Appendix H

Air quality assessment

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MAYFIELD WEST RECYCLING FACILITY – PRODUCTION INCREASE
AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

RAMBOLL ENVIRON

MAYFIELD WEST RECYCLING FACILITY – PRODUCTION INCREASE
AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

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EXECUTIVE SUMMARY

Benedict Recycling Pty Ltd (Benedict Recycling) is seeking approval to increase the volume of material handled at the Mayfield West Recycling Facility (the recycling facility) at 1a McIntosh Drive, Mayfield West, NSW. Ramboll Environ Australia Pty Ltd (Ramboll Environ) has been commissioned by EMM Consulting Pty Ltd (EMM) on behalf of Benedict Recycling to conduct an air quality and greenhouse gas assessment of operations at the recycling facility.

Emissions of TSP, PM_{10}, $PM_{2.5}$ and odour were estimated for peak proposed future operations associated with the Recycling Facility. Atmospheric dispersion modelling predictions of air pollution emissions for operations were undertaken using the CALPUFF dispersion model.

Existing air quality and meteorological conditions were analysed through a number of data resources, drawing on a meteorological modelling dataset prepared for the Newcastle area and data from the NSW Office of Environment and Heritage lower Hunter air quality monitoring network.

The results of the dispersion modelling conducted indicated that the operations at the recycling facility was unlikely to result in exceedances of the applicable NSW EPA assessment criteria for TSP, PM_{10} and dust deposition or the NEPM reporting goals for $PM_{2.5}$. Potential odour impacts from the Recycling Facility were conservatively assessed, with resultant predicted odour concentrations well below applicable impact assessment criterion.

A greenhouse gas quantification assessment was undertaken for the Recycling Facility. The annual Scope 1 and Scope 3 emissions at full production represent approximately 0.00097% of total GHG emissions for NSW and 0.00024% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

1. INTRODUCTION

Benedict Recycling Pty Ltd (Benedict Recycling) is seeking approval to increase the volume of material handled at the Mayfield West Recycling Facility (the recycling facility) at 1a McIntosh Drive, Mayfield West, NSW (see **Figure 1-1**).

Development consent (DA 15291) was granted for the recycling facility on 8 March 2016, including acceptance of up to 90,000 tonnes per annum (tpa) of waste and ancillary activities. The recycling facility imports inert pre-classified general solid waste (non-putrescible), such as construction and demolition wastes, and selected commercial and industrial wastes, for processing (eg crushing, shredding and sorting) to produce saleable recycled materials. The site also includes ancillary activities.

Since the commencement of operations, Benedict Recycling has identified additional demand for the disposal and recycling of excavated materials from large civil works (eg road projects), commercial developments (eg excavations for high rise buildings) and smaller developments (eg residential building sites). These volumes are far greater than originally expected. Benedict proposes to increase the annual volume of material received at the recycling facility from 90,000 tpa to 315,000 tpa, and proposes minor changes to the site layout to include an additional stockpile area (the proposal).

Ramboll Environ Australia Pty Ltd (Ramboll Environ) has been commissioned by EMM Consulting Pty Limited (EMM) on behalf of Benedict Recycling to conduct an air quality and greenhouse gas assessment of the proposed increase in material handling at the Recycling Facility.

This report provides:

- characterisation of the existing environment, specifically the existing air quality, prevailing meteorology and regulatory context;
- review of potential emission sources and mitigation measures;
- calculation of annual particulate matter emissions from the Recycling Facility;
- atmospheric dispersion modelling of emissions for proposed increased operations at Recycling Facility to predict potential air quality impacts at surrounding sensitive receptor locations; and
- quantification of greenhouse gas emissions from the peak future operations of the Recycling Facility.

1.1 Study objectives

The objective of the study is to identify the potential air quality and greenhouse gas related impacts associated with the project, satisfy the Secretary's Environmental Assessment Requirements (SEARs) and to make recommendations for additional mitigation and management measures if required.

1.2 Secretary's Environmental Assessment Requirements

The SEARs for the project are as follows:

- **Air Quality and Odour** – including
  - a quantitative assessment of potential air quality, dust and odour impacts of the development in accordance with relevant Environment Protection Authority guidelines;
  - the details of buildings and air handling systems and strong justification for any material handling, processing or stockpiling external to a building;
  - a greenhouse gas assessment; and
  - details of proposed mitigation, management and monitoring measures.

The air quality requirements are specifically addressed in **Section** 7**,** 8**, 9** and **10** of the report with earlier sections providing the baseline information and study

methodology. The greenhouse gas requirements are specifically addressed in **Section 11** of the report.

The air quality assessment is guided by the NSW Environment Protection Authority (NSW EPA) Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ("the Approved Methods for Modelling", (NSW EPA, 2005).

Figure 1-1: Site Location

Source: EMM (2016)

2. PROJECT DESCRIPTION AND LOCAL SETTING

2.1 Overview

Benedict Recycling is seeking development consent for the continuation of approved operations, with an increase in the volume of material handled at the site from 90,000 tpa to a total of 315,000 tpa (the proposal). An additional product stockpile storage area is proposed, as shown in **Figure 2-1**. The additional stockpile area has an area of 13,110 m², increasing

A description of the approved operations and changes under the proposal are provided below.

2.2 Approved operations

The recycling facility has two main components (**Figure 2-1**):

- The main recycling facility on the west of the site, accepting and processing co-mingled inert waste;
- ancillary activities on the east of the site that may include temporary storage, including for light and heavy vehicles.

The EIS considered impacts from both components, particularly the combined traffic volumes. The main recycling facility has commenced operations, while the ancillary waste activity area has not yet been developed. Accordingly, the impacts assessed in the EIS are conservative (ie over-estimated) for current operations at the site.

The recycling facility is approved to accept up to 90,000 tpa of 'Pre-classified general solid waste (non-putrescible)' as defined by EPA (2014). This mainly consists of the following wastes:

- co-mingled and segregated building and demolition waste—soils, bricks, concrete, paper/cardboard, cloth, plastics, rubber, plasterboard, ceramics, glass, metal and wood;
- vegetation and uncontaminated soils;
- tiles, asphalt, suitable slags and concrete batching waste;
- excavated natural materials (ENMs) including virgin natural excavated material (VNEM) such as sand and sandstone which are generated during bulk earthworks and road and infrastructure repair; and
- rail ballast and spoils.

No special, hazardous restricted solid waste (including asbestos) is accepted at the site.

The recycled materials able to be produced include soils, mulches, road-base, metals and drypaper/cardboard. These products meet recycled material specifications while recovering a range of materials that may otherwise be disposed to landfill. All of the materials brought onto the site are taken from the site as products or as rejects for disposal at a licensed landfill. No materials are land-filled or otherwise disposed anywhere within the site.

The approved hours of operation of the recycling facility are:

- waste delivery and dispatch to and from the premises: Monday to Friday, 6 am–6 pm, Saturday 6 am-5 pm and Sunday 7 am–3 pm; and
- waste processing at the premises: Monday to Saturday, 7 am–6 pm.

The recycling facility has approval to accept (but not process) waste 24 hours per day on occasion.

Figure 2-1: Site Layout

Source: EMM (2016)

2.3 Proposed changes to the recycling facility

Additional demand to recycle the types of excavated materials approved to be received by the recycling facility (eg ENM, VNEM and the like) has been identified.

Benedict Recycling proposes to receive and process an additional 225,000 tpa of materials that meet the EPA's definition of 'Pre-classified general solid waste (non-putrescible)' at the recycling facility to meet the identified market demand.

Therefore, development consent is sought for the operation of the recycling facility generally as described in the 2015 EIS (EMM 2015), with an increase in the volume of material handled at the site up to a total of 315,000 tpa. An additional product

stockpile storage area is proposed, as shown in Figure 2.1. The additional stockpile area has an area of 13,110 m², increasing the total stockpiling area at site to approximately 27,900 m^2.

There would be no change to the classification of waste materials already approved to be received at the recycling facility, general site operations, waste processing, overall site boundaries or approved hours of operation.

Equipment that will be used at the recycling facility for the proposed increased operations is listed in **Table 2-1.** Benedict Recycling will ensure that all plant and equipment complies with the applicable emission standards prescribed within the NSW Government *Protection of the Environment Operations (Clean Air) Regulation* 2010.

Table 2-1 Equipment and activities

Plant (or equivalent)	Quantity	Typical Activities
Equipment used across the site		
Front end loader (eg Volvo L150)	2	Unloading and loading trucks Moving waste and products
Generator	1	Power for weighbridge, offices, amenities and lighting
Trucks (customers)	8	Delivering waste and dispatching products Returning to/leaving the site
Equipment used in processing shed		
Excavator (eg Komatsu PC120)	1	Sorting waste using a variety of excavator attachments Loading feed to processing plant Loading trucks
Flip-flow screen waste sorter (eg Finlay 883flip flow)	1	Sorting co-mingled waste
Picking line	2	Sorting co-mingled waste from flip flow
Campaign processing in yard		
Excavator (eg Komatsu PC220) and secondary crusher/screen (egMetsoLT1213)	1	Loading material to crusher Crushing/screening material
Timber shredder (eg Komptech Crambo)	1	Shredding timber and vegetation

3. PROJECT SETTING

3.1 Existing land use and topography

The recycling facility is located at Mayfield West, in the Newcastle local government area, approximately 6.5km northwest of the Newcastle central business district. The site is bounded by the Hunter River South Arm to the north, Steel River Industrial Estate to the west and south, and the former BHP Steelworks site and Tourle Street to the east. The site was formerly a chemical manufacturing plant operated by Delta EMD, with abandoned buildings and structures associated with the former facility still in place.

The topography of the site is generally flat, dominated by the river flatlands of the Hunter River. **Figure 3-1** illustrates the topography of the area surrounding the facility.

3.2 Nearest Residences

The recycling facility is located in the immediate vicinity of a number of industrial and commercial operations, principally to the immediate west in the Steel River Industrial Estate. Further afield to the south are the residential areas of Mayfield West, Mayfield and Warabrook. A mixture of residential and industrial receptors, representative of the surrounding region, have been selected as assessment locations for this report. Relevant details of these receptors are listed within **Table 3-1**.

Figure 3-2 illustrates the location of these assessment locations relative to the recycling facility.

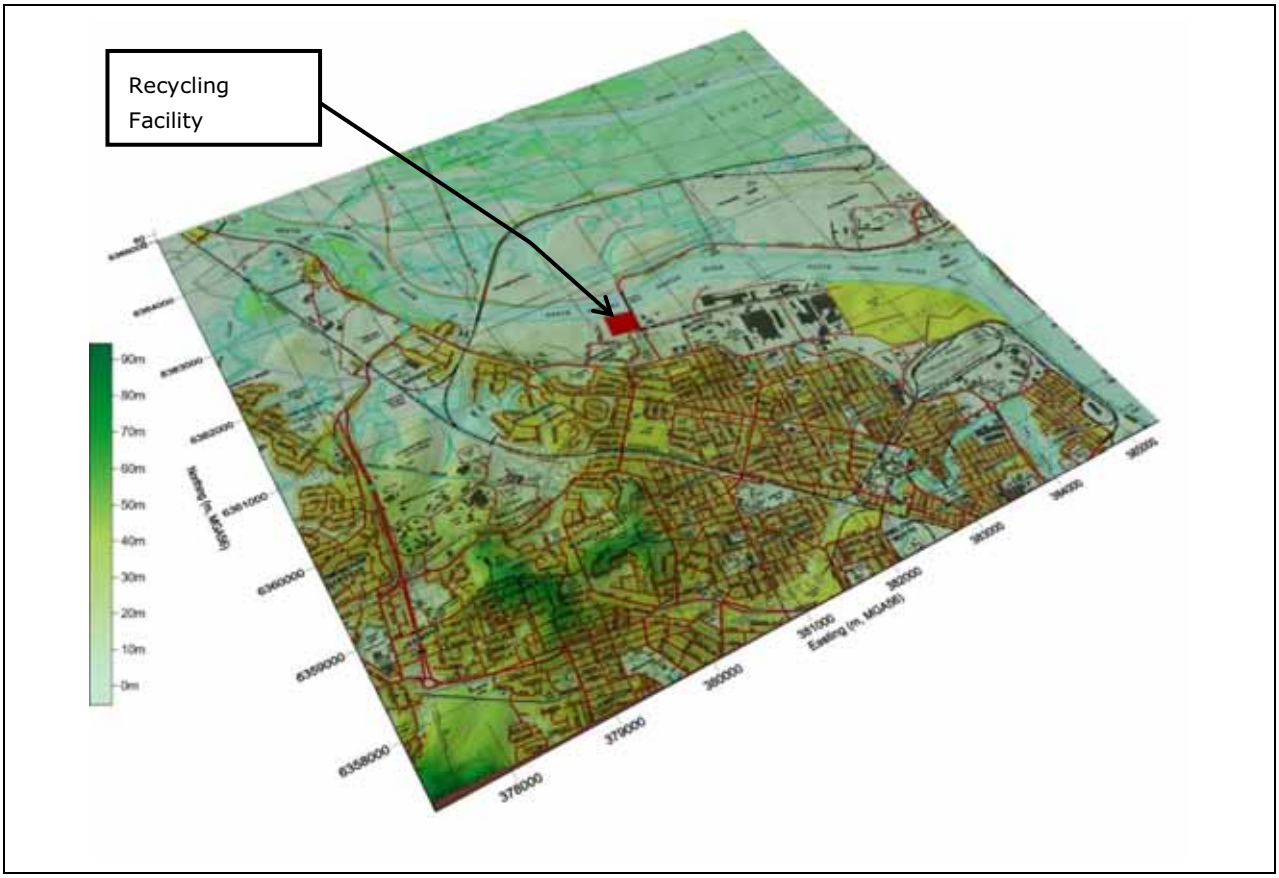

Figure 3-1: Topography Surrounding the Recycling Facility

Note: Vertical Exaggeration of 2 applied

Table 3-1 Selected surrounding sensitive receptor locations

Receptor ID	Location (m, MGA56S)		Elevation (m, AHD)	Receptor type
	Easting	Northing		
R1	381977	6360373	13	Residential
R2	381723	6360432	17	Residential
R3	381354	6360489	14	Residential
R4	381185	6360515	12	Residential
R5	381051	6360548	13	Residential
R6	380959	6360594	14	Residential
R7	380726	6360721	15	Residential
R8	380310	6360853	21	Residential
R9	380107	6361052	17	Residential
R10	381099	6361201	10	Industrial
R11	381085	6361052	11	Industrial
R12	381073	6360905	14	CSIRO
R13	381494	6361128	8	Future residential

Note: Receptors 10 and 11 are neighbouring industrial properties, receptor 12 is the CSIRO Energy Centre and receptor 13 is a potential future receptor location at the old BHP Steelworks site.

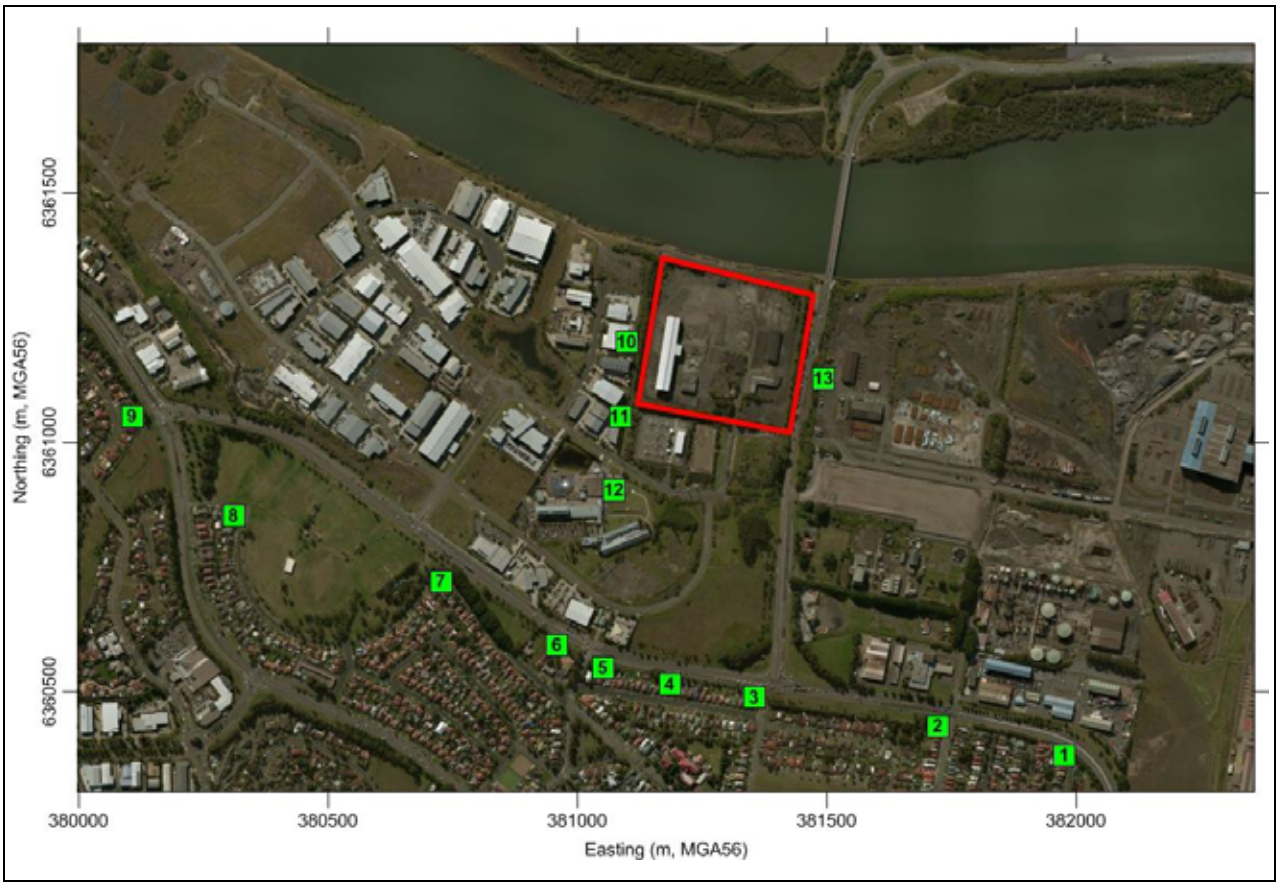

Figure 3-2: Surrounding assessment locations

4. AIR QUALITY ASSESSMENT CRITERIA

The project must demonstrate compliance with the impact assessment criteria outlined in the Approved Methods for Modelling (EPA, 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 Approved Methods for Modelling specifies that the impact assessment criteria for 'criteria pollutants[1]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be presented, requiring consideration of existing ambient background concentrations for the criteria pollutants assessed.

For this assessment, focus has been given to the emissions of primary particulate matter (PM), including total suspended particulate matter (TSP) and particulate matter with an equivalent aerodynamic diameter of less than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$). Dust deposition, as a result of the TSP emissions, is also assessed.

In addition to PM, the recycling facility has the potential to generate odourous emissions, particularly associated with the storage of green waste, although no composting will be allowed to occur. Odour emissions are therefore quantified and assessed in this report.

4.1 Goals applicable to airborne particulate matter

Air quality limits for PM are typically given for various particle size metrics, including TSP, PM_{10} and $PM_{2.5}$. PM_{10} and $PM_{2.5}$ require specific consideration due to their health impact potential.

The impact assessment criteria for TSP and PM_{10} are prescribed in the Approved Methods for Modelling, however $PM_{2.5}$ is not included. Reference is therefore made to the $PM_{2.5}$ reporting standards issued by the National Environmental Protection Council (NEPC) (NEPC, 2003). The National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) $PM_{2.5}$ reporting standards were first published as advisory goals in 2003 for the purpose of supporting the monitoring and evaluation of ambient $PM_{2.5}$ concentrations ahead of the setting ambient air quality standards for this pollutant. The AAQ NEPM was varied in December 2015 to adopt these 'advisory reporting standards' as formal standards for $PM_{2.5}$ (NEPC, 2015).

The air quality criteria applied for PM in this assessment are presented in **Table 4-1**.

[1] 'Criteria pollutants' is used to describe air pollutants that are commonly regulated and typically used as indicators for air quality. In the Approved Methods the criteria pollutants are TSP, PM_{10}, NO_2, SO_2, CO, ozone (O_3), deposition dust, hydrogen fluoride and lead.

Table 4-1 Impact assessment criteria for PM

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

Note 1: NSW EPA, 2005 *Approved Methods for Modelling*

Note 2: NSW EPA impact assessment criterion based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal

Note 3: NEPC, 2015, *National Environment Protection (Ambient Air Quality) Measure,* as amended

4.2 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 4-2** 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 4-2 Impact assessment criteria for 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

4.3 Criteria for Odour Mixtures

The odour performance criteria are expressed in terms of odour units. The detectability of an odour is defined as a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour threshold and defines one odour unit (OU). An odour criterion of less than 1 OU would theoretically result in no odour impact being experienced.

A concentration of 7 OU means that the sample requires a dilution with clean air 7 times to become odour free; thus an odour concentration expressed as 7 OU coincides with a dilution-to-threshold (D/T) ratio of 7, and 2 OU equates to a D/T ratio of 2 (and so on).

The NSW Technical Framework - Assessment and Management of Odour from Stationary Sources recommends that, as a design goal, no individual be exposed to ambient odour levels of greater than 7 OU (NSW DEC, 2006). Although the level at which an odour is perceived to be a nuisance can range from 2 OU to 10 OU, experience gained through odour assessments from proposed and existing facilities in NSW indicates that an odour performance goal of 7 OU is likely to represent the level below which "offensive" odours should not occur (for an individual with a 'standard sensitivity' to odours) (NSW DEC 2006).

Odour performance criteria are designed to take into account the range in sensitivities to odours within the community, and provide additional protection for individuals with a heightened response to odours, using a statistical approach which depends on the size of the affected population.

As the affected population size increases, the number of sensitive individuals is also likely to increase, which suggests that more stringent criteria are necessary in these situations. In addition, the potential for cumulative odour impacts in relatively sparsely populated areas can be more easily defined and assessed than in highly populated urban areas.

Where a number of the factors simultaneously contribute to making an odour "offensive", an odour goal of 2 OU at the nearest residence (existing or any likely future residences) is appropriate, which generally occurs for affected populations equal or above 2000 people. The EPA odour performance criteria are therefore based on considerations of risk of odour impact rather than on differences in odour acceptability between urban and rural areas.

Odour performance goals for various population densities are outlined in Table 7.5 of the Approved Methods for Modelling (EPA, 2005), and summarised in **Table 4-3**. They are expressed as the 99th percentile value, nose response time average (approximately one second).

For this assessment, an odour performance criteria of 2 OU is adopted.

Table 4-3 EPA odour performance criteria vs. population density

Population of Affected Community	Odour Performance Criteria (OU(1))
Urban area (> 2000)	2
500 – 2000	3
125 – 500	4
30 – 125	5
10-30	6
Single residence (< 2)	7

Source: Approved Methods for Modelling, EPA 2005

Note 1: Odour concentration over a nose response time averaging period (1 second), with permissible frequencies of occurrence at 99th percentile for Level 2 assessments

4.4 Steel River Industrial Estate Criteria

In addition to the NSW EPA assessment criteria listed in the previous sections, the recycling facility is also subject to a Strategic Impact Assessment Study (SIAS) prepared for the adjoining Steel River Industrial Estate (APT Peddle Thorpe, 1998). The SIAS includes criteria for an 'environmental envelope' which is considered to have an acceptable level of impact for industrial development in the area.

The SIAS criteria for Steel River Industrial Estate are presented in **Table 4-4**. It can be seen that for TSP and PM_{10}, the criteria is equal to or greater than the NSW EPA assessment criteria. Consequently, if the NSW EPA assessment criteria are satisfied, the SIAS criteria for Steel River Industrial Estate will also be satisfied. These criteria have not been considered further in this report.

It is noted that lead, nitrogen dioxide and sulphur dioxide are not considered significant high risk pollutants from the recycling facility and have not been addressed further within this assessment.

Table 4-4 Steel River Industrial Estate SIAS Criteria

Pollutant	Criteria	Averaging Time
TSP	90µg/m³	Annual
PM_{10}	150µg/m³	24-hour
	50µg/m³	Annual
Lead	1.5µg/m³	Annual
Nitrogen Dioxide	16pphm	1-hour
	5pphm	Annual
Sulphur Dioxide	25pphm	10-minutes
	20pphm	1-hour
	2pphm	Annual

5. CLIMATE AND DISPERSION METEOROLOGY

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

In order to characterise the dispersion meteorology of the region surrounding the facility, long-term climate records, time resolved meteorological monitoring data and meteorological modelling for the region was drawn upon, as documented in the following sections.

5.1 Meteorological Modelling

In 2012, Ramboll Environ (then ENVIRON Australia) undertook a detailed meteorological modelling exercise for the Newcastle region as part of an air quality impact assessment in the region. This modelling was conducted using a combination of the TAPM regional meteorological model and the CALMET diagnostic meteorological model, utilising local and regional meteorological monitoring datasets to refine model calculations. Modelling was conducted for a 50km x 55km modelling domain centred over the Mayfield/Kooragang Island area. The meteorological modelling focused on the 2010 calendar year, which was shown to be representative of the Newcastle region based on analysis of annual, seasonal and diurnal trends in local monitoring data. The modelling underwent thorough independent peer review as well as review by the NSW EPA. Full details of the meteorological modelling conducted are presented in that report (ENVIRON, 2012).

The outputs of the ENVIRON 2012 meteorological modelling have been accessed for use in this assessment. Hourly-varying meteorological predictions were extracted from the model at the recycling facility for analysis within this report.

Section 4.1 of DEC (2005) specifies that meteorological data representative of a site can 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).

5.2 Prevailing annual wind regime

5.2.1 Inter-annual variability

In order to understand the interannual variability in the Newcastle area, hourly weather observations were collected from the closest Bureau of Meteorology (BoM) automatic weather station (AWS) to the recycling facility. This station is the Nobbys Signal AWS, located approximately 7km east-southeast of the site. Annual wind roses generated from hourly wind speed and direction recorded between 2010 and 2014 are presented in **Appendix A**.

The wind roses generated from the Nobbys Signal AWS highlight consistency in wind speed and direction patterns across the five years analysed. All years exhibit dominant flow from the northwest with more variable flow from the northeast to south-southwest. Annual average wind speed and percentage calm conditions (winds less than 0.5m/s) are also similar across the five years.

From the above analysis, it is considered that there is limited recent inter-annual variability in wind speed and direction experienced in the Newcastle region and it was considered appropriate to apply to 2010 meteorological model developed by ENVIRON, and described in **Section 5.1**, as the basis for meteorological analysis at the recycling facility.

5.2.2 Annual, seasonal and diurnal wind regime – recycling facility

The wind rose of recorded wind speed and direction extracted from the Newcastle region meteorological model at the recycling facility is presented in **Figure 5-1**. The annual wind pattern is dominated by west-northwesterly flow, with a secondary easterly quadrant flow also evident. The highest wind speeds predicted at the site are most frequently experienced from the west-northwest direction. The average wind speed for the dataset is 2.8m/s, with a frequency of calm conditions occurring in the order of 3% of the time. It is noted that wind speeds are lower than those recorded at the BoM Nobbys Station AWS, however this difference is expected considered the coastal location of that station.

Seasonal and diurnal (dividing the day into four periods) wind roses for the recycling facility dataset are also presented within **Appendix A**.

Seasonal variation is evident in the data predicted at the site. The dominant west-northwest component evident in the annual wind direction profile is most defined during the winter, while summer experiences a higher proportion of flow from the easterly quadrant. Wind speed is typically highest during summer, while the incidence of calms is highest during the autumn months.

Diurnal variation in the recorded wind regime is also notable in the data predicted at the site. Wind speeds are greatest during the daylight periods, peaking during the period between noon and 6pm. The occurrence of easterly flow is greatest in the afternoon hours, with the earlier hours of the day experiencing flow from the western half of the directional spectrum. Wind speeds are notably lower between the evening and early morning hours, with the southwesterly component the dominant wind direction.

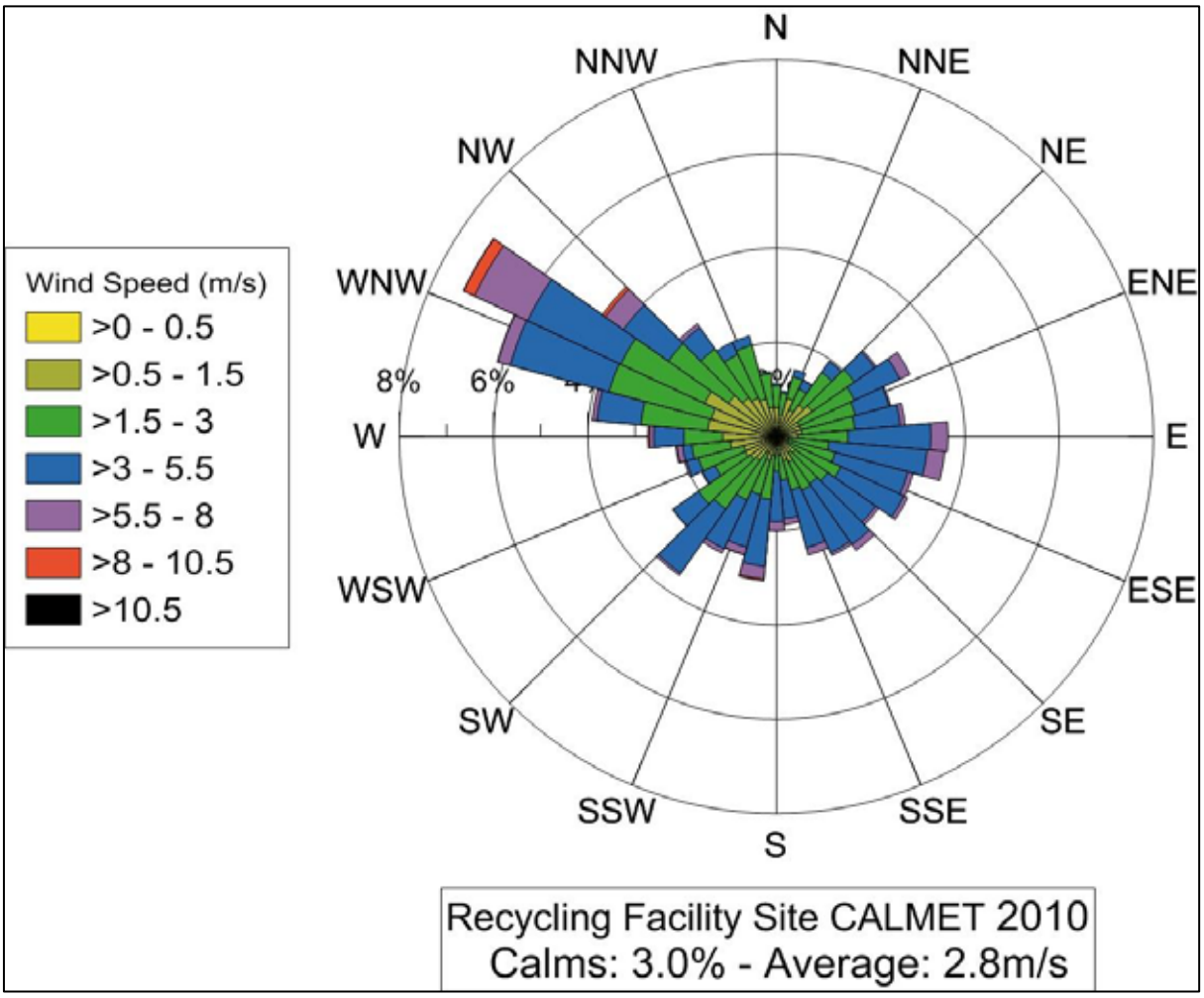

Figure 5-1: Annual Wind Rose – recycling facility – 2010

5.3 Ambient temperature

Monthly mean minimum temperatures are in the range of 7°C to 19°C, with mean maximum of 18°C to 29°C, based on the long-term average record from the BoM Newcastle University climate station, the closest long-term climate monitoring station to the site (2.5km southwest). Peak temperatures occur during summer months with the highest temperatures typically being recorded between November and March. The lowest temperatures are usually experienced between June and August.

The CALMET-generated temperature for the recycling facility during 2010 has been compared with long-term trends recorded at the BoM Newcastle University climate station to determine the representativeness of the dataset. **Figure 5-2** presents the monthly variation in predicted temperature during 2010 compared with the recorded regional mean, minimum and maximum temperatures. There is good agreement between temperatures predicted during 2010 and the recorded historical trends, indicating that the dataset is representative of conditions likely to be experienced in the region.

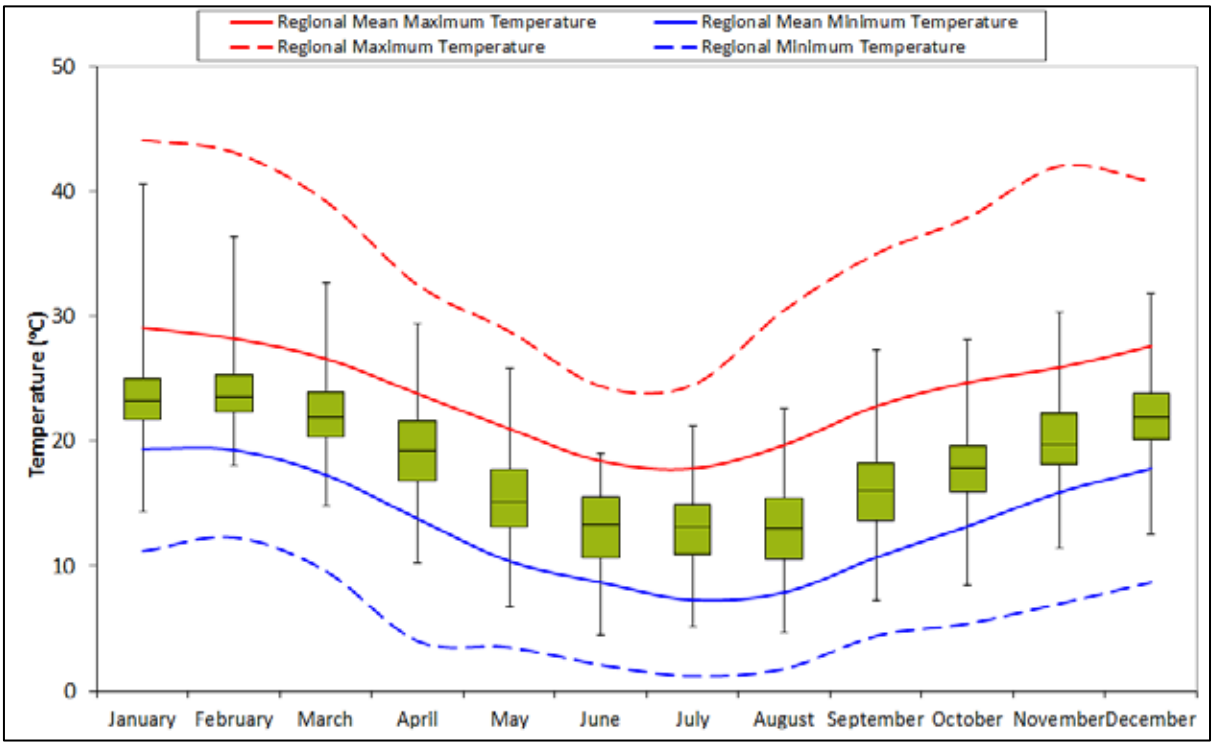

Figure 5-2: Temperature Comparison between CALMET-generated recycling facility 2010 dataset and Historical Averages (1998-2015) – Newcastle University

Note: CALMET-generated temperatures for the site 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 Newcastle University are depicted as line graphs.

5.4 Rainfall

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 1998 at Newcastle University, the region is characterised by high rainfall, with a mean annual rainfall of 1,130mm, and an annual rainfall range between 914mm and 1,516mm. There is significant variation in monthly rainfall throughout the year, with the period between January and June typically experiencing higher falls than the remainder of the year.

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

5.5 Atmospheric stability

Atmospheric stability refers to the degree of turbulence or mixing that occurs on the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Pasquill-Turner assignment scheme identifies six Stability Classes, "A" to "F", to categorise the degree of atmospheric stability prevailing at a given time (defined in **Table 5-1**).

Table 5-1 Description of atmospheric stability classes

Atmospheric Stability Class	Category	Description
A	Very unstable	Low wind, clear skies, daytime conditions
B	Unstable	Light to moderate winds, clear skies, daytime conditions
C	Slightly unstable	Moderate wind, slightly overcast daytime conditions
D	Neutral	High winds, cloudy days and nights, transition between day and night (and vice versa)
E	Stable	Moderate wind, slightly overcast, night-time conditions

The frequency of occurrence of each atmospheric stability class predicted by CALMET at the recycling facility site for the modelling period is illustrated in **Figure 5-3**. Stability classes E and F, corresponding to a stable atmosphere, were predicted to occur cumulatively 48% of the time. Stability class D, corresponding to a neutral atmosphere, was predicted to occur approximately 15% of the time.

The predicted seasonal variation in atmospheric stability at the recycling facility site is presented in **Figure 5-4**. Autumn and winter typically experience a higher occurrence of neutral to stable atmospheric conditions than spring and summer.

The diurnal variation in CALMET predicted atmospheric stability is presented in **Figure 5-5**. The presented profiles illustrate that atmospheric instability increases during daylight hours as convective energy increases, while stable atmospheric conditions prevail during night periods due to the occurrence of lower wind speeds and reduced convective mixing.

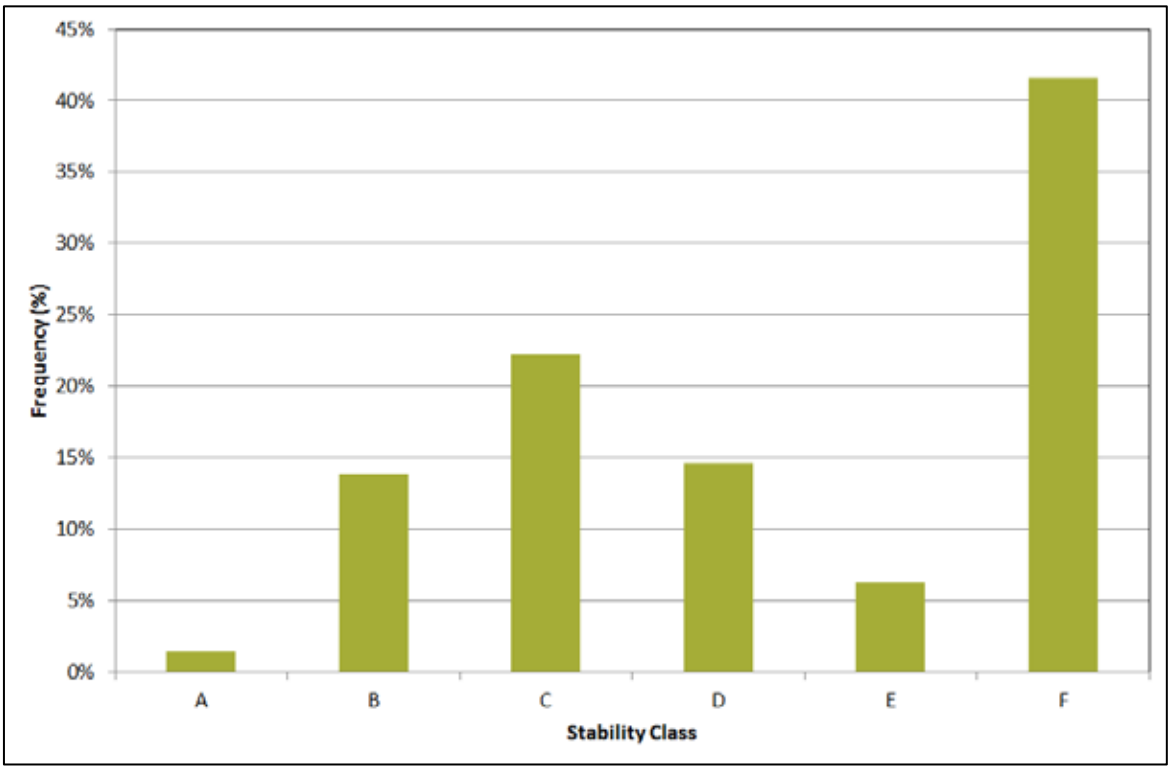

Figure 5-3: CALMET-predicted annual occurrence of atmospheric stability classes at the recycling facility

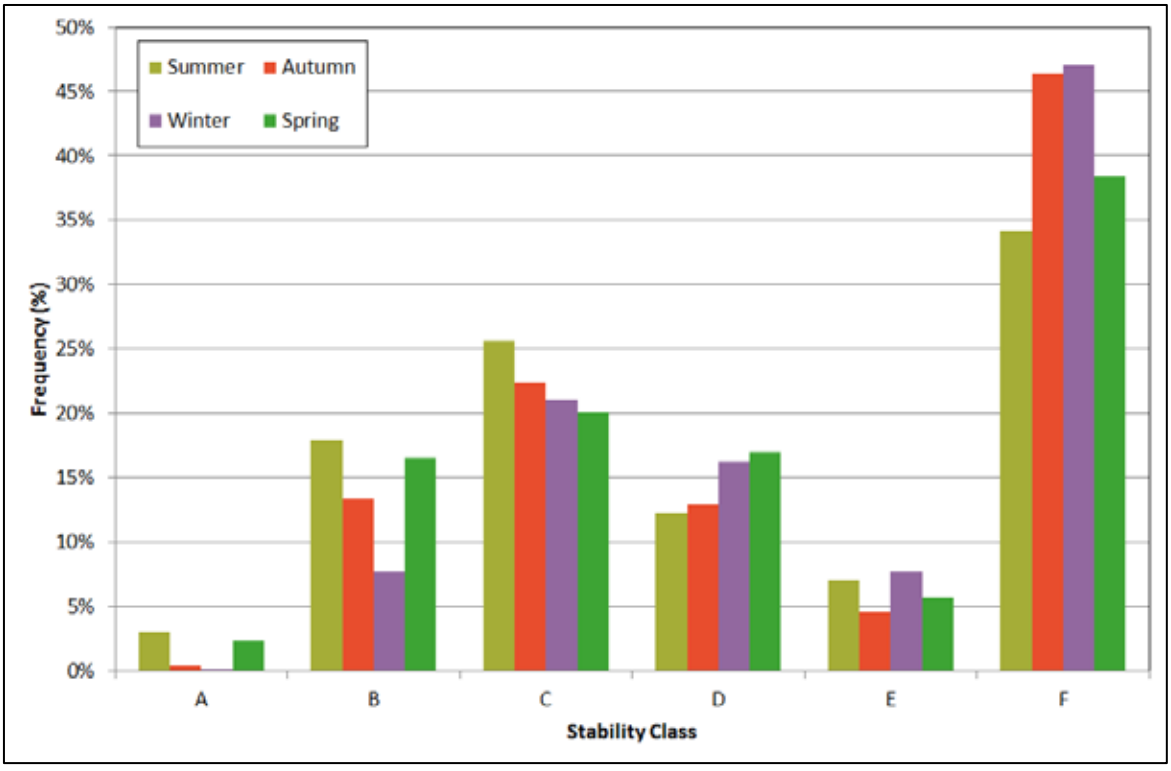

Figure 5-4: CALMET-predicted seasonal occurrence of atmospheric stability classes at the recycling facility

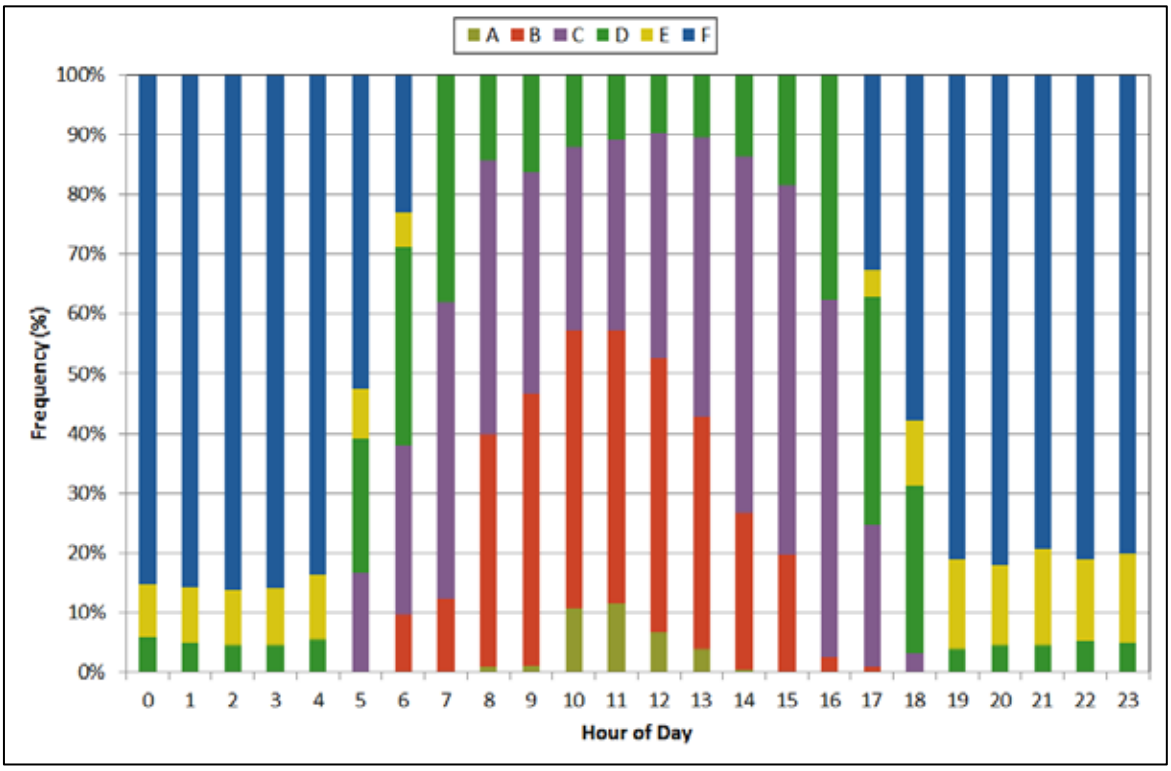

Figure 5-5: CALMET-predicted diurnal variation in atmospheric stability classes at the recycling facility

5.6 Mixing depth

The diurnal variation in CALMET-predicted atmospheric mixing depth for the recycling facility is illustrated in **Figure 5-6**. The atmospheric mixing depth increases during the day as the heat from the sun promotes convective mixing with maximum depths occurring in the afternoon coinciding with peak solar energy. Mixing depth reduces as the sun sets, removing solar energy, and mechanical mixing becomes more dominant.

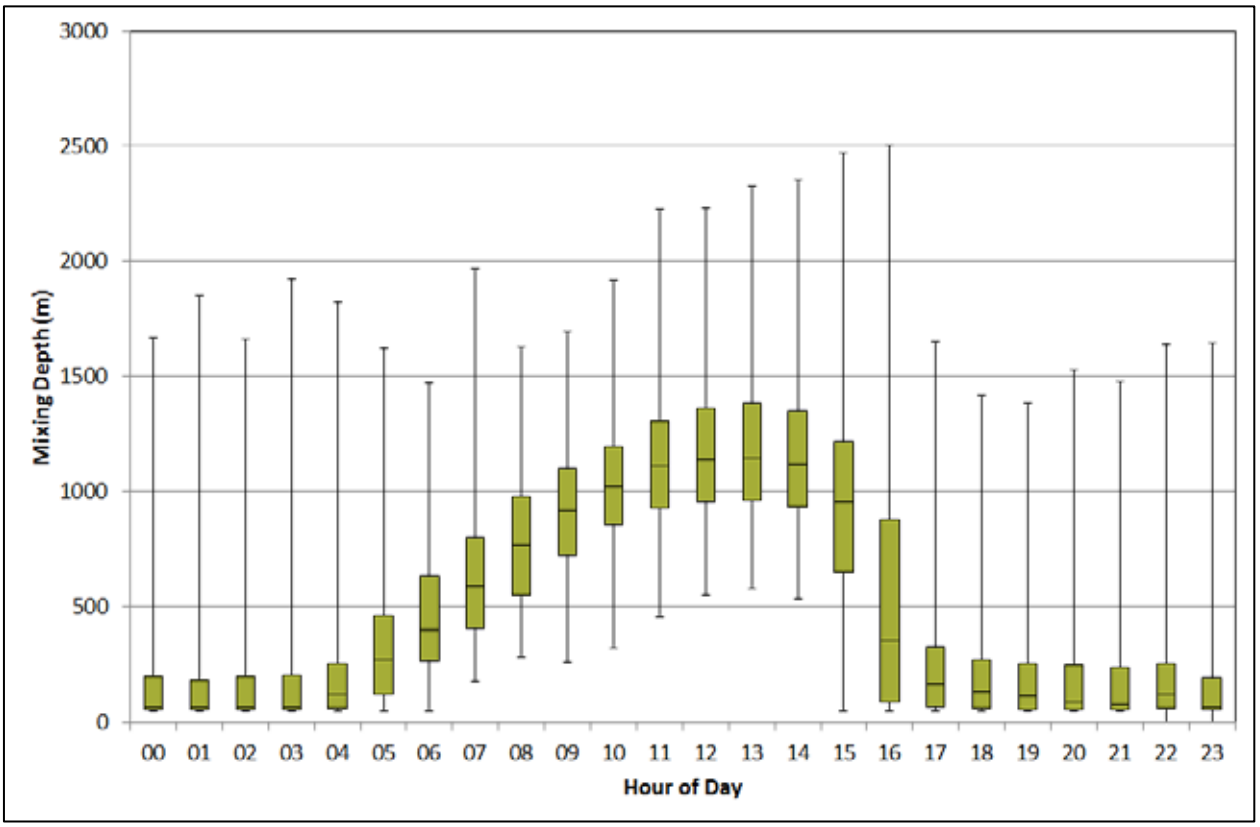

Figure 5-6: CALMET Predicted diurnal variation in atmospheric mixing depth – recycling facility site – 2010

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

6. EXISTING AIR QUALITY ENVIRONMENT

The quantification of cumulative air pollution concentrations and the assessment of compliance with ambient air quality criteria necessitate the characterisation of baseline air quality. The following sections provide a review of surrounding air pollution sources and air quality monitoring data.

6.1 Existing Local Sources of Atmospheric Emissions

Air quality in the Newcastle area is affected by a number of air emission sources including:

- industrial operations, including NSW EPA-licensed premises;
- mobile sources, such as emissions from road, rail and marine transport;
- emissions from light industrial, commercial and residential activity;
- construction and demolition activities;
- 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.

6.2 Monitoring Data Available for Baseline Air Quality Characterisation

No air quality monitoring is conducted at the proposed recycling facility. The NSW Office of Environment and Heritage (OEH) maintain a network of six air quality monitoring stations across the Newcastle region, referred to as the Lower Hunter Air Quality Monitoring Network (LHAQMN). These are located at:

- Mayfield – established in mid-2014, approximately 400m south-southwest of the site;
- Carrington – established in mid-2014, approximately 4.3km east-southeast of the site;
- Stockton – established in mid-2014, approximately 5.4kmeast-southeast of the site;
- Wallsend – established in 1992, approximately 5.8km west-southwest of the site;
- Newcastle – established in 1992, approximately 6.2m southeast of the site; and
- Beresfield – established in 1993, approximately 11.5km northwest of the site.

All available daily-varying PM_{10} and $PM_{2.5}$ monitoring data from the LHAQMN recorded since January 2010 was obtained in order to analyse existing ambient particulate matter concentrations in the Newcastle region.

In addition to these OEH monitoring stations, the Newcastle Coal Infrastructure Group (NCIG) maintain a network of monitoring locations surrounding the NCIG Coal Export Terminal at Kooragang Island. Relevant to the study area, NCIG record PM_{10} and TSP concentrations at a location within the Steel River Industrial Estate (approximately 500m west-southwest of the site) and dust deposition levels at a location in Mayfield West (approximately 800m southwest of the site). Results from these monitoring locations are reported by NCIG in publicly available Annual Environmental Monitoring Reports (AEMR). To supplement the data recorded by LHAQMN, NCIG monitoring results reported in AEMR documentation have been accessed.

6.2.1 PM_{10}

Daily-average PM_{10}concentrations were collated from the NSW OEH LHAQMN station for the period between January 2010 and June 2016.

A time-series of 24-hour average PM_{10} concentrations recorded by the LHAQMN stations between 2010 and 2016 is presented in **Figure 6-1**.

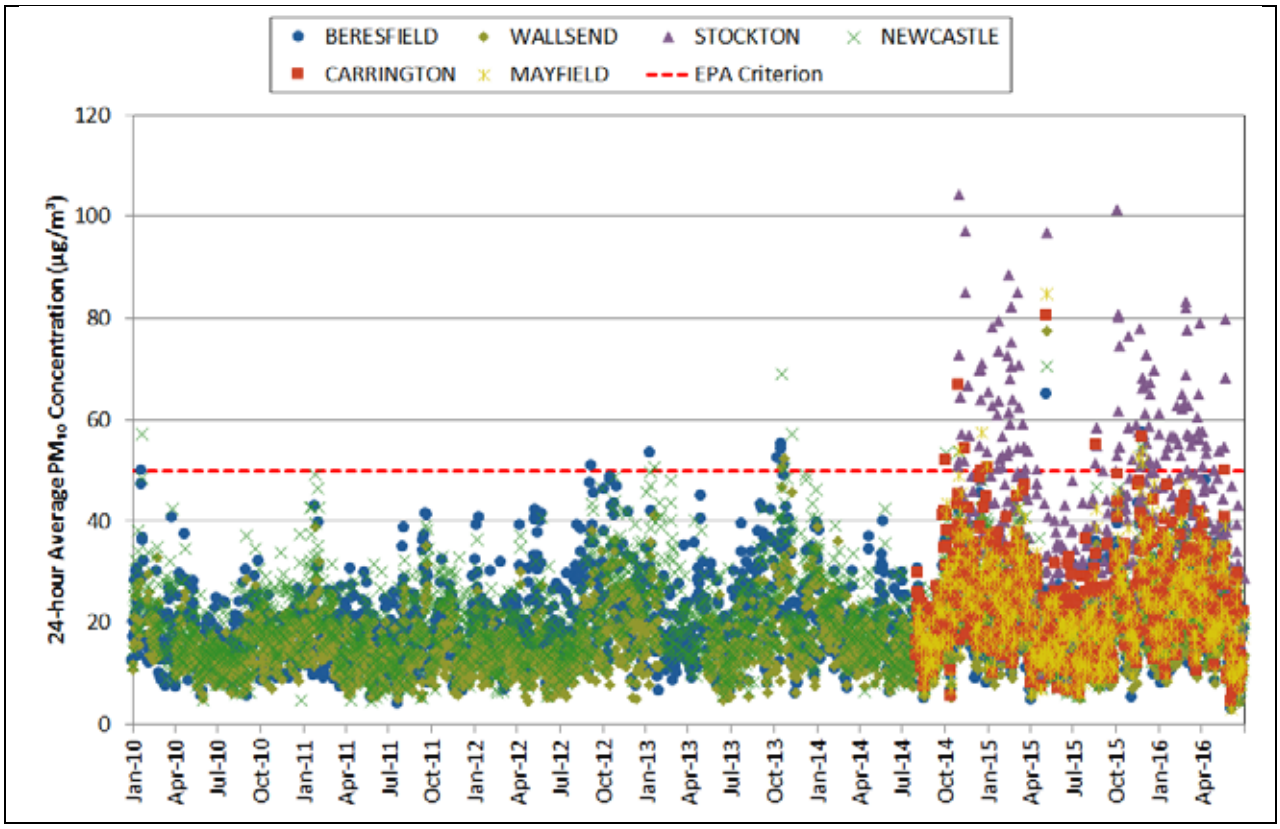

Figure 6-1: Timeseries plot of 24-hour average PM_{10} concentrations – NSW OEH LHAQMN – 2010 - 2016

To understand the relationship in PM_{10} concentrations recorded across the LHAQMN 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 6-1**.

Table 6-1 Relationship Between PM_{10} Monitoring Datasets – LHAQMN – August 2014 to June 2016

	Pearson Product Moment Correlation Coefficient (r)					
	Wallsend	Carrington	Stockton	Newcastle	Mayfield	Beresfield
Wallsend	1					
Carrington	0.91	1				
Stockton	0.72	0.83	1			
Newcastle	0.93	0.93	0.81	1		
Mayfield	0.94	0.90	0.74	0.91	1	
Beresfield	0.91	0.82	0.66	0.81	0.86	1

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

- With the exception of concentrations recorded at the Stockton air quality monitoring station, daily varying PM_{10} concentrations recorded across the LHAQMN

exhibit a highly linear relationship (*r* greater than 0.71 at all stations). Concentrations recorded by these stations show consistency, both with regards to magnitude and the daily-varying profile;
- Data at the Stockton station is consistently higher than both the concentrations recorded at the other stations in the LHAQMN and the NSW EPA assessment criterion. Analysis of the dominant meteorological conditions concurrent with these conditions indicates that the Stockton station is heavily influenced by sea salt aerosol (i.e. winds from the easterly quadrant correspond to highest concentrations);
- Exceedance of the NSW EPA 24-hour average impact assessment criterion occurs at all LHAQMN 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 2013, 2014 and 2015 are directly attributable to extensive hazard reduction or bushfire events in NSW (NSW EPA, 2014, 2015, 2016).

The frequency of 24-hour average PM_{10} concentrations recorded across the LHAQMN between 2010 and 2016, excluding Stockton, has been analysed to determine the likelihood of ambient concentrations in the area surrounding the recycling facility. A frequency histogram of recorded PM_{10} concentrations is presented in **Figure 6-2**.

The frequency distribution presented in **Figure 6-2** highlights that 24-hour average PM_{10} concentrations recorded by the LHAQMN were less than 30µg/m^3 approximately 89% of the time between January 2010 and June 2016. The likelihood of a 24-hour average PM_{10} concentration greater than 50µg/m^3 was 0.4%, equating to approximately two days (1.6 days) in a calendar year.

To assess the cumulative 24-hour average PM_{10} impact of emissions from the recycling facility, each 24-hour average PM_{10} concentration recorded across all LHAQMN stations, between January 2010 and June 2016, is paired with each daily model prediction. The frequency distribution of the resultant cumulative (project contribution plus background contribution) concentrations is compared with the frequency distribution of the background (as presented in **Figure 6-2**) to analyse the probability of additional exceedances attributable to the operation of the recycling facility. Further discussion is made in **Section 9.2**.

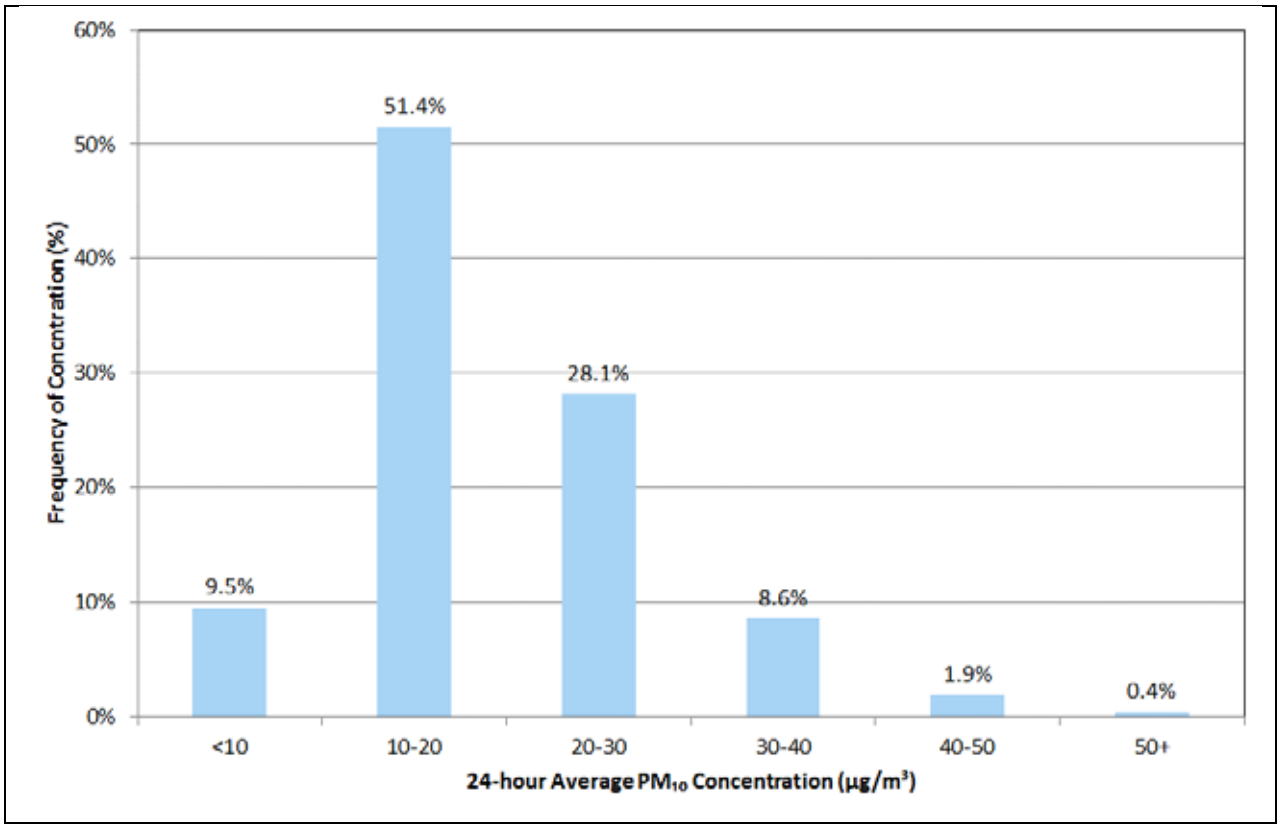

Figure 6-2: Frequency of 24-hour average PM_{10} concentrations – NSW OEH LHAQMN – 2010 - 2016

The LHAQMN-wide average PM_{10} concentration for the six years of monitoring data was 19.4µg/m^3. It is noted that the annual average PM_{10} concentrations reported by NCIG at the Steel River monitoring station ranged from 16.4µg/m^3 and 20.8µg/m^3 between 2010 and 2013. Consequently, it is considered that the LHAQMN-wide annual average PM_{10} concentration is appropriate for the assessment of cumulative annual average concentrations from the recycling facility.

6.2.2 $PM_{2.5}$

Daily-average $PM_{2.5}$concentrations were collated from the LHAQMN station for the period between January 2010 and June 2016.

A time-series of 24-hour average $PM_{2.5}$ concentrations recorded by the LHAQMN stations between 2010 and June 2016 is presented in **Figure 6-3**. The relationship between the monitoring locations in the LHAQMN is demonstrated by the calculated *r*-values for each $PM_{2.5}$ dataset pairing as presented in **Table 6-2**.

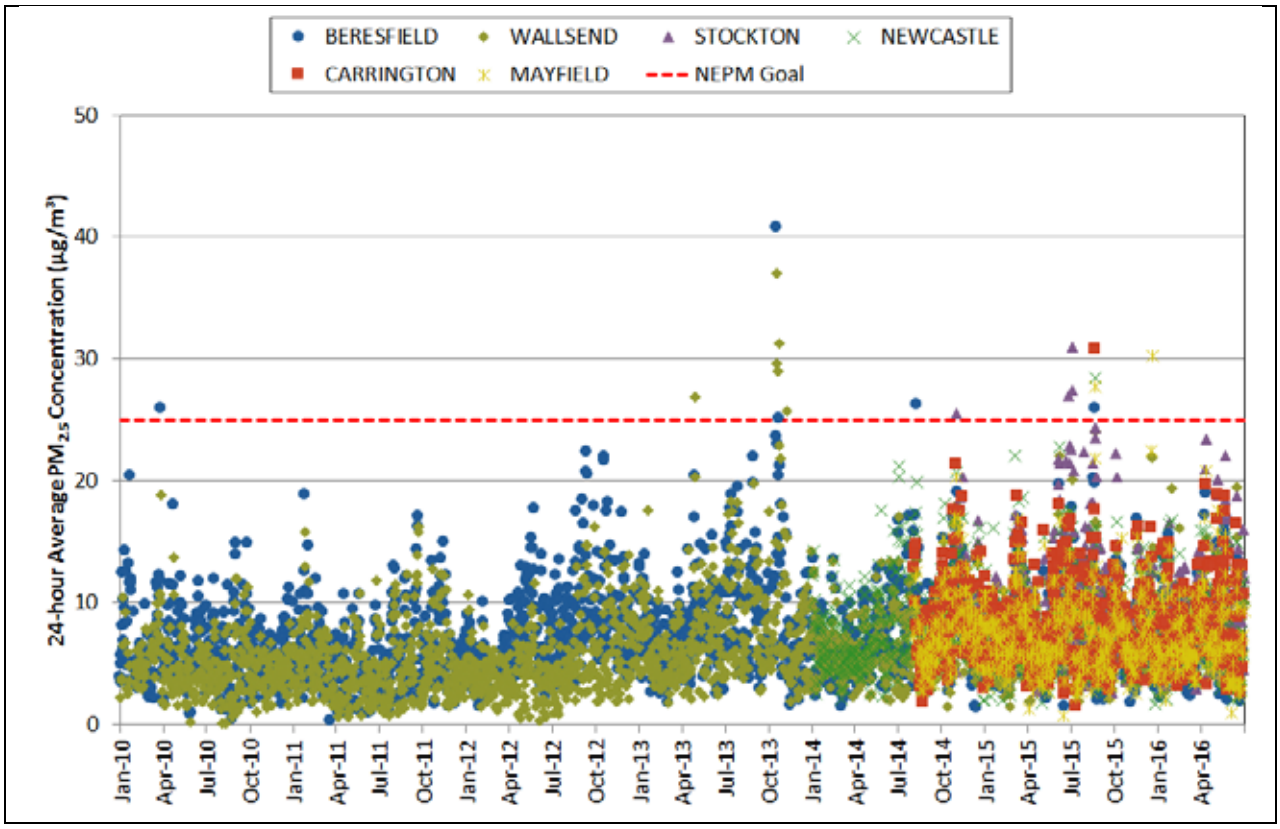

Figure 6-3: Timeseries plot of 24-hour average $PM_{2.5}$ concentrations – NSW OEH LHAQMN – 2010 - 2016

Table 6-2 Relationship Between $PM_{2.5}$ Monitoring Datasets – LHAQMN – August 2014 to June 2016

	Pearson Product Moment Correlation Coefficient (r)					
	Wallsend	Carrington	Stockton	Newcastle	Mayfield	Beresfield
Wallsend	1					
Carrington	0.75	1				
Stockton	0.68	0.75	1			
Newcastle	0.73	0.78	0.68	1		
Mayfield	0.79	0.81	0.67	0.72	1	
Beresfield	0.74	0.74	0.68	0.73	0.75	1

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

- Similar to the PM_{10} concentrations, the daily varying $PM_{2.5}$ concentrations recorded across the LHAQMN, excluding Stockton, exhibit a moderate to strong linear relationship (*r* greater than 0.68 at all stations). The recorded $PM_{2.5}$ concentrations recorded by these stations show consistency, both with regards to magnitude and the daily-varying profile;
- Exceedance of the NSW EPA 24-hour criterion occurs at all LHAQMN stations. The driving influence behind these elevated concentrations is typically natural events such as dust storms and bushfires. As was identified for PM_{10}, bushfires and hazard reduction burns coincide with exceedance days during 2013, 2014 and 2015.

The frequency of 24-hour average $PM_{2.5}$ concentrations recorded across the LHAQMN between 2010 and 2016, excluding Stockton, has been analysed to determine the

likelihood of ambient concentrations in the area surrounding the recycling facility. A frequency histogram of recorded $PM_{2.5}$ concentrations is presented in **Figure 6-4**.

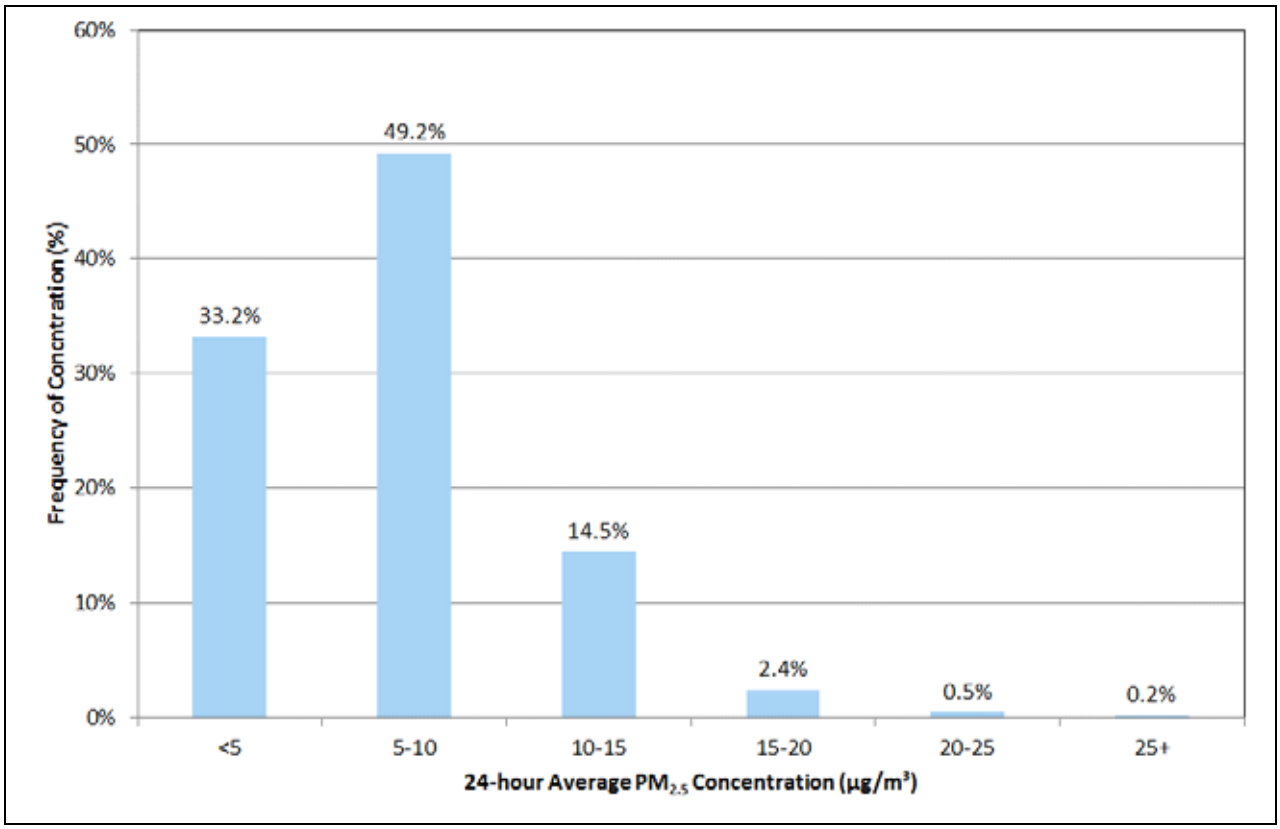

Figure 6-4: Frequency of 24-hour average $PM_{2.5}$ concentrations – NSW OEH LHAQMN – 2010 - 2016

The frequency distribution presented in **Figure 6-4** highlights that 24-hour average $PM_{2.5}$ concentrations recorded by the LHAQMN were less than 15µg/m^3 approximately 97% of the time between January 2010 and June 2016. The likelihood of a 24-hour average $PM_{2.5}$ concentration greater than the NEPM Advisory Goal of 25µg/m^3 was 0.2%, equating to approximately one day (0.8 days) in a calendar year.

Cumulative 24-hour $PM_{2.5}$ concentrations will be assessed in the same manner as 24-hour PM_{10} concentrations (see **Section 6.2.1**).

The LHAQMN-wide average $PM_{2.5}$ concentration for the five years of monitoring data was 7.0µg/m^3, which will be adopted for the assessment of cumulative annual average $PM_{2.5}$ concentrations from the recycling facility.

6.2.3 TSP

As stated, NCIG record TSP and PM_{10} concentrations at a location within the Steel River Industrial Estate. Based on results presented within NCIG AEMR for 2010 to 2013, annual average TSP concentrations at Steel River ranged from 33.6µg/m³ to 43.2µg/m³. The ratio between concurrent PM_{10} and TSP concentrations at Steel River ranged from 0.43 to 0.51.

In the absence concurrent TSP monitoring data for the LHAQMN, the ratio of 0.43 from the NCIG Steel River monitoring station will be applied to the five-year annual average PM_{10} concentration to derive a corresponding TSP concentration. The derived annual average TSP concentration for the LHAQMN is 44.7µg/m³, which will be adopted for the assessment of cumulative annual average TSP concentrations from the recycling facility.

6.2.4 Dust deposition

NCIG maintain a dust deposition gauge at Mayfield West. Annual average monthly deposition levels are reported in NCIG AEMR for 2010, 2011 and 2012. Dust deposition levels ranged from 1.2g/m^2/month to 1.5g/m^2/month. A value of 1.5g/m^2/month will be adopted for the assessment of cumulative annual average dust deposition levels from the recycling facility.

6.2.5 Odour

It is noted that the odour impact criterion specified by the NSW EPA is applicable to incremental (i.e. from the recycling facility alone). Consequently, no consideration has been given to cumulative impacts with surrounding odourous emission sources.

7. EMISSIONS ESTIMATION

Fugitive dust sources associated with the operation of the recycling facility under the proposal were principally quantified through the application of NPI emission estimation techniques (specifically the Emission Estimation Technique Manual for Mining) and United States Environmental Protection Agency (US-EPA) AP-42 emission factor equations. Particulate matter emissions were quantified for various particle size fractions, with the TSP fraction being estimated to provide an indication of dust deposition rates. Coarse particles (PM_{10}) and fine particle ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the US-EPA AP-42).

Odour emission rates were quantified using publically available odour monitoring results relevant to green waste storage at similar recycling facilities. It is noted that there is expected to be relatively small quantities of green waste delivered to the proposed facility or stored at the facility and there will be no composting.

7.1 Sources of Operational Emissions

Sources of atmospheric emissions associated with the recycling facility include:

- Vehicle entrainment of particulate matter due to the haulage of material along the sealed roads in the recycling facility;
- Unloading of material to the raw material storage areas within the main shed and in the external yard;
- Crushing and screening of larger material in the external yard;
- Transport of broken materials to the main shed for processing;
- Crushing and screening plant operations within the main shed;
- Loading and transfer of crushed material to stockpiles;
- Loading of product to truck for dispatch;
- Odour emissions from the storage of certain materials (assumed to be 100% green waste for this assessment);
- Diesel fuel combustion by on-site plant and equipment; and
- Wind erosion associated with the external yard (conservatively assumed to be from the portion of the site that is currently unsealed although much of this will eventually be sealed or armoured).

Emissions of non-particulate matter pollutants (including oxides of nitrogen, carbon monoxide and sulphur dioxide) associated with diesel fuel combustion are likely to be minor in nature relative to particulate matter emissions. Such emissions were not included in this assessment.

7.2 Emission Scenario

To assess the potential change in emissions associated with the proposal, one emission scenario representative of peak operations was assessed. The modelling assumptions made in this assessment are listed within **Appendix B.**

Due to uncertainty regarding the distribution and processing of raw materials at site, for particulate matter emission calculation purposes it is assumed all material delivered to site (315,000tpa) is solid building waste (concrete, bricks, etc). All material is hauled to and unloaded in the heavy waste yard to the north of the site, subjected to external stockpiling, handling and breaking, transfer of broken material to the main shed for internal handling, screening and crushing and then loaded to trucks for distribution to market.

In reality, not all material received at site will not require screening and crushing. Consequently, it is considered that the peak scenario described is highly conservative for the estimation of particulate matter from the recycling facility.

With the exception of associated truck movements, activities in the ancillary waste activities area in the east of the site have not been modelled. While exact details of activities are unknown at this time, it is expected that activities in this area will be infrequent in occurrence and have a lower emission potential than those associated with the recycling facility, particularly campaign crushing in the heavy waste yard. Many processes, including glass crushing activities, would occur within enclosed buildings and related emissions will be negligible. Emissions from the ancillary waste activities area are considered to be a minor and have not been considered further within this assessment.

7.3 Emission Reduction Factors

Based on information provided by EMM, the following emission reduction factors were applied to account for controls that are currently in place at the facility:

- Paved internal roads – 30% reduction for water application (US-EPA, 2011);
- Water spraying at stockpiles, crushing and screening plant and material handling - 50% reduction for water sprays (NPI, 2012).

While activities in the shed would experience some level of wind break from the structure, the shed is not fully enclosed; therefore, no emission reduction factor for wind breaks has been included in this assessment.

7.4 Particulate Matter Emissions

A summary of recycling facility-related emissions by source type is presented in **Table 7-1** and illustrated in **Figure 7-1**. Control measures implemented at the site, as documented in **Section 7.3**, have been taken into account in the emission estimates.

Table 7-1 and **Figure 7-1** highlight that, for proposed operations, the most significant source of emissions are associated with truck movements on paved surfaces and diesel combustion emissions. Further details regarding emission estimation factors and assumptions are provided in **Appendix 2**.

Table 7-1 Calculated Annual TSP, PM_{10} and $PM_{2.5}$ Emissions

Emissions Source	Calculated Emissions (kg/annum) by Source		
	TSP	PM_{10}	$PM_{2.5}$
Material Delivery - Waste to external yard	3,536.8	678.9	164.2
Truck Unloading at external yard	236.3	86.6	13.0
Raw Material Handling - external yard	236.3	86.6	13.0
Material breaking/crushing - external yard	425.3	189.0	28.4
Transfer to Shed	894.0	171.6	41.5
Crushing - Shed	94.5	42.5	7.9
Screening - shed	173.3	58.3	3.9
Crushed material Handling - shed	236.3	86.6	13.0
Product Truck Loading - shed	236.3	86.6	13.0
Product Transportation from site	1,109.7	213.0	51.5
Wind Erosion - Exposed surfaces and stockpiles	281.9	140.9	21.1
Diesel Combustion	1,475.6	1,475.6	1,357.5
Total	**8,936.02**	**3,316.34**	**1,728.12**

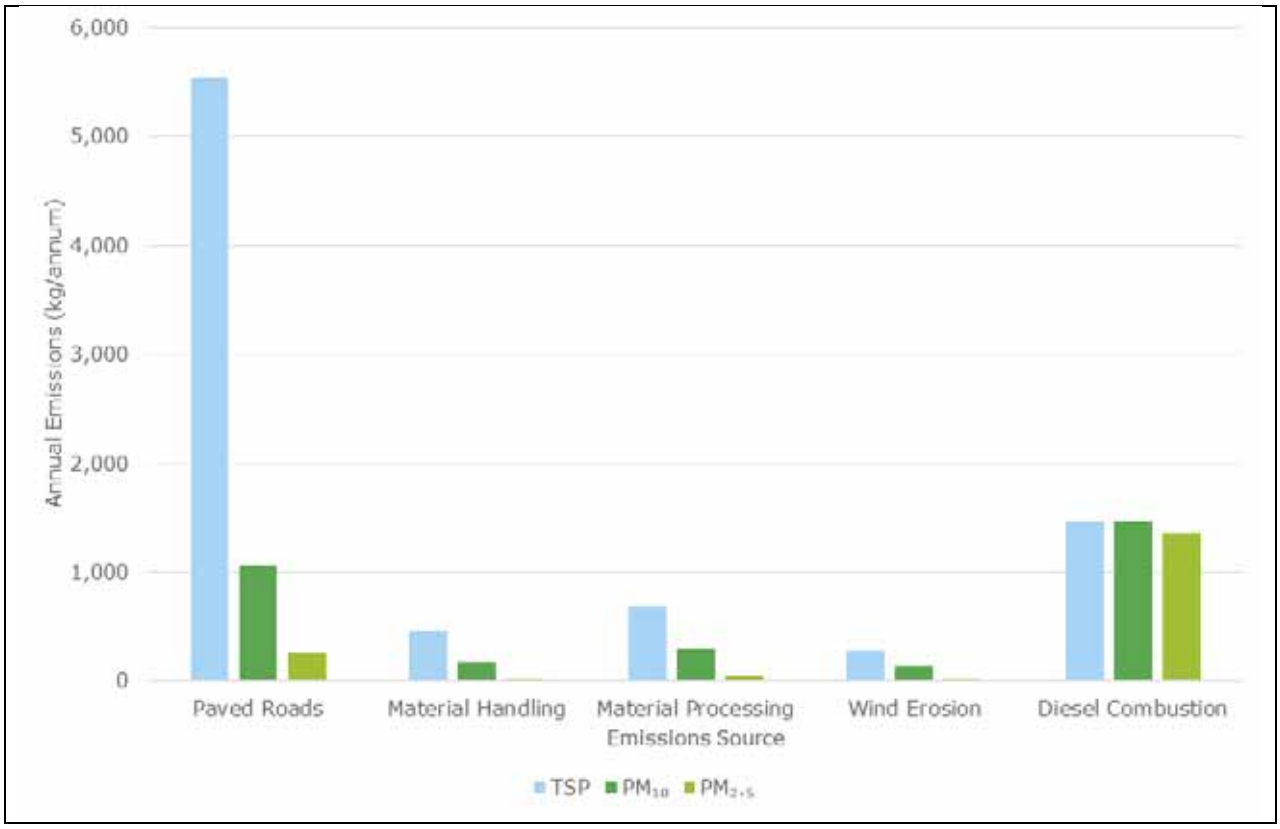

Figure 7-1: Comparison of Calculated Annual TSP, PM_{10} and $PM_{2.5}$ Emissions by Source Type

7.5 Odour Emissions

Given that that majority of material received by the recycling facility would be inert building waste, the potential for odour emissions arising from the proposal would be low. Nevertheless, odour emissions have been quantified for this assessment for the waste streams with the highest odour potential, being green waste and glass material, although there will be no composting on site.

To quantify odour emission rates from the storage of odourous materials, a literature review of recent odour impact assessments involving green waste storage in NSW was undertaken. A summary of relevant odour emission rates are presented in **Table 7-2**. There were no data in the literature applicable to glass material.

Table 7-2 Odour Emission Rates – Green Waste Storage

Site	Specific Odour Emission Rate ($OU.m^3/m^2/second$)	Type	Reference
SITA Kemps Creek	0.134	Greenwaste area	Holmes Air Science, 2007
Spring Farm Advanced Resource Recovery Technology Facility	1.279	Greenwaste area	Pacific Environment, 2013
Veolia Camellia Recycling Facility	0.28	Dry Waste	CH2M Hill, 2013
Euchareena Road Resource Recovery	0.2	Green waste delivery bays	Heggies, 2009

It can be seen from the odour emissions rates presented in **Table 7-2** that a range of variability exists for green waste storage. The maximum odour emission rate presented in **Table 7-2**, 1.279OU.m^3/m^2/second, will be adopted in this assessment as a conservative assumption.

The original assessment for the recycling facility (ENVIRON, 2015) assumed a green waste stockpile volume of up to 500m^3 and height 2m to estimate odour emissions. For the current assessment, the nominal stockpile dimensions have been up-scaled proportionally to the proposed increase in raw material handling, returning a green waste stockpile volume of approximately 1,700 m^3. It is noted that while all odour generating materials would be stored and processed within the main shed, no control factors have been applied to emission calculations.

8. DISPERSION MODELLING METHODOLOGY

8.1 Dispersion Model Selection and Application

As discussed in **Section 5.1**, the CALPUFF modelling system has been selected to conduct dispersion modelling for the assessment of the recycling facility, drawing on a meteorological model developed for the Newcastle region by ENVIRON.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the transport pathway. In the simulation of pollutant dispersion, CALPUFF uses the 3-Dimensional meteorological field generated by CALMET as discussed in **Section 5.1**. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected assessment locations and at grid intercepts across the modelling domain. CALPOST is then used to process these files, producing tabulations that summarise results of the simulation (Scire et al., 2006).

Ground level concentrations are predicted for a regular Cartesian receptor grid covering a 2.5km (east-west) by 2.5km (north-south) computational domain, set within the CALMET modelling domain and centred over the recycling facility, with a grid resolution of 250m. Ground level concentrations were also predicted at the various discrete assessment locations listed in **Table 3-1**.

Modelling simulations were undertaken for the 12 month period between 1 January 2010 and 31 December 2010 using the CALMET meteorological model dataset generated for the Newcastle region (see **Section 5.1** for description of input meteorology).

8.2 Source and Emissions Data

The methodology and results of the emissions inventory developed for this study are presented in **Section 7** and **Appendix B**. Emissions were allocated spatially in accordance with the site layout illustrated in **Figure 2-1**. Wind erosion emissions are varied relative to hourly wind speed. Further details are provided in **Appendix B**.

8.3 Model Results

Dispersion simulations were undertaken to predict concentrations of TSP, PM_{10}, $PM_{2.5}$, odour and dust deposition rates. Model results are expressed as the maximum predicted concentration for each averaging period at the selected assessment locations over the 2010 modelling period.

The results are presented in the following formats:

- Tabulated results of particulate concentrations, odour concentrations and dust deposition rates at the selected assessment locations are presented and discussed in **Section 9**.
- Isopleth plots, illustrating spatial variations in facility-related incremental TSP, PM_{10}, $PM_{2.5}$, odour and dust deposition are provided in **Appendix C**.

Odour impacts are expressed as a maximum 1-second (nose response) concentration for comparison with the EPA odour performance criterion of 2OU. Predicted 1-hour average concentrations were converted using the peak-to-mean ratio of 2.3, as per Table 6.1 of the NSW EPA Approved Methods for Modelling.

Isopleth plots of the maximum 24-hour average concentrations presented in **Appendix C** do not represent the dispersion pattern on any individual day, but rather illustrate the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2010 modelling period.

9. DISPERSION MODELLING RESULTS

9.1 Incremental (recycling facility-only) concentration and deposition rates

Table 9-1 presents the incremental concentrations and deposition rates predicted attributable to operations at the recycling facility (in isolation) at each of the surrounding assessment receptors.

It can be seen from the results presented within **Table 9-1** that the predicted incremental concentrations are low relative to the existing background and the corresponding cumulative EPA assessment criterion or NEPM goal. The deposition rates and odour concentrations predicted are well below the applicable incremental assessment criterion.

Incremental annual average dust deposition level isopleth plots for proposed operations are presented in **Appendix C**.

9.2 Cumulative (recycling facility plus background) concentration and deposition rates

9.2.1 Annual Average Concentrations

Table 9-2 presents the cumulative annual average concentrations for TSP, PM_{10} and $PM_{2.5}$ and cumulative annual average dust deposition. It can be seen from the results presented that the cumulative impacts from the recycling facility will be below the applicable criterion or advisory goal across all assessment locations.

9.2.2 24-hour Average Concentrations

From the incremental results presented in **Table 9-1**, assessment location R10, an industrial receptor immediately adjacent to the western boundary of site, has the highest predicted 24-hour average impact for PM_{10} and $PM_{2.5}$.

To provide an analysis of the likelihood of compliance with the NSW EPA assessment criterion for 24-hour average PM_{10} (50µg/m^3) and NEPM Goal for 24-hour average $PM_{2.5}$ (25µg/m^3), the change in concentration frequency distribution was calculated.

Each predicted 24-hour average concentration for assessment location R10 (365 individual concentrations) was paired with each recorded 24-hour average concentration recorded by the LHAQMN between January 2010 and July 2016 (8,211 and 6,772 individual concentrations for PM_{10} and $PM_{2.5}$ respectively). Each combination of model prediction and recorded concentration (2,997,015 potential combinations for PM_{10} and 2,471,780 potential combinations for $PM_{2.5}$) was collated, with the resultant frequency distribution presented in **Figure 9-1** for PM_{10} and **Figure 9-2** for $PM_{2.5}$.

The resultant frequency distribution for PM_{10} and $PM_{2.5}$ at assessment location R10 shows an increase in the occurrence of concentrations greater than the applicable criteria/goal of 0.29% and 0.05% respectively. Based on a calendar year, this equates to 1.05 exceedance days for PM_{10} and 0.17 additional exceedance days for $PM_{2.5}$. Given the proximity of assessment location R10 to the site boundary and the highly conservative emissions scenario adopted (i.e. 100% of material is hard material requiring external and internal processing), it is considered that the derived frequency of additional exceedance for cumulative PM_{10} is a conservative upper bound.

On the basis of this cumulative analysis and given that assessment location R10 had the highest predicted 24-hour average PM_{10} and $PM_{2.5}$ concentrations of the surrounding receptors, it is concluded that recycling facility emissions would have a very low potential for adverse impacts in the surrounding environment.

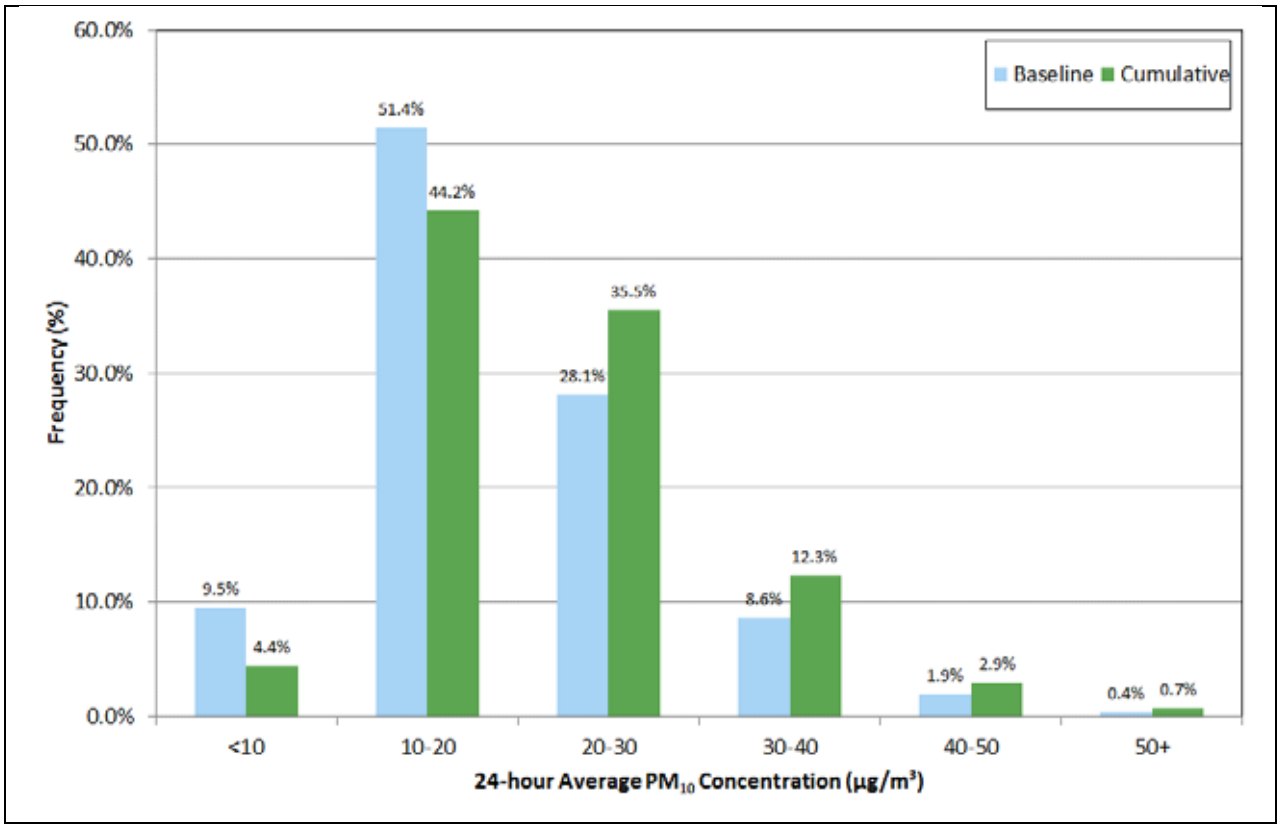

Figure 9-1: Frequency Distribution of All Potential Cumulative 24-hour Average PM_{10} Concentration Combinations – assessment location R10

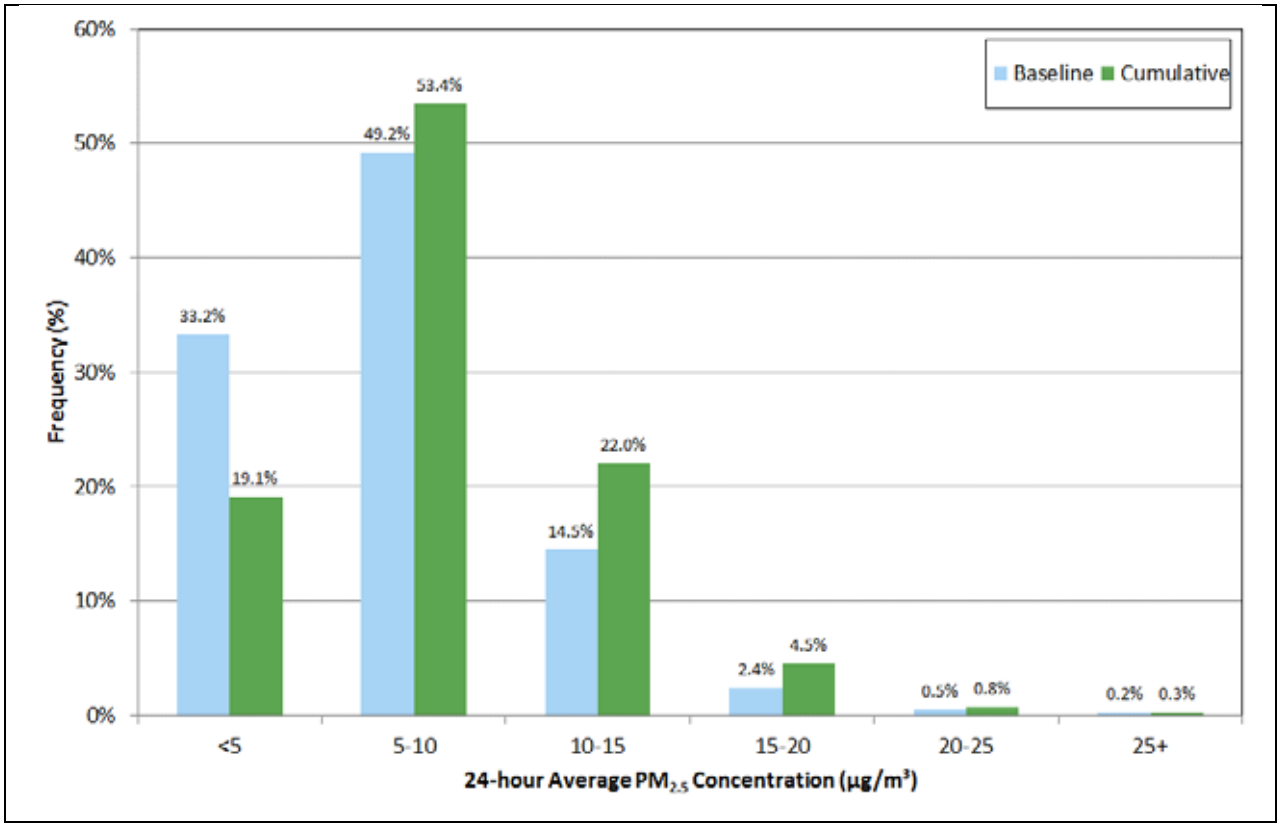

Figure 9-2: Frequency Distribution of All Potential Cumulative 24-hour Average $PM_{2.5}$ Concentration Combinations – assessment location R10

Table 9-1 Incremental concentration/deposition due to recycling facility

Assessment location	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	Odour 99th Percentile 1-second OU
R1	0.2	1.2	0.1	0.7	0.1	<0.1	0.1
R2	0.2	1.5	0.1	0.9	0.1	<0.1	0.1
R3	0.2	2.0	0.1	1.1	0.1	<0.1	0.1
R4	0.2	2.8	0.1	1.6	0.1	<0.1	0.1
R5	0.2	2.8	0.1	1.6	0.1	<0.1	0.1
R6	0.2	2.3	0.1	1.3	0.1	<0.1	0.1
R7	0.2	2.0	0.1	1.2	0.1	<0.1	0.1
R8	0.1	1.8	0.1	1.1	<0.1	<0.1	0.1
R9	0.1	1.3	0.1	0.9	<0.1	<0.1	0.1
R10	5.5	11.5	2.4	6.7	1.3	0.7	0.1
R11	2.5	8.0	1.0	4.3	0.5	0.3	0.1
R12	0.9	5.3	0.4	3.0	0.2	0.1	0.1
R13	2.1	8.0	1.1	4.6	0.6	0.1	0.1
Criteria	**90**	**50**	**30**	**25**	**8**	**2**	**2**

Table 9-2 Cumulative concentration/deposition due to recycling facility

Receptor Location	Modelled Pollutant			
	Annual Average TSP	Annual Average PM_{10}	Annual Average $PM_{2.5}$	Annual Average Dust Deposition
Unit	**µg/m³**			**g/m²/month**
R1	44.9	19.5	7.1	1.5
R2	44.9	19.5	7.1	1.5
R3	44.9	19.5	7.1	1.5
R4	44.9	19.5	7.1	1.5
R5	44.9	19.5	7.1	1.5
R6	44.9	19.5	7.1	1.5
R7	44.9	19.5	7.1	1.5
R8	44.8	19.5	7.0	1.5
R9	44.8	19.5	7.0	1.5
R10	50.2	21.8	8.3	2.2
R11	47.2	20.4	7.5	1.8
R12	45.6	19.8	7.2	1.6
R13	46.8	20.5	7.6	1.6
Criterion / Advisory Goal	**90**	**30**	**8**	**4**

9.3 Comparison with original air quality impact assessment

It is noted that while the original air quality impact assessment for the Recycling Facility completed for the (Environ, 2015) calculated significantly lower annual particulate matter emission rates than the current assessment due to lower annual material handling rate (90,000tpa vs 315,000tpa), the results of the dispersion modelling presented within the original air quality assessment are comparable with the results presented within this assessment.

The reason for this similarity is due to the emissions scenario that was modelled in the original air quality assessment, which assumed that short-term campaign processing of heavy waste in the external yard (three two-week periods per year) would occur continuously throughout the dispersion modelling period. The up-scaled hourly emission rates for the original assessment were therefore higher for activities in the external yard than the emission rates applied in this assessment.

10. AIR QUALITY MITIGATION TECHNIQUES

The modelling results show that there is unlikely to be an adverse impact associated with emissions from the recycling facility on the surrounding environment. The following management measures were integrated into the dispersion modelling process and will be implemented during operations to minimise air quality impacts:

- all existing sealed/hardstand areas will be retained;
- disturbance of unsealed areas by plant or vehicle movements will be prevented by surfacing areas with coarse crushed concrete/rock or asphalt (leaving only 4,000 m^2 of the 89,000 m^2 site unsealed);
- water sprays will be used over any other bare or unsealed surfaces that have potential to generate unacceptable amounts of dust;
- all vehicle movements will be restricted to designated routes marked out by appropriate signage and fencing using sealed internal roads;
- access to unsealed areas will be prevented;
- water sprays will be used at stockpiles, crushing and screening plants and during material handling;
- a wheel wash in the weighbridge area will be used to clean truck tyres to prevent mud or sediment being carried to and deposited on the access road (and public roads);
- existing sheds are used to undertake particulate generating activities where possible; and
- no composting will be undertaken on the site.

11. GREENHOUSE GAS ASSESSMENT

11.1 Introduction

The estimation of greenhouse gas (GHG) emissions for the proposed recycling facility is based on the National Greenhouse Accounts Factors (NGAF) workbook (DoE, 2015). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the "Method 1" approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the National Greenhouse and Energy Reporting Act 2007 (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2015). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category and should not be used to make comparisons between organisations (WBCSD, 2004), for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels and purchased electricity, making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

11.2 Estimated emissions

The GHG emissions sources included in this assessment are presented in **Table 11-1** representing the most significant sources associated with the Project. Emission are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and scope 1 and 3 emission factors for diesel and gasoline consumption.

Table 11-1: GHG emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel) by onsite plant and equipment	Minor	Indirect upstream emissions from the extraction, production and transport of diesel fuel.
		Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.
		Indirect downstream emissions generated from off-site transportation of product
		Indirect emissions generated from employee travel

The adopted activity data for the emission estimates is presented in **Table 11-2**.

Annual diesel consumption has been estimated using the activity rates presented in Section 11 of the 2015 AQIA (135kL/annum) upscaled to the proposed 315,000tpa operations. As per the previous assessment, diesel fuel would be consumed by mobile plant and onsite generator for electricity generation. Electricity consumption (from the

grid) is unknown at this time, but is anticipated to be minor relative to diesel consumption. Consequently, Scope 2 GHG emissions have not been included in calculations.

An estimate of diesel consumption from product transportation has been made based on the NSW average fuel consumption rate for articulated trucks of 56.9 L/ 100 km (ABS, 2015[2]). An upper estimate of annual vehicle kilometres travelled (VKT) is based on a nominal return trip distance to market (25 km) and the number of trips per day (assumed to be 36 two-way trips per day).

Emissions are estimated for the travel of employees to and from site each day. In estimating GHG emissions from employee travel, it is assumed that a total of 14 employees will be required to travel 10km each way to site, while the NSW average fuel consumption rate for passenger vehicles of 10.7 L/ 100 km (ABS, 2015) is adopted.

Table 11-2: Estimated activity data for GHG emissions

Production (tonnes/annum)	On-site Diesel (kL/annum)	Electricity (kWh/annum)	Product Transport Diesel (kL/annum)	Employee Travel Fuel (kL/annum)
315,000	473	504,000	154	84

The estimated annual GHG emissions for each source is presented in **Table 11-3**. The annual Scope 1 and Scope 3 emissions at full production represent approximately 0.00097% of total GHG emissions for NSW and 0.00024% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014[3].

Table 11-3: Summary of estimated annual GHG emissions (tonnes CO_2-e / annum)

Scope 1 emissions	Scope 2 emissions	Scope 3 emissions			
On-site Diesel	Electricity	On-site Diesel	Electricity	Product Transport (Diesel)	Employee Travel
1,268	N/A	97	N/A	446	215

Note: GHG emissions are reported in tonnes of carbon dioxide equivalents (t CO2-e). Non-CO_2 gases are converted to CO_2-e by multiplying the quantity of the gas by its Global Warming Potential (GWP) – see Table 26 of the NGAF workbook.

[2] http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

[3] http://ageis.climatechange.gov.au/

12. CONCLUSIONS

Ramboll Environ was commissioned by EMM to undertake an Air Quality and Greenhouse Gas Assessment for the proposed increase in throughput at the recycling facility.

Emissions of TSP, PM_{10}, $PM_{2.5}$ and odour were estimated for peak proposed future operations associated with the recycling facility. Atmospheric dispersion modelling predictions of air pollution emissions for operations were undertaken using the CALPUFF dispersion model.

The results of the dispersion modelling conducted indicated that the proposed increase in material handling at the recycling facility is unlikely to result in exceedances of the applicable NSW EPA assessment criteria for TSP, PM_{10} and dust deposition or the NEPM reporting goals for $PM_{2.5}$. Potential odour impacts from the recycling facility were conservatively assessed, with resultant predicted odour concentrations well below applicable impact assessment criterion.

A greenhouse gas quantification assessment was undertaken for the recycling facility. The annual Scope 1 and Scope 3 emissions at full production represent approximately 0.00097% of total GHG emissions for NSW and 0.00024% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

13. REFERENCES

ABS (2015). Survey of Motor Vehicle Use, Australia, 12 months ended 31 October 2014. Released 15/10/2015. http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

APT Peddle Thorp (1998). Strategic Impact Assessment Study Concerning Land at Tourle Street and Industrial Drive, Mayfield – The "Steel River" Project. February 1998.

Bureau of Meteorology. Climate statistics from the Newcastle University location.

Bureau of Meteorology. Hourly observations from the Nobbys Signal AWS location.

CH2MHILL (2013). Camellia Recycling Centre- Environmental Impact Statement.

Countess Environmental (2006) *WRAP Fugitive Dust Handbook.*

DoE (2014). Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia. National Greenhouse and Energy Reporting (Measurement) Determination 2008. July 2014. Published by the Commonwealth of Australia, Department of Environment.

DoE (2015). National Greenhouse Accounts Factors – Australian National Greenhouse Accounts. August 2015. Published by the Commonwealth of Australia, Department of Environment

Environ (2012), Air Quality Assessment for the Terminal 4 Project.

Environ (2015). Report. 15 June 2015.

Heggies (2009). Euchareena Road Resource Recovery Centre Air Quality Assessment.

Holmes Air Science (2007). Air Quality Assessment: Proposed SAWT–Biowise Facility Elizabeth Drive, Kemps Creek.

NCIG (2011). Newcastle Coal Infrastructure Group Coal Export Terminal - Annual Environmental Management Report – 2011.

NCIG (2012). Newcastle Coal Infrastructure Group Coal Export Terminal - Annual Environmental Management Report – 2012.

NCIG (2014). Newcastle Coal Infrastructure Group Coal Export Terminal - Annual Environmental Management Report – 2013.

NEPC (1998). National Environmental Protection Measure for Ambient Air Quality. National Environmental Protection Council.

NEPC (2003). National Environmental Protection Measure (Ambient Air Quality) Measure, as amended, made under the National Environment Protection Act 1994. National Environmental Protection Council, 7 July 2003.

NEPC (2015). Variation to the National Environment Protection (Ambient Air Quality) Measure. National Environment Protection Act 1994. National Environmental Protection Council, 15 December 2015.

NHMRC (1996). Ambient Air Quality Goals Recommended by the National Health and Medical Research Council, National Health and Medical Research Council, Canberra.

NPI EETM (2012). National Pollutant Inventory, Emission Estimation Technique Manual for Mining, Version 3, Environment Australia.

NSW EPA (2005), Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

Pacific Environment (2013), Spring Farm Advanced Resource Recovery Technology (ARRT) Facility –Air Quality And Odour Impact Assessment.

NSW OEH (2016), Air quality monitoring data from Lower Hunter Air Quality Monitoring Network monitoring stations

Stull R. B. (1997). An Introduction to Boundary Layer Meteorology, Kluwer Academic Publishers, London.

Sturman A.P. and Tapper N.J. (2006). The Weather and Climate of Australia and New Zealand, Second Edition, Oxford University Press, 541 pp.

US-EPA (2004a). User's Guide for the AMS/EPA Regulatory Model - AERMOD.

US-EPA (2004b). AP-42 Emission Factor Database, Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing, United States Environmental Protection Agency, 2004.

US-EPA (2006). AP42 Emission Factor Database, Chapter 13.2.4 Aggregate Handling and Storage Piles, United States Environmental Protection Agency, 2006.

US-EPA (2011). AP42 Emission Factor Database, Chapter 13.2.1 Paved Roads, United States Environmental Protection Agency, 2011.

WBCSD (2004). The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition. World Business Council for Sustainable Development & World Resources Institute. March 2004

14. GLOSSARY OF ACRONYMS AND SYMBOLS

AEMR	Annual Environmental Monitoring Report
AHD	Australian Height Datum
Approved Methods for Modelling	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AWS	Automatic Weather Station
Benedict Recycling	Benedict Recycling Pty Ltd
BoM	Australian Bureau of Meteorology
CO_2-e	CO2 equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
D/T	dilution-to-threshold
DCCEE	Department of Climate Change and Energy Efficiency
DEC	NSW Department of the Environment and Conservation
DGRs	Director General's Assessment Requirements
DoE	Department of Environment
EMM	EMGA Mitchell McLennan
EPL	Environmental Protection Licence
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
LGA	Local government area
µg	Microgram (g x 10-6)
µm	Micrometre or micron (metre x 10-6)
m^3	Cubic metre
NCIG	Newcastle Coal Infrastructure Group
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NGAF	National Greenhouse Accounts Factors
NPI	National Pollutant Inventory
OU	Odour unit
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
OEH	Office of Environment and Heritage

Ramboll Environ	Ramboll Environ Australia Pty Ltd
SIAS	Strategic Impact Assessment Study
SEARs	Secretary's Environmental Assessment Requirements
TAPM	"The Air Pollution Model"
The Recycling Facility	The Mayfield West Recycling Facility
tpa	Tonnes per annum
TSP	Total Suspended Particulate
US-EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VKT	Vehicle Kilometres Travelled

APPENDIX 1
WIND ROSES

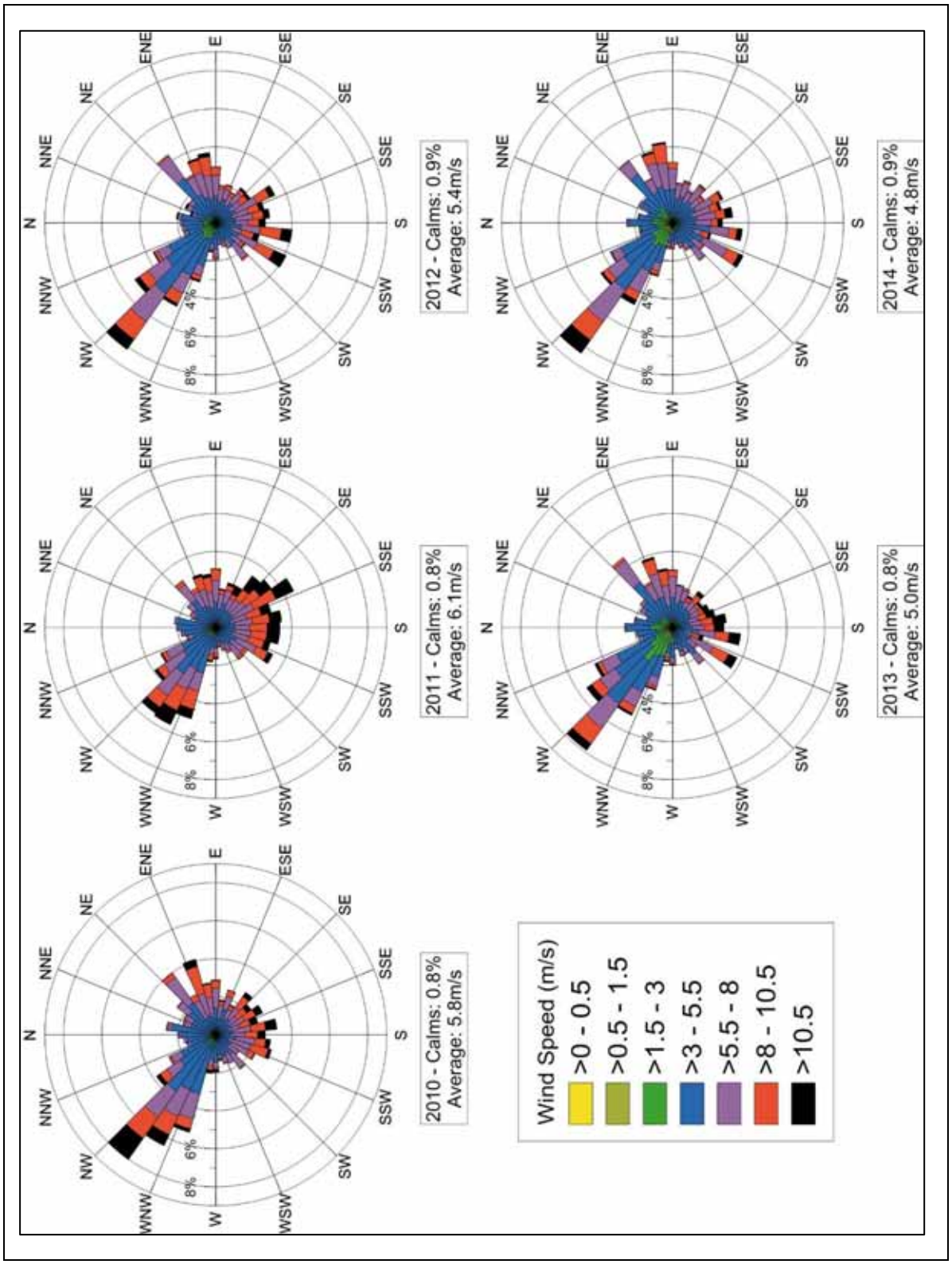

Figure A1.1 Inter-annual Wind Rose Comparison – BoM Nobbys Signal Station – 2010 to 2014

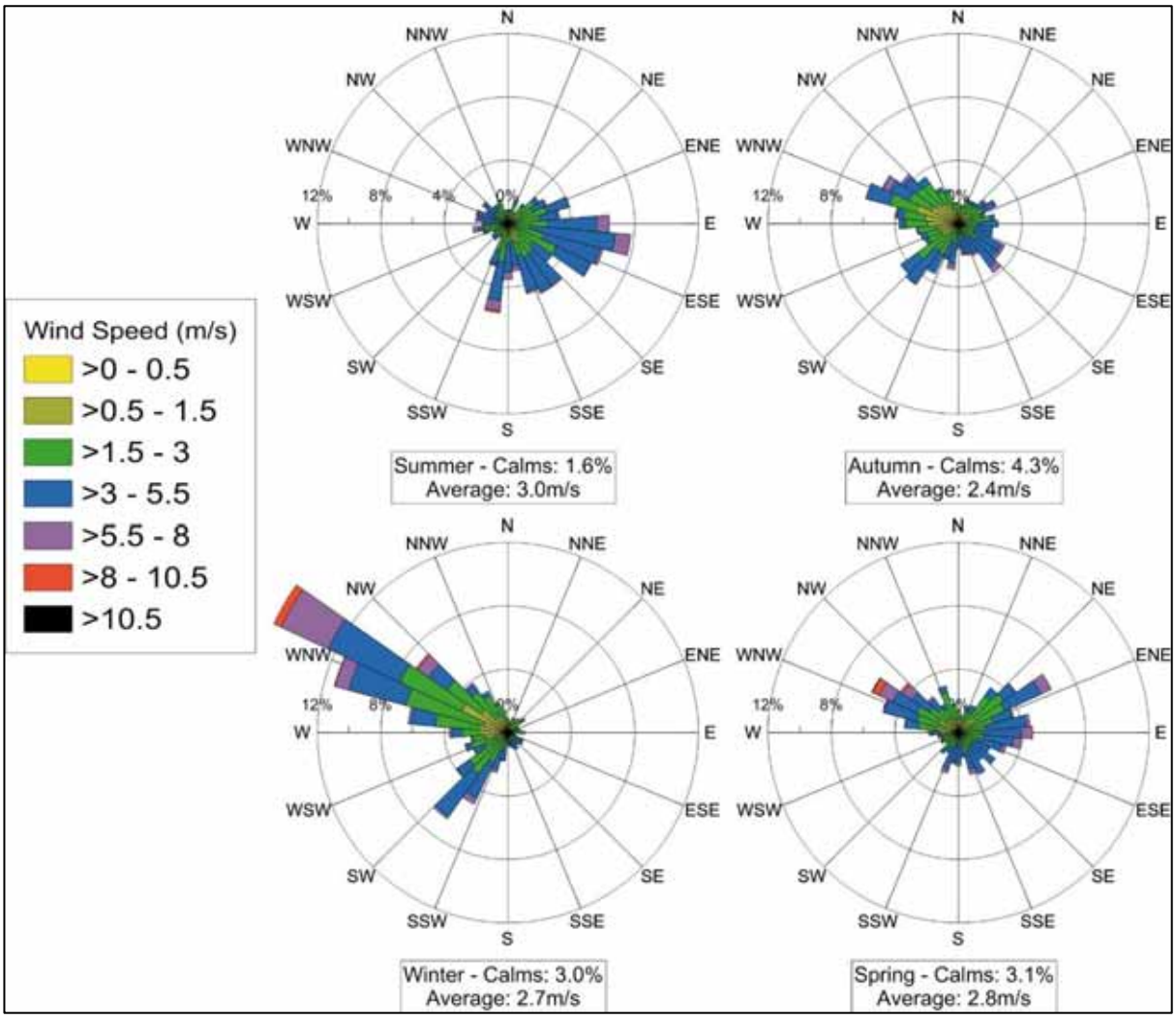

Figure A1.2 Seasonal Wind Roses – Recycling Facility site - 2010

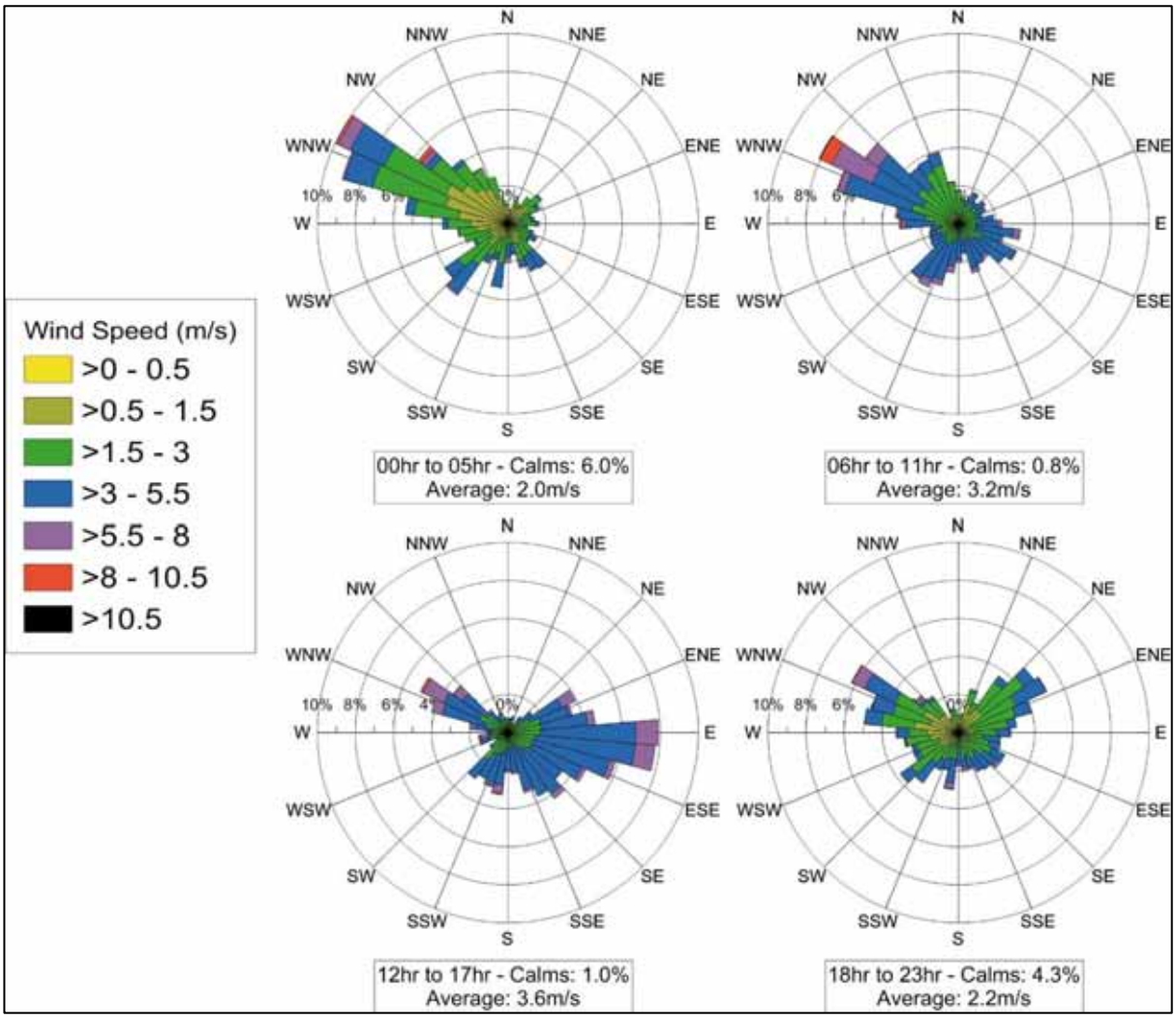

Figure A1.3 Diurnal Wind Roses – Recycling Facility site - 2010

APPENDIX 2
EMISSIONS INVENTORY

INTRODUCTION

Air emission sources associated with the Recycling Facility 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);
- AP-42 Chapter 13.2.4 – Aggregate Handling and Storage Piles (US-EPA 2006);
- AP-42 Chapter 11.19.2 – Crushed Stone Processing and Pulverized Mineral Processing (US-EPA 2006b); and
- AP-42 Chapter 13.2.1 – Paved Roads (US-EPA 2011).

Particulate matter releases were quantified for TSP, PM_{10} and $PM_{2.5}$ using ratios for that particle size fraction available within the literature (principally the US-EPA AP-42), as documented in subsequent sections.

Sources of Particulate Matter Emissions

Air emissions associated with the Recycling Facility would primarily comprise fugitive particulate matter releases. Potential sources of emission were identified as follows:

- Vehicle entrainment of particulate matter due to the haulage of material along the sealed roads in the Recycling Facility;
- Unloading of material to the raw material storage areas within the main shed and in the external yard;
- Screening plant operations within the main shed;
- Loading and transfer of screened material to stockpiles;
- Breaking and shredding of larger material in the external yard;
- Loading of product to truck for dispatch;
- Odour emissions from the storage of certain materials (assumed to be 100% green waste for this assessment);
- Diesel fuel combustion by on-site plant and equipment; and
- Wind erosion associated with stockpiled materials.

Operational Assumptions

To compile an emissions inventory for existing and proposed operations at the site, the following general assumptions were made:

- Wind erosion area for stockpiled materials of 0.66 ha
- Assumed average truck weights (average of loaded and unloaded weights) of 30 t for all deliveries. Conservative as a large proportion of deliveries will be from lighter vehicles.

Particulate Matter Emission Factors Applied

The emission factor equations applied within the assessment are documented in this subsection. **Table A2.1** lists the uncontrolled emission factors that were applied for the peak emission scenario, references the source of the listed factors and whether the factor is derived from a specific equation or a published default emission factor.

Table A2.1 Emission Estimation Factors Applied

Emission Source	TSP Emission Factor	PM_{10} Emission Factor	$PM_{2.5}$ Emission Factor	Emission Factor Unit	Source of Factor
Material Delivery - Shed	0.04237	0.00813	0.00197	kg/Vehicle KM Travelled	AP-42 13.2.1 - Paved Road Equation
Truck Unloading - Shed	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Raw Material Handling - Shed	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Screening - shed	0.01250	0.00430	0.00080	kg/tonne	USEPA AP-42 11.19.2 - Screening Factor
Screened material Handling - shed	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Truck Unloading - Heavy Waste Yard	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Raw Material Handling - Heavy Waste Yard	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Shredding/Breaking - Heavy Waste Yard	0.00270	0.00120	0.00022	kg/tonne	USEPA AP-42 11.19.2 - Crushing Factor
Screened material Handling - Heavy Waste Yard	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Dispatch Truck Loading	0.00150	0.00055	0.00008	kg/tonne	USEPA AP-42 11.19.2 –Material Transfer Factor
Material Transportation from site	0.04237	0.00813	0.00197	kg/Vehicle KM Travelled	AP-42 13.2.1 - Paved Road Equation
Wind Erosion - Exposed surfaces and stockpiles	850.0	425.0	63.8	kg/ha/year	AP-42 11.9 - Wind erosion of exposed areas factor

Details relating to the emission equations referenced in **Table A2.1** are presented in the following sections.

Paved Roads Equation

The emissions factors for paved roads, as documented within AP42 Chapter 13.2.2 -"Paved Roads" (US-EPA 2011), was applied as follows:

$E = k\ (sL)^{0.91}(W)^{1.02}$

Where:

E = Emissions Factor (g/VKT)

sL = road surface silt loading (g/m^2)

W = mean vehicle weight (tonnes)

k = constant of 1.5 for PM_{10}

Material parameters are listed in **Table A2.2**.

Diesel Calculations

Diesel combustion emissions of $PM_{2.5}$ are described in the tables below. It is assumed that 92% of PM_{10} emissions from diesel combustion is $PM_{2.5}$, emissions have been up-scaled accordingly.

Table A2.3 Likely Onsite Diesel Equipment and Fleet and $PM_{2.5}$ Emissions

Equipment	Number	Make (or similar)	Power Rating (kW)	Operating Hours	$PM_{2.5}$ Emission Factor (g/kWh) – USEPA Tier 2	NPI Load Factor	Annual Emissions (kg/year)
Generator	1	Himoinsa HJW-80 T5	68	4,224	0.0004	1	114.9
Front End Loader	2	Volvo L150	185	4,224	0.0002	0.5	156.3
Excavator	1	Komatsu PC120	64	4,224	0.0004	0.5	108.1
Flip-flow waste screen	1	Finlay 883	72	4,224	0.0004	1	121.7
Excavator	1	Komatsu P220	134	4,224	0.0002	0.5	113.2
Secondary Crusher	1	Metso LT1213	310	4,224	0.0002	1	261.9
Timber Shredder	1	Komptech Crambo 6000	429	4,224	0.0002	1	362.4

Emission Factor Source: NSW EPA (2014) Reducing Emissions from Non-road Diesel Engines. Prepared by ENVIRON Australia Pty Ltd.

Table A2.4 $PM_{2.5}$ Emissions – Trucks Moving Onsite

Equipment	PM Emission Factor (g/VKT) - 1996 ADR70/00	Annual VKT	Annual Emissions (kg/year)
Trucks moving on site	0.584	134,671	78.6

Emission Factor Source: NSW EPA (2012) Technical Report No. 7, Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year,On-Road Mobile Emissions.

Table A2.5 $PM_{2.5}$ Emissions – Trucks Idling Onsite

Equipment	Trucks onsite at any hour	Emission Factor PM (g/hr) - USEPA	Hours per year	Annual Emissions (kg/year)
Trucks Idling on site	8	1.196	4,224	40.4

Emission Factor Source: NSW EPA (2012) Technical Report No. 7, Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year, On-Road Mobile Emissions.

Recycling Facility Related Input Data

Material property inputs used in the emission equations presented in **Table A2.1** are detailed in **Table A2.2**. It is noted that minimal details relating to the material properties were available at the time of reporting. To compensate, values were adopted from the literature.

Table A2.2 Material Property Inputs for Emission Estimation Factors Applied

Material Properties	Units	Value	Source of Information
Moisture Content of material	%	2.1	AP42 13.2.4 default for stone quarrying and processing
Silt Loading of Paved Roads – Material Deliveries and Product Dispatch	g/m^2	0.6	Default baseline loading for roads with traffic <500 vehicles per day - US-EPA AP42 (2011)

Key operational details by process used in the emission calculations are listed in **Table A2.3**.

Table A2.3 Emission Estimation Activity Rates Applied for Emission Calculations

Process	Unit	Amount
Material Delivery - Waste to external yard	Annual VKT (km)	101,010
Truck Unloading at external yard	Tonnes of material	315,000
Raw Material Handling - external yard	Tonnes of material	315,000
Concrete breaking - external yard	Tonnes of material	315,000
Transfer to Shed	Annual VKT (km)	1,969
Crushing - Shed	Tonnes of material	315,000
Screening - shed	Tonnes of material	315,000
Crushed material Handling - shed	Tonnes of material	315,000
Product Truck Loading - shed	Tonnes of material	315,000
Product Transportation from site	Annual VKT (km)	140,000
Material Delivery - Waste to external yard	Annual VKT (km)	31,692
Wind Erosion – Material storage area and stockpiles	Area (ha)	0.66

APPENDIX 3
INCREMENTAL ISOPLETH PLOTS

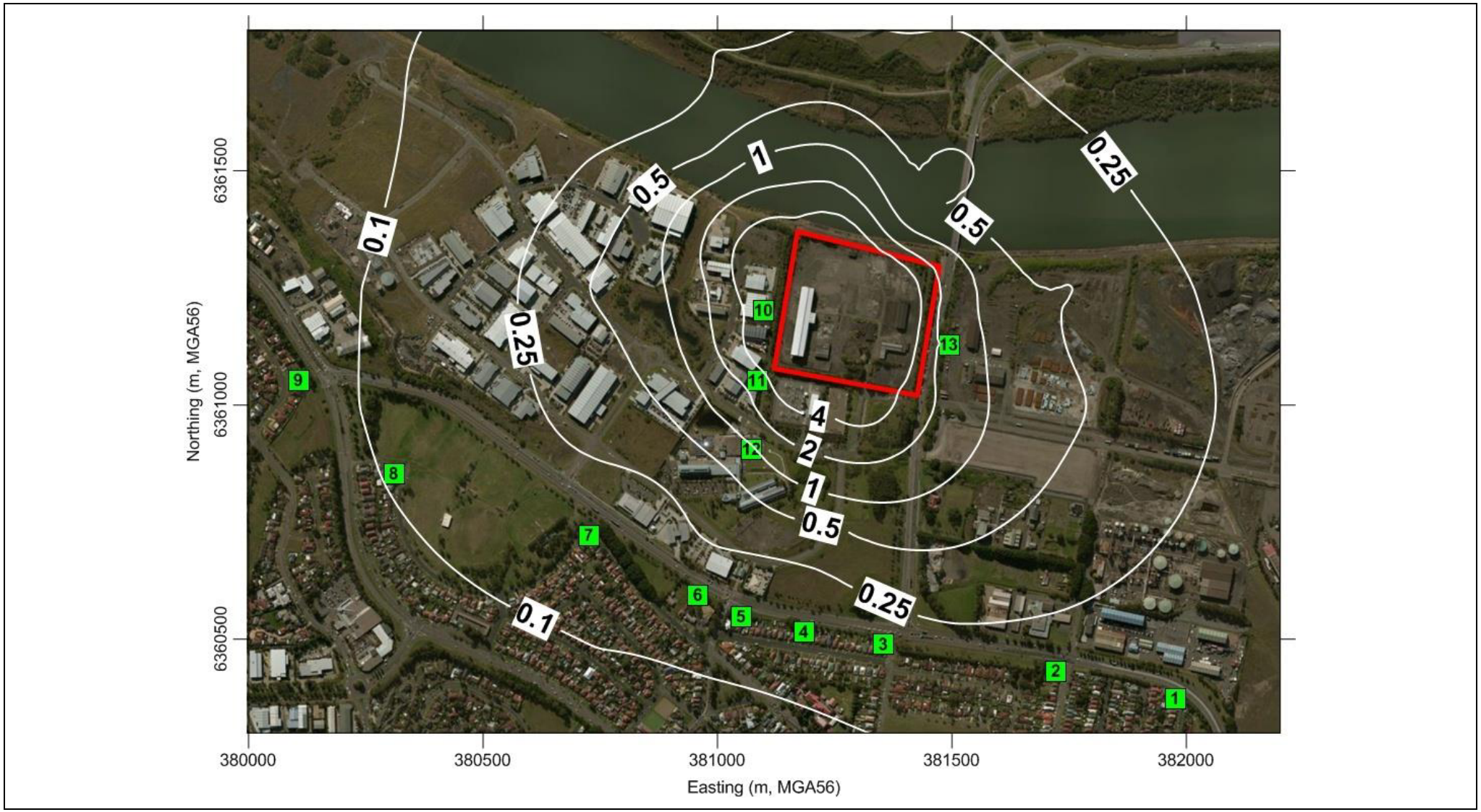

Figure A3.1 Predicted Incremental Annual Average TSP Concentrations (µg/m³)