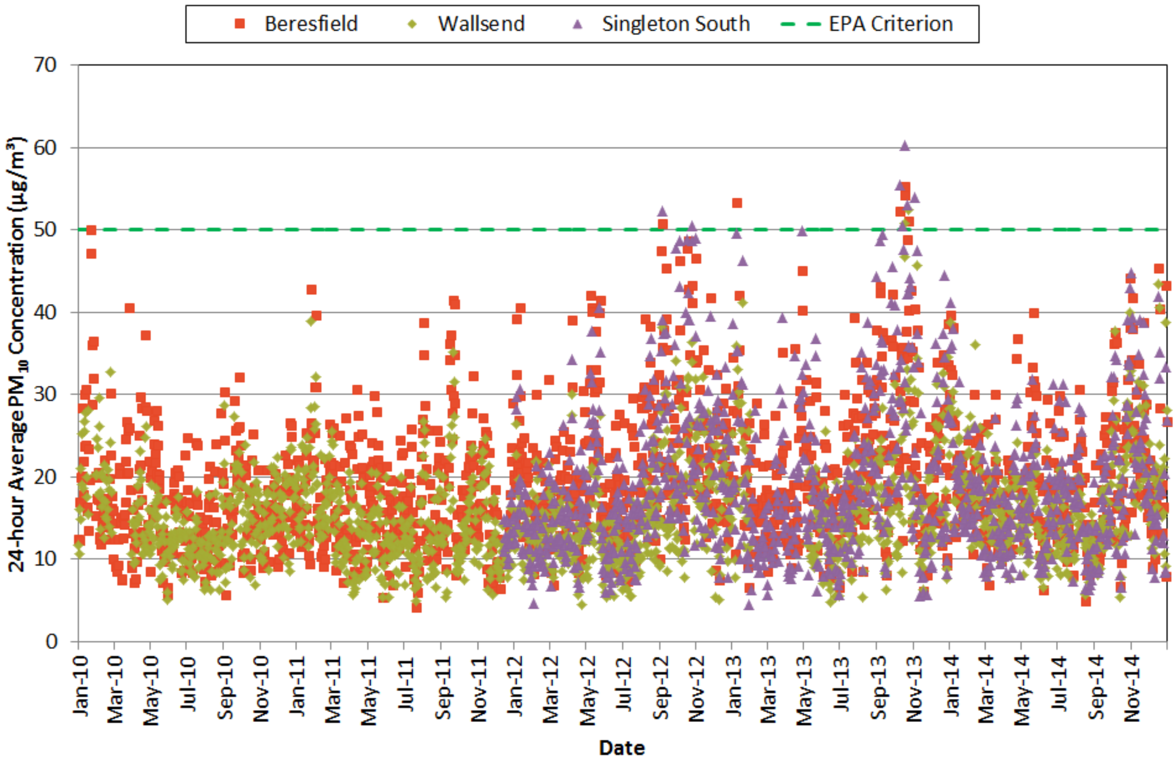

Figure 10: Time series comparison of 24-hour average PM_{10} concentrations between 2010 and 2014 – NSW OEH Wallsend, Beresfield and Singleton South Monitoring Stations

To further understand the relationship in PM_{10} concentrations recorded across these monitoring stations, the Pearson product moment correlation coefficient, *r*, was calculated for each dataset pairing. A value of 1 for *r* indicates a significant linear relationship between two datasets. The calculated *r* for each PM_{10} dataset pairing is presented within **Table 5**.

Table 5: Relationship Between PM_{10} Monitoring Datasets – Wallsend, Beresfield and Singleton South Monitoring Stations – 2010 - 2014

	Pearson Product Moment Correlation Coefficient (r)		
	Wallsend	Beresfield	Singleton South
Wallsend	1		
Beresfield	0.80	1	
Singleton South	0.78	0.86	1

The following key points are identified from the table and figures:

- Daily varying PM_{10} concentrations recorded across the three OEH stations exhibit a highly linear relationship (*r* greater than 0.78 at all stations). Concentrations recorded by these stations show consistency, both in magnitude and the daily-varying profile. Ambient PM_{10} concentrations are therefore considered to be strongly influenced by regional emission sources; and
- Exceedance of the NSW EPA 24-hour average impact assessment criterion occurs at all three OEH stations. The driving influence behind these elevated concentrations is typically natural

events such as dust storms and bushfires. In particular, the elevated concentrations illustrated during late 2013 are directly attributable to extensive bushfire events in NSW during that time.

A frequency distribution of 24-hour average PM_{10} concentrations recorded across the three OEH monitoring stations between 2010 and 2014 is presented to estimate the likelihood of ambient concentrations within various concentration bands, for the Kurri Kurri area. A frequency histogram of recorded PM_{10} concentrations is presented in **Figure 11**.

The frequency distribution presented in **Figure 11** highlights that 24-hour average PM_{10} concentrations recorded by the three stations were less than 30µg/m^3 approximately 90% of the time between January 2010 and December 2014. The likelihood of a 24-hour average PM_{10} concentration of greater than 50µg/m^3 was 0.7%. This equates to two and a half days in a calendar year.

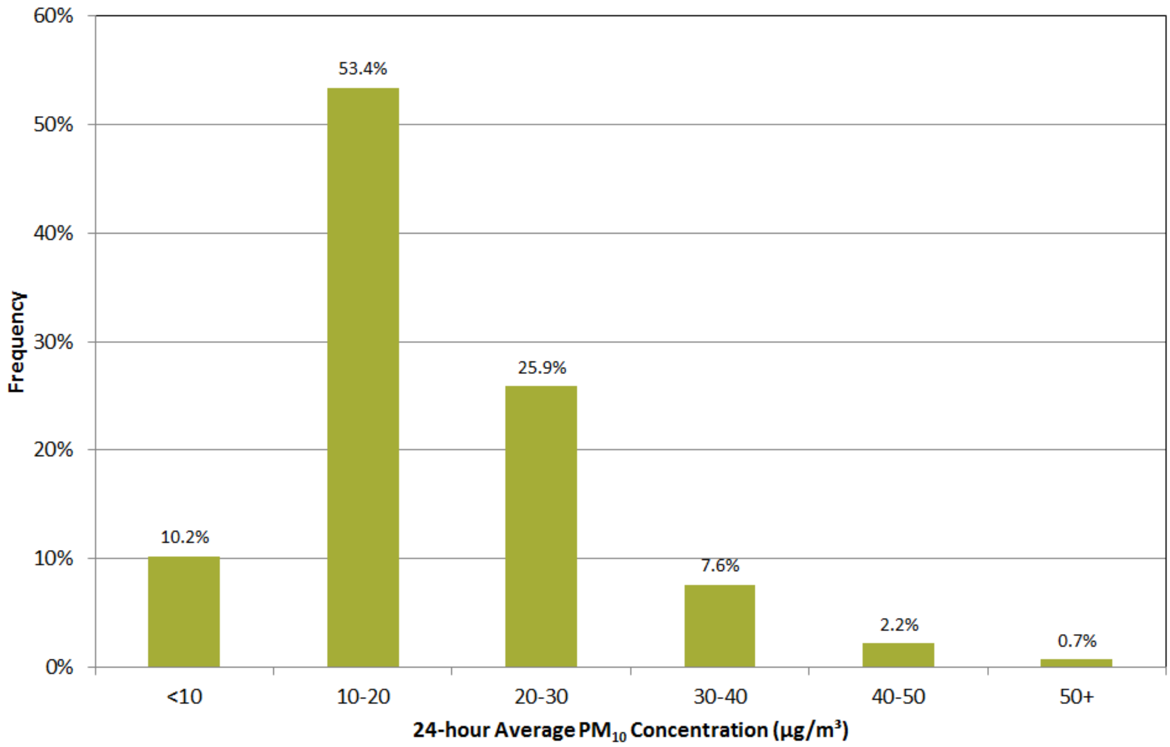

Figure 11: Frequency of 24-hour average PM_{10} concentrations – NSW OEH Wallsend, Beresfield and Singleton South Monitoring Stations – 2010 – 2014

To account for background concentrations in this air quality impact assessment of the Project, the OEH Beresfield station will be drawn on as the key data resource. The following concentrations have been adopted:

- Maximum 24-hour average PM_{10} concentration of 48.8µg/m^3, which is the highest concentration recorded during 2014 not already in exceedance of the EPA assessment criterion of 50µg/m^3; and
- Five year (2010-2014) average PM_{10} concentration of 19.2µg/m^3.

3.3.4 $PM_{2.5}$

A time-series of 24-hour average $PM_{2.5}$ concentrations recorded by the three surrounding OEH stations between 2010 and 2014 is presented in **Figure 12**.

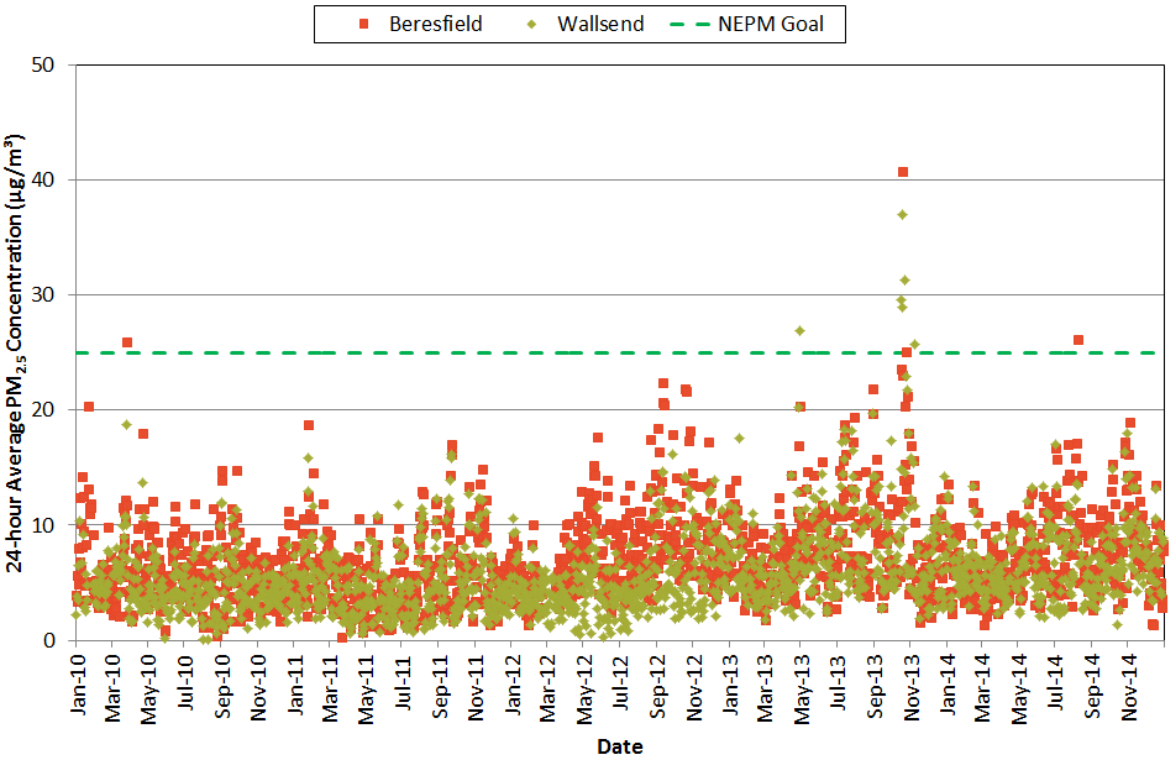

Figure 12: Time series comparison of 24-hour average $PM_{2.5}$ concentrations between 2010 and 2010 and 2014 – NSW OEH Wallsend and Beresfield Monitoring Stations

To further understand the relationship in $PM_{2.5}$ concentrations recorded between the two NSW OEH stations, the Pearson product moment correlation coefficient, *r*, was calculated for corresponding concentrations. A *r* value of 0.85 was calculated, indicating that a strong linear relationship between the two datasets.

The following key points are identified from the above analysis:

- Daily-varying $PM_{2.5}$ concentrations recorded by the Beresfield and Wallsend stations show consistency, both in magnitude and the daily-varying profile. Ambient $PM_{2.5}$ concentrations, like PM_{10} concentrations, are therefore considered to be strongly influenced by regional emission sources; and
- Exceedance of the NSW EPA 24-hour average impact assessment criterion occurs at both OEH stations. The driving influence behind these elevated concentrations is typically natural events such as dust storms and bushfires. In particular, the elevated concentrations illustrated during late 2013 are directly attributable to extensive bushfire events in NSW during that time.

A frequency distribution of 24-hour average $PM_{2.5}$ concentrations recorded across the two OEH monitoring stations between 2010 and 2014 is presented to estimate the likelihood of ambient concentrations within various concentration bands for the Kurri Kurri area. A frequency histogram of recorded $PM_{2.5}$ concentrations is presented in **Figure 13**.

The frequency distribution presented in **Figure 13** highlights that 24-hour average $PM_{2.5}$ concentrations recorded by the two stations were less than 15µg/m^3 approximately 97% of the time between January 2010 and December 2014. The likelihood of a 24-hour average $PM_{2.5}$ concentration of greater than 25µg/m^3 was 0.3%. This equates to approximately one day in a calendar year.

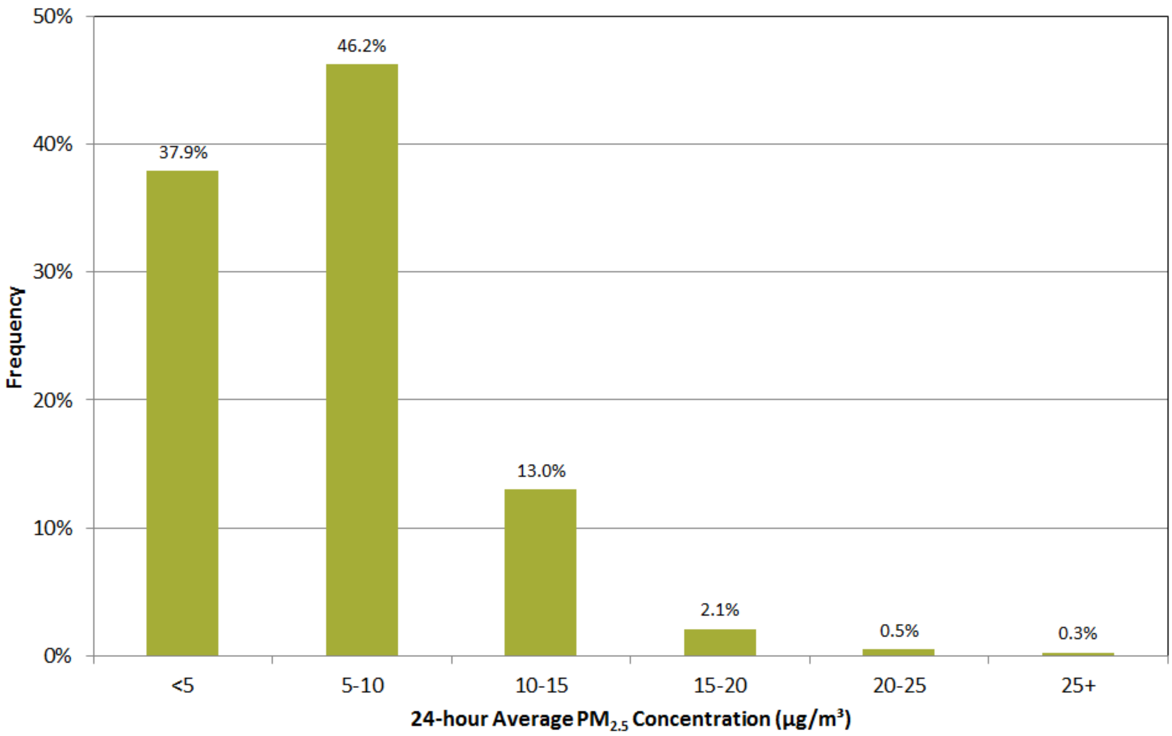

Figure 13: Frequency of 24-hour average $PM_{2.5}$ concentrations – NSW OEH Wallsend and Beresfield Monitoring Stations – 2010 – 2014

To account for background concentrations in this air quality impact assessment of the Project, the OEH Beresfield station will be drawn on as the key data resource. The following concentrations have been adopted:

- Maximum 24-hour average $PM_{2.5}$ concentration of 19.0µg/m^3, which is the highest concentration recorded during 2014 not already in exceedance of the NEPM Advisory Reporting Goal of 25µg/m^3; and
- Five year (2010-2014) average $PM_{2.5}$ concentration of 7.0µg/m^3.

3.3.5 Total Suspended Particulates

There is currently no monitoring of ambient total suspended particulates (TSP) concentrations conducted in the vicinity of the Smelter site. TSP is defined as all particulates with an aerodynamic diameter of less than 50-100 µm.

Based on Ramboll Environ's experience of paired PM_{10} and TSP monitoring datasets in the Hunter Valley region (ENVIRON, 2009), the PM_{10} particle size mass fraction is typically of the order of 40% of the recorded TSP mass. On this basis, and in the absence of site-specific monitoring data for TSP, a baseline TSP concentration of 47.8µg/m^3, derived from the adopted PM_{10} concentration detailed in **Section 3.3.3** (19.2µg/m^3), will be adopted as indicative of existing annual average TSP concentrations.

3.3.6 Dust Deposition

There is currently no monitoring of ambient dust deposition at the Project site. As part of the environmental management practices implemented during the recent construction of the Hunter Expressway (which passes within 500m of the Project site), NSW Roads and Maritime Services (RMS) undertook dust deposition monitoring at six locations along the road corridor. The closest monitoring site to the Smelter site was located approximately 1 km to the south of the Project site and was classified as a “background” monitoring location (i.e. outside the influence of construction activities).

Based on data presented in the Hunter Expressway Construction Compliance Reports 6 and 7, prepared by Bowditch Group (2013 and 2014) on behalf of RMS, the annual average dust deposition recorded at the closest station to the Project site between January 2013 and January 2014 was 1.6 g/m^2/month. This value will be adopted as the representative background in the assessment of cumulative dust deposition impacts.

3.3.7 Combustion-related Pollutants

In addition to particulate matter pollutants, this assessment will quantify and assess emissions of various pollutants associated with the onsite combustion of diesel fuel by mobile plant and equipment. Pollutants to be assessed include nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). Of these pollutants, only NO_2, SO_2 and CO have NSW EPA impact assessment criteria applicable to cumulative (increment + background) concentrations. The criteria for individual VOCs and PAHs are applicable to the project increment only.

While no monitoring for these pollutants is conducted at the Smelter, maximum and average concentrations were adopted from the closest NSW EPA stations, specifically Beresfield for NO_2 and SO_2 and Newcastle (located approximately 30km east-southeast) for CO. The adopted concentrations are as follows:

- NO_2 – maximum 1-hour concentration of 73.3µg/m^3 and average of 16.7µg/m^3;
- SO_2 - maximum 1-hour concentration of 81.2µg/m^3, maximum 24-hour average concentration of 18.3µg/m^3 and average of 3.7µg/m^3; and
- CO – maximum 1-hour concentration of 9,611µg/m3 and maximum 8-hour average concentration of 2,760µg/m3.

The following points are noted in relation to the adopted background concentrations:

- The maximum 1-hour, 8-hour and 24-hour concentrations adopted are the peak concentrations recorded during 2014 at the Beresfield/Newcastle OEH stations;
- The maximum 1-hour average CO concentration was derived from the 8-hour average CO concentration using the following empirical relationship has been used:

$$C_{60} = C_{480}\left[\frac{480}{60}\right]^{0.6}$$

  Source: modified from Hanna et al. (1977) as quoted in MFE (2004).

  Where:

  C_{60} = concentration of pollutant at time 60 minutes.

  C_{480} = concentration of pollutant based on averaging time of 480 minutes (8-hours).

- The average concentrations for all pollutants is the average recorded concentration between 2010 and 2014 at the respective NSW OEH monitoring station;

3.3.8 Lead

Background lead concentrations in ambient air have been declining significantly since lead was phased out of petrol in 2002. Lead was previously measured at six sites in NSW, three in the Sydney (the CBD, Earlwood and Rozelle), Port Kembla, Wallsend and Warrawong. These monitoring stations have since been decommissioned and there has been no ambient lead monitoring since 2005 following the significant decrease in lead concentrations.

By 2004, annual average lead concentrations throughout NSW had decreased to typically less than 0.03µg/m³ (well below the criterion of 0.5µg/m³), and many 24-hour average concentrations were below the minimum detection limit (OEH, 2010).

4. ASSESSMENT METHODOLOGY AND CRITERIA

4.1 Criteria

The Project must demonstrate compliance with the impact assessment criteria outlined in the *Approved Methods for Modelling* (DEC, 2005). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

The primary emissions to air from the Project would be particulate matter (PM) from material handling and processing. For this assessment, focus has been given to the primary PM size fractions of Total Suspended Particulate (TSP) matter, particulate matter with an equivalent aerodynamic diameter of 10 microns (PM_{10}) and particulate matter with an equivalent aerodynamic diameter of 2.5 microns ($PM_{2.5}$). Dust deposition is also considered based on TSP emissions.

In addition to PM, the Project would have the potential to generate diesel combustion –related pollutants, as documented in **Section 3.3.7**, and assorted individual air quality toxins, metals and metalloids. The assessment criteria for these pollutants are documented in the following sections.

4.1.1 Goals Applicable to Airborne Particulate Matter

Ambient air quality limits for particulates are typically given for various particle size fractions, including TSP, PM_{10} and $PM_{2.5}$. Although TSP is defined as all particulates with an aerodynamic diameter of less than 50-100 µm, an effective upper limit of 30 µm aerodynamic diameter is frequently assigned. PM_{10} and $PM_{2.5}$ are of particular concern due to potential health impact.

Air quality limits issued by the Federal and NSW government for particulates are given in **Table 6**.

Table 6: Impact Assessment Goals for Airborne Particulates

Pollutant	Averaging Period	Concentration (µg/m³)	Reference
TSP	Annual	90	NSW EPA[1]
PM_{10}	24 hours	50	NSW EPA[1]
	24 hours	50[3]	NEPM[2]
	Annual	30	NSW EPA[1]
$PM_{2.5}$	24 hours	25	NEPM[4]
	Annual	**8**	NEPM[4]

Note 1: NSW EPA *Approved Methods for Modelling (DEC 2005)*

Note 2: NEPC, 2003, *National Environment Protection (Ambient Air Quality) Measure,* as amended

Note 3: Provision made for up to five exceedances of the limit per year

Note 4: Advisory reporting goal issued by the NEPC (2003)

Note: Concentrations referenced to standard temperature and pressure (STP - 0°C, 1ATM)

The NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998, with compliance to be achieved by 2008. All State jurisdictions commenced formal reporting against the NEPM standards in 2002.

The NSW 24-hour PM_{10}impact assessment criterion of 50µg/m^3 is numerically identical to the equivalent (NEPM reporting standard except that the NEPM reporting standard allows for five exceedances per year. It is noted, that the NSW EPA requires assessment of predicted 24-hour average PM_{10} against the maximum predicted concentration and that no additional exceedances occur as a results of a project.

The NSW EPA does not prescribe ambient air quality criteria for $PM_{2.5}$. Reference may, however, be made to the $PM_{2.5}$ advisory reporting goals issued by the NEPC (2003), as referenced in **Table 6**.

The air quality impact assessment criteria for airborne particulate concentrations are applicable at sensitive receptors. These are defined by the *Approved Methods for Modelling* (DEC, 2005) as the nearest existing, or likely future, off-site dwellings or school, hospital, office or public recreational area. In assessing against these criteria, the total air pollutant concentration (incremental plus background concentration) must be reported as the 100th percentile (i.e. the maximum) concentration in units consistent with the impact assessment criteria. These must then be compared with the relevant impact assessment criteria.

4.1.2 Dust Deposition Criteria

Nuisance dust deposition is regulated through the stipulation of maximum permissible dust deposition rates. The NSW EPA impact assessment goals for dust deposition are given in **Table 7** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided.

Table 7: EPA Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m^2/month	4 g/m^2/month

Source: *Approved Methods for Modelling*, EPA 2005

4.1.3 Gaseous Air Pollutants

Emissions may occur as a result of fuel combustion from processes associated with the Project, principally idling and moving locomotives, trucks and freight handling equipment. Key combustion-related pollutants of interest include NO_2, SO_2, CO, PAHs and VOCs. While numerous VOC species are emitted following the combustion of diesel fuel, this assessment focussed primarily on the compounds benzene, toluene, xylenes (total xylene) and ethylbenzene to assess the potential health impact of individual organic species. These species are quantifiable based on available emission factors, and may be used as markers of the relative toxicity of organic compounds from combustion.

Air quality limits applicable to these potential gaseous emissions are summarised in **Table 8**.

The air quality impact assessment criteria for SO_2, NO_2 and CO are applicable at the nearest existing or likely future off-site dwellings or other sensitive receptors, including schools, hospitals, work places and public recreation areas. In assessing against these criteria, the total concentration (incremental plus background concentration) must be reported as the 100th percentile in concentration units consistent with and compared to the relevant impact assessment criteria (DEC, 2005).

The criteria specified for benzene, ethylbenzene and PAHs are applicable at and beyond the boundary of the facility. For a Level 2 assessment as is undertaken in the current study, the incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

The impact assessment criteria given for toluene and xylenes are applicable at any existing or likely future off-site dwelling or establishment. The incremental concentration (predicted concentration due to the Project in isolation) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

Table 8: Criteria for gaseous air pollutants

Pollutant	Averaging period	Concentration		Reference
		$\mu g/m^3$ [1]	pphm[2]	
NO_2	1-hour	246	12	NSW EPA[3]
	Annual	62	3	NSW EPA[3]
SO_2	1-hour	570	20	NSW EPA[3]
	24-hour	228	8	NSW EPA[3]
	Annual	60	2	NSW EPA[3]
CO	1-hour	30,000	2,500	NSW EPA[3]
	8-hour	10,000	900	NSW EPA[3]
Benzene	1-hour	31	0.9	NSW EPA[3,4]
Ethylbenzene	1-hour	8,000	1,800	NSW EPA[3,4]
Toluene	1-hour	370	9	NSW EPA[3,4]
Xylene (total)	1-hour	190	4	NSW EPA[3,4]
PAHs (as BaP)	**1-hour**	**0.4**	**-**	NSW EPA[3]

Note 1: Gas volumes expressed at 0°C and 1 atmosphere

Note 2: pphm – parts per hundred million

Note 3: *Approved Methods for Modelling*

Note 4: For a Level 2 Assessment (defined within the Approved Methods for Modelling), expressed as the 99.9th Percentile Value. The current assessment constitutes a Level 2 Assessment

4.1.4 Trace Metals

A number of material samples have been collected from the Smelter, including the carbon plant, spent pot lining storage shed and potentially contaminated soil. Laboratory analysis for metals content has been undertaken for each of these samples, with the results highlighting that varying concentrations of arsenic, cadmium, chromium, fluoride, lead, nickel and zinc were detected. Of these metals, the *Approved Methods for Modelling* (DEC, 2005) classifies arsenic, cadmium, chromium nickel and lead as toxic air pollutants. The applicable assessment criteria are specified in **Table 9**. For a Level 2 assessment, as is undertaken in this assessment, the incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

Table 9. Criteria for toxic air pollutants

Pollutant	Averaging Period	Concentration		Reference
		µg/m³	pphm	
Arsenic and compounds	1-hour	0.09	N/A	EPA[1]
Cadmium and compounds	1-hour	0.018	N/A	
Chromium VI compounds	1-hour	0.09	N/A	
Nickel and compounds	1-hour	0.18	0.009	

Note 1: Approved Methods for the Modelling (DEC 2005)

Note 2: For a Level 2 Assessment (defined within the Approved Methods for Modelling), expressed as the 99.9th Percentile Value. The current assessment constitutes a Level 2 Assessment

In addition to these pollutants, the impact assessment criterion for lead is presented in **Table 10** and is applicable at the nearest sensitive receptor. In assessing against these criteria, the total air pollutant concentration (incremental plus background concentration) must be reported as the 100th percentile in concentration units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.

Table 10. Criteria for lead

Pollutant	Averaging Period	Concentration (µg/m³)	Reference
Lead	Annual	0.5	EPA[1]

Note 1: *Approved Methods for the Modelling* (DEC 2005)

4.2 Methodology

4.2.1 Dispersion Model Selection and Application

The atmospheric dispersion modelling carried out within this assessment used the AMS/US EPA regulatory model known as AERMOD (US-EPA, 2004a).

AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it is considered to provide more realistic results with concentrations that are generally lower and more representative of actual concentrations compared to the ISC model.

Compared to ISC, AERMOD represents an advanced new-generation model which requires additional meteorological and land-use inputs to provide more refined predictions.

Predicted concentrations and deposition rates were calculated for a regular Cartesian receptor grid covering a 10km by 10km computational domain centred over the Smelter site, with a grid resolution of 200 m.

Simulations were undertaken for the 12 month period between 1 January 2014 and 31 December 2014 using the on-site meteorological monitoring dataset as input (see **Section 3.2** for description of input meteorology).

4.2.2 Emissions Estimation

Air emission sources associated with the demolition of the Smelter were identified and quantified through the application of National Pollution Inventory (NPI) and United States Environmental Protection Agency (US-EPA) AP-42 emission estimation techniques.

Air pollutant emissions during the Works would largely comprise of particulate matter (TSP, PM_{10} and $PM_{2.5}$). Particulate matter emission sources associated with Works activities at the Project site would include:

- Vehicle movements on paved and unpaved roads;
- Erosion of stockpiles and freshly exposed areas on-site;
- Handling, transfer and storage of materials;
- Heavy earthwork operations such as excavation and earth moving activities; and
- Re-contouring of land and soil exposure for reseeding.

As discussed in **Section 2**, the Works would predominantly be undertaken between the hours of 7am and 6pm.

Annual calculated emissions are presented in **Table 11**, **Table 12** and **Table 13** for particulate matter, trace metals toxics and diesel-combustion air pollutants respectively.

Assumptions:

- Annual material handling by activity area as follows:
  - 5,400t for demolition works (assumed 10% of total demolition material for Stage 1 and Stage 2).
  - 189,000t for the Capped Waste Stockpile.
  - 67,000t for contaminated soil excavation and handling.
  - 20,000t for non-recyclable demolition waste.
- Annual diesel consumption calculated to be 3,072 kL, consistent with the greenhouse gas assessment completed for the Project EIS (Ramboll Environ, 2015);
- All activities are assumed to occur 12 hours per day, 300 days per year;
- A 75% emission reduction factor has been applied to all hauling on unpaved roads to account for emission control by water truck; and
- A 50% emission reduction factor has been applied to all demolition, crushing, hauling and wind erosion sources to account for emission control by watering.

Further details regarding emission estimation factors and assumptions are provided in **Appendix A**.

Wind erosion and wind sensitive material handling emissions are varied relative to hourly wind speed. Further details are provided in **Appendix B**.

4.2.3 Excluded Emission Sources

In addition to the emission sources identified in **Section 4.2.2**, air pollutant emissions are also likely to be associated with the demolition of the three stacks and one water tower via controlled explosives detonation. This specific demolition works could generate emissions of particulate matter and individual air toxics. However, given the short term nature of these specific demolition activities and considering all other on-site activities would be suspended during detonation events, associated emissions have not been included within the air quality impact assessment. Specific management measures for detonation events are presented in **Section 6**.

The excavation works proposed for the Project would involve the removal of potentially contaminated soils. As a result of the contaminated soils being exposed to the ambient air environment there is potential for some odorous emissions to be released. Onsite surveys of the soils identified that there were few volatile contaminants and odorous compounds detected.

Overall, odorous emissions are not expected to be significant (particularly beyond the Project site and Hydro land) during excavation works related to the Project.

Table 11: Calculated Annual TSP, PM_{10} and $PM_{2.5}$ Emissions

Activity Area	Emission Source	Annual Emissions (kg/annum)		
		TSP	PM_{10}	$PM_{2.5}$
Demolition Works	Demolition Works	4.1	1.5	**0.2**
	Loading to trucks	4.1	1.5	0.2
	Haul to Crusher	76.8	19.6	2.0
	Unloading to Crusher	8.1	3.0	0.4
	Crushing	1.6	0.7	0.1
	Loading to trucks	8.1	3.0	0.4
	Haul to Stockpiling Area	131.6	33.5	3.4
	Unloading to Stockpiling Area	4.1	1.5	0.2
	Material Handling - Stockpiling Area	4.1	1.5	0.2
	Wind Erosion - Exposed surfaces and stockpiles	159.4	79.7	12.0
Capped Waste Storage	Loading to trucks	283.5	104.0	15.6
	Haul to Containment Cell	8,446.8	2,152.8	215.3
	Unloading to Containment Cell	141.8	52.0	7.8
	Material Handling - Containment Cell	141.8	52.0	7.8
	Wind Erosion - Exposed surfaces and stockpiles	637.5	318.8	47.8
Contaminated Soil Excavation	Loading to trucks	100.5	36.9	5.5
	Haul to Storage Area	3,811.0	971.3	97.1
	Unloading to Storage Area	100.5	36.9	5.5
	Material Handling - Storage Area	100.5	36.9	5.5
	Wind Erosion - Exposed surfaces and stockpiles	212.5	106.3	15.9
Non-recyclable Demolition Waste	Loading to trucks	30.0	11.0	1.7
	Haul offsite	650.1	165.7	16.6
All Site	Diesel Combustion	11,059.2	11,059.2	10,137.6
	TOTAL	**26,117.4**	**15,248.8**	**10,598.9**

Table 12: Calculated Annual Trace Metal and Toxics Emissions

Emission Source	Annual Emissions (kg/annum)					
	Arsenic	Cadmium	Chromium	Lead	Nickel	PAHs
Demolition Works	0.9	9.4	11.8	74.0	-	56.4
Capped Waste Storage	-	-	35.8	-	207.7	87.6
Contaminated Soil Excavation	-	-	-	-	-	40.6
Non-recyclable Demolition Waste	0.1	1.1	1.4	8.8	-	12.2
Total	**1.0**	**10.5**	**49.0**	**82.8**	**207.7**	**196.8**

Table 13: Calculated Annual Diesel Combustion Emissions

Pollutant	Annual Emissions (kg/annum)
NO_x	138,240.0
SO_2	73.7
CO	57,139.2
PAHs	5.1
VOCs	12,902.4
Benzene	78.8
Ethylbenzene	40.6
Toluene	160.0
Xylenes	218.7

4.2.4 Volatile Organic Compounds

Calculated emissions of VOCs from the Project have been speciated as benzene, ethylbenzene, toluene and xylenes. In order to derive emission rates for each of these VOC species, the US EPA Speciate Profile 8775 - *Diesel Exhaust Emissions from 2007 Model Year Heavy-Duty Diesel Engines with Controls*, has been adopted. The adopted percentage of total VOC for individual pollutants is presented in **Table 14**.

Table 14: Percentage composition of speciated VOCs

VOC Species	Percentage of Diesel VOC (%)
Benzene	0.61
Ethylbenzene	0.31
Toluene	1.24
Xylene	1.70

4.2.5 Trace Metals

As stated in **Section 4.1.4**, a number of trace metals and toxics were detected in the various material sampled onsite at the Smelter. To calculate annual emissions, mean trace metals content has been adopted for each of the key areas of activities. Where more than one sample was available for a material type, the highest mean content was applied. To calculate annual emissions of each pollutant, the content was applied to the relevant calculated PM_{10} emissions. The adopted trace metal / toxic content by material type is presented in **Table 15**.

Table 15: Trace Metal / Toxics Content of Materials

Pollutant	Toxic Content (mg toxic/kg material) by Material	
	Building Demolition	Haul Roads / Contaminated Soil
Arsenic	10.2	-
Cadmium	101.6	-
Chromium	128.2	-
Lead	801.3	-
Nickel	-	-
PAHs	591.8	34.2

4.2.6 Model Results

Dispersion simulations were undertaken to predict ground level concentrations of TSP, PM_{10}, $PM_{2.5}$, dust deposition rates, gaseous pollutants and trace metals. Model results are expressed as the maximum predicted concentration for each averaging period at the selected assessment locations over the 2014 modelling period.

The results are presented in the following formats:

- Tabulated results of particulate matter, gaseous and individual toxic air pollutant concentrations and dust deposition rates at the selected assessment locations are presented and discussed in **Section 5**.
- Isopleth plots, illustrating spatial variations in facility-related incremental TSP, PM_{10}, $PM_{2.5}$, PAHs and individual trace metals chromium and nickel are provided in **Appendix B**.

Isopleth plots of the 99.9th percentile 1-hour and maximum 24-hour average concentrations presented in **Appendix B** do not represent the dispersion pattern on any individual hour or day, but rather illustrate the maximum concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2014 modelling period.

4.2.7 Modelling of NO_x emissions

NO_x emissions associated with fuel combustion are primarily emitted as NO with some NO_2. In order to conservatively assess the transformation of NO_x to NO_2, it has been assumed that 100 percent of NO emissions are converted to NO_2. This highly conservative approach is consistent with the Approved Methods for Modelling.

5. IMPACT ASSESSMENT

5.1 Dispersion Modelling

The results of the dispersion modelling undertaken are presented as follows:

- Particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) concentrations and deposition rates in **Table 16**;
- NO_2, SO_2 and CO concentrations in **Table 17**; and
- Individual air toxics and metals concentrations in **Table 18**.

The results presented in these tables highlight the following:

- At all surrounding sensitive receptor locations, the predicted incremental and cumulative concentrations and deposition rates are below the applicable NSW EPA assessment criteria and NEPM advisory reporting goals;
- Where the criterion is applicable at or beyond site boundary (individual toxics and metals), the predicted concentrations are within applicable NSW EPA assessment criterion.

Table 16: Predicted Incremental and Cumulative Particulate Matter Concentrations and Deposition Rates

Receptor ID	Predicted Concentration (µg/m^3)										Annual Dust Deposition (g/m^2/month)	
	Annual TSP		24-hour PM_{10}		Annual PM_{10}		24-hour $PM_{2.5}$		Annual $PM_{2.5}$			
	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.
Criterion	**N/A**	**90**	**N/A**	**50**	**N/A**	**30**	**N/A**	**25**	**N/A**	**8**	**2**	**4**
1	1.0	48.7	2.2	47.6	0.6	19.7	1.7	20.7	0.5	7.5	0.1	1.7
2	1.1	48.8	2.4	47.8	0.7	19.8	1.8	20.8	0.5	7.5	0.1	1.7
3	0.2	47.9	0.5	45.9	0.1	19.2	0.3	19.3	0.1	7.1	<0.1	1.6
4	0.0	47.8	0.2	45.6	0.0	19.1	0.1	19.1	0.0	7.0	<0.1	1.6
5	0.1	47.8	0.3	45.7	0.0	19.1	0.2	19.2	0.0	7.0	<0.1	1.6
6	0.0	47.8	0.1	45.5	0.0	19.1	0.1	19.1	0.0	7.0	<0.1	1.6
7	0.0	47.8	0.2	45.6	0.0	19.1	0.2	19.2	0.0	7.0	<0.1	1.6
8	0.1	47.8	0.3	45.7	0.0	19.1	0.2	19.2	0.0	7.0	<0.1	1.6
9	0.3	48.1	0.7	46.1	0.2	19.3	0.5	19.5	0.2	7.2	<0.1	1.6
10	0.7	48.5	1.5	46.9	0.4	19.5	1.1	20.1	0.3	7.3	<0.1	1.6
11	0.2	47.9	0.5	45.9	0.1	19.2	0.4	19.4	0.1	7.1	<0.1	1.6
12	0.6	48.3	1.4	46.8	0.4	19.5	1.0	20.0	0.3	7.3	<0.1	1.6
13	0.0	47.8	0.1	45.5	0.0	19.1	0.1	19.1	0.0	7.0	<0.1	1.6
14	0.3	48.1	0.8	46.2	0.2	19.3	0.6	19.6	0.1	7.1	<0.1	1.6
15	0.5	48.2	1.1	46.5	0.3	19.4	0.8	19.8	0.2	7.2	<0.1	1.6
16	0.2	48.0	0.5	45.9	0.1	19.2	0.3	19.3	0.1	7.1	<0.1	1.6
17	0.0	47.8	0.1	45.5	0.0	19.1	0.1	19.1	0.0	7.0	<0.1	1.6
18	0.0	47.8	0.2	45.6	0.0	19.1	0.1	19.1	0.0	7.0	<0.1	1.6
19	0.0	47.8	0.2	45.6	0.0	19.1	0.1	19.1	0.0	7.0	<0.1	1.6

Note: Incr = Incremental Concentration from Project, Cumul = Cumulative Concentration between Project Increment and Background

Table 17: Predicted Incremental and Cumulative NO_2, SO_2 and CO Concentrations

Receptor ID	Predicted Concentration (µg/m³)													
	1-hour NO_2		Annual NO_2		1-hour SO_2		24-hour SO_2		Annual SO_2		1-hour CO		8-hour CO	
	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.
Criterion	**N/A**	**246**	**N/A**	**62**	**N/A**	**570**	**N/A**	**228**	**N/A**	**60**	**N/A**	**100,000**	**N/A**	**30,000**
1	39.4	112.7	1.5	18.2	<0.1	81.2	<0.1	18.3	<0.1	3.3	16.3	9,627.2	3.4	2,763.4
2	40.1	113.4	1.7	18.4	<0.1	81.2	<0.1	18.3	<0.1	3.3	16.6	9,627.4	3.9	2,763.9
3	10.7	84.1	0.3	17.0	<0.1	81.2	<0.1	18.3	<0.1	3.3	4.4	9,615.3	0.9	2,760.9
4	5.0	78.3	0.1	16.8	<0.1	81.2	<0.1	18.3	<0.1	3.3	2.0	9,612.9	0.3	2,760.3
5	17.2	90.5	0.1	16.8	<0.1	81.2	<0.1	18.3	<0.1	3.3	7.1	9,618.0	0.9	2,760.9
6	4.1	77.5	0.1	16.7	<0.1	81.2	<0.1	18.3	<0.1	3.3	1.7	9,612.6	0.2	2,760.2
7	4.6	77.9	0.1	16.7	<0.1	81.2	<0.1	18.3	<0.1	3.3	1.9	9,612.8	0.5	2,760.5
8	6.3	79.6	0.1	16.8	<0.1	81.2	<0.1	18.3	<0.1	3.3	2.6	9,613.5	0.7	2,760.7
9	19.2	92.5	0.5	17.2	<0.1	81.2	<0.1	18.3	<0.1	3.3	7.9	9,618.8	1.4	2,761.4
10	26.3	99.6	1.1	17.8	<0.1	81.2	<0.1	18.3	<0.1	3.3	10.9	9,621.8	2.4	2,762.4
11	7.2	80.5	0.2	16.9	<0.1	81.2	<0.1	18.3	<0.1	3.3	3.0	9,613.9	0.7	2,760.7
12	21.8	95.1	0.9	17.6	<0.1	81.2	<0.1	18.3	<0.1	3.3	9.0	9,619.9	2.2	2,762.2
13	2.2	75.5	<0.1	16.7	<0.1	81.2	<0.1	18.3	<0.1	3.3	0.9	9,611.8	0.2	2,760.2
14	14.4	87.8	0.5	17.2	<0.1	81.2	<0.1	18.3	<0.1	3.3	6.0	9,616.8	1.4	2,761.4
15	19.6	92.9	0.6	17.3	<0.1	81.2	<0.1	18.3	<0.1	3.3	8.1	9,619.0	1.6	2,761.6
16	8.7	82.0	0.3	17.0	<0.1	81.2	<0.1	18.3	<0.1	3.3	3.6	9,614.5	0.8	2,760.8
17	2.2	75.6	<0.1	16.7	<0.1	81.2	<0.1	18.3	<0.1	3.3	0.9	9,611.8	0.2	2,760.2
18	9.6	82.9	<0.1	16.7	<0.1	81.2	<0.1	18.3	<0.1	3.3	4.0	9,614.8	0.5	2,760.5
19	7.8	81.1	<0.1	16.7	<0.1	81.2	<0.1	18.3	<0.1	3.3	3.2	9,614.1	0.4	2,760.4

Note: Incr = Incremental Concentration from Project, Cumul = Cumulative Concentration between Project Increment and Background

Table 18: Predicted Incremental Air Toxics and Metals Concentrations

Receptor ID	Incremental 99.9th Percentile 1-hour Predicted Concentration (µg/m³)									Incremental Annual Lead (µg/m³)
	Benzene	Ethylbenzene	Toluene	Xylenes	PAHs	Arsenic	Cadmium	Chromium	Nickel	
Criterion	**29**	**8,000**	**360**	**190**	**0.4**	**0.09**	**0.018**	**0.09**	**0.18**	**0.5**
1	0.02	0.01	0.05	0.05	0.08	<0.01	0.002	0.01	0.02	<0.01
2	0.02	0.01	0.05	0.05	0.11	<0.01	0.002	0.01	0.01	0.01
3	<0.01	<0.01	0.01	0.01	0.03	<0.01	0.001	0.00	0.00	<0.01
4	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.000	0.00	0.00	<0.01
5	<0.01	<0.01	0.02	0.01	0.02	<0.01	0.001	0.00	0.01	<0.01
6	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.000	0.00	0.00	<0.01
7	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.000	0.00	0.00	<0.01
8	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.000	0.00	0.00	<0.01
9	0.01	<0.01	0.02	0.01	0.03	<0.01	0.001	0.00	0.01	<0.01
10	0.01	0.01	0.03	0.04	0.07	<0.01	0.001	0.00	0.01	<0.01
11	<0.01	<0.01	0.01	0.01	0.02	<0.01	0.000	0.00	0.00	<0.01
12	0.01	0.01	0.03	0.03	0.07	<0.01	0.001	0.00	0.01	<0.01
13	<0.01	<0.01	<0.01	<0.01	0.00	<0.01	0.000	0.00	0.00	<0.01
14	0.01	<0.01	0.02	0.02	0.04	<0.01	0.001	0.00	0.00	<0.01
15	0.01	<0.01	0.02	0.03	0.06	<0.01	0.001	0.00	0.01	<0.01
16	<0.01	<0.01	0.01	0.01	0.04	<0.01	0.000	0.00	0.01	<0.01
17	<0.01	<0.01	<0.01	<0.01	0.00	<0.01	0.000	0.00	0.00	<0.01
18	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.000	0.00	0.01	<0.01
19	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.000	0.00	0.00	<0.01
Boundary Maximum	0.08	0.04	0.16	0.22	0.29	<0.01	0.011	0.05	0.15	0.05

6. MITIGATION MEASURES

In addition to the management measures described in **Table 2** the following would be implemented as part of an Air Quality Management Plan (AQMP) to mitigate the potential impacts arising from the Project.

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken;
- Record any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation in the log book;
- Carry out regular site inspections to monitor compliance with the AQMP, record inspection results, and make an inspection log available to the local authority when asked;
- Establish four dust deposition monitoring locations around the Project site. Where practicable the monitoring locations would be established a minimum of three months prior to the Project to establish baseline conditions;
- Keep site fencing, barriers and scaffolding clean using wet methods;
- Impose and signpost a maximum-speed-limit of 20 km/h on all roads and work areas;
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction;
- Provide an adequate water supply on the Project site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate;
- Use enclosed chutes and conveyors and covered skips where possible and appropriate;
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate;
- Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust);
- Vehicles entering and leaving the Project site would be covered to prevent escape of materials during transport; and
- Haul routes would be inspected for integrity and, where required, instigate necessary repairs to the surface as soon as reasonably practicable.

As discussed in **Section 4.2.3**, the demolition of the Smelter would involve the demolition of three stacks and one water tower via controlled explosives detonation. Specific mitigation measures that would be applied to the demolition of the stacks and the tower would also be included in the AQMP and include the following:

- Removal of dust from inside the stacks through wash downs, as practicable;
- The stack and water tower exclusion zones would be sealed with concrete or bitumen and/or treated with a chemical dust suppressant;
- The stack and water tower exclusion zones would be swept and watered immediately prior to detonation;
- Appropriate water sprays would be implemented prior to, during and after the completion of the detonation event;
- Predicted wind directions and speed for the proposed detonation event would be reviewed to determine whether predicted conditions would minimise the potential for dust to impact on surrounding sensitive locations; and
- Wind direction and speed would be monitored prior to and during the detonation event to minimise the potential for dust to impact on surrounding sensitive locations..

7. CONCLUSION

This Air Quality Impact Assessment has been prepared by Ramboll Environ on behalf of Hydro Aluminium Kurri Kurri Pty Ltd to support an Environmental Impact Statement for submission to the Department of Planning and Environment prepared to assess for the Project at the former Hydro Aluminium Kurri Kurri aluminium smelter site.

Emissions of particulate matter, individual metals and air toxics and diesel-combustion related air pollutants were quantified for peak Stage 2 operations. Ground level concentrations were predicted at selected sensitive receptor locations surrounding the Smelter site using the AERMOD dispersion model.

Based on the predicted concentrations, the assessment concluded that applicable NSW EPA impact assessment criteria would not be exceeded at any of the surrounding sensitive receptor locations.

A range of mitigation and management measures were recommended that would control emissions from the Project and minimise potential air quality impacts.

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9. LIMITATIONS

Ramboll Environ Australia Pty Ltd (Ramboll Environ) prepared this report in accordance with the scope of work as outlined in our proposal to Hydro Aluminium Kurri Kurri Pty Ltd dated 15 December 2014 and in accordance with our understanding and interpretation of current regulatory standards.

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

Ramboll Environ did not independently verify all of the written or oral information provided to Ramboll Environ during the course of this investigation. While Ramboll 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 Ramboll 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.

9.1 User Reliance

This report has been prepared exclusively for Hydro Aluminium Kurri Kurri Pty Ltd and may not be relied upon by any other person or entity without E Ramboll Environ's express written permission.

APPENDIX A
EMISSIONS INVENTORY BACKGROUND

Introduction

Air emission sources associated with the various phases of the Project were identified and quantified through the application of accepted published emission estimation factors, collated from a combination of United States Environmental Protection Agency (US-EPA) AP-42 Air Pollutant Emission Factors and NPI emission estimation manuals, including the following:

- NPI Emission Estimation Technique Manual for Mining (NPI, 2012)
- NPI Emission Estimation Technique Manual for Combustion Engines (NPI, 2008);
- AP-42 Chapter 11.19.2 –Crushed Stone Processing and Pulverized Mineral Processing (US-EPA, 2004b);
- AP-42 Chapter 13.2.2 – Unpaved Roads (US-EPA 2006); and
- AP-42 Chapter 11.9 - Western Surface Coal Mining (US-EPA 1998).

Particulate emissions were quantified for various particle size fractions. TSP emissions were estimated and modelled to predict dust deposition rates and TSP concentrations. PM_{10} and $PM_{2.5}$ emissions were estimated using ratios for the different particle size fractions available within the literature, as documented in subsequent sections.

Sources of Particulate Matter Emissions

Air emissions associated with the facility will primarily comprise of fugitive particulate matter releases. Sources of atmospheric emissions associated with the facility include:

- Vehicle movements on paved and unpaved roads;
- Erosion of stockpiles and freshly exposed areas on-site;
- Handling, transfer and storage of materials;
- Heavy earthwork operations such as excavation and earth moving activities; and
- Re-contouring of land and soil exposure for reseeding.

Emissions Scenario Assumptions

In addition to the assumptions listed in **Section 4.2.2**, the following assumptions were made in the development of the project emissions inventory:

- A nominal 0.5 ha of erodible surface at any given time has been applied to each of the demolition works, demolition material stockpiling, capped storage area, crusher area and temporary soil storage areas. An area of 1 ha has been adopted for wind erosion from the Containment Cell.
- Haul distances for are as follows:

Road	Length
Demolition waste to crusher area	0.35km
Crusher area to stockpiling area	0.6km
SPL/Capped waste storage to Containment Cell	1.1km
Excavated soil transport	1.4km
Non-recyclable demolition waste to offsite	0.8km

- Average truck weights (accounting for loaded and unloaded weights) is assumed to be 30t. Empty truck weight is assumed to be 20t, while load in truck is assumed to be 30t.
- Calculated annual emissions from wind dependent particulate matter sources (materials handling, wind erosion) were varied hourly by wind speed to ensure that higher emissions occurred during periods of higher wind speeds.

Particulate Matter Emission Factors Applied

The emission factor equations applied within the assessment are documented in this subsection. **Table B1** lists the uncontrolled emission factors that were applied for the two emission scenarios, references the source of the listed factors and whether the factor is derived from a specific equation or published default.

Table B1 Emission Estimation Factors Applied

Activity Area	Emission Source	Emission Factor			Emission Factor Unit	Source of Factor
		TSP	PM_{10}	$PM_{2.5}$		
Demolition Works	Demolition Works	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Loading to trucks	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Haul to Crusher	2.44	0.62	0.06	kg/Vehicle KM Travelled	AP-42 13.2.2 - Unpaved Road Equation
	Unloading to Crusher	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Crushing	0.00060	0.00027	0.00005	kg/tonne	USEPA AP-42 11.19.2 - Tertiary Crushing Factor
	Loading to trucks	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Haul to Stockpiling Area	2.44	0.62	0.06	kg/Vehicle KM Travelled	AP-42 13.2.2 - Unpaved Road Equation
	Unloading to Stockpiling Area	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Material Handling - Stockpiling Area	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Wind Erosion - Exposed surfaces and stockpiles	850	425	63.75	kg/ha/year	AP-42 11.9 - Wind erosion of exposed areas factor
Capped Waste Storage	Loading to trucks	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Haul to Containment Cell	2.44	0.62	0.06	kg/Vehicle KM Travelled	AP-42 13.2.2 - Unpaved Road Equation
	Unloading to Containment Cell	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Material Handling - Containment Cell	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Wind Erosion - Exposed surfaces and stockpiles	850	425	63.75	kg/ha/year	AP-42 11.9 - Wind erosion of exposed areas factor
Contaminated Soil Excavation	Loading to trucks	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Haul to Storage Area	2.44	0.62	0.06	kg/Vehicle KM Travelled	AP-42 13.2.2 - Unpaved Road Equation
	Unloading to Storage Area	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling

Table B1 Emission Estimation Factors Applied

Activity Area	Emission Source	Emission Factor			Emission Factor Unit	Source of Factor
		TSP	PM_{10}	$PM_{2.5}$		
	Material Handling - Storage Area	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Wind Erosion - Exposed surfaces and stockpiles	850	425	63.75	kg/ha/year	AP-42 11.9 - Wind erosion of exposed areas factor
Non-recyclable Demolition Waste	Loading to trucks	0.00150	0.00055	0.00008	kg/tonne	AP-42 11.19.2 - Default for Material Handling
	Haul offsite	2.44	0.62	0.06	kg/Vehicle KM Travelled	AP-42 13.2.2 - Unpaved Road Equation
All	Diesel Combustion	0.0036	0.0036	0.0033	kg/litre	NPI Combustion Engines - Miscellaneous Industrial Vehicles

Unpaved Roads Equation

The emissions factors for unpaved roads, as documented within AP42 Chapter 13.2.2 -"Unpaved Roads" (US-EPA 2006a), was applied as follows:

$$E = k\,(s/12)^{a}(W*1.1023/3)^{b}$$

Where:

E = Emissions Factor (lb/VMT)

s = surface material silt content (%)

W = mean vehicle weight (tonnes)

The following constants are applicable:

Constant	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
K (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

The metric conversion from lb/VMT to g/VKT is as follows:

1 lb/VMT = 0.2819 kg/VKT

A silt content of 4.8% was assumed for unpaved roads, adopted from default for “Sand and Gravel Processing – Plant Road” presented in US-EPA 2006a (deemed to be most appropriate to Smelter site demolition activities).

APPENDIX B
INCREMENTAL POLLUTANT ISOPLETHS

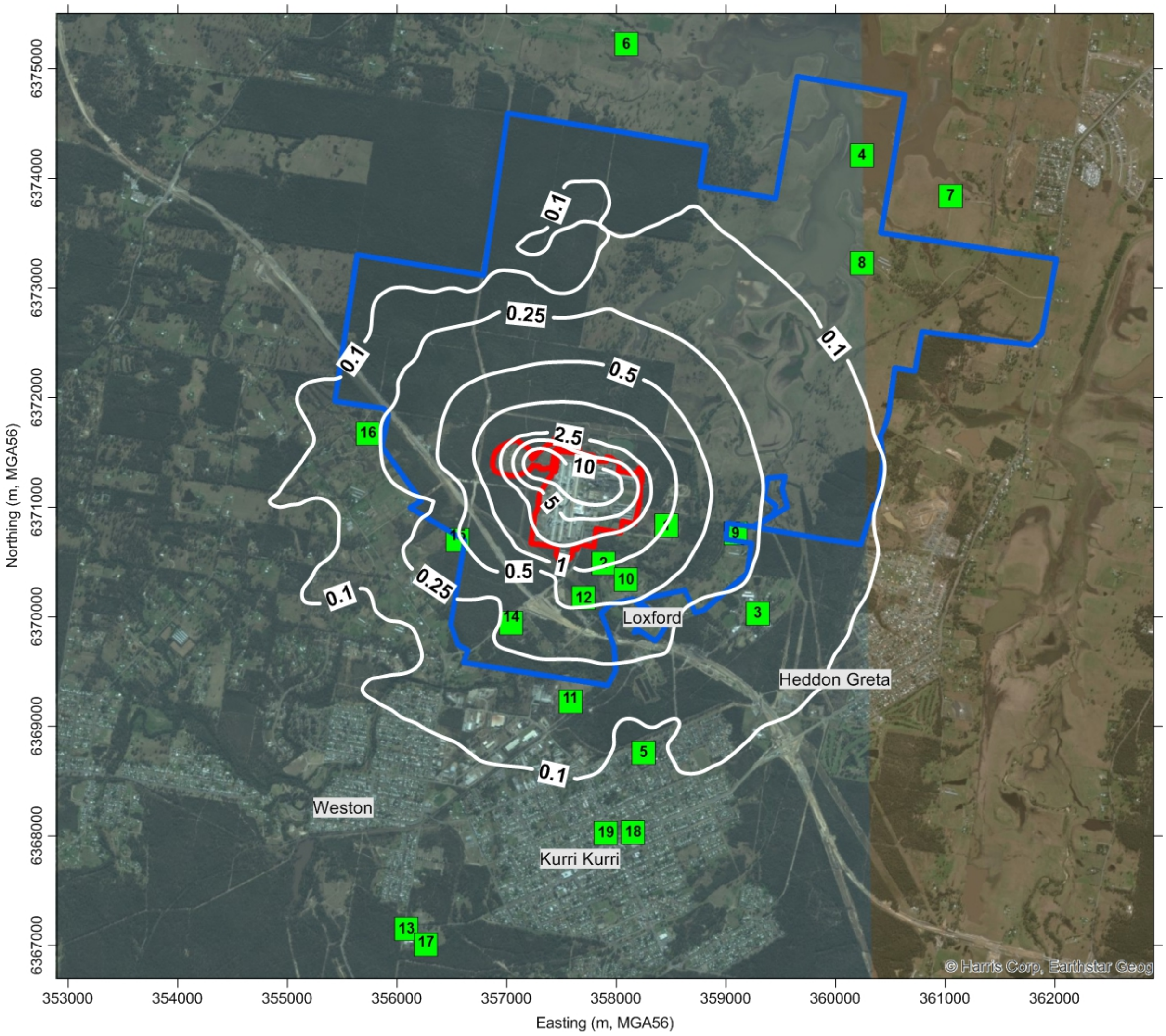

Figure B1 – Predicted incremental annual average TSP concentrations (µg/m³)

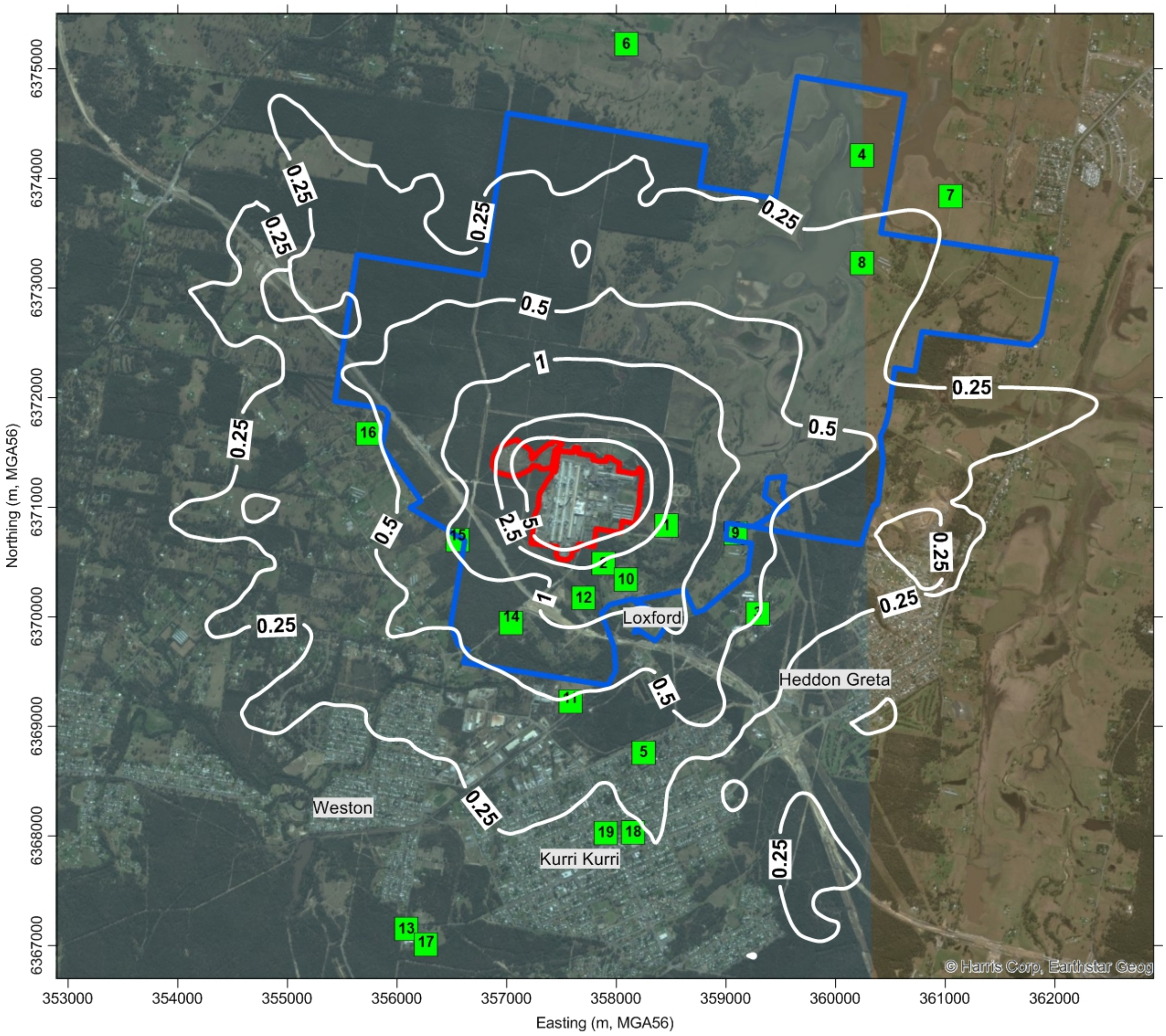

Figure B2 – Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

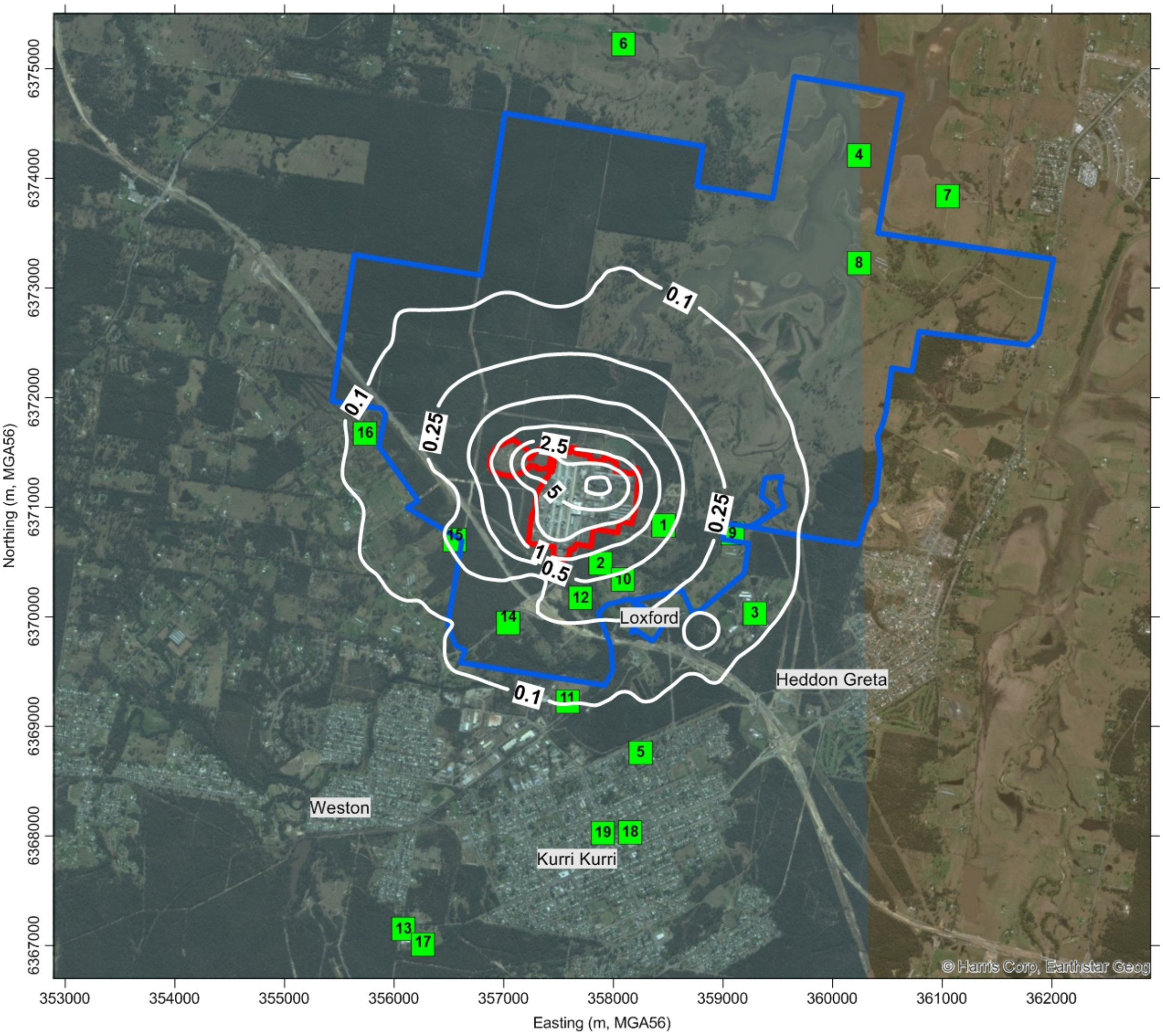

Figure B3 – Predicted incremental annual average PM_{10} concentrations (µg/m³)

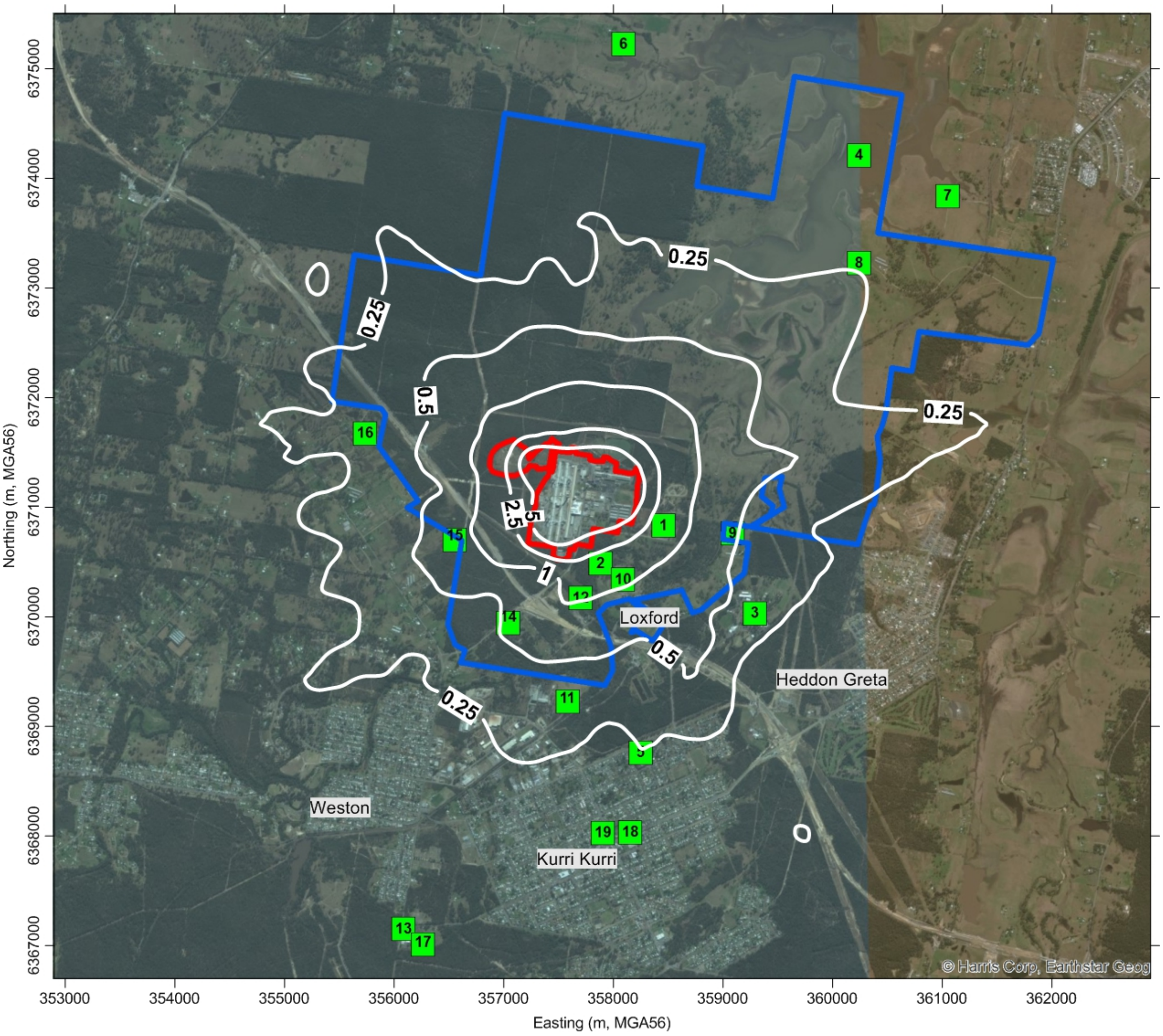

Figure B4 – Predicted incremental 24-hour average $PM_{2.5}$ concentrations (µg/m³)

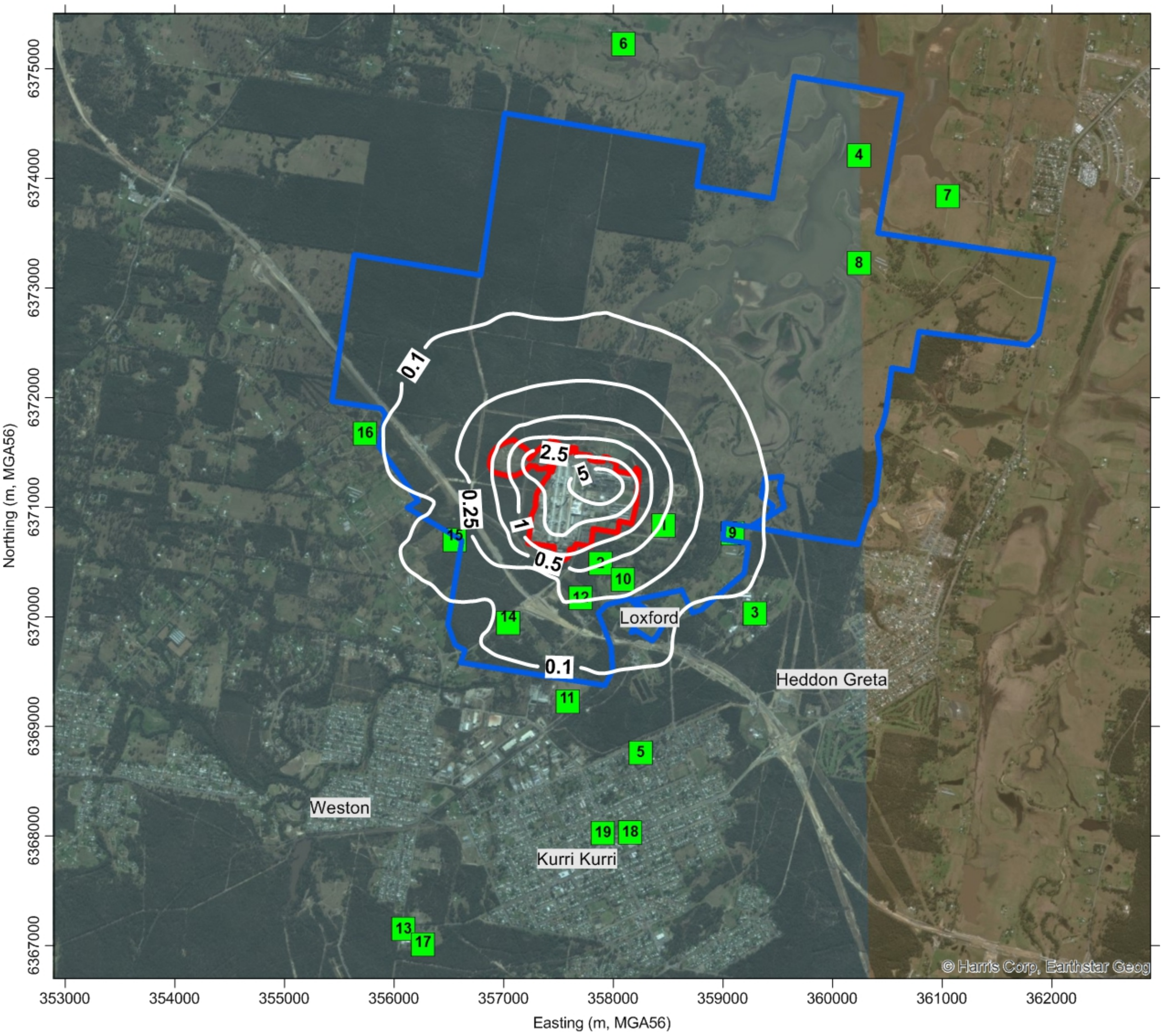

Figure B5 – Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)