Appendix O

Air quality impact assessment

Woodlawn Advanced Energy Recovery Centre

Air quality impact assessment

Prepared for Veolia Environmental Services (Australia) Pty Ltd

October 2022

Woodlawn Advanced Energy Recovery Centre

Air quality impact assessment

Veolia Environmental Services (Australia) Pty Ltd

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Version	Date	Prepared by	Approved by	Comments
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Approved by

Scott Fishwick
National Technical Lead – Air Quality
10 October 2022

Ground floor 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

Executive Summary

ES1 Introduction

Veolia Environmental Services (Australia) Pty Ltd (Veolia) owns and operates the Woodlawn Eco Precinct (the Eco Precinct), located on Collector Road, approximately 6 kilometres (km) west of Tarago, approximately 50 km south of Goulburn and 70 km north of Canberra. The Eco Precinct is located in the Goulburn Mulwaree local government area (LGA).

Veolia is proposing to develop and operate the Woodlawn Advanced Energy Recovery Centre (ARC), an energy recovery facility (ERF), at the existing Woodlawn Eco Precinct in Tarago, NSW. The Woodlawn ARC, hereafter the project, will be designed to recover energy from waste that would otherwise be disposed of to landfill.

EMM Consulting Pty Ltd (EMM) has been commissioned to prepare an air quality impact assessment (AQIA) for the project, which will be included as an appendix to the environmental impact statement (EIS) for the project.

The Eco Precinct features the following current activities:

- Woodlawn Bioreactor (the Bioreactor) – a landfill in which leachate is recirculated to help bacteria break down the waste, enhancing the early generation, capture and extraction of landfill gas, including leachate and landfill gas management systems.
- Woodlawn BioEnergy Power Station – utilises landfill gas from the Bioreactor to generate electricity.
- Woodlawn Mechanical Biological Treatment (MBT) Facility – extracts the organic content from a portion of the municipal solid waste (MSW) for use in tailings dam remediation.
- Agriculture – includes a working farm that applies sustainable management practices.
- Aquaculture and horticulture – use of captured waste heat from the BioEnergy Power Station for use in sustainable fish farming and hydroponic horticulture at the Eco Precinct.
- Renewable energy generation – the Woodlawn Wind Farm (operated by Iberdrola) which has an installed capacity to generate up to 48.3 MW of electricity, and a solar farm with installed capacity to produce up to 2.3 MW of electricity.

The project involves construction and operation of the following key components comprising the ARC:

- construction of the ARC, comprising an ERF for the thermal treatment of residual MSW and commercial and industrial (C&I) waste (referred to as waste feedstock) that would otherwise be disposed to landfill;
- thermal treatment in the ARC of up to 380,000 tonnes per annum (tpa) of residual waste feedstock (ie diversion of approved incoming waste deliveries to the ARC tipping hall instead of to the Bioreactor);
- generation of up to 240,000 megawatt hours (MWh) of electricity per annum;
- on-site management of residual by-products generated by the ARC, including construction of an encapsulation cell; and
- construction of ancillary infrastructure to facilitate construction and operation of the project, including a new access road.

ES2 Local setting and existing environment

The locality surrounding the Eco Precinct has been cleared for grazing and/or cultivation. Land immediately surrounding the operational areas of the Eco Precinct is owned by Veolia, providing a buffer between operations and surrounding private properties. This includes the Veolia owned properties Pylara and Woodlawn Farm, both of which have houses situated on them.

Sensitive receptors surrounding the Eco Precinct include rural properties, with the closest non-Veolia owned receptors located approximately 4.5 km to the south-west of the ARC building stack. The town of Tarago is approximately 6 km from the project to the east, which includes residential properties and other sensitive community land uses such as schools and recreation areas. Other nearby villages and towns include Collector 20 km to the north-west, Lake Bathurst 9 km to the north-east and Bungendore 24.5 km to the south-west.

Analysis of meteorology for the region is presented based on the automatic weather station (AWS) at the Eco Precinct, along with regional Bureau of Meteorology (BoM) monitoring locations at Goulburn Airport and Canberra Airport. Analysis of background air quality is based on air quality monitoring stations at Goulburn, Canberra and Bargo.

ES3 Emission sources

This report presents a quantitative modelling assessment of potential air quality impacts for the operation of the project, prepared in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2022).

In order to provide a reference source of real-world operational emissions for the estimation of emissions from the project, Veolia has obtained air pollution emissions monitoring data from the Veolia United Kingdom & Ireland (Veolia UKI) ERF in Staffordshire, located approximately 25 km north-west of Birmingham in the United Kingdom (hereafter referred to as the Staffordshire ERF).

Emissions from the ARC building stack were quantified for three scenarios:

- Scenario 1 – reference case emissions – expected emissions (based on Staffordshire ERF emissions monitoring data);
- Scenario 2 – reference case emissions – maximum emissions (based on Staffordshire ERF emissions monitoring data); and
- Scenario 3 – regulatory case scenario, adopting emission standards presented in NSW EPA 2021 document *NSW Energy from Waste Policy Statement* (hereafter referred to as the NSW EfW Policy).

Scenario 1 is considered to be representative of likely emissions and impacts from the normal operations of the project. The calculated emissions from the ARC building stack for Scenario 2 and Scenario 3 are considered to be highly conservative for the following reasons:

- Scenario 2 adopts the maximum (100^{th} percentile) measured concentrations from the Staffordshire ERF and applies emission upscaling factors to account for potential inter-annual variability. Hence this scenario assumes that the ARC would emit at the single highest concentration from the Staffordshire data, for every hour of its operations.
- Scenario 3 adopts the NSW EfW Policy emission standards as the emission concentration for each pollutant, thereby assuming that the plant is emitting the maximum allowed under the NSW policy during every hour of operation.
- Both Scenario 2 and 3 adopt maximum projected flow rates for all hours and applies the calculated maximum emission rates for every hour of the modelling period.

In addition to the ARC building, the project will introduce the following air pollutant emissions sources to the Eco Precinct:

- Truck movements – including the transportation of stabilised APCr from the ARC building to the APCr encapsulation cell, transfer of incinerator bottom ash aggregates (IBAA) to the bioreactor or potentially off site for future reuse and the diversion of 380,000 tpa of incoming waste deliveries to the ARC tipping hall and away from the Bioreactor.
- Fugitive dust emissions from the handling and storage of material at the incinerator bottom ash (IBA) area and APCr encapsulation cell.
- Diesel fuel combustion by mobile plant and equipment and the auxiliary diesel burners and generator.

Emissions from all existing and approved operations at the Eco Precinct and the neighbouring Woodlawn Mine were also quantified for inclusion in the dispersion modelling to predict cumulative air quality impacts.

Other contributing sources of air pollutant emissions to existing background air quality include:

- dust entrainment due to vehicle movements along unsealed roads and sealed roads with high silt loadings;
- dust emissions from agricultural activities, in particular livestock operations;
- fuel combustion-related emissions from on-road and non-road engines;
- wind generated dust from exposed areas within the surrounding region; and
- seasonal emissions from household wood burning for heating during winter.

The primary air pollutants emitted by the Eco Precinct, including the project, will comprise of:

- particulate matter (PM), specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$);
- oxides of nitrogen (NO_x)[1], including nitrogen dioxide (NO_2);
- sulfur dioxide (SO_2);
- carbon monoxide (CO);
- hydrogen fluoride (HF);
- hydrogen chloride (HCl);
- ammonia (NH_3);
- dioxins and furans;

[1] By convention, NO_x = Nitrous oxide (NO) + NO_2.

- polycyclic aromatic hydrocarbons (PAHs);
- volatile organic compounds (VOCs);
- assorted metals and metalloids[2]; and
- odour.

ES4 Modelling results

Dispersion modelling for this assessment used the CALPUFF modelling system in accordance with NSW EPA guidance.

The results obtained from the dispersion modelling show that all predicted concentrations and deposition rates are below the applicable impact assessment criterion at all surrounding sensitive assessment locations. Furthermore, it is noted that the cumulative impact results presented for the three project scenarios are not significantly different from the results presented for existing operations at the Eco Precinct. This indicates the following key points:

- the introduction of the project will not significantly change air quality impacts currently associated with the Eco Precinct;
- the diversion of waste to the ARC and away from the Bioreactor will reduce particulate matter emissions associated with the movement of trucks on unpaved roads; and
- relative to ambient background concentrations, air quality impacts associated with the Eco Precinct and the project are minor at surrounding sensitive assessment locations.

To provide context to the modelling results, a comparison between concentrations of $PM_{2.5}$, NO_2 and CO recorded at regional air quality monitoring stations and the maximum predicted concentrations across all sensitive assessment locations was made. The peak concentrations recorded on a day heavily influenced by bushfire emissions (1 January 2020), the average recorded concentration between 2014 and 2021 across the region and the maximum predicted concentration from existing operations at the Eco Precinct and from the project (ie emissions from approved Eco Precinct and Scenario 2 sources) are presented in Figure ES1. It can be seen that the predicted concentrations from the project are equivalent to approved Eco Precinct impacts, well below typical ambient air pollutant concentrations for the region and negligible relative to a bushfire affected day.

[2] A metalloid is a chemical element which has properties that are intermediate between those of typical metals and non-metals (eg silicon, arsenic).

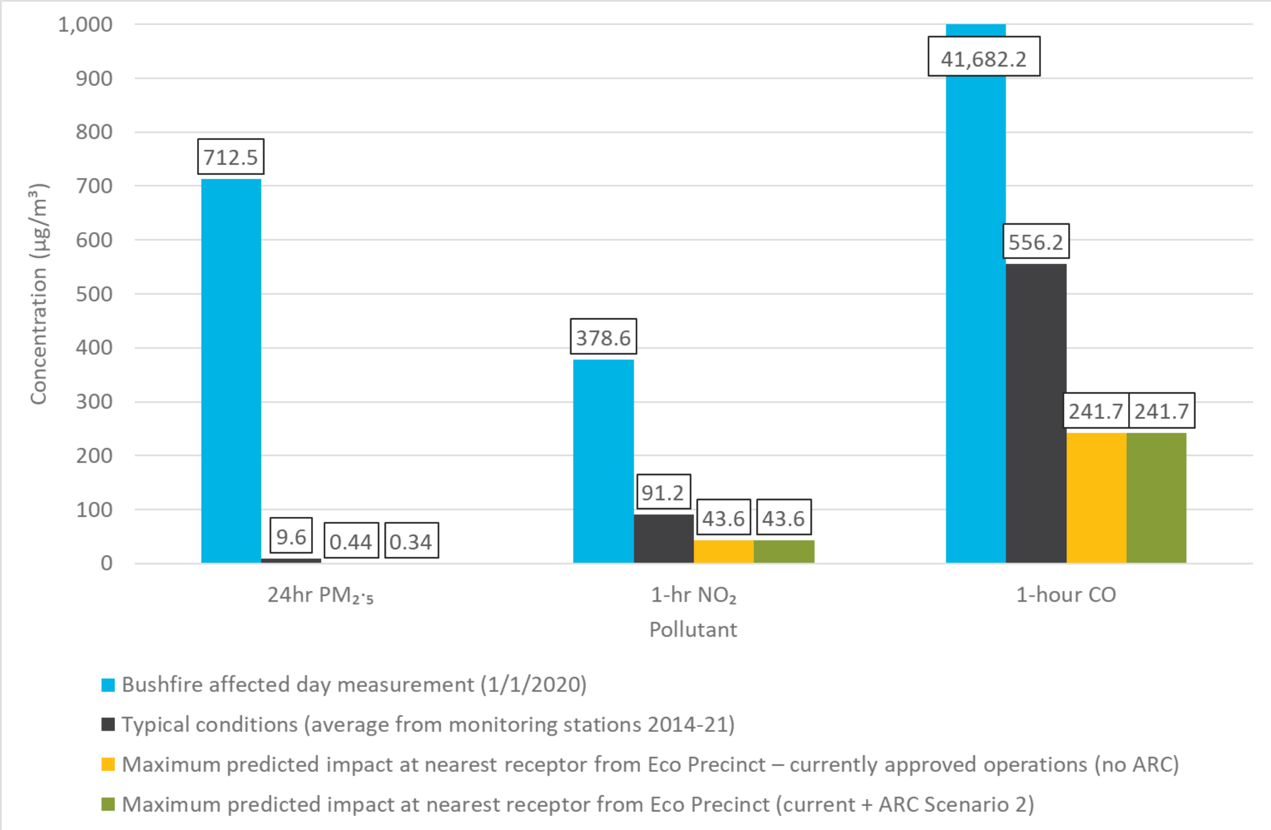

Figure ES1 Comparison of measured regional ambient concentrations and predicted concentrations from the approved Eco Precinct and project (Scenario 2)

Note: Y-axis is cropped at 1,000 µg/m³ for data visualisation purposes. The maximum 1-hour CO concentration from the dataset was 41,682.2 µg/m³.

ES5 Mitigation measures

Veolia will implement a range of air pollution emission mitigation technologies and practices to minimise air pollutant emissions from the project. For the ERF process, these measures include:

- fully enclosed tipping hall with fast opening doors, negative pressure extraction and an odour filtration system to minimise odour emission release;
- the control of NO_x emissions by selective non-catalytic reduction (SNCR);
- the injection of NH_3 in the post-combustion chamber to control NO_x emissions;
- the injection of hydrated lime to neutralise acid gas formation;
- the injection of activated carbon to adsorb dioxins/furans and other contaminants including heavy metals;
- diversion of all flue gas through a baghouse containing fabric filter bags to remove particulates (as APCr); and
- the handling and processing of IBA material within a semi enclosed building.

The European Union Industrial Emissions Directive (IED) 2010/75/EU (Integrated Pollution Prevention and Control) *Best Available Techniques Reference Document for Waste Incineration* (Neuwahl et al 2019) documents best available techniques (BAT) for the management of environmental impacts, including air pollution, from the waste incineration industry.

A review of proposed mitigation measures for the project relative to BAT was undertaken, with the review highlighting that the project is well aligned with BAT for the control of air pollutant emissions.

Veolia will implement a comprehensive continuous emissions monitoring system (CEMS) in accordance with the requirements of the EfW Policy and will establish an ambient air quality monitoring program for the project.

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1 Introduction

Veolia Environmental Services (Australia) Pty Ltd (Veolia) owns and operates the Woodlawn Eco Precinct (the Eco Precinct), located on Collector Road, approximately 6 kilometres (km) west of Tarago, approximately 50 km south of Goulburn and 70 km north of Canberra. The Eco Precinct is located in the Goulburn Mulwaree local government area (LGA).

Veolia is proposing to develop and operate the Woodlawn Advanced Energy Recovery Centre (ARC), an energy recovery facility (ERF), at the existing Woodlawn Eco Precinct in Tarago, NSW. The Woodlawn ARC, hereafter the project, will be designed to recover energy from residual waste that would otherwise be disposed of to landfill.

The regional setting is shown in Figure 1.1 and local setting is shown in Figure 1.2.

The project involves construction and operation of the following key components comprising the ARC:

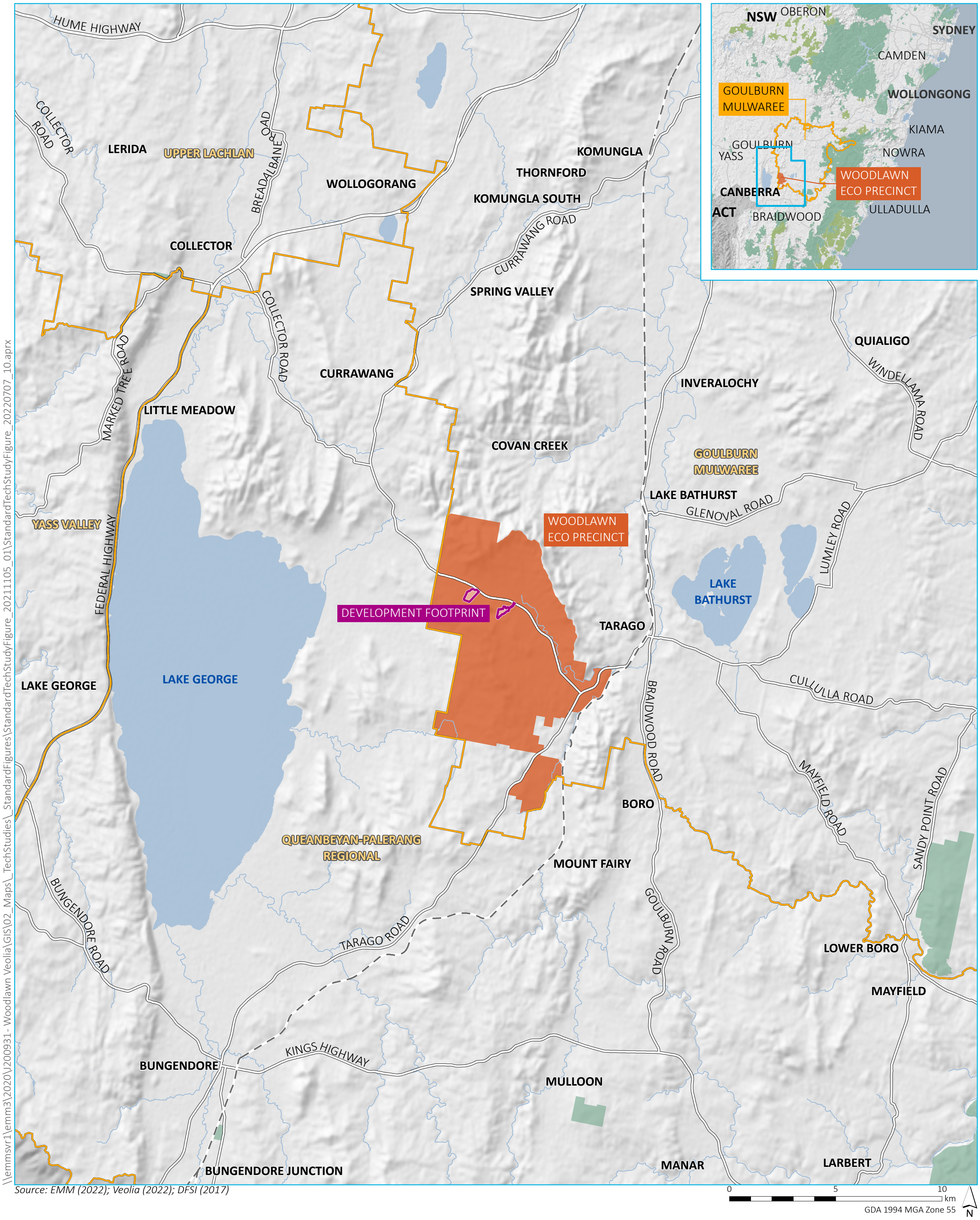
- development of an ERF for the thermal treatment of residual MSW and commercial and industrial (C&I) waste (the waste feedstock) that will otherwise be disposed of to landfill;
- thermal treatment in the ARC of up to 380,000 tonnes per annum (tpa) of the waste feedstock;
- generation of up to 240,000 megawatt hours (MWh) of electricity per annum;
- on-site management of residual by-products generated by the ARC; and
- ancillary development of site infrastructure to facilitate construction and operation of the project.

1.1 Purpose of this report

EMM Consulting Pty Ltd (EMM) has been commissioned to prepare an air quality impact assessment (AQIA) for the project, included as an appendix to the environmental impact statement (EIS) for the project (EMM 2021a). The AQIA presents a quantitative assessment of potential air quality impacts, prepared in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW Environment Protection Authority (EPA) 2022 – hereafter the Approved Methods for Modelling).

The assessment follows the Level 2 assessment approach detailed in the Approved Methods for Modelling, including the following tasks:

- estimation of air pollutant emissions for all activities using emission source specific or accepted emission estimation techniques;
- refined dispersion modelling, using a regulatory dispersion model with site-specific inputs, was used to predict ground level concentrations for key pollutants at assessment locations;
- cumulative impacts were calculated by taking into account the combined effect of background air quality, and model predicted impacts from air pollutant emission sources at the Eco Precinct, including existing approved sources and new sources associated with the project; and
- air quality impacts were evaluated by comparing against pollutant-specific impact assessment criteria.



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Woodlawn Eco Precinct
- Rail line
- Major road
- Watercourse
- Named waterbody
- NPWS reserve
- Local government area

Regional setting

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 1.1

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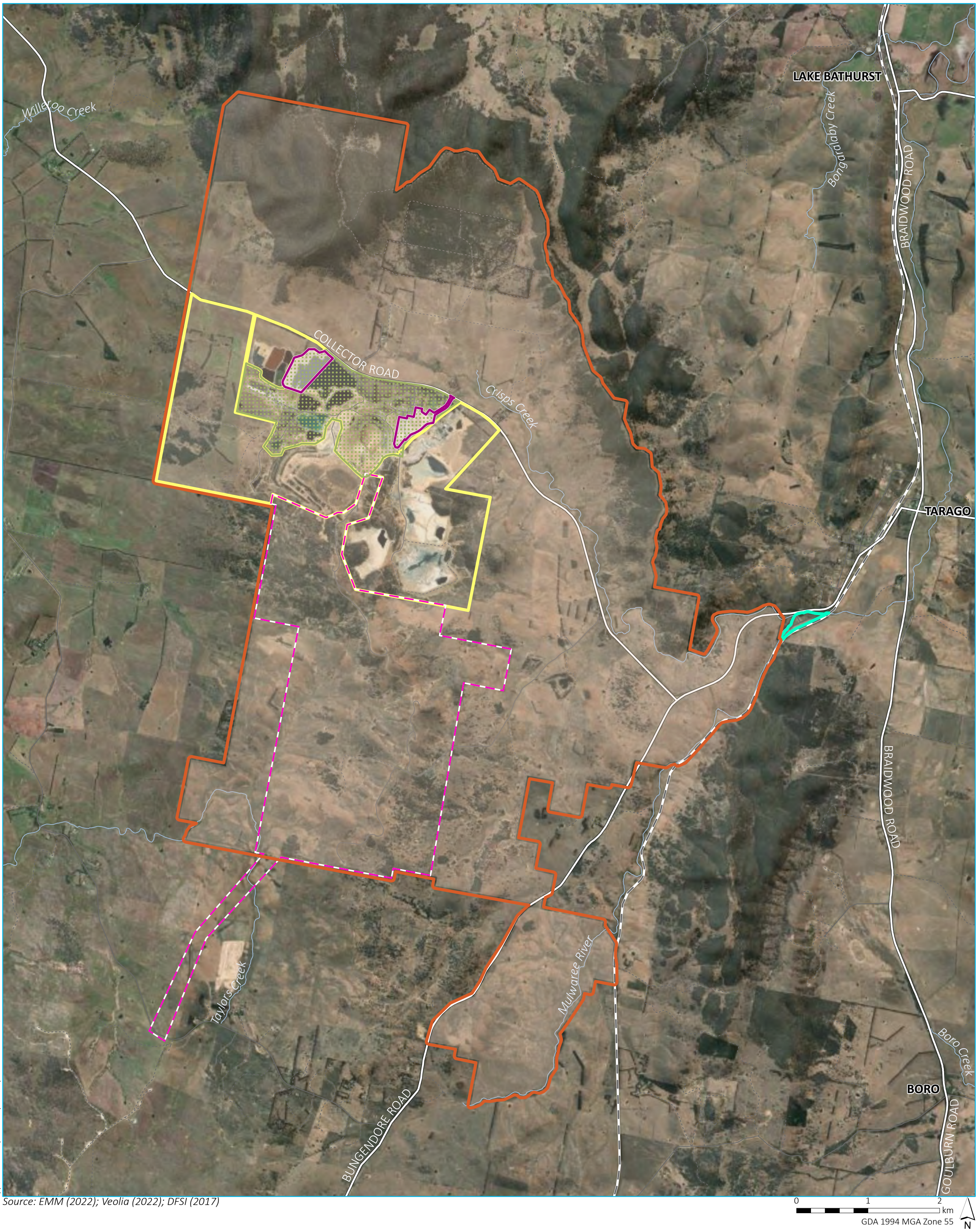

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Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Local setting

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 1.2

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1.2 Assessment guidelines and requirements

This AQIA addresses the Secretary's Environmental Assessment Requirements (SEARs), issued on 2 July 2021. Table 1.1 lists the matters relevant to this assessment and where they are addressed in this report.

Table 1.1 Relevant matters raised in SEARs

Requirement	Section addressed
Air quality and odour – a quantitative assessment of the potential air quality, dust and odour impacts of the development (construction and operation) on surrounding landowners, businesses and sensitive receptors, in accordance with relevant Environment Protection Authority (EPA) guidelines, including:	
• A description of all potential air emissions and odours and their sources, including construction, operational, transport sources and dust generation.	Chapter 4, 7
• Details of the receiving environment, including meteorology and climate, topography, surrounding land use, sensitive receptors and ambient air quality.	Chapter 3, 5, 6
• Modelling of 'worst case' (including a trip or emergency shutdown), regulatory and reference facility emission scenarios.	Chapter 7, 9
• Consideration of the recent (May 2021) amendments to air pollutant standards in the *National Environment Protection (Ambient Air Quality) Measure* (NEPC, 1998).	Chapter 4, 9
• Justification for the level of assessment undertaken based on risk factors, including but not limited to the proposal location, characteristics of the receiving environment and the type and quantity of the pollutants emitted.	Chapter 8, 9
• Details of the proposed technology and a demonstration that it is technically fit for purpose, including details of commissioning and proof of performance.	Chapter 10
• Details of emission control techniques and practices, including emission sampling and monitoring, that will be employed, and benchmark these against best practice emission control and management, with reference to the European IPPC Bureau 'Industrial Emissions Directive', BAT (Best Available Techniques) Reference Document (BREF) BREF 2019 and the *NSW Energy from Waste Policy Statement* (EPA, 2021).	Chapter 10
• Demonstrate a commitment to continual improvement with respect to emission control techniques and practices.	Chapter 10
• An assessment of cumulative air quality and odour impacts associated with the facility and surrounding developments, including any approved (but not yet constructed) developments and the proposed Jerrara Power Energy from Waste Facility (SSD22879238).	Section 9.2
• Details of all air quality and odour management, mitigation and monitoring measures.	Chapter 10
• A plume rise assessment prepared in accordance with relevant Civil Aviation Safety Authority guidelines.	Section 9.4

2 Project overview

2.1 Existing operations

Veolia owns and operates the Woodlawn Eco Precinct, an amalgamation of landholdings totalling approximately 6,000 ha in area located approximately 50 km south of Goulburn and 70 km north of Canberra. The Eco Precinct has provided sustainable and innovative waste management services since 2004.

Waste management operations, energy recovery technologies and energy generation, and other sustainable land uses within the Eco Precinct include:

- Woodlawn Bioreactor (the Bioreactor) – a landfill in which leachate is recirculated to help bacteria break down the waste, enhancing the early generation of gas, enabling more efficient capture and extraction of landfill gas, including leachate and landfill gas management systems.
- Woodlawn BioEnergy Power Station – utilises landfill gas from the Bioreactor to generate electricity.
- Woodlawn Mechanical Biological Treatment (MBT) Facility – processes garden organics and MSW to extract the organic content for use in tailings dam remediation.
- Agriculture – a working farm (sheep and cattle) that applies sustainable management practices.
- Aquaculture and horticulture – operation which uses captured heat from the BioEnergy Power Station for use in sustainable fish farming and hydroponic horticulture at the Eco Precinct.
- Renewable energy generation – the Woodlawn Wind Farm (operated by Iberdrola), with an installed capacity of 48.3 MW, and a solar farm (operated by Veolia) with an installed capacity of 2.3 MW.

The Eco Precinct is served by the Crisps Creek IMF near Tarago. Crisps Creek IMF is located approximately 6 km to the east of the Eco Precinct (8.5 km by road). Integrated waste management operations are augmented by two waste transfer terminals located in Sydney: the Clyde Transfer Terminal, which commenced operation in 2004, and the Banksmeadow Transfer Terminal, which commenced operation in 2016.

Waste is transported from the Sydney transfer terminals in purpose-built shipping containers by rail via the Goulburn-Bombala Railway line to the Crisps Creek IMF. The Crisps Creek IMF has an approved throughput of 1.18 million tpa. On receipt at the Crisps Creek IMF, containers are loaded on to trucks for delivery to the Eco Precinct. Waste from the regional area is also approved to be transported to the Eco Precinct by road, up to 130,000 tpa (with written consent).

Figure 2.1 summarises the approved waste volumes for the Eco Precinct. The Bioreactor, BioEnergy Power Station, Crisps Creek IMF and MBT Facility are described in further detail in the following sections.

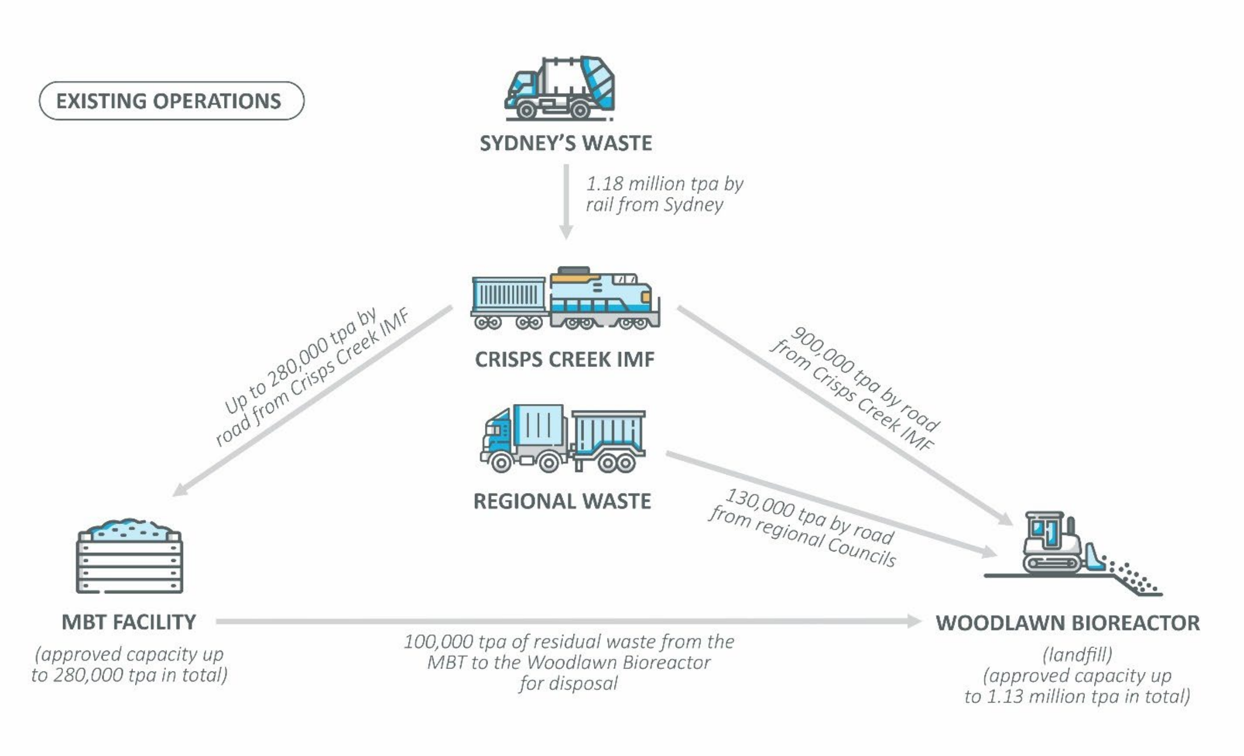


Figure 2.1 Approved waste volumes at the Eco Precinct

2.1.1 Woodlawn Bioreactor and BioEnergy Power Station

Approved under the original consent (DA31-02-99) and subsequently modified by MP 10_0012, the Bioreactor was the first stage of the Eco Precinct developed by Veolia. The Bioreactor is located in the former open-cut mine void. The Bioreactor includes a landfill gas collection system. Landfilling operations commenced in September 2004. The Bioreactor is approved to receive up to 1,130,000 tpa of waste for landfilling, comprising up to:

- 900,000 tpa of putrescible and non-putrescible waste received via rail from Sydney;
- 130,000 tpa (with written consent) of putrescible waste received via road from areas regional to the Eco Precinct; and
- 100,000 tpa of residual waste from the MBT facility.

Operations at the Bioreactor are approved Monday–Saturday from 6.00 am to 10.00 pm.

The Bioreactor decomposes putrescible waste more efficiently than traditional landfills through the recirculation of leachate. Waste is deposited in the Bioreactor, with optimal moisture and temperature conditions to achieve enhanced production of landfill gas, which is collected by infrastructure within the void.

In 2008, the first purpose-built landfill gas-fired engines were installed at the BioEnergy Power Station. The methane contained in the landfill gas is used as fuel to generate electricity at the BioEnergy Power Station which is exported to the grid. There are currently seven engines installed on site, although approvals provide for a staged increase in the number of engines installed at the BioEnergy Power Station commensurate with increases in the landfill gas yields. There is a vacant area adjacent to the BioEnergy Power Station reserved for the future development of a second building to house additional gas engines, known as Hub 2. Excess heat from the operation of the BioEnergy Power Station is used for aquaculture and hydroponic horticulture trials at the Eco Precinct.

A Leachate Treatment Plant (LTP) was approved in late 2017 (DA31-02-99-Mod-3/MP 10_0012 Mod 2) to improve the performance of the Bioreactor. It commenced operating in 2018 and manages leachate that is pumped from the Bioreactor void. The leachate treatment plant facilitates better environmental and operational performance by allowing Veolia to extract and treat greater volumes of leachate from the Bioreactor, minimising the generation of odour, enabling more efficient gas extraction and maximising the waste to energy benefits of the Bioreactor. Six evaporation dams are used to manage the accumulation of treated leachate via natural and assisted evaporation.

2.1.2 Crisps Creek IMF

Approved under the original DA31-02-99 and subsequently modified by MP 10_0012, the IMF forms an integral part of the logistical operations of the Eco Precinct. The IMF is located 8.5 km by road from the Bioreactor, near the village of Tarago (Figure 1.2), adjacent to the Goulburn-Bombala Railway line. Containers of compacted waste which are transported from the Sydney region by rail are unloaded and transferred onto road trailers at the IMF for transport to the Bioreactor. The IMF is approved to accept 1.18 Mtpa of waste from Sydney for transport to the Eco Precinct. Crisps Creek IMF operates Monday–Saturday from 6.00 am to 10.00 pm and receives waste from up to two trains per day which are transported to the Eco Precinct via truck during these hours.

2.1.3 Woodlawn MBT facility

Approved under MP06_0239 in 2007, the MBT facility (originally known as the Woodlawn Alternative Waste Technology Project) is approved to receive up to 280,000 tpa of waste from councils in Sydney metropolitan area. Waste is transported to the MBT Facility via Crisps Creek IMF as part of the integrated operations. The first stage of the MBT was commissioned in March 2017 and commenced operation in July 2017.

Waste is processed at the MBT Facility to extract recyclable materials and to produce an organic output from the organic fraction. The material is matured on site. Stage 1 of the MBT facility commenced operations in 2017 and is able to process up to 144,000 tpa of MSW and 40,000 tpa of green waste.

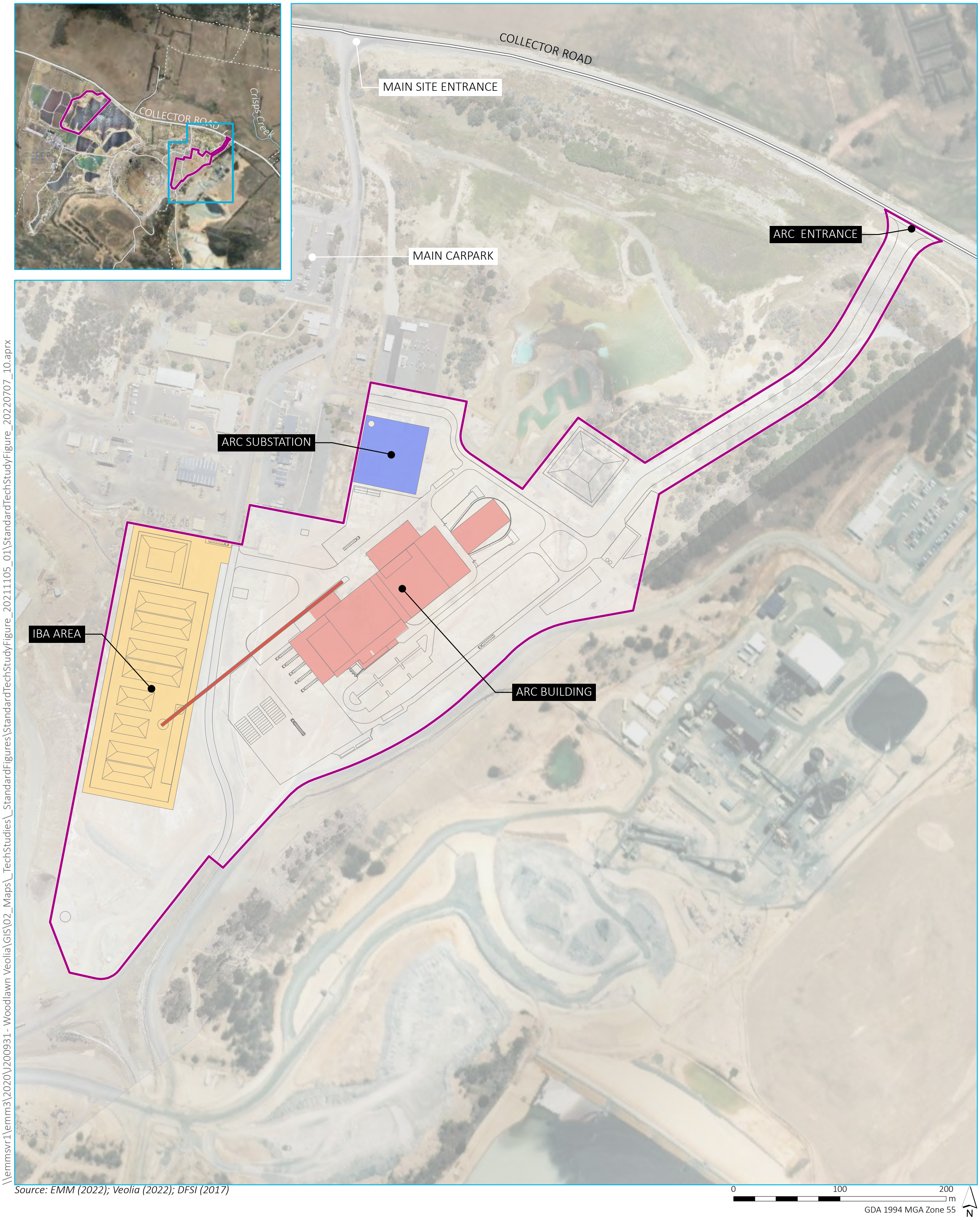
Operations at the MBT Facility are approved Monday–Saturday from 6.00 am to 10.00 pm for waste receival and operation of mobile plant and equipment, while the infrastructure and fermentation/processing activities operate on a continuous basis 24 hours per day, seven days a week.

2.2 Project description

The project consists of the construction and operation of the ARC, an ERF for the thermal treatment of residual MSW and C&I waste feedstock, and supporting infrastructure.

The portion of the development footprint encompassed by the ARC building and ancillary infrastructure, IBA area and new access road and intersection is referred to broadly as 'the ARC'. This area currently contains former mine plant infrastructure, water management infrastructure (plant collection dam) and other disturbed areas subject to ancillary waste management operations.

The development footprint of the ARC is shown in Figure 2.2, while Table 2.1 provides an overview of the project.



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Site layout detail
- Major road
- ARC building
- ARC substation
- IBA area

Development footprint

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 2.2

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Table 2.1 Project overview

Project element	Summary of the project
The ARC building	The ARC building will house the energy recovery plant and will be fully enclosed. The building will be approximately 54 m at the highest point of the roof, with a stack of approximately 85 m in height. Residual waste feedstock will be processed within the ARC building to generate electricity.
Annual throughput	The ARC will have the capacity to process up to 380,000 tpa of residual waste feedstock and will have generation capacity of up to 240,000 megawatt hours (MWh) of electricity per annum.
Incinerator bottom ash (IBA) area	The IBA area provides for the processing of IBA for reuse and or disposal and includes screening, metals recovery and maturation. Construction and use of the IBA area, located to the west of the ARC building, will include: • the IBA processing building; • IBA maturation pad (for IBA maturation and stockpiling of the resultant incinerator bottom ash aggregates (IBAA)); and • associated infrastructure for wastewater and leachate management.
Encapsulation cell	The encapsulation cell will involve staged construction and operation of a lined and engineered landfill cell for encapsulation of the stabilised residual by-products (APCr) from the flue gas treatment (FGT) system. The encapsulation cell will be located approximately 1.8 km north-west of the ARC building. Stabilised APCr will be transported via the internal road network from the ARC building by truck to the encapsulation cell.
Ancillary infrastructure	Construction and use of ancillary infrastructure will include: • sub-contractors lay down area; • a new substation for export of generated electricity; and • utilities.
Transport and access	Construction and use of: • a new site access road and intersection with Collector Road; • internal access roads, car and bus parking facilities; • a container marshalling area; and • weighbridges for inbound and outbound vehicles.
Workforce	Construction: approximately 300 construction jobs. Operation: approximately 40 full time equivalent (FTE) operational jobs.
Hours	Construction: 24 hours per day, seven days a week. Operation: 24 hours per day, seven days per week. Receival of residual waste feedstock via road to the ARC: 6.00 am to 10.00 pm, Monday to Saturday.

The energy recovery process occurs within the ARC building and consists of the following stages:

- Stage 1: receival of residual waste feedstock and storage.
- Stage 2: combustion and heating.
- Stage 3: energy recovery and electricity generation.
- Stage 4: flue gas treatment.
- Stage 5: residue handling and treatment.

A schematic depicting the key stages in the process listed above is provided in Figure 2.3 and discussed in the following sections.

2.2.1 Stage 1 receival of residual waste feedstock and storage

Residual waste feedstock will be transported to the Eco Precinct in containers by truck from the Crisps Creek IMF. Trucks will enter the ARC, within the Eco Precinct, using a dedicated access road and intersection with Collector Road and be weighed at the incoming weighbridge on entry to the ARC, before reporting to the container marshalling area where they will be instructed to access into the marshalling area or be directed to the tipping hall.

The **tipping hall (1)** will be an enclosed hall where residual waste feedstock will be received by truck. The hall will include unloading bays for depositing residual waste feedstock into the waste bunker. **Tipping platforms (2)** will be used for unloading. Trucks with containerised residual waste feedstock will reverse into the tipping hall where the trailer and container will be positioned on a tipping platform, the prime mover will be unhooked and moved away, the container door will be opened. The tipping platform will be activated to tip the residual waste feedstock into the **waste bunker (3)**. Tipping platforms would be a combination of fixed and mobile platforms. A mobile platform will be temporarily used in the event a fixed platform breaks down.

During operations, the tipping hall will be maintained under negative air pressure, with air from the hall being drawn into the furnace. The tipping hall will also be equipped with an extraction system. This, and the fast closing truck access doors, which remain closed unless a truck is entering or departing the tipping hall, minimise the potential for release of odour to the environment. An odour extraction and filtration system will be installed for use when the combustion chamber is not operating.

From the waste bunker, the waste will be lifted by **overhead grab cranes (4)** and fed into a **feed hopper (5)**. The overhead grab cranes will be used to mix and distribute the material in the waste bunker prior to feeding the waste into the feed hopper. The cranes are able to be operated in fully automatic, semi-automatic and manual modes, and each will be sized to carry out all functions by itself, to ensure operations can continue in the case of crane breakdown.

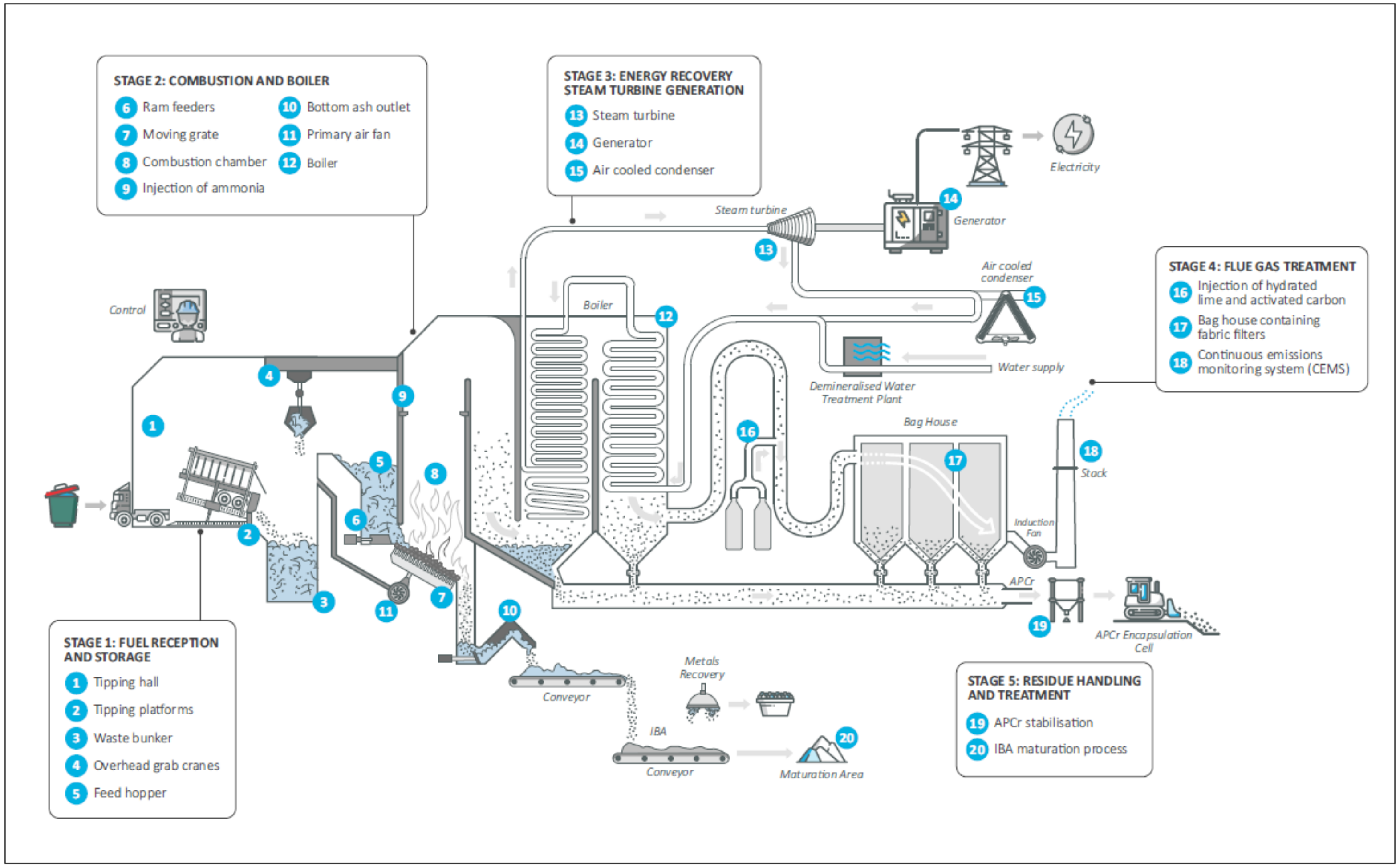


Figure 2.3 Schematic of the ARC process

2.2.2 Stage 2 combustion and heating

i Feed hopper

The feed hopper will be used to deliver the waste via a chute onto a moving grate, ensuring continuous delivery of the residual waste feedstock onto the grate for combustion. **Ram feeders (6)** will be used to push the waste from the chute onto the **moving grate (7)** inside the **combustion chamber (8)**. The chute will be designed to ensure the waste is held in an oxygen depleted environment, which will reduce the risk of fire propagation from the combustion chamber to the tipping hall and waste bunker.

Ammonia (9) will be injected into the hot gas stream for the purpose of controlling oxides of nitrogen (NO_x) within the combustion chamber where the temperature conditions are correct for the denitrification process to occur.

ii Grate system

The ARC will operate using moving grate technology with a single processing line. The angled grate will consist of alternating rows of fixed and moving grate bars, which will push the residual waste feedstock forward whilst providing a tumbling motion to the feedstock. This is designed to facilitate effective drying, ignition, combustion, energy release and complete burn-out before the **bottom ash outlet (10).**

The combustion chamber will be designed to retain the heated gases resulting from combustion at a temperature above 850°C for at least two seconds in compliance with the NSW EPA EfW Policy Statement. This process will be tightly controlled to ensure optimum combustion to both facilitate destruction of the residual waste, whilst maximising heat production.

Typically, the process will be designed for continuous waste combustion in the range between 60% and 107% of the thermal design load. Short-term peaks caused by the non-homogeneity of the residual waste will be absorbed by the system up to 110% of the design load.

As a contingency measure and in case the temperature in the secondary combustion chamber drops below the specified temperature range, diesel fired auxiliary burners will automatically start operation. Evidence shows that such activation occurs very rarely. Predominantly the burners will remain in a stand-by position and will be cooled by cooling air fans. The auxiliary burners will, however, routinely be used for start-up and shut down of the ARC. No residual waste will be fed onto the grate until the diesel burners have raised the temperature of the furnace to 850°C during start-up.

Air will be drawn from the bunker and tipping hall by the **primary air fan (11),** which will allow for odour control. The air will be pre-heated by a steam preheater and directed under the grate. A secondary air system will deliver combustion air to burn out and mix the flue gases, located at the top of the boiler.

iii Boiler

The **boiler (12)** will be contained within a boiler hall. The thermal energy (heat) released during the combustion process will be transferred to the boiler, where it will be absorbed by the feed water, converted into steam, superheated and transferred to the turbine hall (steam turbine), which is described further in stage 3. The process will use heat exchangers to generate steam heated typically to around 400°C at a pressure of 60 bar.

Feed water will be supplied to the steam-water circuit from the feed water tank by pumps.

2.2.3 Stage 3 energy recovery and electricity generation

The turbine hall will consist of the **steam turbine (13)**, which will be powered by the steam generated in the boiler hall. Electricity will be generated in the turbine hall by a **generator (14)** coupled to the steam turbine.

The electricity generated will supply the electrical energy needs of the complete ARC (parasitic load), while the balance will be exported to the grid via the substation.

Alternatively, the high-pressure steam would be directed to the **air cooled condensers** (ACC) **(15)** via a turbine bypass station. During start-up or turbine shut-off the high-pressure steam will be completely bypassed to the ACC for condensation.

After passing through the steam turbines the expanded steam will be condensed in the ACC. The condensate will be returned to the feed water tank.

2.2.4 Stage 4 flue gas treatment system

The FGT system is a comprehensive and dedicated system specifically designed to manage the flue gas from the ARC. It will incorporate a number of stages including circulation of the flue gas to limit the formation of particulates, the addition of reagents to remove contaminants and the use of fabric filters to remove particulates from the flue gas prior to discharge into the atmosphere.

Flue gas is a mixture of gases resulting from combustion and other reactions in the combustion chamber. Untreated flue gases from the ARC contain substances such as particulate matter, acid gases or organochlorides, hydrochloric acid (HCl) and hydrogen fluoride (HF)), sulfur dioxide (SO_2), NO_x, heavy metals (mercury, lead, cadmium, chromium, copper, zinc, nickel, etc), carbon monoxide (CO), together with polyhalogenated aromatics such as dioxins, a class of species including polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs). Therefore, the FGT system will be a critical element of the ARC required to meet stringent air quality standards.

The FGT system controls the emissions of NO_x, acid gases, heavy metals and dioxins. The products of incomplete combustion such as CO and volatile organic compounds (VOCs) will be managed through efficient combustion control on the grate and combustion chamber.

The generation of NO_x will be controlled in the combustion process, with the secondary air injection controlling the temperature of combustion and the amount of free oxygen in the combustion zone. This limits the amount of excess air, thereby reducing the potential for NO_x formation in the combustion zone.

After combustion control, the control and abatement of NO_x emissions will be achieved through selective non-catalytic reduction (SNCR) technology, whereby the combustion chamber has a selective SNCR system using ammonia. **Ammonia will be injected (9)** into the hot gas stream for the purpose of controlling NO_x. This will occur in the post-combustion chamber where the temperature conditions will be correct for the denitrification process to occur. Typical reducing agents include urea or ammonia water.

The combustion of waste in the ARC will generate acid gases and small amounts of dioxins, furans and heavy metals in the flue gas. These pollutants will be abated and or neutralised as follows:

- **Injection of hydrated lime (16)** – hydrated lime will be injected for the purpose of neutralising acid gases.
- **Injection of activated carbon (16)** – activated carbon will be injected to adsorb dioxins, furans and other contaminants including heavy metals. This will occur prior to the fabric filters such that the residues are captured before emission to atmosphere.

Hydrated lime and activated carbon will be metered and injected to the reaction ducting which will ensure turbulent flow and mixing of the hydrated lime, activated carbon and flue gas, to maximise the neutralisation of acid gases and adsorption of dioxins, furans and heavy metals.

The flue gas will be directed through **a bag house (17)**, which will contain fabric filter bags. The flue gas will be drawn through the bags which will remove fine dust particulate, spent lime and activated carbon. Particulates collected in this process are known as air pollution control residues (APCr), which will be temporarily stored in a silo prior to stabilisation and transport to the proposed encapsulation cell within the Eco Precinct.

Cleaned gases will be released through the stack, located next to the bag house and approximately 85 m in height. These gases will be monitored continuously to ensure they meet strict environmental legislation via the **continuous emissions monitoring system (CEMS) (18)**. The system will be managed automatically by the distributed control system (DCS), which will monitor the exhaust gases and automatically adjust dosing of reagents to provide a consistent output from the stack, even with variability in the waste feedstock.

2.2.5 Stage 5 residue handling and treatment

i IBA

Following combustion, approximately 20% of the original waste by weight remains as IBA. It will be discharged through an ash quencher, to reduce the temperature of the ash, and transferred through a series of conveyors. The IBA will flow over a grizzly screen to remove large items, before being discharged and collected on a conveyor from below the moving grate. Stockpiling bays and open topped bins will collect oversize material.

IBA will then be transferred by conveyor to the IBA area for screening and maturation.

ii APCr

The APCr will be collected from the boiler hall and from the filter bags within the bag house. It will be transferred to a collecting silo (**APCr stabilisation (19)**).

The APCr is expected to be classified as a hazardous waste, which requires treatment (stabilisation) to enable it to be disposed to a restricted waste landfill. This stabilisation process will occur within the ARC building. The proposed treatment option will be based on cement stabilisation. This process will involve the following steps:

1. Storage of ash: APCr will be transferred to dedicated silos with sufficient storage capacity for five days production, located adjacent to the reagents store.
2. Stabilisation: APCr will be transferred from the silos to the adjacent stabilisation facility, which will involve the mixing of a solid binding agent (eg cement) with the APCr at an approprate ratio plus water. A mixer will be used to combine the APCr with the solid binding agent. The resulting ash/cement mix is a spadable, granular aggregate, typically with a fraction size of minus 40 mm.
3. Disposal: The stabilised APCr will be transferred (internally) from the ARC building using truck and trailer (or tractor and bin), through the Eco Precinct internal road network and will be unloaded in the encapsulation cell.
4. Compaction and curing: To minimise the storage volume of the stabilised APCr, post-placement compaction will be conducted within the encapsulation cell. The process may also involve moisture adjustment followed by spreading and compaction/densification with plant such as bulldozers or front-end loaders.

3 Local setting and assessment locations

3.1 Local setting, land use and topography

The Eco Precinct is located in the Goulburn Mulwaree LGA on Collector Road, approximately 6 km west of the village of Tarago, and 50 km south of Goulburn, NSW, shown in Figure 1.1. Other nearby villages and towns include Collector 20 km to the north-west, Lake Bathurst 9 km to the north-east and Bungendore 24.5 km to the south-west.

The locality surrounding the Eco Precinct has been cleared for grazing and/or cultivation. Land immediately surrounding the operational areas of the Eco Precinct is owned by Veolia, providing a buffer between operations and surrounding private properties. This includes the land which forms part of the Eco Precinct, and Pylara Farm as shown in Figure 1.2.

The Eco Precinct has an average elevation of approximately 800 m above Australian Height Datum (AHD) across the site with a maximum of 1,000 m AHD in the north-eastern corner along the ridgeline of the Great Dividing Range. The region is characterised by undulating plains with the Great Dividing Range running through the Eco Precinct in a north-south alignment.

A three-dimensional representation of the local topography is presented in Figure 3.1.

3.2 Assessment locations

Sensitive receptors surrounding the Eco Precinct include rural properties, with the closest non-Veolia owned receptors located approximately 4.5 km from the project to the south-west. As stated previously, the town of Tarago is located approximately 6 km to the east, and includes residential properties and other sensitive community land uses such as a school and recreation areas.

In 2021 the local area had a total population of 1,139, comprising a population of 510 in Tarago State Suburb (SSC), 218 in Lake Bathurst SSC, 167 in Currawang SSC and 244 in Mount Fairy SSC (ABS 2021).

To assess potential air quality impacts from the project, a range of sensitive land uses were selected as discrete model prediction locations. These locations are used to assess compliance with applicable ambient air quality impact assessment criteria. A summary of assessment locations by type and the closest distance to the ARC stack is provided in Table 3.1 while the assessment locations are illustrated Figure 3.2.

A full list of assessment locations is provided in Appendix A.

Table 3.1 Summary of assessment locations

Assessment location type	Count	Closest distance to ARC stack (km)
Agriculture	22	6.8
Church	1	10.3
Commercial	1	10.4
Community	1	7.5
Industrial	2	0.4
Preschool	1	7.1
Residential	181	4.5
School	1	7.0
Veolia-owned residences	4	1.2
Vineyard	1	8.4

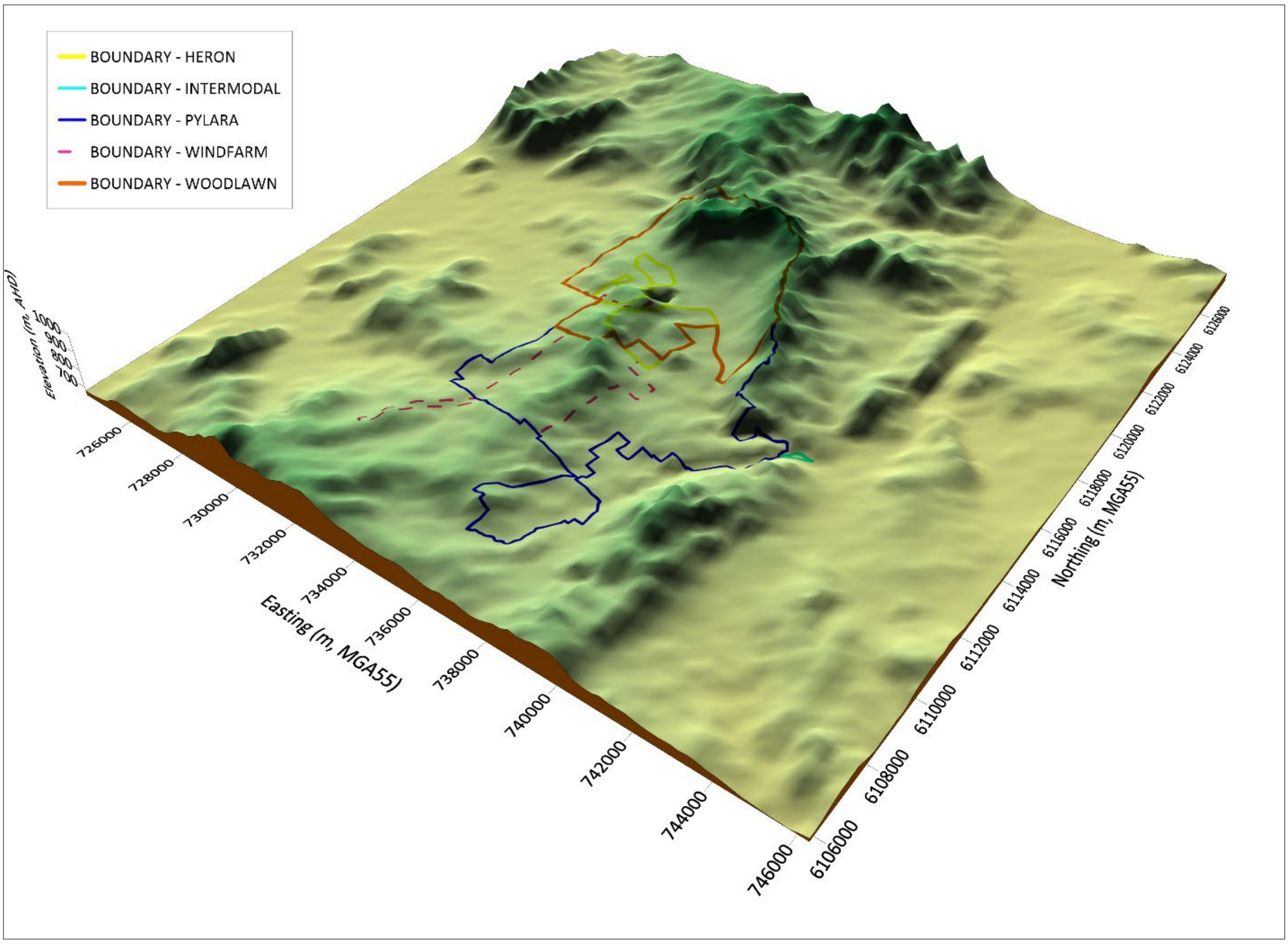
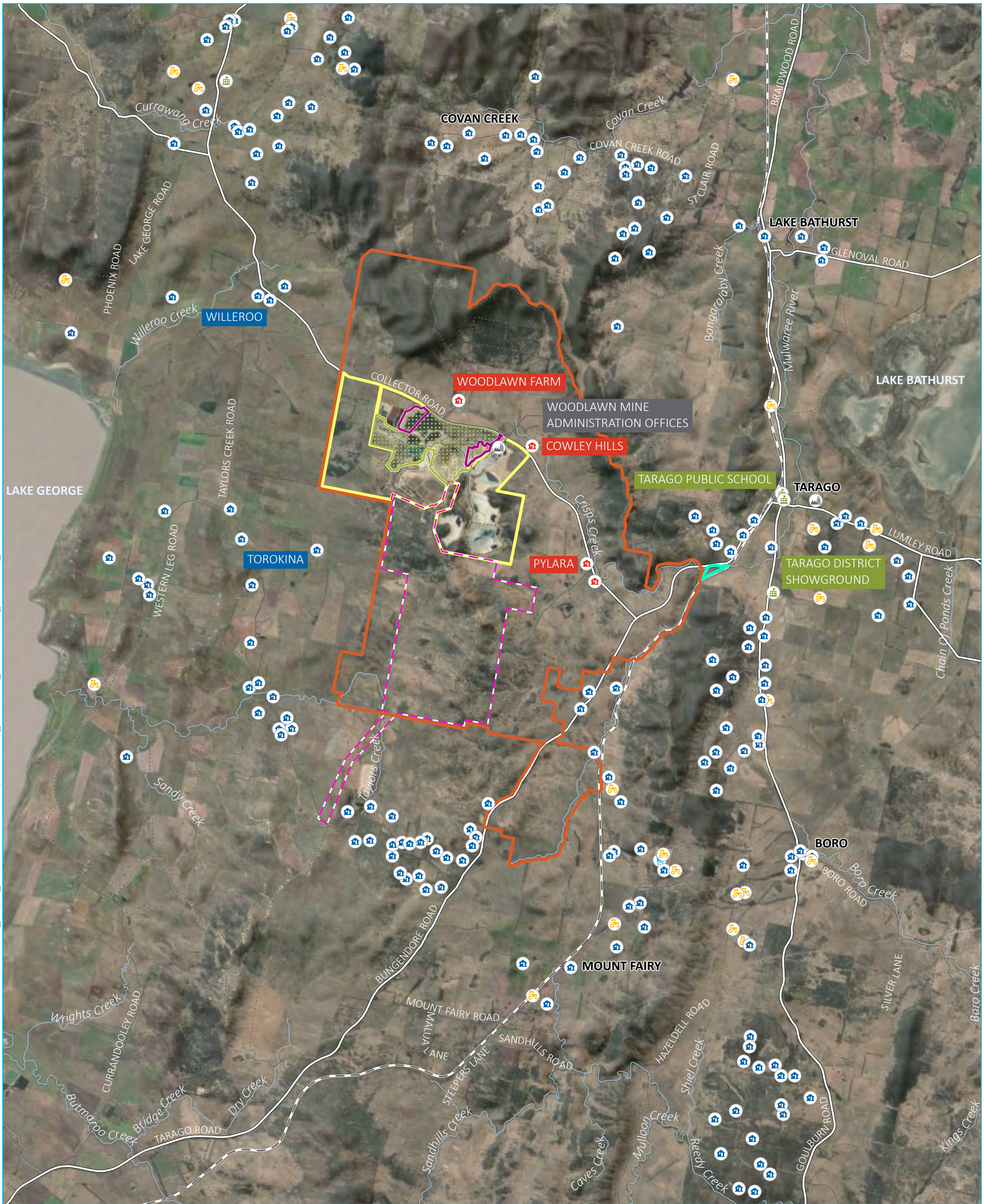


Figure 3.1 3-dimensional topography of the Eco Precinct and surrounding area

Source: NASA Shuttle Radar Topography Mission data.



Source: EMM (2022); Veolia (2022); DFSI (2017)

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KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment locations

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 3.2

EMM
creating opportunities

4 Pollutants and assessment criteria

4.1 Potential air pollutants

The primary air pollutants emitted by the Eco Precinct, including the project, will comprise of:

- particulate matter (PM), specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$);
- oxides of nitrogen (NO_x)[3], including nitrogen dioxide (NO_2);
- sulfur dioxide (SO_2);
- carbon monoxide (CO);
- hydrogen fluoride (HF);
- hydrogen chloride (HCl);
- ammonia (NH_3);
- dioxins and furans;
- polycyclic aromatic hydrocarbons (PAHs);
- volatile organic compounds (VOCs);
- assorted metals and metalloids[4]; and
- odour.

A summary of air pollutants that are relevant to each Eco Precinct component is presented in Table 4.1. Detailed air pollutant emission calculations are documented in Chapter 7 and Appendix C.

[3] By convention, NO_x = Nitrous oxide (NO) + NO_2.

[4] A metalloid is a chemical element which has properties that are intermediate between those of typical metals and non-metals (eg silicon, arsenic).

Table 4.1 Air pollutants by Eco Precinct component

Air pollutant	Eco Precinct component				
	ARC building	APCr encapsulation cell	Bioreactor and support facilities	MBT Facility and support facilities	BioEnergy Power Station and flares
TSP	✓	✓	✓	✓	✓
PM_{10}	✓	✓	✓	✓	✓
$PM_{2.5}$	✓	✓	✓	✓	✓
NO_x	✓		✓	✓	✓
SO_2	✓		✓	✓	✓
CO	✓		✓	✓	✓
HF	✓				
HCl	✓				
NH_3	✓				
Dioxins and furans	✓				
PAHs	✓				
VOCs	✓		✓	✓	✓
Metals/ metalloids	✓	✓	✓	✓	
Odour	✓		✓	✓	

4.2 Impact assessment criteria

4.2.1 Particulate matter

The EPA's impact assessment criteria for particulate matter, as documented in Section 7 of the Approved Methods for Modelling, are presented in Table 4.2. The assessment criteria for PM_{10} and $PM_{2.5}$ are numerically consistent with the national air quality standards that are defined in the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM) (Department of the Environment 2021).

TSP, which relates to airborne particles less than around 50 µm in diameter, is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts (EPA 2013). Particles less than 10 µm in diameter, accounted for in this assessment by PM_{10} and $PM_{2.5}$, are a subset of TSP and are fine enough to enter the human respiratory system, and are therefore more directly correlated with health impacts. The EPA impact assessment criteria for PM_{10} and $PM_{2.5}$ are therefore used to assess the potential impacts of airborne particulate matter on human health.

The Approved Methods for Modelling classifies TSP, PM_{10}, $PM_{2.5}$ and dust deposition as 'criteria pollutants'. The impact assessment criteria for criteria pollutants are applied at the nearest existing or likely future off-site sensitive receptors[5], and compared against the 100th percentile (ie the highest) dispersion modelling prediction for the relevant averaging period. Both the incremental (project only) and cumulative (project plus background) impacts need to be presented, with the latter requiring consideration of the existing ambient background concentrations.

At some locations, the background concentrations of PM_{10} and $PM_{2.5}$ can exceed the impact assessment criteria due to the influence of regional events such as bushfires and dust storms. In such circumstances, there is a requirement to demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.

For dust deposition, the EPA (2022) specifies criteria for the project-only increment and cumulative dust deposition levels. Dust deposition impacts are derived from TSP emission rates and particle deposition calculations in the dispersion modelling process.

Table 4.2 Impact assessment criteria for particulate matter

PM metric	Averaging period	Impact assessment criterion
TSP	Annual	90 µg/m³
PM_{10}	24 hour	50 µg/m³
	Annual	25 µg/m³
$PM_{2.5}$	24 hour	25 µg/m³
	Annual	8 µg/m³
Dust deposition	Annual	2 g/m²/month (project increment only)
		4 g/m²/month (cumulative)

Notes: µg/m³: micrograms per cubic meter; g/m²/month: grams per square metre per month.

4.2.2 Gaseous pollutants

As stated, the project and other components of the Eco Precinct will (or currently) generate emissions of a range of gaseous pollutants, including NO_x, CO, SO_2 and VOCs. The relevant impact assessment criteria for off-site ambient air quality concentrations arising from all existing and proposed emission sources at the Eco Precinct, as defined by the EPA (2022), are summarised in Table 4.3.

Impact assessment criteria are not prescribed for total VOCs; however, one of the more commonly assessed VOCs is benzene, which also has one of the more stringent impact assessment criteria of all the principal toxic air pollutants. Benzene is therefore adopted as a suitable proxy for the assessment of VOCs, on the basis that if compliance is achieved for benzene, compliance can also be assumed for other VOCs.

[5] EPA (2022) defines a sensitive receptor as a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.

Table 4.3 Impact assessment criteria for gaseous pollutants – NSW EPA Approved Methods for Modelling (2022)

Pollutant	Averaging period	Impact assessment criterion (µg/m³)
NO_2	1 hour	164
	Annual	31
SO_2	1 hour	286
	24 hour	57
CO	1 hour	30,000
	8 hour	10,000
HF	24 hour	1.5
	7 day	0.8
	30 day	0.4
	90 day	0.25
Benzene	1 hour (99.9th percentile)	29
Dioxins and furans	1 hour (99.9th percentile)	2.00E-06
PAHs (as BaP)	1 hour (99.9th percentile)	0.4
NH_3	1 hour (99.9th percentile)	330
HCl	1 hour (99.9th percentile)	140

The impact assessment criteria presented in Table 4.3 are applied in the following ways:

- The impact assessment criteria for NO_2, SO_2, CO and HF are applicable at the nearest existing or likely future off-site sensitive receptor. In assessing compliance against the applicable criteria, the maximum cumulative concentration (project sources plus other Eco Precinct sources plus Woodlawn Mine sources plus background concentration) at each receptor must be reported as the 100^{th} percentile concentration (ie maximum concentration) for the relevant averaging period.

- Consistent with the Approved Methods for Modelling, the impact assessment criteria for benzene, dioxins and furans, PAHs (as BaP), NH_3 and HCl are applicable at or beyond the boundary of the facility. For the purpose of this AQIA the boundary of the facility is defined as the boundary of the Veolia integrated waste management operations (shown in Figure 1.2), rather than the development footprint of the project.

  This approach is considered appropriate for the following reasons:

  - there are project-related emission sources that occur beyond the development footprint (eg APCr haulage) within the boundary of the Veolia integrated waste management operations;

  - if the development footprint were taken as the “boundary of the facility”, this would treat other Veolia-operated areas within the integrated waste management operations boundary (eg Bioreactor) as sensitive receptor locations; and

  - there are existing sources of air pollutants across the Eco Precinct that should be considered in combination with emissions from the project.

  The incremental impact (ie predicted impacts due to emissions from project sources plus Eco Precinct sources only) for each pollutant reported as the 99.9^{th} percentile 1 hour average concentration.

4.2.3 Metals and metalloids

Emissions of individual metals and metalloids may be generated by the combustion process for the project and the handling of various materials across the Eco Precinct (eg IBA and APCr from the project, capping material, MBT product, etc). The EPA specifies impact assessment criteria for many principal and individual toxic air pollutants in the Approved Methods for Modelling.

Through site material geochemistry sampling and analysis and source sampling results (see reference facility discussion in Section 7.2.1), a range of geochemistry profiles for emission sources at the Eco Precinct have been developed. Of the detected elements, those with an applicable EPA impact assessment criterion are presented in Table 4.4.

It is noted that for each of the elements listed in Table 4.4, with the exception of lead, the impact assessment criterion specified by the EPA must be applied at or beyond the boundary of the project, which as stated in Section 4.2.2 is taken to be the area marked by the boundary of Veolia integrated waste management operations (Figure 1.2), with the incremental impact (ie predicted impacts due to the project pollutant source alone) for each pollutant reported as the 99.9^{th} percentile 1 hour average concentration. The criterion for lead is an annual average and is applied at all assessment locations.

For the purpose of this report, the incremental impact for metals and metalloids is assessed as the combined contribution from all proposed new sources associated with the project (eg ARC stack, IBA and IBAA processing and handling, APCr haulage and handling) in combination with future emissions from approved operations within the Eco Precinct (eg Bioreactor, MBT etc).

Table 4.4 Impact assessment criteria – metals and metalloids

Element	Impact assessment criterion (µg/m³)	Averaging period
Antimony	9	99.9th percentile 1 hour
Arsenic	0.09	99.9th percentile 1 hour
Beryllium	0.004	99.9th percentile 1 hour
Cadmium	0.018	99.9th percentile 1 hour
Chromium[1]	0.09	99.9th percentile 1 hour
Copper[2]	3.7	99.9th percentile 1 hour
Lead	0.5	Annual average
Manganese	18	99.9th percentile 1 hour
Mercury[3]	1.8	99.9th percentile 1 hour
Nickel	0.18	99.9th percentile 1 hour
Zinc[4]	18	99.9th percentile 1 hour

1. Assessed as 100% chromium VI from Approved Methods for Modelling (EPA 2022).
2. Assessed as copper dusts and mists from Approved Methods for Modelling (EPA 2022).
3. Assessed as inorganic mercury from Approved Methods for Modelling (EPA 2022).
4. Assessed as zinc chloride fumes from Approved Methods for Modelling (EPA 2022), considered to be highly conservative for zinc dust.

4.3 Emission limits – NSW EPA Energy from Waste Policy

Separate to the previously discussed ambient air quality impact assessment criteria that are applicable to ground level concentrations of air pollutants at specific locations in the surrounding environment (eg sensitive receptors, at or beyond site boundary), the NSW EPA have specified stack emission concentration standards in the 2021 document *NSW Energy from Waste Policy Statement* (EPA 2021, hereafter the NSW EfW Policy). As stated in Section 2 of EPA (2021), the intention of the NSW EfW Policy is to outline the policy framework and technical criteria that apply to facilities proposing to recover energy from waste in NSW.

The emission standards presented in Table 1 of NSW the EfW Policy are listed in Table 4.5. Further consideration of these emission standards will be made in the emissions inventory section of this AQIA (Section 7.2).

Table 4.5 ***NSW Energy from Waste Policy Statement* (EPA 2021) – emission standards**

Pollutant	Concentration[1]	Averaging period
Solid particles (total)	20 mg/Nm^3	One hour or the minimum sampling period specified in the relevant test method, whichever is the greater.
Type 1 and 2 substances in aggregate[2]	0.3 mg/Nm^3	One hour or the minimum sampling period specified in the relevant test method, whichever is the greater.
Mercury	0.04 mg/Nm^3	One hour or the minimum sampling period specified in the relevant test method, whichever is the greater.
Cadmium and thallium (total)	0.02 mg/Nm^3	One hour or the minimum sampling period specified in the relevant test method, whichever is the greater.
Dioxins and furans	0.1 ng/Nm^3	One hour or the minimum sampling period specified in the relevant test method, whichever is the greater.
SO_2	100 mg/Nm^3	One hour
NO_x as NO_2 equivalent	250 mg/Nm^3	One hour
CO	80 mg/Nm^3	One hour
HCl	50 mg/Nm^3	One hour
HF	4 mg/Nm^3	One hour
VOCs	20 mg/Nm^3	One hour
NH_3	5 mg/Nm^3	24 hours

1. Expressed at dry, 273 K, 101.3 kPa and 11 % oxygen.
2. As defined in the Protection of the Environment Operations (Clean Air) Regulation 2010 – Type 1 and 2 substances include antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin and vanadium (or compounds containing one or more of these elements).

4.4 Odour impact assessment criteria

There are no instrument-based methods that can measure an odour response in the same way as the human nose. Therefore “dynamic olfactometry” is typically used as the basis of odour quantification by regulatory authorities. Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air to a panel of people with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. The correlations between the known dilution ratios and the panellists’ responses are then used to calculate the number of dilutions of the original sample required to achieve the odour detection threshold. The units for odour measurement using dynamic olfactometry are “odour units” (ou) which are dimensionless and are effectively “dilutions to threshold”.

The odour nuisance level can be as low as 2 ou and as high as 10 ou (for less offensive odours), whereas an odour assessment criterion of 7 ou is likely to represent the level below which ‘offensive’ odours should not occur. The *Technical Framework for Assessment and Management of Odour from Stationary Sources in NSW* (NSW DECC 2006) recommends that, as a design criterion, no individual should be exposed to ambient odour levels of greater than 7 ou.

The EPA (2022) prescribes odour goals which take into account the population density for a particular area. The most stringent odour goal of 2 ou is acceptable for the whole population and therefore appropriate for built-up areas. Odour goals are only applied for odour impact assessment (ie compared against the 99th percentile of the dispersion modelling predictions) and are not used, for example, to determine compliance for an existing facility.

A summary of the EPA's population-based odour assessment criteria is presented in Table 4.6.

Table 4.6 Impact assessment criteria for complex mixtures of odorous air pollutants

Population of affected community	Odour units (ou), nose response time average^, 99th percentile
~ 2	7
~ 10	6
~ 30	5
~ 125	4
~ 500	3
Urban (2000) and/or schools and hospitals	2

Note: ^ a nose response average refers to the instantaneous perception of odours by the human nose and is derived using peak-to-mean ratios, described in Section 9.3.1.

The odour impact assessment prepared for the Woodlawn Expansion Project (Heggies 2010) adopted an odour goal of 6 ou, based on the number of sensitive receptor locations in the immediate vicinity of the Eco Precinct. The annual independent odour audits (ie TOU 2021) have also adopted 6 ou as an odour performance goal for the Eco Precinct, used for compliance with condition 7 (f) of Schedule 4 of the Project Approval.

For consistency with historical studies completed at the Eco Precinct, this AQIA will adopt an odour impact assessment criterion of 6 ou.

As reported in the most recent independent odour audit (TOU 2021), there were 98 odour complaints received between 1 April 2020 and 31 April 2021. This was attributed to high rainfall conditions over the audit period which impacted the efficiency of the landfill gas containment and extraction at the Bioreactor, increasing the formation of fugitive landfill gas emission pathways from the void surface.

For conservative purposes, and to reflect the recent increase in odour complaints received from the local community, an odour goal of 2 ou is also considered in this assessment. As stated in Section 3.2, the suburb of Tarago had a population of 510 in 2021, which under the data presented in Table 4.6 would equate to an odour criterion of approximately 3 ou.

5 Meteorology and climate

5.1 Introduction

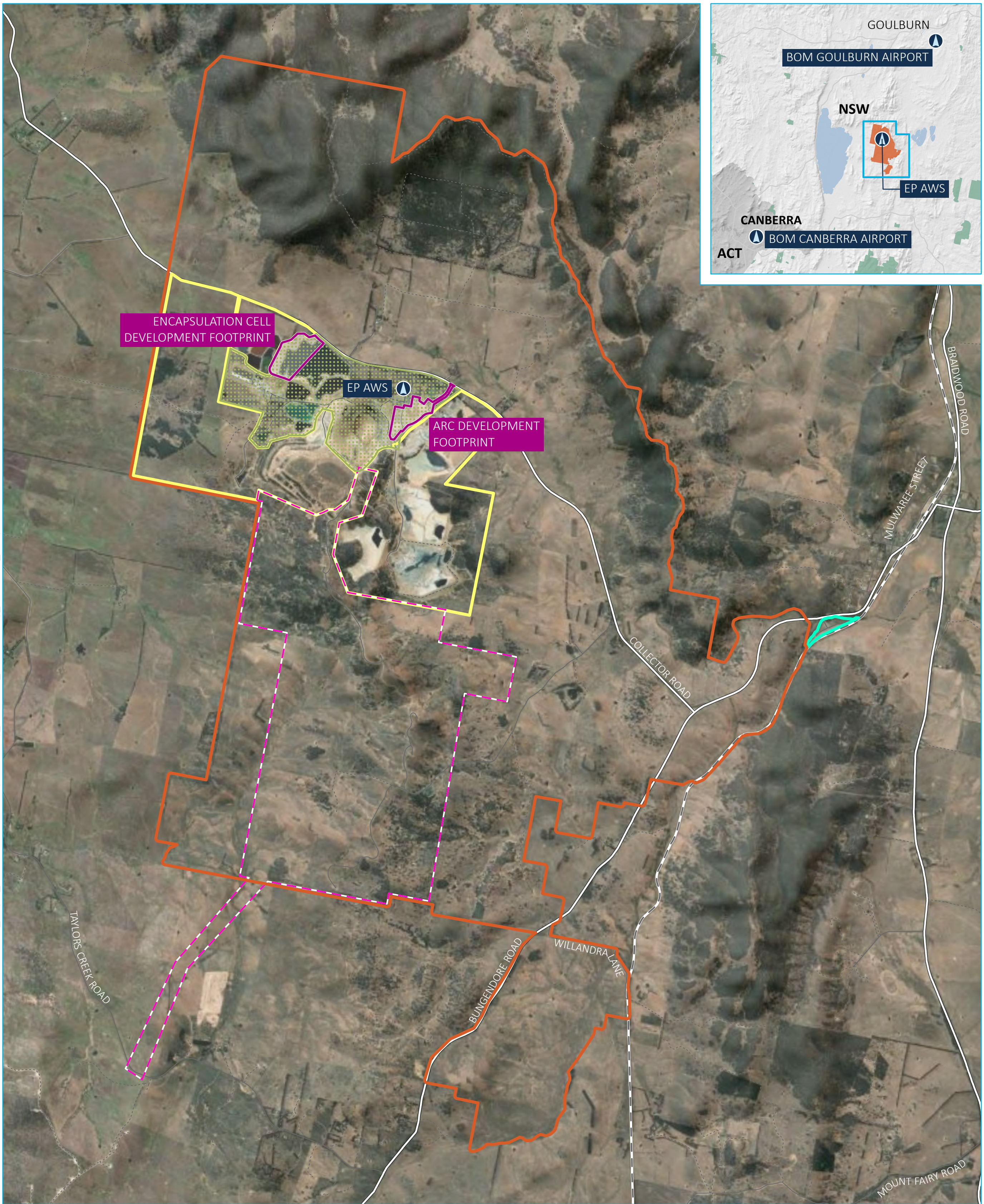
Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

Veolia maintain a comprehensive automatic weather station (AWS) at the Eco Precinct in accordance with the EPL for the operations. The Eco Precinct AWS (EP AWS) is the primary resource adopted for analysing meteorological conditions in the local area. The 2021 Independent Audit for the Eco Precinct (Ramboll 2021) identifies that the EP AWS meets the requirements of the NSW EPA Approved Methods for Sampling of Air Pollutants in New South Wales (EPA 2007)

Additional data has been sourced from the Bureau of Meteorology (BoM) AWS locations at:

- Goulburn Airport (31 km north-north-east of the EP AWS); and
- Canberra Airport (44 km south-west of the of the Eco Precinct).

The location of these surface observation sites in relation to the Eco Precinct is shown in Figure 5.1.



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Source: EMM (2022); Veolia (2022); BOM (2021); DFSI (2017)

KEY

- Development footprint
- Observation site
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Meteorological observation sites for the region

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 5.1

EMM
creating opportunities

5.2 Selection of a representative dataset for modelling

The selection of a representative year considers data availability (the higher the data capture rate the more complete the modelling period) and representativeness of that year when compared to longer term conditions. The representativeness of the selected year is particularly important for wind conditions, which has the greatest influence on dispersion, and ambient background (the modelling year should avoid years with significantly lower or higher ambient background concentrations).

Five years of hourly meteorological data from the EP AWS were reviewed for the period between 2016 and 2020. A summary plot of the analysed data is presented in Appendix B and shows that data capture was high across all years with the exception of 2017. Veolia have identified that the EP AWS was not operational between May 2017 and August 2017 due to sensor damage.

Annual wind roses for the period 2016 to 2020 are presented in Appendix B. The analysis shows consistency in wind direction and average wind speed. The frequency of calm winds (less than or equal to 0.5 m/s) is slightly higher for 2016 and 2017, however this is expected to be associated with the station downtime and sensor replacement. The high degree of consistency in recorded winds for the period between 2018 and 2020 indicates that any of these calendar years would be suitable for modelling.

Annual wind roses for the BoM Goulburn Airport and Canberra Airport AWS locations for 2016 to 2020 are also presented in Appendix B. For both sites, the annual wind speed and direction profile is comparable across all presented years. This further supports the above conclusion that any of the presented calendar years would be suitable for modelling purposes.

The inter-annual variation in temperature and relative humidity recorded by the EP AWS is also presented in Appendix B. The box and whisker plots compare the variation of recorded air temperature and relative humidity by hour of the day across the analysed years. These plots demonstrate that temperature and relative humidity measured across each year are consistent.

The calendar year 2018 was selected for modelling based on the following:

- data capture rate of 99% for all parameters;
- annual wind roses show consistency in wind direction, average wind speed and percentage occurrence of calm winds (<= 0.5 m/s) with other years; and
- the 2019 and 2020 calendar years were specifically excluded due to the occurrence of extensive drought and bushfire events which resulted in elevated concentrations of recorded PM_{10} and $PM_{2.5}$, which are not representative of a typical year (further discussion in Section 6.3).

5.3 Prevailing winds

The annual wind rose for data recorded by the EP AWS during 2018 is presented in Figure 5.2. The wind rose shows a prevailing wind alignment to the east and west, consistent with the other analysed years between 2016 and 2020 (Appendix B). The prevailing east-west wind direction is aligned with the path of the surrounding topographical features (see Figure 3.1).

The annual average wind speed recorded in 2018 was 3.4 m/s. The annual average frequency of calm conditions (wind speeds less than 0.5 m/s) was 7.8%. Calm winds are typically associated with stable atmospheric conditions (see Section 5.5) which have a lower potential for the dispersion of air pollutant emissions.

Diurnal wind roses for the EP AWS 2018 dataset are shown in Figure 5.3. The recorded wind direction patterns are east-west aligned during both day and night periods, however the occurrence of westerly winds is highest during the day. The average wind speed during the day was 3.8 m/s compared to 3.0 m/s at night-time, while the percentage of calms is higher at night (11.1% versus 4.7% during the day).

Seasonal wind roses for the EP AWS 2018 dataset are shown in Figure 5.4. The mean wind speed ranges from 3.1 m/s in autumn and summer to 3.9 m/s in winter. The frequency of calm conditions ranged from 5.0% in summer to 11.8% in autumn. The recorded wind pattern across all seasons was east-west aligned, with a higher occurrence of westerly winds during the winter months.

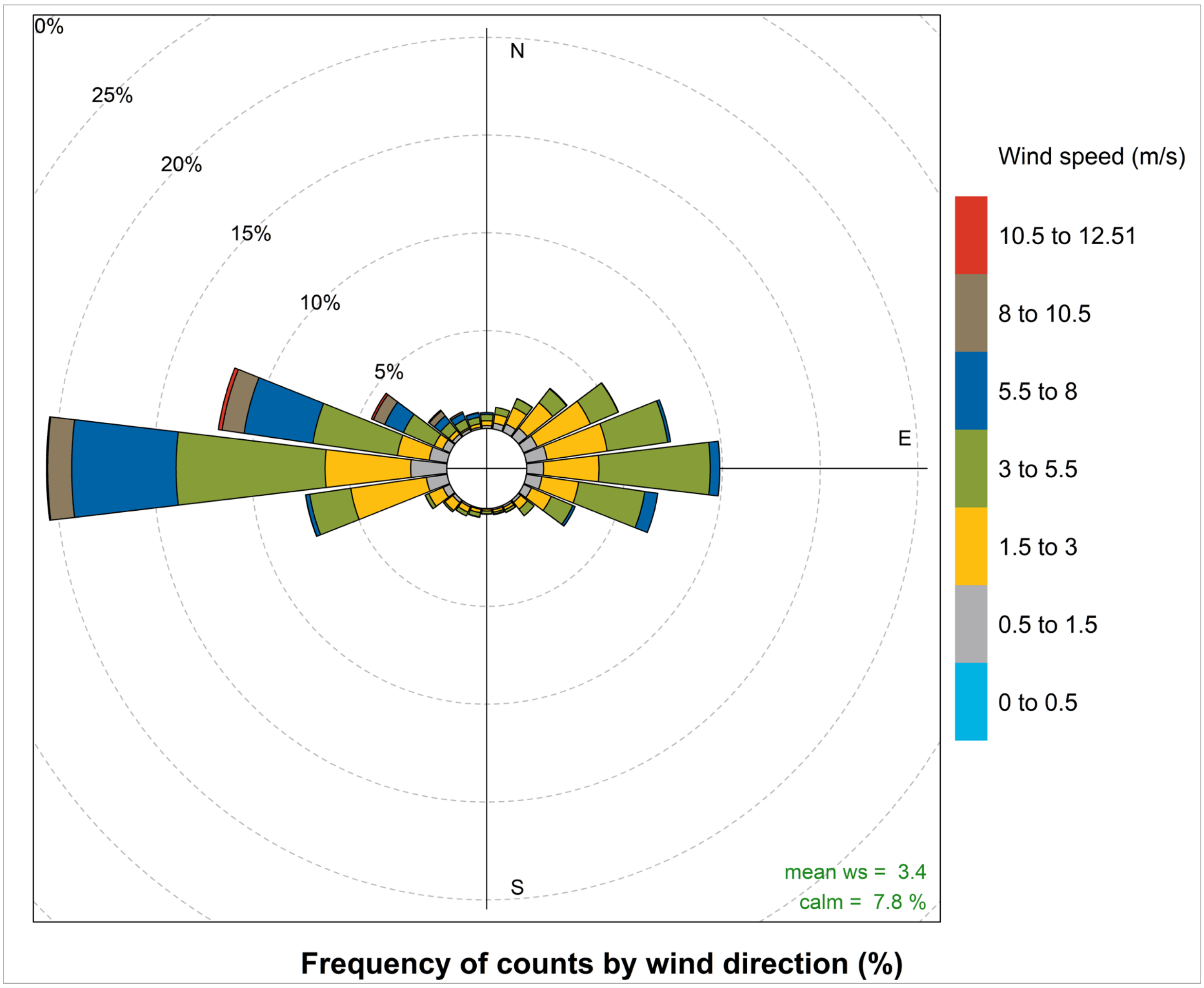


Figure 5.2 Recorded wind speed and direction – EP AWS – 2018

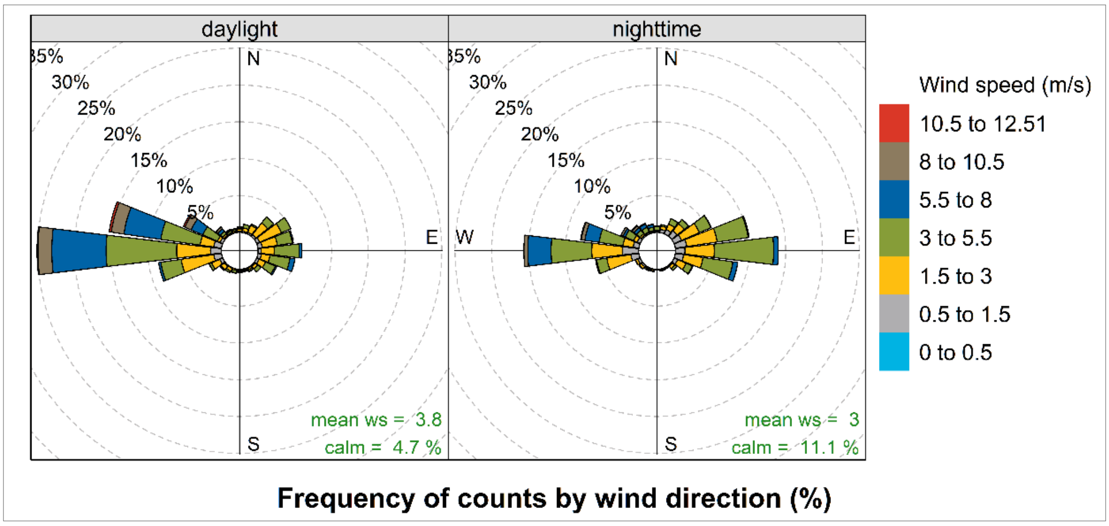


Figure 5.3 Recorded diurnal wind speed and direction – EP AWS – 2018

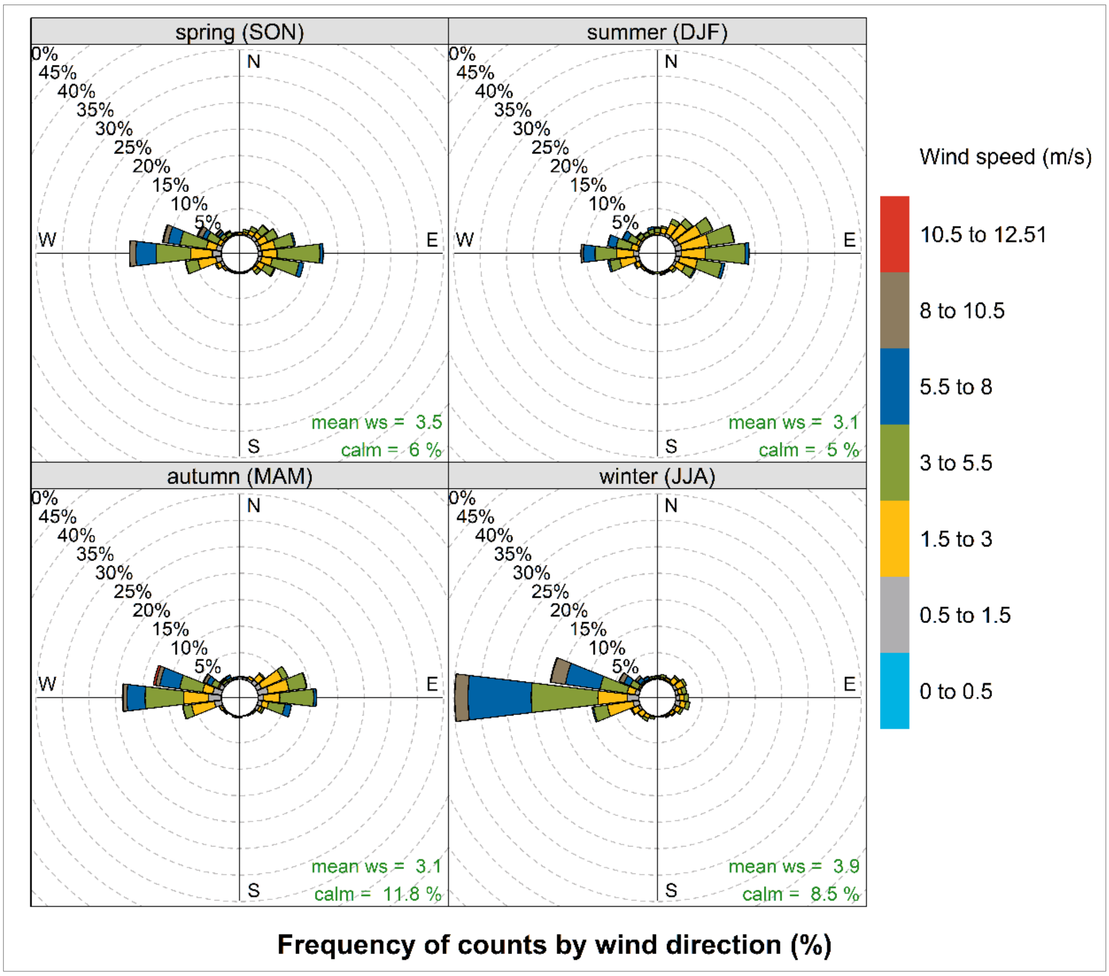


Figure 5.4 Recorded seasonal wind speed and direction – EP AWS – 2018

5.4 Meteorological modelling

The atmospheric dispersion modelling for this assessment uses the CALMET/CALPUFF model suite. Surface observations are included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind field. Surface observations from the three stations listed in Section 5.1 were incorporated into the CALMET modelling.

In the absence of upper air measurements, CALMET has been run using prognostic upper air data (as a three-dimensional '3D.dat' file), which is used to derive an initial wind field (known as the Step 1 wind field in the CALMET model). The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and is adopted for this assessment. The Air Pollution Model (TAPM) was used to generate the upper air data ('3D.dat') for each hour of the model run period for input into CALMET.

Two CALMET modelling domains were configured, both centred over the Eco Precinct:

- An outer CALMET grid of 90 km (x axis) by 90 km (y axis) was run with a resolution of 1 km. Surface meteorological data from the EP AWS and BoM AWS locations at Goulburn Airport and Canberra Airport were incorporated into the modelling. TAPM-generated 3D.dat file with 3 km grid resolution was used as prognostic input file to Step 1 wind field calculations.

- An inner CALMET grid of 35 km (x axis) by 35 km (y axis) was run with a resolution of 0.25 km. Surface meteorological data from the EP AWS and BoM AWS locations at Goulburn Airport and Canberra Airport were incorporated into the modelling. TAPM-generated 3D.dat file with 1 km grid resolution was used as prognostic input file to Step 1 wind field calculations.

A comparison of wind direction and wind speed extracted from CALMET and TAPM at the Eco Precinct with the measurements from the EP AWS during 2018 is presented in Figure 5.5. This figure shows close agreement between the three wind speed/direction profiles, which is to be expected due to the influence of observations on respective model calculations.

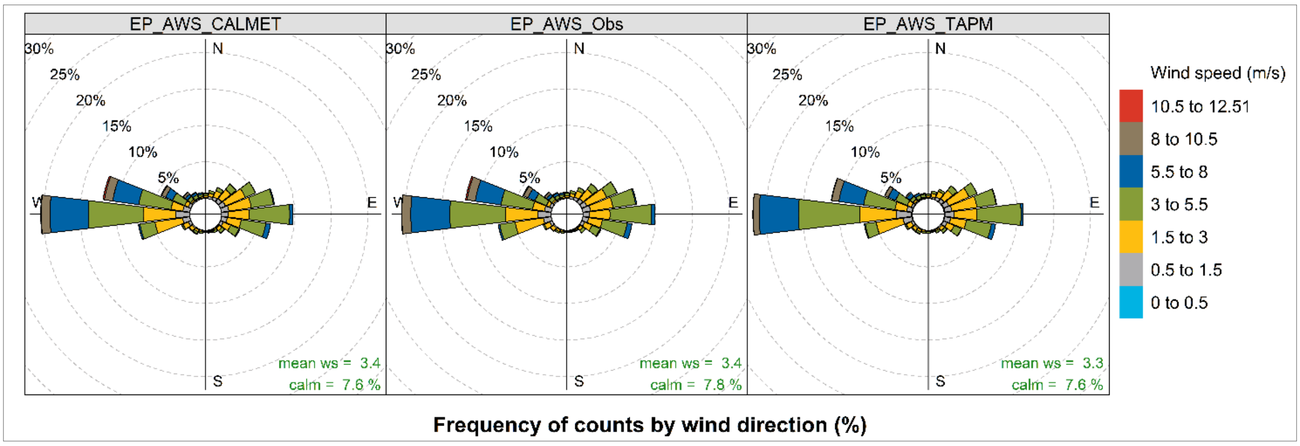


Figure 5.5 Comparison between CALMET-predicted, observations and TAPM-predicted at EP AWS – 2018

The CALMET model predicts spatially varying wind fields for each hour of the 12 month modelling period, taking surface meteorological observations, upper air prognostic model data, land cover and terrain features into consideration. An example one hour extraction from the CALMET-predicted wind field is presented in Figure 5.6, showing the predicted variation in wind direction (arrow pointing in the direction wind is blowing towards) and wind speed (marked by size of wind arrow) in the vicinity of the Eco Precinct and Tarago overlayed on terrain contours (coloured lines). The particular extracted hour wind field presented in Figure 5.6 shows southerly air flow to the east of Tarago, diverting to south-south-easterly flow at Tarago and easterly winds at the Eco Precinct on the other side of the dominant ridgeline.

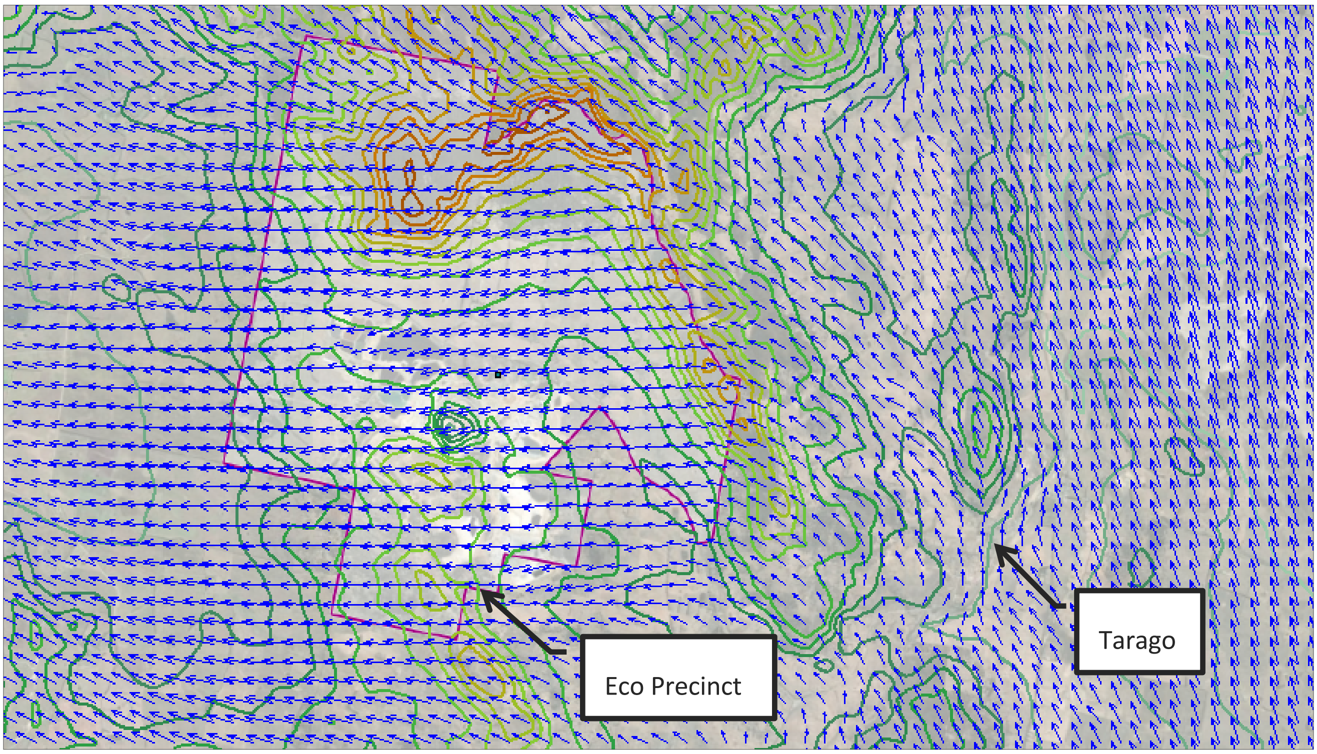


Figure 5.6 Example of spatial variation in CALMET-predicted wind field – Eco Precinct and Tarago

A detailed overview of the meteorological modelling completed for this AQIA is presented in Appendix B.

5.5 Atmospheric stability and boundary layer heights

Atmospheric stability refers to the degree of turbulence or mixing that occurs within the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (ie the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically, about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 5.7 illustrates the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by CALMET. The diurnal profile shows that atmospheric instability increases during the daylight hours as the sun generated convective energy increases, whereas stable atmospheric conditions prevail during the night-time.

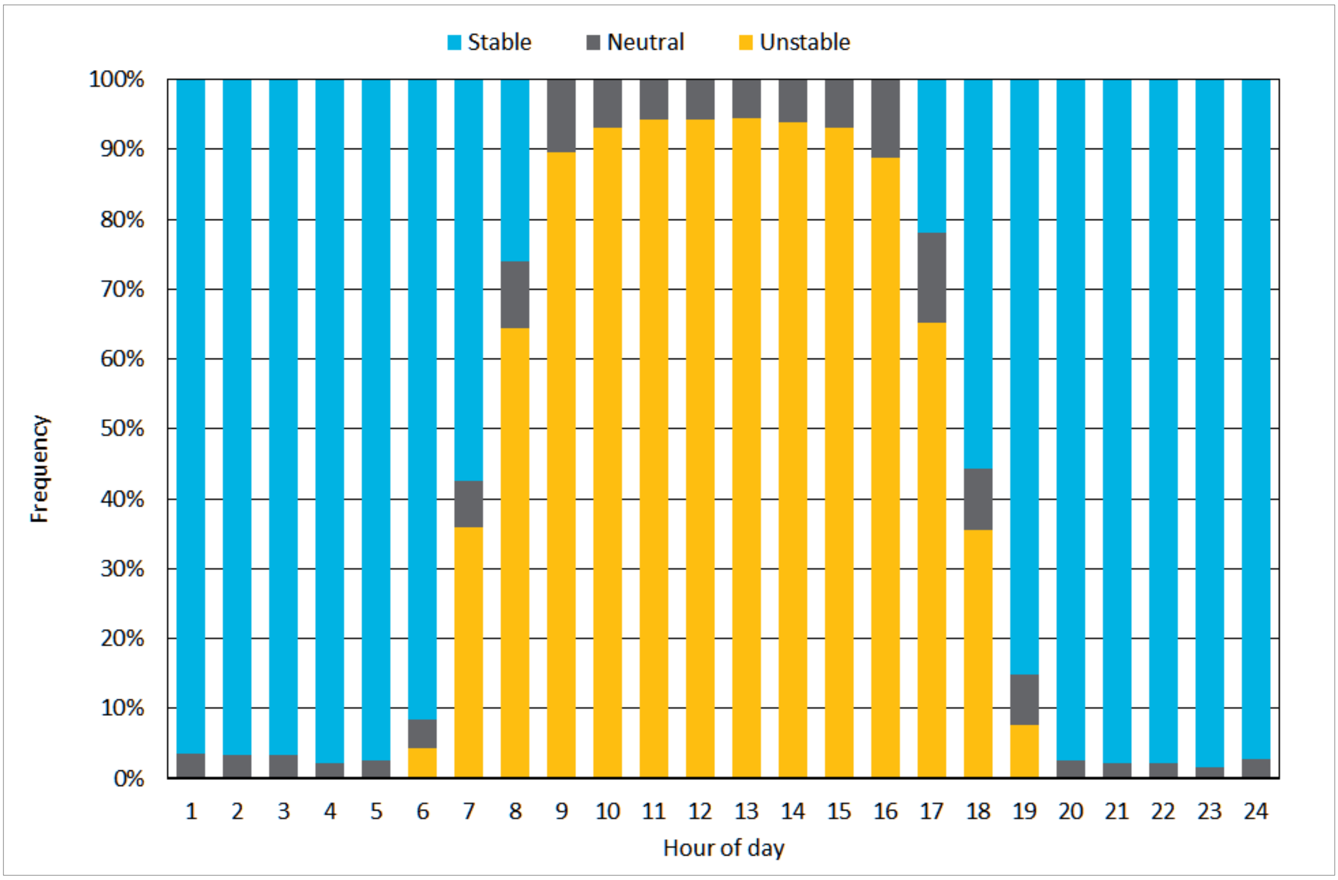


Figure 5.7 Diurnal variations in CALMET-generated atmospheric stability – Eco Precinct

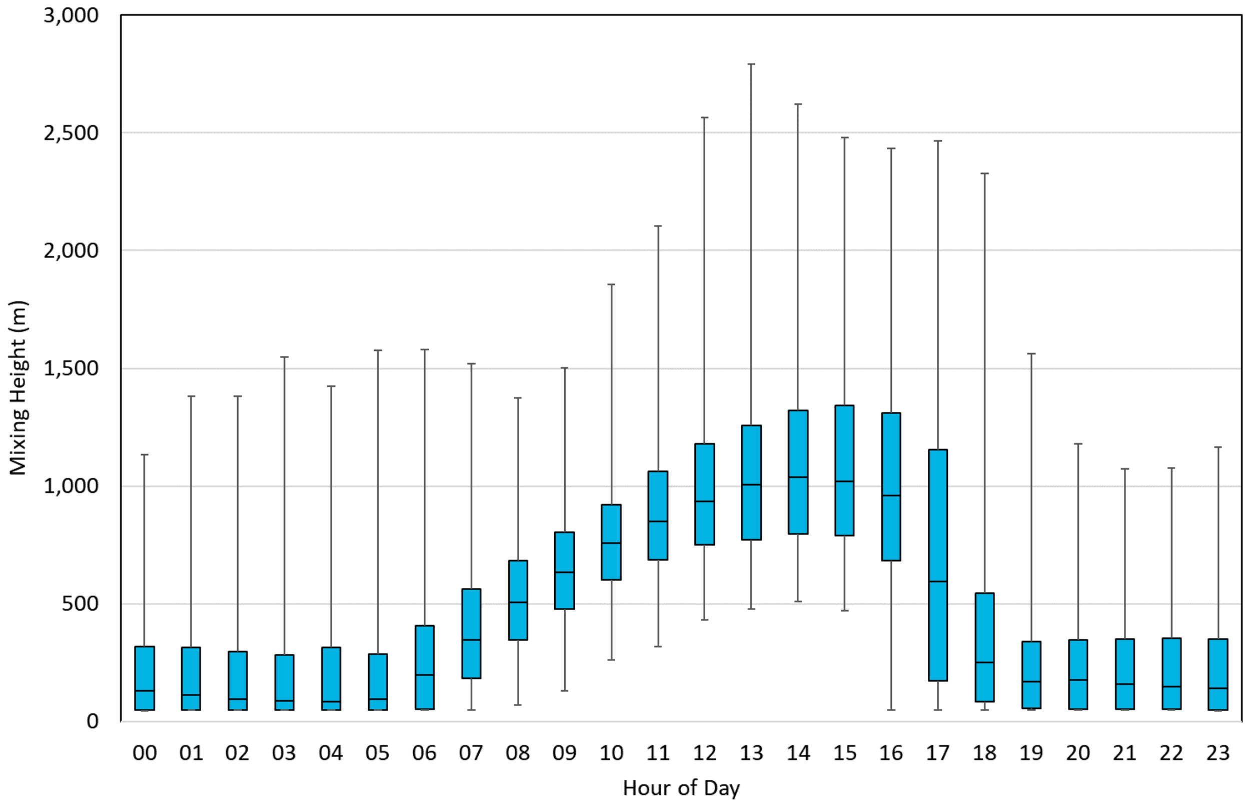
The seasonal variation in atmospheric stability is presented in Table 5.1, showing the highest percentage occurrence of stable conditions (associated with poorer dispersion) during the winter months.

Table 5.1 Frequency of occurrence of atmospheric stability by season

Season	Frequency (%) by atmospheric stability		
	Unstable	Neutral	Stable
Summer	51%	2%	48%
Autumn	37%	5%	58%
Winter	28%	10%	61%
Spring	44%	5%	52%

Mixing height refers to the height of the atmosphere above ground level within which the dispersion of air pollution occurs. The mixing height of the atmosphere is influenced by mechanical (associated with wind speed) and thermal (associated with solar radiation) turbulence. Similar to the Monin-Obukhov length analysis above, higher daytime wind speeds 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 heights and greater potential for the atmospheric dispersion of pollutants.

Figure 5.8 presents the hourly-varying atmospheric boundary layer depths generated by CALMET. This diurnal profile for stability and mixing height indicates that the dispersion of emissions would be greatest during daytime hours.



Box and whisker plot showing upper and lower quartile range (boxes) and minimum and maximum (whiskers). The mean is shown by the line in the centre of the box.

Figure 5.8 Diurnal variation in CALMET-generated mixing heights

6 Existing ambient air quality

6.1 Existing sources of emissions

The National Pollutant Inventory (NPI 2021) and EPA (2021) environment protection licence (EPL) databases have been reviewed to identify significant existing sources of air pollutants in the local region. In addition to the Eco Precinct and the Crisps Creek IMF, the only other significant existing industrial source of air pollutant emissions is the neighbouring Woodlawn Mine.

Emissions from existing operations at the Eco Precinct and Woodlawn Mine have been explicitly quantified and modelled in combination with emissions from the project (Section 7.2.6).

Other contributing sources of air pollutant emissions to existing background air quality include:

- dust entrainment due to vehicle movements along unsealed roads and sealed roads with high silt loadings;
- dust emissions from agricultural activities, in particular livestock operations;
- fuel combustion-related emissions from on-road and non-road engines;
- wind generated dust from exposed areas within the surrounding region; and
- seasonal emissions from household wood burning for heating during winter.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. It is considered these additional local and regional emission sources are accounted for in the monitoring data analysed in the following sections of this report.

6.2 Air quality monitoring data resources

To demonstrate compliance with impact assessment criteria, consideration of cumulative impact is required to assess how the project will interact with existing and future sources of emissions. The approach for cumulative assessment is to model existing sources of emissions and add this to the regional background dataset to derive a site-specific ambient background for the local area.

The Eco Precinct air quality monitoring network includes a meteorological monitoring station and four dust deposition gauges. The neighbouring Woodlawn Mine records 24 hour average concentrations of TSP and PM_{10} by high volume air sampler (HVAS) on a one-in-six-day basis.

The dust deposition gauges will be used to represent background dust deposition levels in cumulative impact assessment calculations. The Woodlawn Mine HVAS monitoring results for PM_{10} and TSP will be referenced in this analysis, however have limited value for cumulative impact assessment purposes on the basis of the one-in-six-day nature of sampling. For example, the HVAS results may not represent a true indication of the daily maximum PM_{10} or number of days over the impact assessment criterion (as some higher days may be missed) and a few high daily values can disproportionately influence the annual average concentrations, as there are less 'normal day' values to smooth out the effect of these peak events.

In order to understand the likely ambient background concentrations of other pollutants at the Eco Precinct due to limited (PM_{10}) or no ($PM_{2.5}$, NO_2, SO_2 and CO) local monitoring, the following regional monitoring resources have been accessed:

- the NSW Department of Planning and Environment (DPE) air quality monitoring station (AQMS) at Goulburn (38 km north-north-east of the Eco Precinct) for PM_{10}, $PM_{2.5}$ and NO_2;
- the NSW DPE AQMS at Bargo (125 km north-east of the Eco Precinct) for SO_2 only; and
- the ACT Government AQMS sites for PM_{10}, $PM_{2.5}$, NO_2, O_3 and CO at:
  - Florey (52 km west-south-west of the Eco Precinct);
  - Civic (47 km west-south-west of the Eco Precinct); and
  - Monash (59 km south-west of the Eco Precinct).

While spatially distant from the Eco Precinct, these regional air quality monitoring resources provide high quality long-term hourly-varying datasets located within the NSW Southern Tablelands and ACT.

As all monitoring sites are located in areas featuring greater urban development than the Eco Precinct surrounds, it is considered that the adoption of these datasets will conservatively represent ambient background air pollutant concentrations for use in this assessment. As stated above, the existing approved operations at the Eco Precinct and Woodlawn Mine sites will be modelled for cumulative impact assessment purposes.

The location of the referenced air quality monitoring locations is presented in Figure 6.1.

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Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm

Monitoring station

- Air quality monitoring station
- Dust deposition
- PM_{10} HVAS

- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Air quality monitoring locations

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 6.1

EMM
creating opportunities

6.3 PM_{10} and $PM_{2.5}$ concentrations

Summary statistics for PM_{10} and $PM_{2.5}$ for the period January 2014 to December 2021 at the three ACT Government AQMS sites and NSW DPE Goulburn AQMS are presented in Table 6.1. Timeseries plots of daily-varying PM_{10} and $PM_{2.5}$ concentrations at these four regional monitoring locations are presented in Figure 6.2 and Figure 6.3 respectively.

From the results summary in Table 6.1 and timeseries plots (Figure 6.2 and Figure 6.3), it is noted that a significantly higher number of exceedances were recorded during 2019 and 2020 due to the extensive bushfires that occurred between November 2019 and February 2020. Additionally, the 2018 calendar year exhibits elevated concentrations of PM_{10}, which is considered reflective of intensifying drought conditions across eastern Australia with associated dust storm events.

Across all air quality monitoring sites, the recorded PM_{10} and $PM_{2.5}$ concentrations follow a similar daily-varying trend over the analysed period. Of particular note from the recorded $PM_{2.5}$ concentrations (Figure 6.3) is the general increasing trend through the winter months of each year. This is considered reflective of emissions from domestic wood heaters.

The NSW DPE Goulburn AQMS station commenced monitoring in November 2019. To illustrate the similarity in regional particulate matter concentrations, a correlation between the PM_{10} and $PM_{2.5}$ concentrations recorded at the three ACT Government AQMS and the Goulburn AQMS was completed. Relative to the Goulburn AQMS monitoring data, Pearson's correlation coefficient (*r*)[6] values of 0.81 (vs Civic), 0.81 (vs Florey) and 0.73 (vs Monash) were calculated for PM_{10}, while *r* values 0.81 (vs Civic), 0.82 (vs Florey) and 0.74 (vs Monash) were calculated for $PM_{2.5}$. These calculated *r* values indicate a strong linear agreement between the PM_{10} and $PM_{2.5}$ concentrations recorded at the ACT Government and Goulburn AQMS sites. The strong linear relationship despite the spatial distance between the Canberra and Goulburn is indicative of broadscale transportation of particulate matter as a key driver to recorded concentrations in the Canberra/Southern Tablelands region.

Due to the influence of bushfire events during 2019 and 2020, the 2018 calendar year has been selected as the modelling period for the AQIA. Due to the intensifying drought conditions discussed above, the use of 2018 as ambient background is considered conservative for cumulative assessment purposes. Due to La Nina-influenced rainfall and the influences on particulate matter removal from the atmosphere, 2021 was also discounted on the grounds of being too low to provide a conservative background concentrations.

For the purpose of cumulative impact assessment, a daily-varying regional average PM_{10} and $PM_{2.5}$ dataset has been derived for 2018, based on the average of concurrent daily concentrations recorded at the three ACT Government AQMS. The following key points are made in relation to the 2018 regional average PM_{10} and $PM_{2.5}$ datasets:

- The 2018 regional average PM_{10} concentration dataset features three exceedances of the EPA 24 hour average criterion of 50 µg/m³. The highest 24 hour average PM_{10} concentration not in exceedance of the EPA criterion is 45.9 µg/m³. The annual average is 12.4 µg/m³ (relative to the EPA criterion of 25 µg/m³).

- The 2018 regional average $PM_{2.5}$ concentration dataset features one exceedance of the EPA 24 hour average criterion of 25 µg/m³. The highest 24 hour average $PM_{2.5}$ concentration not in exceedance of the EPA criterion is 23.1 µg/m³. The annual average is 7.1 µg/m³ (relative to the EPA criterion of 8 µg/m³).

By comparison, it is noted that the average PM_{10} concentration recorded by the Woodlawn Mine HVAS between October 2017 and February 2021, based on online reports, was 12.3 µg/m³, with annual variation ranging from 8.2 µg/m³ to 13.1 µg/m³. While the HVAS dataset does not capture complete years of monitoring, the average results compare well with the adopted regional average PM_{10} dataset.

6 A Pearson's correlation coefficient value of 1 indicates a strong linear relationship between two variables.

6.4 TSP concentrations

As stated, the adjacent Woodlawn Mine undertakes monitoring of TSP and PM_{10} concentrations by HVAS. Data recorded between October 2017 and February 2021 was collated from on online reports (Heron 2021). The annual average TSP concentration recorded over this period was 23.6 µg/m³. Furthermore, the average ratio of recorded PM_{10}/TSP concentrations over the analysed period was 0.52.

To derive an annual average TSP concentration consistent with the 2018 background period, the ratio of 0.52 has been applied to the regional average annual mean PM_{10} concentration for 2018, returning a TSP background concentration of 23.8 µg/m³.

6.5 Dust deposition levels

Veolia record dust deposition levels at four dust deposition gauges:

- DG18 – IMF (Crisps Creek);
- DG22 – east of Bioreactor;
- DG34 – west of Bioreactor; and
- DG28 – “Pylara” residence.

The DG18 (IMF) monitoring location is located off-site from the Eco Precinct and is therefore considered the most representative of dust deposition levels beyond the influence of Eco Precinct operational emissions. The annual average dust deposition levels recorded at DG18 between 2014 and 2020 ranged from 1.0 g/m^2/month to 2.4 g/m^2/month. The annual average dust deposition level for 2018 at DG18 was 1.2 g/m^2/month, which will be adopted as background dust deposition for cumulative impact assessment purposes.

Table 6.1 Summary statistics for PM_{10} and $PM_{2.5}$ – ACT Government and DPE Goulburn AQMS

Year	Civic AQMS		Florey AQMS		Monash AQMS		Goulburn AQMS	
	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
Annual mean concentration (PM_{10} criterion – 25 µg/m³; $PM_{2.5}$ criterion – 8 µg/m³, bold = recorded exceedance)								
2014	10.0	-	10.3	5.8	10.3	6.7	-	-
2015	11.3	6.0	10.7	6.9	10.0	7.4	-	-
2016	10.7	5.6	10.1	7.1	9.9	7.2	-	-
2017	9.5	5.9	9.9	7.3	9.9	**8.2**	-	-
2018	13.1	6.1	12.2	7.3	11.8	7.0	-	-
2019	21.7	**12.1**	22.9	**14.6**	18.3	**13.7**	-	-
2020	22.6	**14.8**	24.8	**19.1**	23.4	**18.9**	19.8	**12.9**
2021	8.8	9.8	10.7	9.3	11.9	5.3	7.3	7.8
Maximum 24-hour average concentration (PM_{10} criterion – 50 µg/m³; $PM_{2.5}$ criterion – 25 µg/m³, bold = recorded exceedance)								
2014	33.5	-	32.6	19.9	32.2	**28.8**	-	-
2015	**73.6**	13.1	**76.2**	**26.5**	**53.1**	**32.6**	-	-
2016	37.3	19.6	29.8	**27.6**	37.9	**39.3**	-	-
2017	45.6	**42.1**	31.2	**25.3**	27.9	**34.0**	-	-
2018	**167.3**	**34.7**	**163.0**	**28.0**	**132.9**	**30.8**	-	-
2019	**300.7**	**258.1**	**363.1**	**329.3**	**260.9**	**264.6**	**494.1**	**333.7**
2020	**815.1**	**672.4**	**875.1**	**762.3**	**962.1**	**962.4**	**556.7**	**516.1**
2021	28.6	21.9	37.8	**28.0**	37.6	**27.9**	30.1	**25.4**
Number of days that the 24-hour average concentration is above the impact assessment criteria								
2014	0	-	0	0	0	2	-	-
2015	1	0	1	2	1	10	-	-
2016	0	0	0	3	0	10	-	-
2017	0	1	0	1	0	12	-	-
2018	3	1	3	1	2	4	-	-
2019	29	27	30	28	22	31	24	28
2020	25	23	22	31	23	37	18	17
2021	0	0	0	2	0	3	0	1

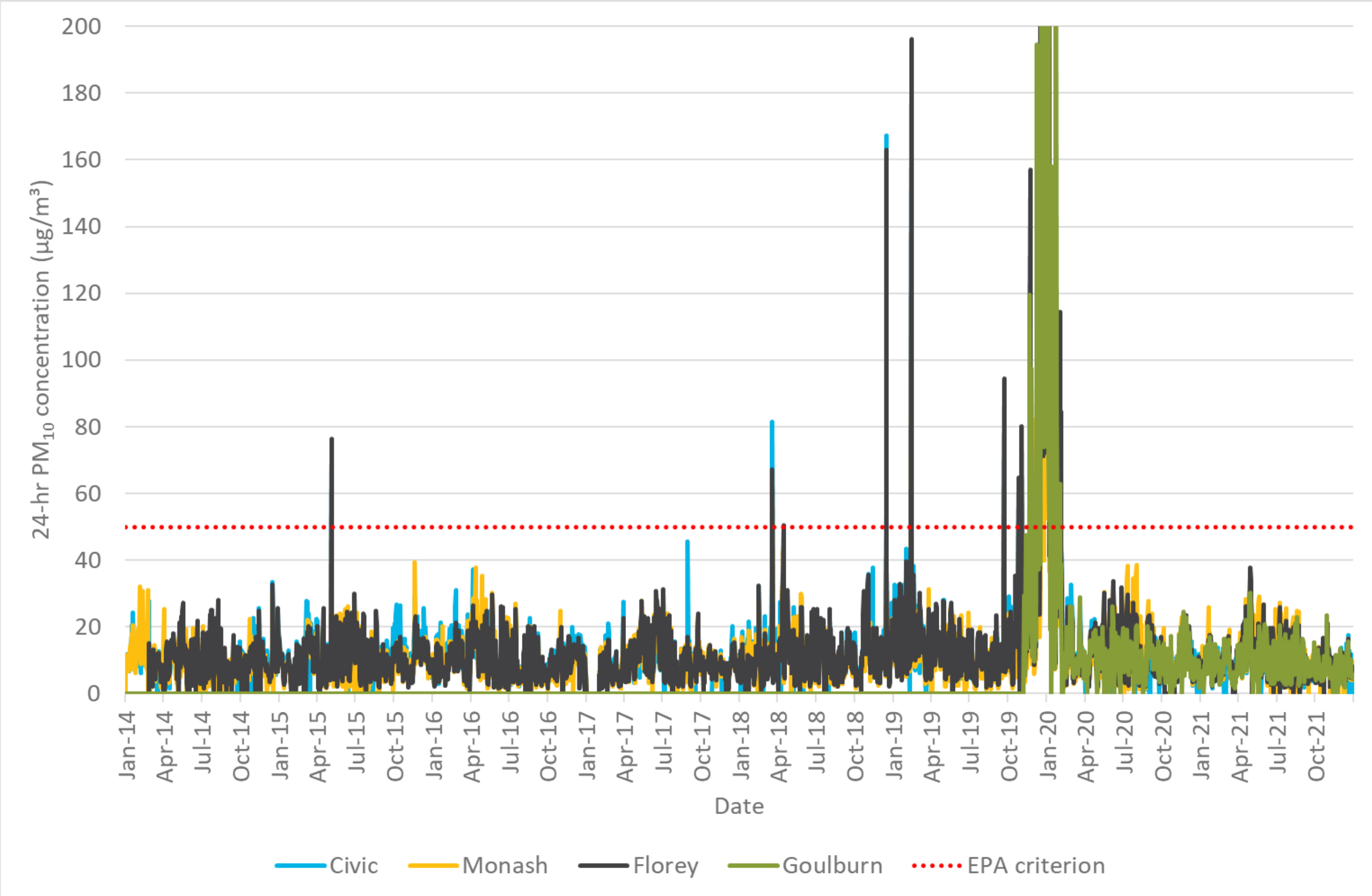


Figure 6.2 Timeseries plot for 24-hour PM_{10} – ACT and Goulburn AQMS – 2014 to 2021

Note: Y-axis cropped at 200 µg/m³ for visual purposes.

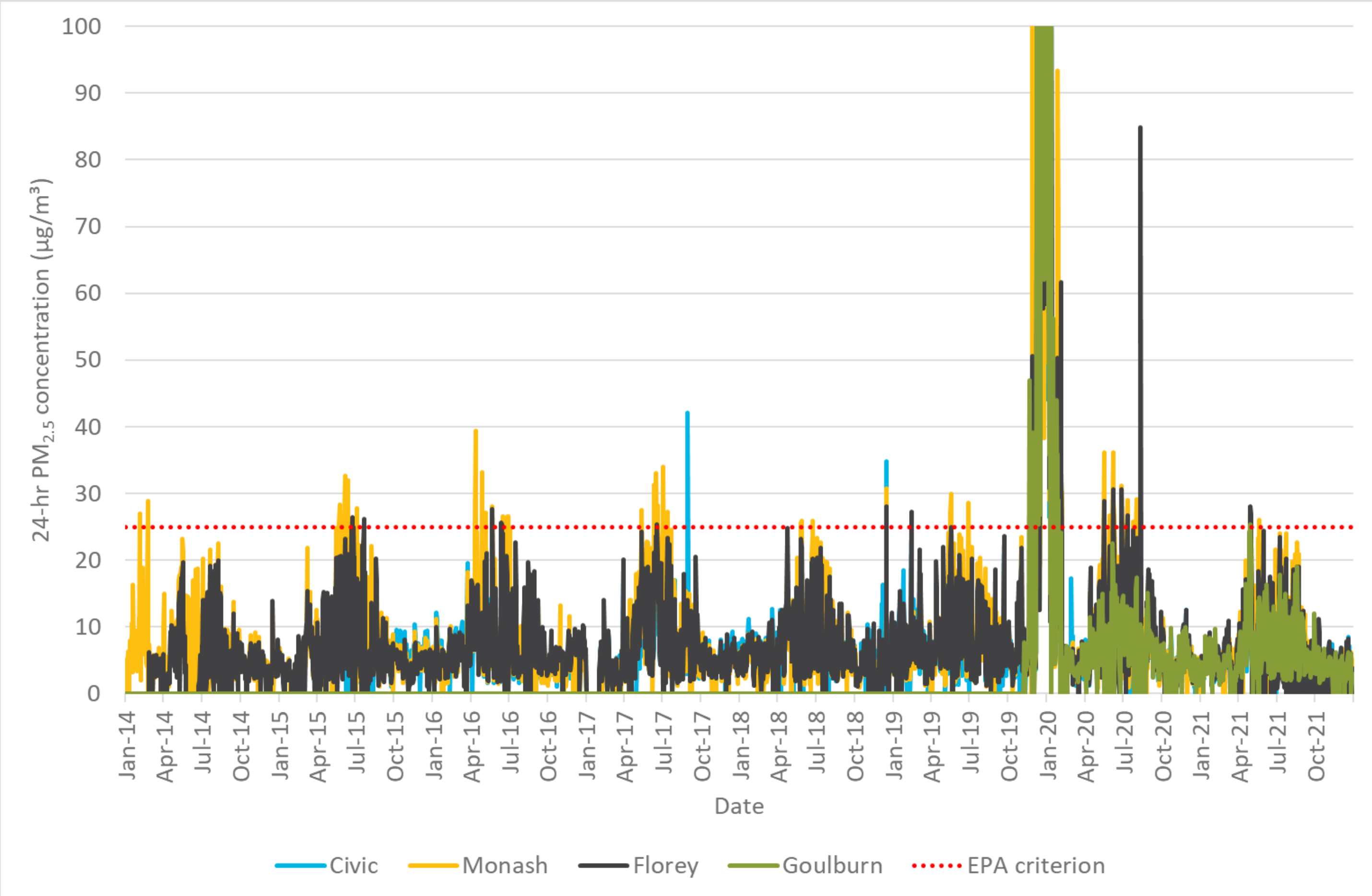


Figure 6.3 **Timeseries plot for 24-hour $PM_{2.5}$ – ACT and Goulburn AQMS – 2014 to 2021**

Note: Y-axis cropped at 100 µg/m³ for visual purposes.

6.6 NO_2, SO_2 and CO concentrations

Summary statistics for NO_2, CO and SO_2 for the period January 2014 to December 2021 at the three ACT Government AQMS sites and NSW DPE Goulburn and Bargo AQMS sites are presented in Table 6.2.

In general, the results of all pollutants at all monitoring locations are well below the applicable impact assessment criteria in all years. Concentrations of SO_2 from the DPE Bargo AQMS in particular are very low across all years. The exception is NO_2 and CO concentrations during 2019 and 2020, which show infrequent exceedances. These exceedances are coincident with the NSW bushfire emergency between November 2019 and February 2020.

Consistent with the 2018 regional average dataset for PM_{10} and $PM_{2.5}$ (Section 6.3), hourly varying regional average datasets for NO_2 and CO were derived from the ACT Government AQMS sites, while SO_2 concentrations were adopted from the DPE Bargo AQMS (SO_2 is not measured at the ACT Government AQMS). The following key points are made in relation to the 2018 background datasets for NO_2, CO and SO_2:

- The 2018 regional average NO_2 concentration dataset features no exceedances of the EPA 1 hour average criterion of 164 µg/m^3. The highest 1 hour average NO_2 concentration is 60.1 µg/m^3. The annual average is 8.7 µg/m^3 (relative to the EPA criterion of 31 µg/m^3).

- The 2018 regional average CO concentration dataset features no exceedances of the EPA 1 hour average criterion of 30,000 µg/m^3. The highest 1 hour average CO concentration is 2,775.7 µg/m^3.

- The 2018 regional average SO_2 concentration dataset features no exceedances of the EPA 1 hour average criterion of 286 µg/m^3. The highest 1 hour average SO_2 concentration is 28.6 µg/m^3. The annual average is 1.0 µg/m^3.

Table 6.2 Summary statistics for NO_2, CO and SO_2 – ACT Government and DPE AQMS sites

Year	Civic AQMS		Florey AQMS		Monash AQMS		Goulburn AQMS	Bargo AQMS
	NO_2 (µg/m³)	CO (µg/m³)	NO_2 (µg/m³)	CO (µg/m³)	NO_2 (µg/m³)	CO (µg/m³)	NO_2 (µg/m³)	SO_2 (µg/m³)
Annual mean concentration (NO_2 criterion – 31 µg/m³; CO criterion – N/A								
2014	6.3	234.9	6.5	1,062.0	6.5	1,034.8	-	0.7
2015	-	-	6.7	387.5	5.9	606.0	-	0.8
2016	-	-	6.1	499.7	5.4	451.5	-	1.3
2017	-	-	6.8	451.4	6.2	431.1	-	1.2
2018	-	-	6.4	454.8	5.4	405.2	-	1.0
2019	-	-	6.7	511.1	6.1	405.4	5.6	1.3
2020	-	-	5.4	612.1	5.4	564.9	5.0	0.8
2021	-	-	5.3	557.9	3.4	164.1	4.3	1.3
Maximum 1 hour average concentration (NO_2 criterion – 164 µg/m³; CO criterion – 30,000 µg/m³ [EPA], SO_2 criterion 286 µg/m³)								
2014	53.6	947.3	67.0	6,252.3	80.4	7,578.6	-	28.6
2015	-	-	40.2	1,515.7	40.2	10,231.1	-	25.7
2016	-	-	53.6	4,054.5	53.6	3,315.6	-	28.6
2017	-	-	53.6	3,467.2	53.6	3,050.4	-	28.6
2018	-	-	53.6	2,879.9	53.6	3,012.5	-	28.6
2019	-	-	388.6	15,649.8	107.2	20,178.0	215.7	57.2
2020	-	-	227.8	27,737.6	160.8	41,682.2	132.7	34.3
2021	-	-	45.6	3,258.8	48.2	2,406.2	38.9	25.7
Number of hours that the 1 hour average concentration is above the impact assessment criteria								
2014	0	0	0	0	0	0	-	0
2015	-	-	0	0	0	0	-	0
2016	-	-	0	0	0	0	-	0
2017	-	-	0	0	0	0	-	0
2018	-	-	0	0	0	0	-	0
2019	-	-	8	1	0	1	1	0
2020	-	-	2	29	0	24	0	0
2021	-	-	0	0	0	0	0	0

1. CO concentrations are reported as 8-hour rolling averages by ACT Government. Reported concentrations were converted to 1-hour using the power law conversion specified by EPA Victoria (2013).
2. Values in bold indicate exceedance of applicable criteria.

6.7 Other pollutants

Lead and HF are classed as primary air pollutants by the NSW EPA and are assessed on the basis of cumulative concentrations. There are no significant sources of HF in the local area and ambient background levels are therefore assumed to be negligible.

The Woodlawn Mine may generate emissions of lead in the handling and processing of ore and waste rock material. Operations at this site will be modelled explicitly for cumulative impact assessment purposes.

6.8 Odour

As stated in Section 4.4, there has been a recent increasing trend in odour complaints received by Veolia from the residents in the surrounding region relating to the Eco Precinct. There were 98 odour complaints received between 1 April 2020 and 31 April 2021, which is the reporting period for the 2021 independent odour audit report (TOU 2021) for the Eco Precinct. The increasing odour complaints are attributed to high rainfall conditions over the audit period which impacted the efficiency of the landfill gas containment and extraction at the Bioreactor, increasing the formation of fugitive landfill gas emission pathways from the void surface.

The date, time and location for odour complaints were reviewed, with the corresponding meteorological conditions (plus the previous eight hours of data) from the EP AWS extracted. Four general areas surrounding the Eco Precinct were noted in the complaints register:

- Lake Bathurst to the north-east;
- Tarago to the east;
- Mount Fairy/Boro to the south-south-east; and
- along Taylors Creek Road to the south-west.

Wind roses were generated from the extracted meteorological data from the odour complaints at each of the four general areas and are overlayed on Figure 6.4. With the exception of the Mount Fairy/Bono location (south-south-east of the Eco Precinct), the wind direction during the complaints periods correspond to being downwind from Eco Precinct odour emission sources (eg Tarago wind rose shows odour complaints coincide with a dominance of winds blowing from the west). For each of the locations, the extracted wind data features a high proportion of calm wind speeds for the complaints periods, ranging from 7.4% calms for the Mount Bathurst complaints up to 28.6% calms for the Mount Fairy/Bono complaints.

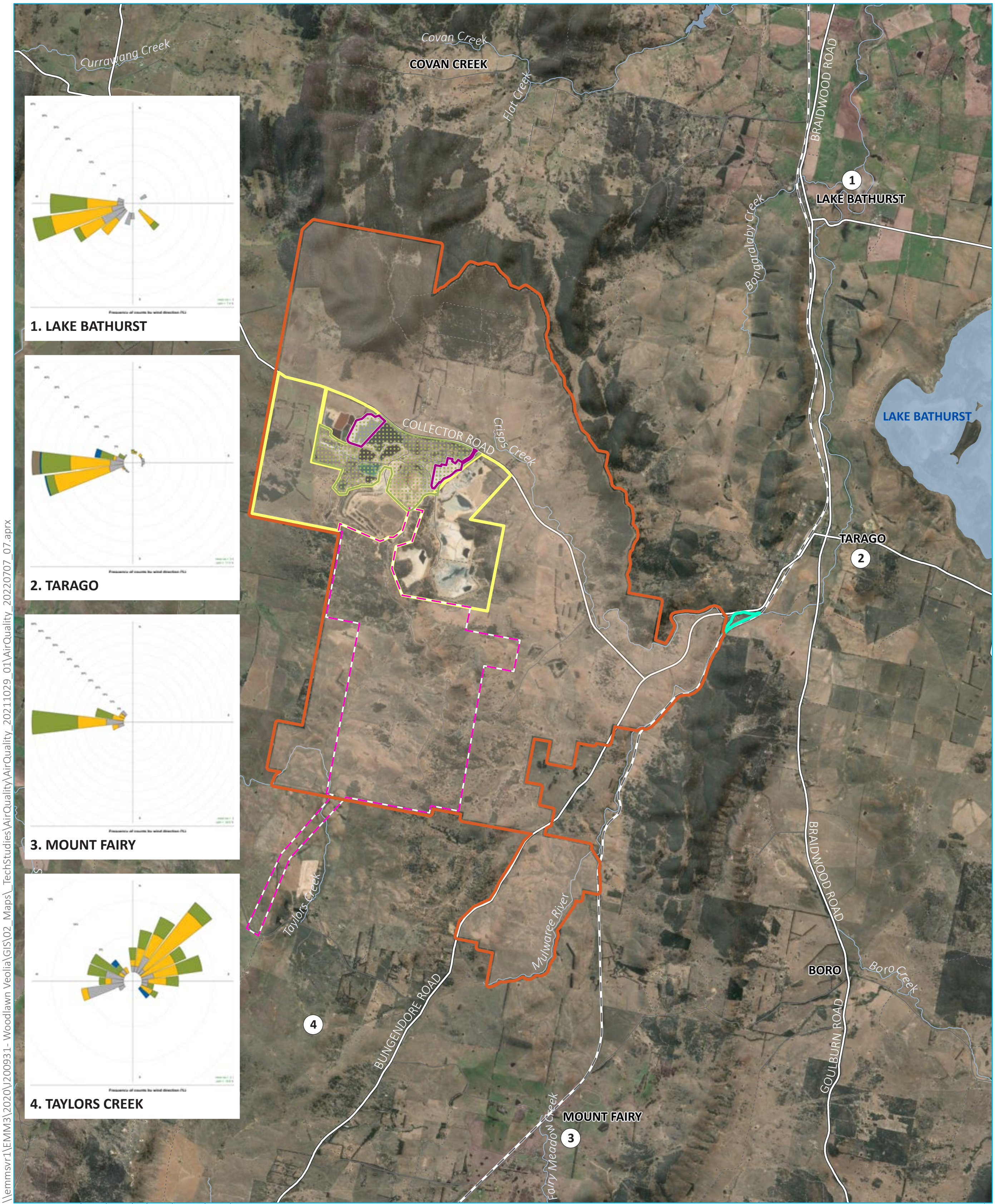
It is noted that the wind data is taken from the EP AWS and therefore the wind direction may not directly represent the wind recorded at the complaints location. This is most applicable for the Mount Fairy/Bono wind rose.

Other than Veolia operations, no other significant sources of odour were identified in the region surrounding the Eco Precinct. In order to represent background odour in the dispersion modelling process for the project, emissions from existing sources of odour will be quantified based on the most recent site-specific emissions monitoring data and modelled.

6.9 Adopted background summary

Background values adopted for cumulative assessment, based on the analysis presented in the preceding sections, are as follows:

- annual average TSP – 23.8 µg/m^3, derived from the 2018 annual average PM_{10} concentration using the ratio of 0.52 from the Woodlawn Mine;
- 24 hour PM_{10} – daily varying concentrations from the 2018 regional average dataset. Concentrations range from 1.9 µg/m^3 to 154.4 µg/m^3, with three existing exceedances of the NSW EPA impact assessment criterion of 50 µg/m^3;
- annual average PM_{10} – 12.4 µg/m^3, from the 2018 regional average dataset;
- 24 hour $PM_{2.5}$ – daily varying concentrations from the 2018 regional average dataset. Concentrations range from 1.2 µg/m^3 to 31.2 µg/m^3, with one existing exceedance of the NSW EPA impact assessment criterion of 25 µg/m^3;
- annual average $PM_{2.5}$ – 7.1 µg/m^3, from the 2018 regional average dataset;
- annual dust deposition – 1.2 g/m^2/month, from the DG18 dust deposition gauge for 2018;
- 1 hour NO_2 – hourly varying concentrations from the 2018 regional average dataset. Concentrations range from 0 µg/m^3 to 60.2 µg/m^3;
- annual average NO_2 – 8.7 µg/m^3, from the 2018 regional average dataset;
- 1 hour CO – hourly varying concentrations from the 2018 regional average dataset. Concentrations range from 47.4 µg/m^3 to 2,775.7 µg/m^3;
- 1 hour SO_2 – hourly varying concentrations from the 2018 DPE Bargo AQMS. Concentrations range from 0 µg/m^3 to 28.6 µg/m^3;
- annual average SO_2 – 1.0 µg/m^3, from the 2018 DPE Bargo AQMS dataset;
- HF – ambient concentrations are assumed to be negligible; and
- lead – local sources (eg Woodlawn Mine) of potential lead emissions have been modelled.



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Windspeed (m/s)

- 8 to 10.5
- 5.5 to 8
- 3 to 5.5
- 1.5 to 3
- 0.5 to 1.5
- 0 to 0.5

Wind roses for odour complaints by location – 2020 to 2021 IOA period

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 6.4

EMM
creating opportunities

7 Emissions inventory

7.1 Project emissions - construction phase

The construction of the project is expected to be undertaken over a period of three years and will include the following stages:

- Stage 1: civil works (cut/fill, compaction, prepare the project study area for construction of the ERF plant (approximately six months duration);
- Stage 2: construction of the ERF plant and associated infrastructure (approximately 24 months duration);
- Stage 3: commissioning and testing phase (approximately nine months duration);
- Stage 4: demobilisation tasks, including landscaping, removing temporary construction facilities and reinstatement of disturbed areas (approximately two months duration); and
- Stage 5: long term commissioning (approximately 12 months duration).

Sources of air pollution during the construction phase are likely to be fugitive releases of particulate matter (earthworks, wind erosion of exposed areas, wheel-generated dust from the movement of plant and vehicles, etc) and pollutants associated with the combustion of diesel fuel (particulate matter, NO_x, VOCs etc).

Throughout the 3 year construction period, it is considered that the 6 month civil works phase will have the greatest potential for air pollutant emission generation. However, the emissions intensity during this phase is expected to be lower than approved operations across the Eco Precinct or future operations of the Eco Precinct with the operational project. Furthermore, any construction-related air pollution emissions will be generated well within Veolia-owned land and distant from surrounding sensitive receptors. Consequently, air quality impacts from the construction phase are expected to be lower than the current or future operational phases.

Construction phase air pollutant emissions and impacts are not considered further in this assessment. Indicative management measures for the construction phase are presented in Section 10.

7.2 Project emissions - operational phase

The project will introduce the following air pollutant emission sources to the Eco Precinct:

- ARC building stack emissions – release point of residual air pollutant emissions from the FGT system;
- truck movements – including the transportation of stabilised APCr from the ARC building to the APCr encapsulation cell, transfer of IBAA to the bioreactor or potentially off site for future reuse and the diversion of 380,000 tpa of incoming waste deliveries to the ARC tipping hall and away from the Bioreactor;
- fugitive dust emissions from the handling and storage of material at the IBA area and APCr encapsulation cell; and
- diesel fuel combustion by mobile plant and equipment and the auxiliary diesel burners and generator.

Emissions from the project are described in the following sub-sections.

7.2.1 Reference facility – Staffordshire ERF

In order to provide a reference source of real-world operational emissions for the estimation of emissions from the project, Veolia has obtained air pollution emissions monitoring data from the Veolia United Kingdom & Ireland (Veolia UKI) ERF in Staffordshire, located approximately 25 km north-west of Birmingham in the United Kingdom (hereafter the Staffordshire ERF).

The Staffordshire ERF accepts residual MSW and C&I waste similar to the Eco Precinct. Indicative feedstock analysis between the likely waste streams for the ARC and from the Staffordshire ERF is provided in Figure 7.1. In the case of the existing waste feedstock received by the Eco Precinct, there is a larger component of organics relative to the Staffordshire ERF. Operational data from the Staffordshire plant are provided in Appendix GG of the EIS.

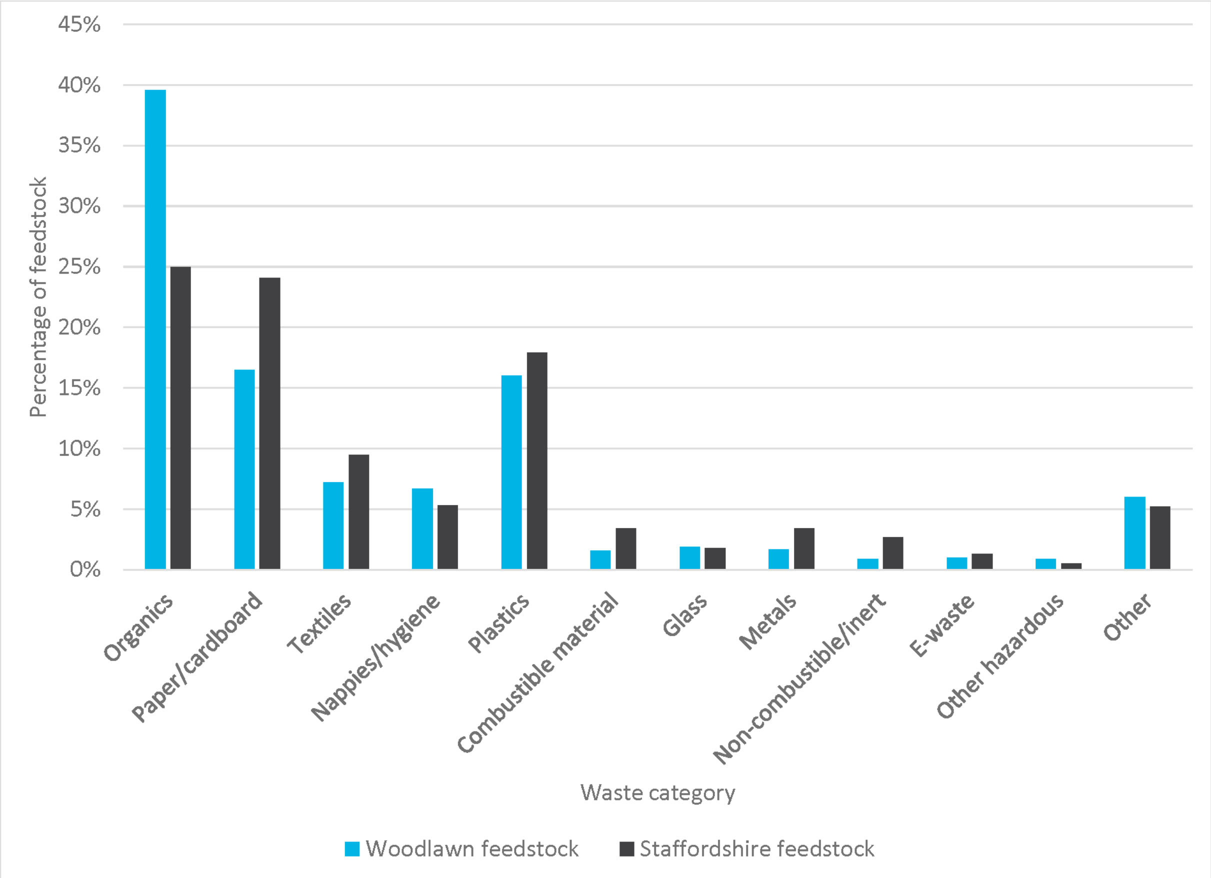


Figure 7.1 Indicative feedstock comparison – Woodlawn vs Staffordshire ERF

The Staffordshire ERF features the same moving grate technology, FGT and SNCR emissions control technology that is proposed for the project. The Staffordshire ERF features two lines (vs a single line for the project) and an annual waste throughput of 340,000 tpa (vs 380,000 tpa for the project). Emissions monitoring data from the Staffordshire ERF was provided by Veolia for the period between 2016 and 2020.

A Best Available Techniques assessment was completed by Ricardo Energy and Environment (Ricardo 2022) for the project and concluded that:

> The Staffordshire ERF is fully operational within a similar jurisdiction fulfils the requirements of a reference facility as it processes similar waste streams and it uses similar technology, albeit at a different scale.

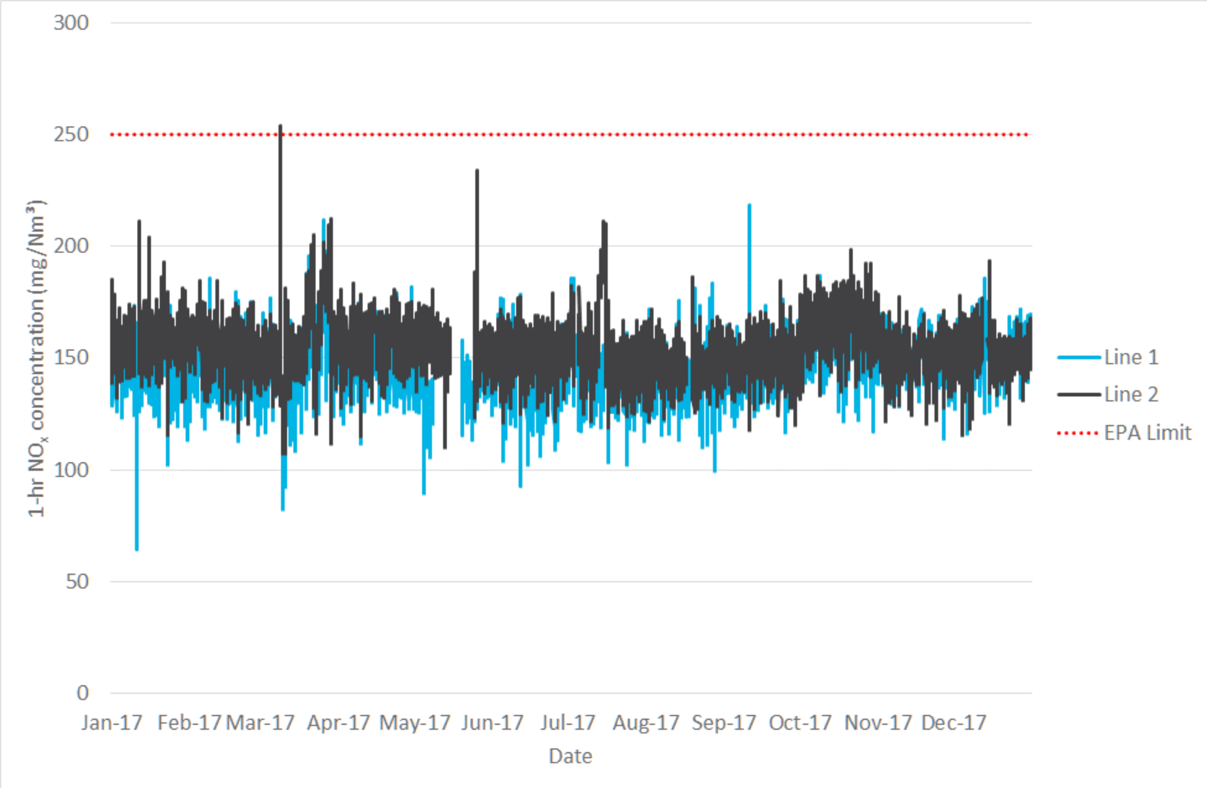
i 2017 Staffordshire ERF emissions data

Veolia UKI advised that of the provided years of monitoring data, the 2017 calendar year represents the most typical operational year with regards to consistency of waste stream, operation of plant and emissions variability. A range of operational data for the plant from 2017 are provided in Appendix GG of the EIS.

For the 2017 calendar year, Veolia UKI provided 12 months of unprocessed 30 minute average CEMS data from the emission stacks at the Staffordshire ERF. The CEMS data contained measurements of NO_x, CO, SO_2, HCl, NH_3, total organic compounds (TOC), solid particles, oxygen content and flow rate.

Hourly-average NO_x, CO, SO_2, HCl, TOC and solid particles concentrations and daily average NH_3 concentrations from the 2017 Staffordshire ERF CEMS dataset are presented in Figure 7.2 through to Figure 7.8. The relevant NSW EPA emissions standards for energy recovery facilities from the NSW EfW Policy are overlayed in each graph.

A summary of the 2017 Staffordshire ERF CEMS data is presented in Table 7.1.



Note: spikes in data above limit discussed in Section 7.2.5.

Figure 7.2 Staffordshire ERF – 1 hour average 2017 CEMS data – NO_x

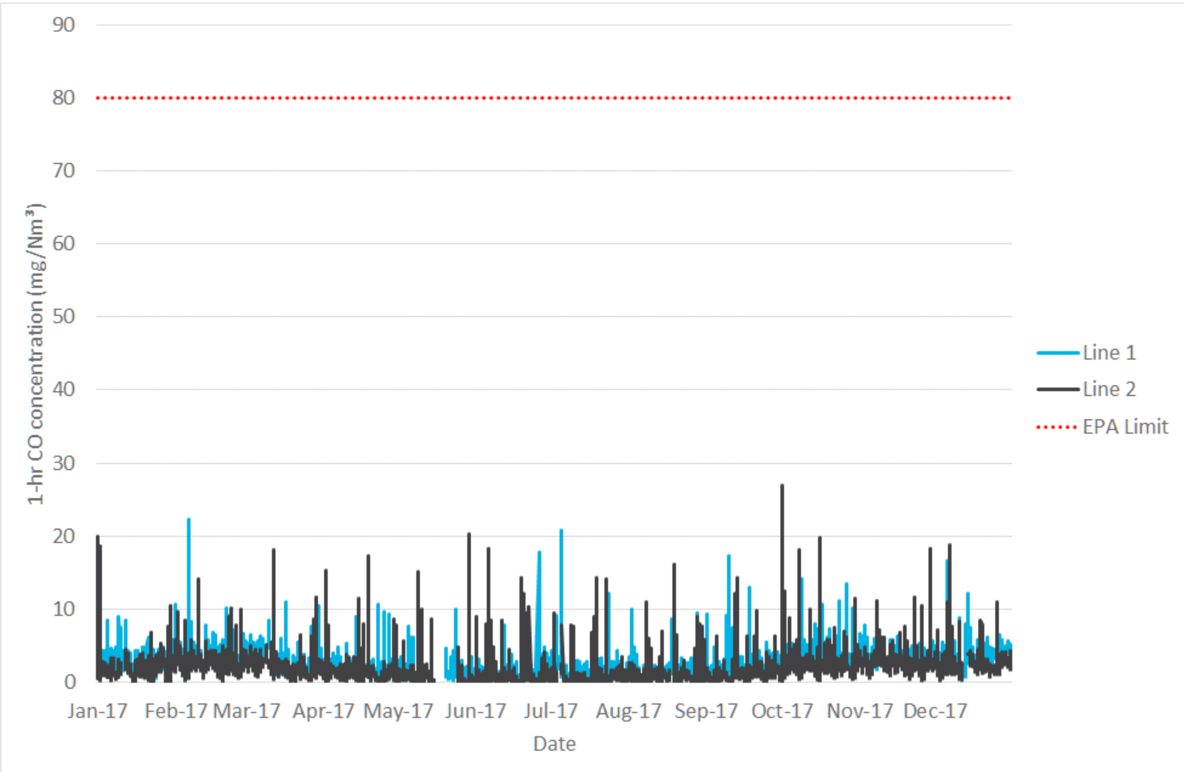
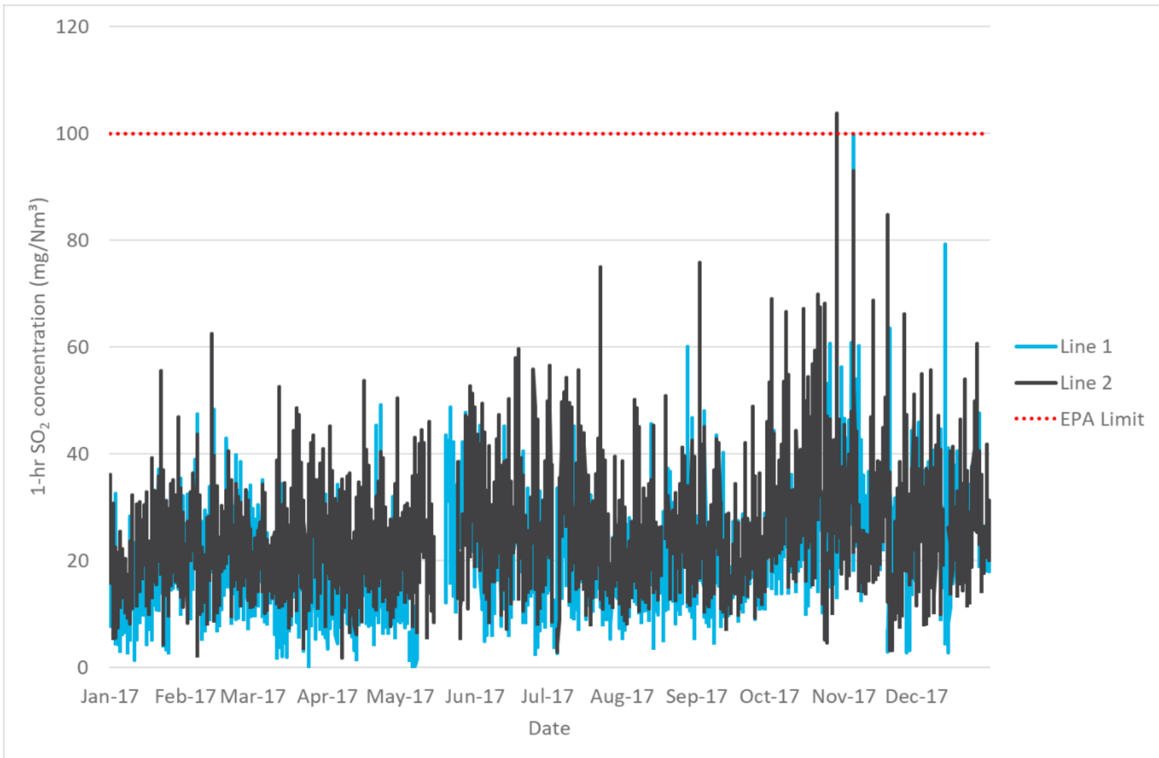


Figure 7.3 Staffordshire ERF – 1 hour average 2017 CEMS data – CO



Note: spikes in data above limit discussed in Section 7.2.5.

Figure 7.4 Staffordshire ERF – 1 hour average 2017 CEMS data – SO_2

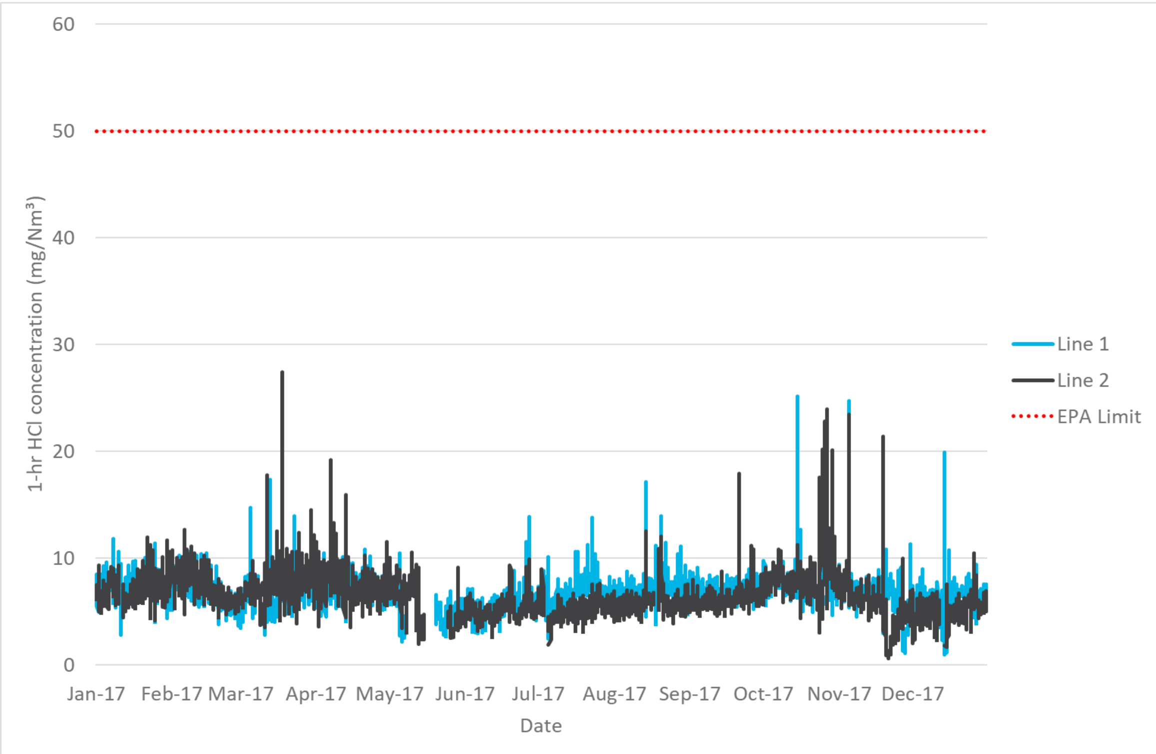


Figure 7.5 Staffordshire ERF – 1 hour average 2017 CEMS data – HCl

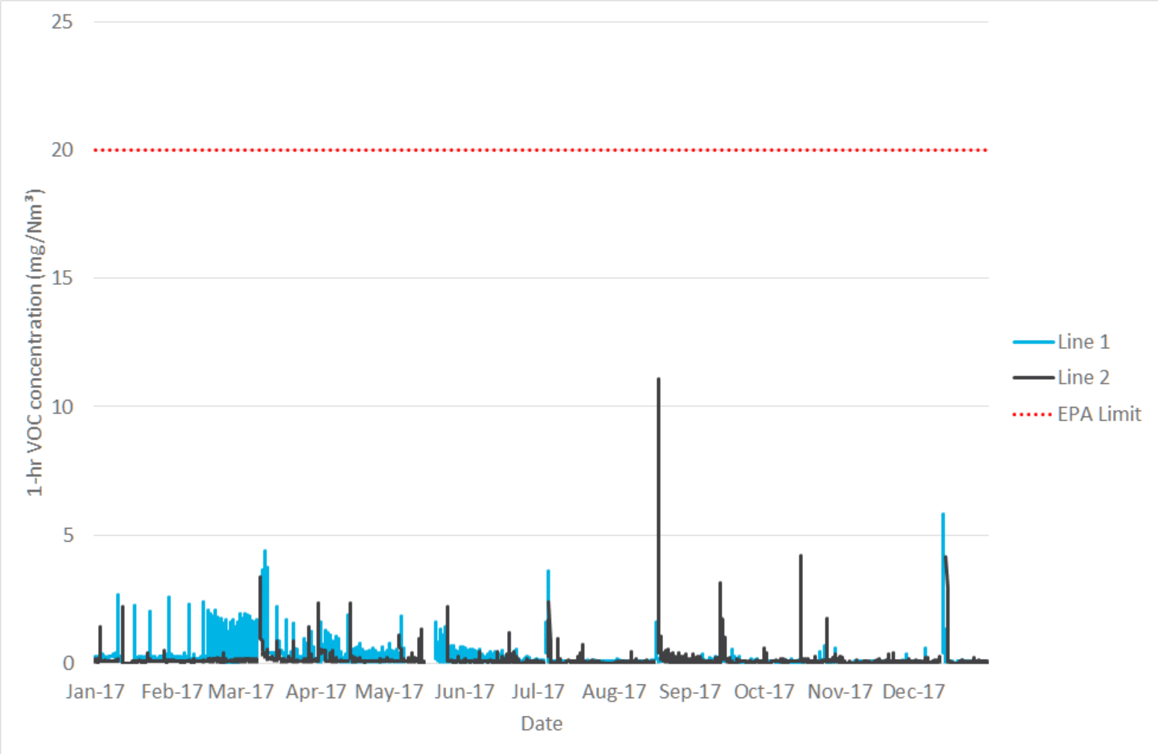


Figure 7.6 Staffordshire ERF – 1 hour average 2017 CEMS data – VOC (as TOC)

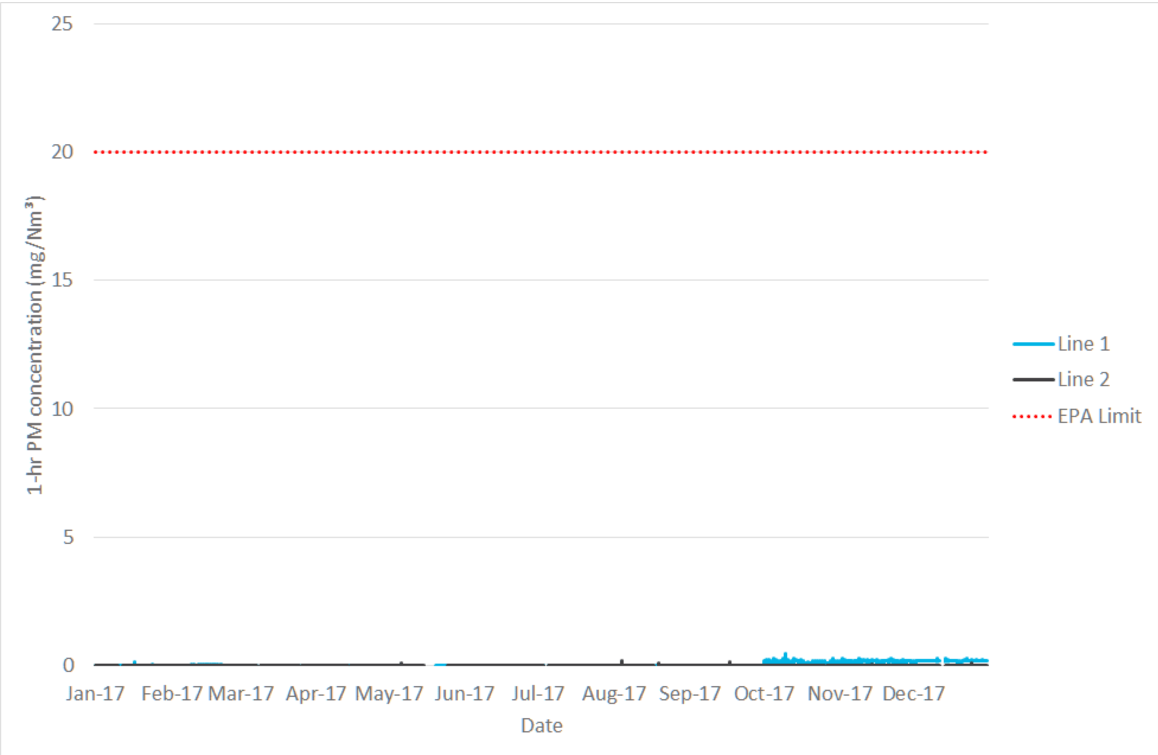
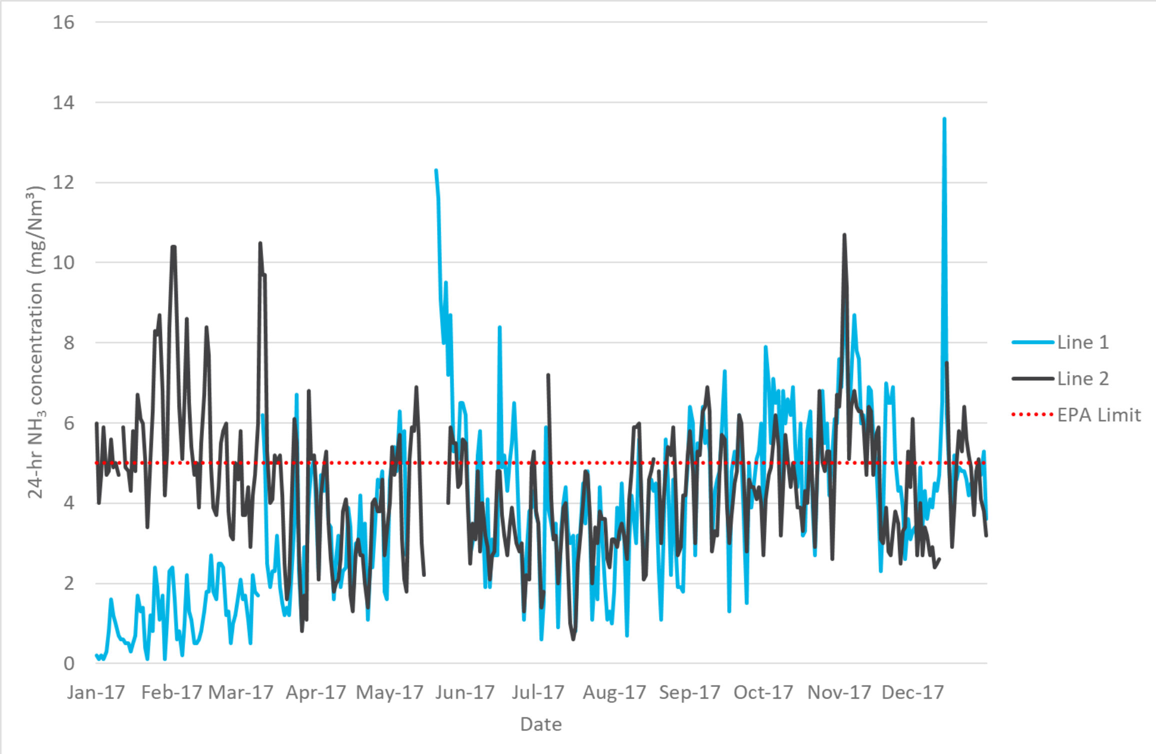


Figure 7.7 Staffordshire ERF – 1 hour average 2017 CEMS data – solid particles



Note: spikes in data above limit discussed in Section 7.2.5

Figure 7.8 Staffordshire ERF – 24 hour average 2017 CEMS data – NH_3

Table 7.1 Staffordshire ERF CEMS data summary – 2017

Air pollutant	Average concentration (mg/Nm^3)	Maximum concentration (mg/Nm^3)	Averaging period	NSW EPA EfW Policy emission standard (mg/Nm^3)
Solid particles	0.046	0.45	1 hour	20
SO_2	24.3	103.8	1 hour	100
NO_x (as NO_2)	154.8	254.0	1 hour	250
CO	2.6	26.9	1 hour	80
HCl	6.8	27.5	1 hour	50
VOC (as TOC)	0.2	11.1	1 hour	20
NH_3	4.4	27.1	1 hour	-
	4.4	13.6	24 hour	5

Note: all emission concentrations expressed at dry, 273 K, 101.3 kPa and 11% oxygen.

From the presented Staffordshire ERF 2017 CEMS data, all recorded pollutants are below the relevant emission standards from the NSW EfW Policy (EPA 2021) with the following exceptions:

- one exceedance hour of the NO_x standard (one off occurrence);
- one exceedance hour of the SO_2 standard (one off occurrence); and
- a high proportion of days (approximately 30%) above the 24 hour average NH_3 standard.

Regarding these exceedances of relevant NSW EfW Policy in the context of project:

- The recorded spikes in NO_x and SO_2 were queried with the operators of the Staffordshire ERF. It is understood that the spikes were associated with waste feed stock consistency issues and are considered to be representative of abnormal emissions. Further discussion on abnormal operational emission is provided in Section 7.2.5.
- The elevated NH_3 concentrations are understood to be reflective of NH_3-slip[7] associated with the SNCR technology installed for the control of NO_X emissions at the Staffordshire ERF. It is important to note that at the time of design and commissioning of the Staffordshire ERF, there was no reportable limit set for NH_3 in the applicable UK Environmental Agency permit for that facility. By comparison, the Woodlawn ARC would be designed to control NH_3 emissions in order to comply with the applicable NSW EPA EfW Policy standard of 5 mg/Nm^3. Through preliminary discussions with technology providers, Veolia have received assurances that the NSW EPA EfW Policy standard for NH_3 will be achieved.

In addition to the CEMS data, monitoring results from twice-yearly stack sampling of pollutants not measured by the CEMS, specifically dioxins and furans, PAHs, HF and assorted metals, were also provided for 2017 (Environmental Compliance Limited 2017a and 2017b). These sampling events also collected measurements of stack flow, temperature, moisture content, oxygen content and barometric pressure.

A summary of these results is presented in the Table 7.2. Where applicable, the NSW EPA emission standards from the NSW EfW Policy are presented for comparison purposes.

The results presented in Table 7.2 show that all recorded concentrations of presented pollutants are well below the relevant NSW EfW Policy emission standards (EPA 2021).

7 NH_3 slip is the un-reacted NH_3 within the flue gases when they exit the boiler.

Table 7.2 Stack sampling results – 2017 – Staffordshire ERF

Pollutant	Unit	Measured emission concentration				NSW EPA EfW Policy emission standard
		Sample 1	Sample 2	Sample 3	Sample 4	
Dioxins and furans (TEQ)[1]	ng/Nm^3	0.012	0.011	0.019	0.024	0.1
PAHs (as BaP)[2]	ng/Nm^3	0.58	0.25	0.43	0.41	-
HF	mg/Nm^3	0.023	0.019	0.030	0.030	4
Mercury	mg/Nm^3	0.0011	0.0007	0.0015	0.0014	0.04
Cadmium + Thallium	mg/Nm^3	0.00107	0.00105	0.00139	0.00132	0.02
Type 1 + 2 substances[3]	mg/Nm^3	0.01849	0.0104	0.01959	0.02158	0.3
Antimony	mg/Nm^3	0.0019	0.0008	0.0010	0.0023	-
Arsenic	mg/Nm^3	0.0005	0.0005	0.0006	0.0006	-
Cadmium	mg/Nm^3	0.0006	0.0006	0.0008	0.0007	-
Chromium	mg/Nm^3	0.0025	0.0013	0.0022	0.0044	-
Cobalt	mg/Nm^3	0.0005	0.0005	0.0006	0.0006	-
Copper	mg/Nm^3	0.0029	0.0020	0.0063	0.0032	-
Lead	mg/Nm^3	0.0018	0.0012	0.0044	0.0033	-
Manganese	mg/Nm^3	0.0050	0.0019	0.0030	0.0028	-
Mercury	mg/Nm^3	0.0011	0.0007	0.0015	0.0014	-
Nickel	mg/Nm^3	0.0042	0.0026	0.0044	0.0049	-
Thallium	mg/Nm^3	0.0005	0.0005	0.0006	0.0006	-
Vanadium	mg/Nm^3	0.0005	0.0005	0.0012	0.0007	-

Note 1: TEQ = toxic equivalents. Recorded dioxins and furans for each sample were adjusted to appropriate TEQ values listed in Clause 40 of the Protection of the Environment Operations (Clean Air) Regulation Clean Air Regulation 2010.

Note 2: Recorded PAHs adjusted for potency equivalency factors (as presented in Table 7.2c) of Approved Methods for Modelling to present as benzo-a-pyrene (BaP).

Note 3: For the Staffordshire ERF data, the Type 1 and 2 substances comprise of antimony, arsenic, chromium, cobalt, copper, lead, manganese, nickel & vanadium.

Note 4: All emission concentrations expressed at dry, 273 K, 101.3 kPa and 11% oxygen.

ii Interannual emissions variability

As previously stated, Veolia UKI advised that the 2017 calendar year represents a typical operational year for Staffordshire ERF with regards to consistency of waste stream, operation of plant and emissions variability. In addition to the detailed 2017 data, summary results for solid particles, TOC, HCl, CO, SO_2 and NO_x were provided by Veolia UKI in the form of measured pollutant concentration as a percentage of the applicable daily UK emissions limit for the period between 2016 to 2020. In order to illustrate inter-annual variability in emissions at the Staffordshire ERF, the maximum recorded percentage of the limit for each pollutant and year was extracted and presented in Figure 7.9.

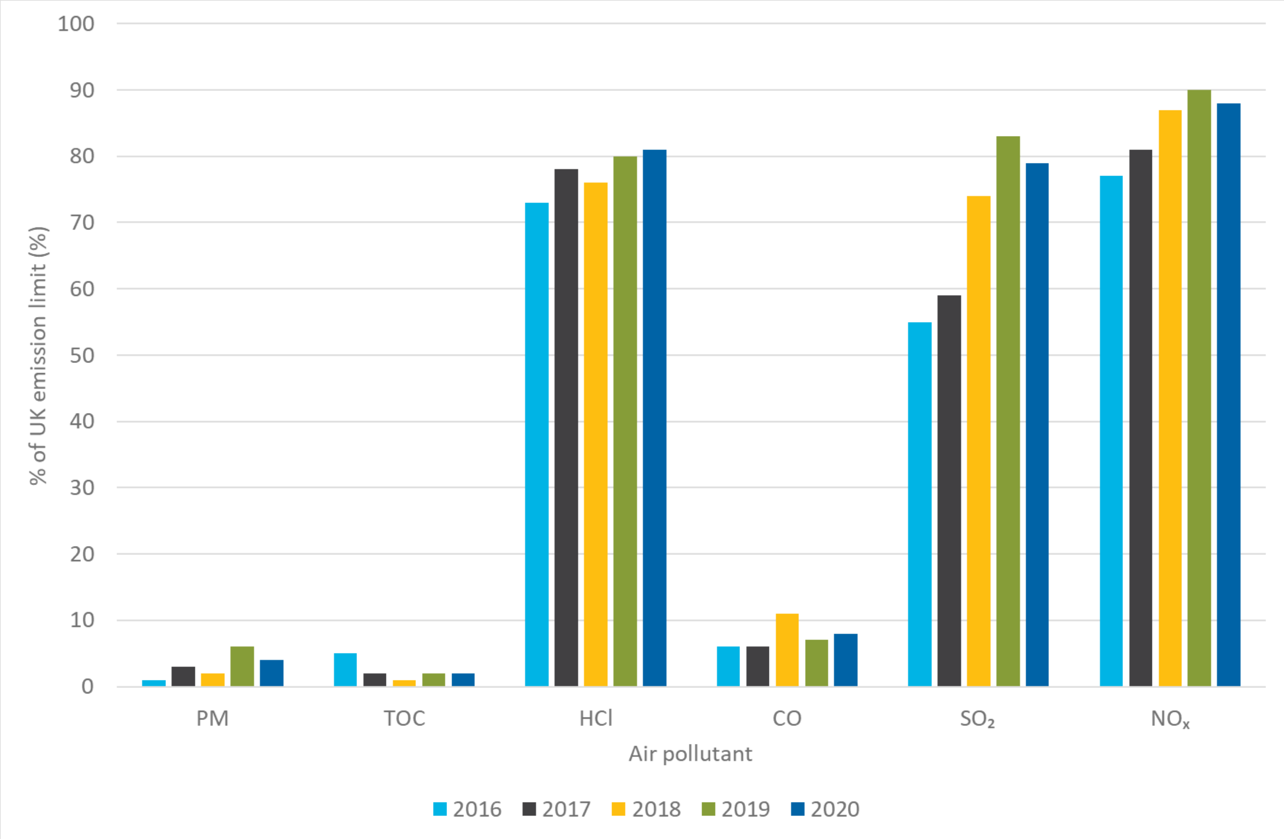


Figure 7.9 Staffordshire ERF – interannual emissions variability – maximum daily concentrations as percentage of applicable UK emissions limit

From the results presented in Figure 7.9, it is noted that 2017 was not the highest year for the presented pollutants. Further discussion of accounting for interannual variability in the emission calculations for this AQIA is presented in Section 7.2.4.

7.2.2 ARC building stack emission conditions

Stack emission conditions were collated from a combination of engineering advice for the ARC building design and measurements from the Staffordshire ERF during 2017. These adopted conditions are summarised in Table 7.3 for the expected case and maximum case reference scenarios.

Table 7.3 ARC building stack parameters – average and maximum conditions

Parameter	Unit	Value		Source
		Average conditions	Maximum conditions	
Stack height	m	85	85	Project design
Stack outlet diameter	m	2.7	2.7	Project design
Stack outlet area	m^2	5.7	5.7	Project design
Exhaust temperature	Degrees C	150	150	Engineer's advice
Exhaust moisture content	%	19.0	19.0	Engineer's advice
Exhaust oxygen content	%	5.0	5.0	Engineer's advice
Exhaust pressure	kPa	100.8	100.8	Staffordshire 2017 sampling
Stack flow (normalised)[1]	Nm^3/s dry	70.6	83.2	Engineer's advice, maximum upscaled based on average vs maximum flow relationship from Staffordshire ERF CEMS data
Stack flow (actual)	Am^3/s	84.9	144.1	Adjusted for temperature, pressure, moisture and oxygen
Exit velocity	m/s	14.8	18.1	Derived from stack flow

1. Expressed at dry, 273 K, 101.3 kPa and 11% oxygen.

7.2.3 ARC building stack emission scenarios

For the purpose of this AQIA, in order to account for emissions from the ARC building stack under a range of conditions, the following three scenarios have been developed:

- Scenario 1 – *reference case emissions – expected emissions*:
  - Scenario 1 assumes the combination of *average* stack emission parameters (Table 7.3) and the *average* measured emission concentrations from the 2017 Staffordshire ERF emissions data (Section 7.2.1i); and
  - the results obtained from dispersion modelling for Scenario 1 should be viewed as the most relevant of potential air quality impacts for the actual operation of the project.
- Scenario 2 – *reference case emissions – maximum emissions*:
  - Scenario 2 assumes the combination of *maximum* stack emission parameters (Table 7.3) and the *maximum* (100^{th} percentile) measured emission concentrations from the 2017 Staffordshire ERF emissions data (Section 7.2.1i);
  - to account for interannual variability in maximum concentrations, the derived emission rates for Scenario 2 are upscaled by the pollutant-specific scaling factors listed in Section 7.2.1ii; and
  - the results obtained from dispersion modelling for Scenario 2 should be viewed as a highly conservative upper bound estimation of potential air quality impacts from the project.

- Scenario 3 – *NSW EfW Policy regulatory case emissions*:
  - Scenario 3 assumes the combination of *maximum* stack emission parameters (Table 7.3) and the NSW EfW Policy emission concentration standards (Table 4.5); and
  - the results obtained from dispersion modelling for Scenario 3 should be viewed as the highest potential impacts from the project if operating at the maximum allowable emission rates under the NSW EfW Policy, and is therefore another highly conservative scenario.

7.2.4 ARC building emission rates

For each emissions scenario listed in Section 7.2.3, the ARC building stack emission rates were derived by combining the relevant flow rate (average or maximum from Table 7.3) with the relevant emission concentration (average, maximum (Table 7.1 and Table 7.2) or NSW EfW Policy standard (Table 4.5)). In addition, a range of other assumptions were required, listed as follows:

- The solid particles emission concentration from Staffordshire ERF and the NSW EfW Policy emission standard refers to total particulates (nominally TSP size fraction), however for the purpose of this AQIA it is conservatively assumed that 100% of total particulates are in the $PM_{2.5}$ size fraction (ie the same emission rate for TSP, PM_{10} and $PM_{2.5}$).
- Speciation profiles for organic species were not available from the Staffordshire ERF dataset, as only total organic compounds are measured. SPECIATE, the US EPA repository of speciation profiles of air pollution sources, provides a speciation profile for waste incineration (profile 122). Benzene, the proxy VOC selected for this AQIA, has a weight percent of 7.7%. When adjusted for non-methane VOC (NMVOC) pollutants, the benzene content is 39.3%, which is applied to the VOC concentration for each scenario to derive a benzene emission rate.
- For Scenario 1 and 2, the average and maximum emission concentrations for each metal/metalloid listed in Table 7.2 was applied to derive individual.
- The Staffordshire ERF stack sampling data did not contain emission concentrations for the Type 1 and 2 substances beryllium, selenium or tin. To derive an emission concentration for each substance, the SPECIATE profiles for waste incineration were collated, with the following fraction of total particulate matter emissions derived and combined with the average and maximum particulate matter emission concentrations from the Staffordshire ERF:
  - beryllium – 0.011% of PM;
  - selenium – 0.070% of PM; and
  - tin – 0.904% of PM.
- Similarly, in order to derive emission rates of zinc from the ARC building stack in the absence of monitoring data from the Staffordshire ERF, the SPECIATE profile of 9.86% of PM was combined the average and maximum particulate matter emission concentrations from the Staffordshire ERF. It is considered that this approach is highly conservative for estimating zinc emissions from the ARC building stack.

Table 7.4 Emission calculations metals/metalloids – Scenario 1 and Scenario 2

Substance	Measured concentration (mg/Nm^3)		Percentage of PM (US EPA SPECIATE profiles for waste incineration)	Emission rates (g/s)	
	Average	Maximum		Average (70.6 Nm^3/s)	Maximum (83.2 Nm^3/s)
Antimony	0.0015	0.0023	-	1.05E-04	1.91E-04
Arsenic	0.0005	0.0006	-	3.64E-05	4.82E-05
Cadmium	0.0006	0.0008	-	4.57E-05	6.24E-05
Chromium	0.0026	0.0044	-	1.84E-04	3.66E-04
Cobalt	0.0005	0.0006	-	3.64E-05	4.82E-05
Copper	0.0036	0.0063	-	2.54E-04	5.24E-04
Lead	0.0027	0.0044	-	1.89E-04	3.66E-04
Manganese	0.0032	0.0050	-	2.24E-04	4.16E-04
Mercury	0.0012	0.0015	-	8.25E-05	1.25E-04
Nickel	0.0040	0.0049	-	2.84E-04	4.08E-04
Thallium	0.0006	0.0006	-	3.96E-05	5.32E-05
Vanadium	0.0007	0.0012	-	5.02E-05	9.98E-05
Derived from measured PM concentration					
PM	0.0462	0.4500	-	3.26E-03	3.74E-02
Beryllium	0.000005	0.000048	0.011%	3.45E-07	3.96E-06
Selenium	0.000032	0.000316	0.070%	2.29E-06	2.63E-05
Tin	0.00042	0.00407	0.904%	2.95E-05	3.38E-04
Zinc	0.00456	0.04439	9.865%	3.22E-04	3.69E-03

Note: All emission concentrations expressed at dry, 273 K, 101.3 kPa and 11% oxygen. No upscaling of emissions has been applied to maximum emission rates in this table, this occurs in Table 7.6.

- Regarding metals/metalloids emissions, the NSW EfW Policy (EPA 2021) only presents emission standards for Type 1 and 2 substances in aggregate, cadmium and thallium (total) and mercury. For Scenario 3, the following steps were taken to derive individual metals/metalloids emissions:
  - mercury emissions were derived by combining the applicable NSW EfW Policy emission standard and the maximum flow rate (Table 7.3);
  - cadmium and thallium emissions were derived from combining the applicable NSW EfW Policy emission standard with the maximum flow rate (Table 7.3) and a cadmium/thallium split of 54%/46% based on the Staffordshire 2017 sampling data;

- in the absence of metal/metalloid profile in the NSW EfW Policy, the Staffordshire ERF stack sampling data and the derived percentages (see previous dot point) were used to develop a speciation profile to apply to the NSW EfW Policy concentration standard for *Type 1 and 2 substances in aggregate* (ie 0.3 mg/Nm^3). The derived speciation profile for Scenario 3 is presented in Table 7.5; and

- for copper and zinc, the relationship between derived Scenario 1 emission concentrations for copper and zinc and the Scenario 1 Type 1 and 2 substances concentration (specifically 20% for copper and 25% for zinc) was applied to the NSW EfW Policy concentration standard for *Type 1 and 2 substances in aggregate* to better align the magnitude of these substances with other metals/metalloid emissions.

Table 7.5 Metals/metalloid as percentage of recorded Type 1 and 2 substances – Staffordshire ERF 2017 emissions data and SPECIATE-derived values (Scenario 3 only)

Metal/metalloid	Percentage of Type 1 and 2 substances
Antimony	8.26%
Arsenic	2.87%
Beryllium	0.03%
Cadmium	3.60%
Chromium	14.47%
Cobalt	2.87%
Lead	14.89%
Manganese	17.67%
Mercury	6.50%
Nickel	22.40%
Selenium	0.18%
Tin	2.32%
Vanadium	3.95%

- As presented in Section 7.2.1ii, some interannual variability in maximum recorded pollutant concentrations was noted for the five year Staffordshire ERF emissions monitoring dataset. To account for potential emissions variability in this AQIA, a proportional relationship between 2017 and the other four years was derived for each pollutant, with the highest ratio for each pollutant adopted to upscale emissions for Scenario 2 (reference case – maximum emissions). The derived upscale factors for Scenario 2 are detailed as follows:
  - the maximum hourly solid particles emission concentration for 2017 is increased by a factor of 2;
  - the maximum hourly VOC (as TOC) emission concentration for 2017 is increased by a factor of 2.5;
  - the maximum hourly HCl emission concentration for 2017 is increased by a factor of 1.04;
  - the maximum hourly CO emission concentration for 2017 is increased by a factor of 1.8;

- the maximum hourly SO_2 emission concentration for 2017 is increased by a factor of 1.4;
- the maximum hourly NO_x emission concentration for 2017 is increased by a factor of 1.1;
- for NH_3, a correlation analysis of 2017 CEMS data found that concentrations of NH_3 were most closely related to CO emissions, therefore emissions of NH_3 were also scaled by a factor of 1.8;
- metals/metalloid concentrations were scaled by a factor of 2, corresponding to the scaling factor for solid particles; and
- for the remaining pollutants (eg HF, PAHs, dioxin and furans), the highest derived scaling factor (2.5 for VOCs) was applied.

It is considered that the three emission scenarios developed for the ARC building stack are sufficiently conservative to account for the potential emissions that could occur from the project. In the case of Scenario 2 (reference case – maximum emissions) and Scenario 3 (regulatory case emissions), the outlined steps taken are considered highly conservative for the purpose of estimating emissions from the ARC building stack. Consequently, all modelling results presented in this AQIA for Scenario 2 and 3 should be viewed as highly conservative accounting for abnormal emissions (see Section 7.2.5 for further discussion). The results for Scenario 1 (reference case – expected emissions) should be viewed as the more realistic impacts from the project.

The calculated ARC building stack emission rates for the three emission scenarios are presented in Table 7.6. A comparison of the calculated ARC building stack emission rates for the three emission scenarios is presented in Figure 7.10 and Figure 7.11.

The following points are noted from these figures:

- the calculated emission rates for Scenario 1 (reference case – expected emissions) are notably lower than both Scenario 2 (reference case – maximum emissions) and Scenario 3 (NSW EfW Policy regulatory case emissions) for the majority of pollutants, with the exception of zinc and copper for which Scenario 1 and 2 are both higher than Scenario 3;
- zinc emissions for Scenario 1 and 2 were derived using the SPECIATE profile for waste incineration in combination with the particulate matter emission rate, rather than actual monitoring data from Staffordshire, leading to highly conservative zinc emission estimates;
- emissions of NO_x, SO_2, NH_3 and benzene are highest under Scenario 2 due in part to the application of the derived upscale factor to the 100^{th} percentile maximum concentration which were noted to be associated with abnormal operating conditions at the Staffordshire ERF; and
- for the remaining pollutants, the Scenario 3 emission rates are the highest quantified, in particular for metals/metalloids, due to the conservative assumption of emission concentrations equivalent to the relevant NSW EfW Policy emission standards.

Table 7.6 Model emission rates – ARC building – reference case

Pollutant	Emission rate (g/s)		
	Scenario 1 - *reference case emissions – expected emissions*	Scenario 2 - *reference case emissions – maximum emissions*	Scenario 3 - *NSW EfW Policy regulatory case emissions*
TSP/PM_{10}/$PM_{2.5}$	3.26E-03	7.48E-02	1.66E+00
Dioxins and furans	1.18E-09	4.99E-09	8.32E-09
SO_2	1.72E+00	1.21E+01	8.32E+00
NO_x	1.09E+01	2.35E+01	2.08E+01
CO	1.82E-01	4.10E+00	6.65E+00
HCl	4.80E-01	2.37E+00	4.16E+00
HF	1.79E-03	6.24E-03	3.33E-01
Benzene	4.42E-03	9.07E-01	6.53E-01
NH_3	3.11E-01	4.12E+00	4.16E-01
PAHs	2.96E-05	1.21E-04	-
Antimony	1.05E-04	3.83E-04	2.06E-03
Arsenic	3.64E-05	9.65E-05	7.15E-04
Beryllium	3.45E-07	7.92E-06	6.79E-06
Cadmium	4.57E-05	1.25E-04	8.91E-04
Chromium	1.84E-04	7.32E-04	3.61E-03
Cobalt	3.64E-05	9.65E-05	7.15E-04
Copper	2.54E-04	1.05E-03	5.00E-03
Lead	1.89E-04	7.32E-04	3.71E-03
Manganese	2.24E-04	8.32E-04	4.41E-03
Mercury	8.25E-05	2.49E-04	3.33E-03
Nickel	2.84E-04	8.15E-04	5.59E-03
Thallium	3.96E-05	1.06E-04	7.72E-04
Vanadium	5.02E-05	2.00E-04	9.86E-04
Zinc	3.22E-04	7.38E-03	6.33E-03

Note: No emission rate quantified for PAHs for Scenario 3 as there is no applicable PAH emission standard listed in the NSW EfW Policy.

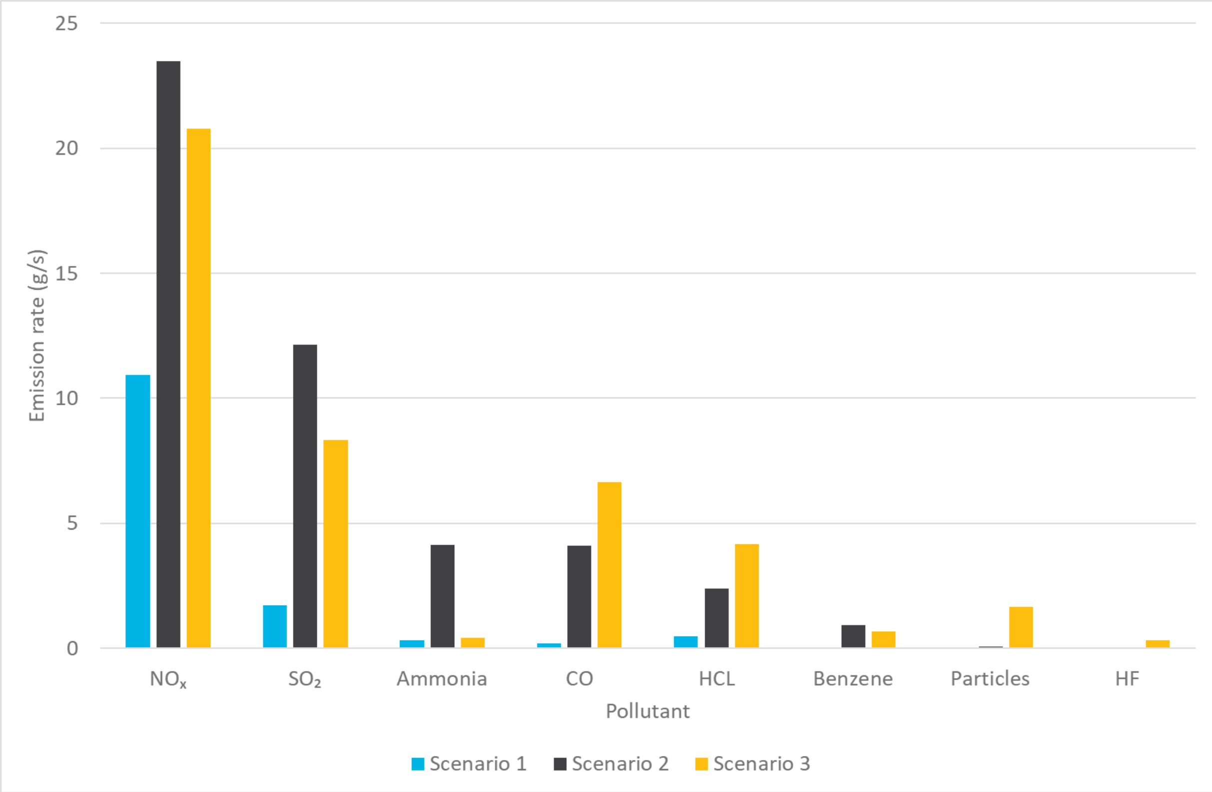


Figure 7.10 **Emission rate comparison – Scenario 1, 2 and 3 – NO_x, SO_2. CO, HCl, NH_3, benzene, particles and HF**

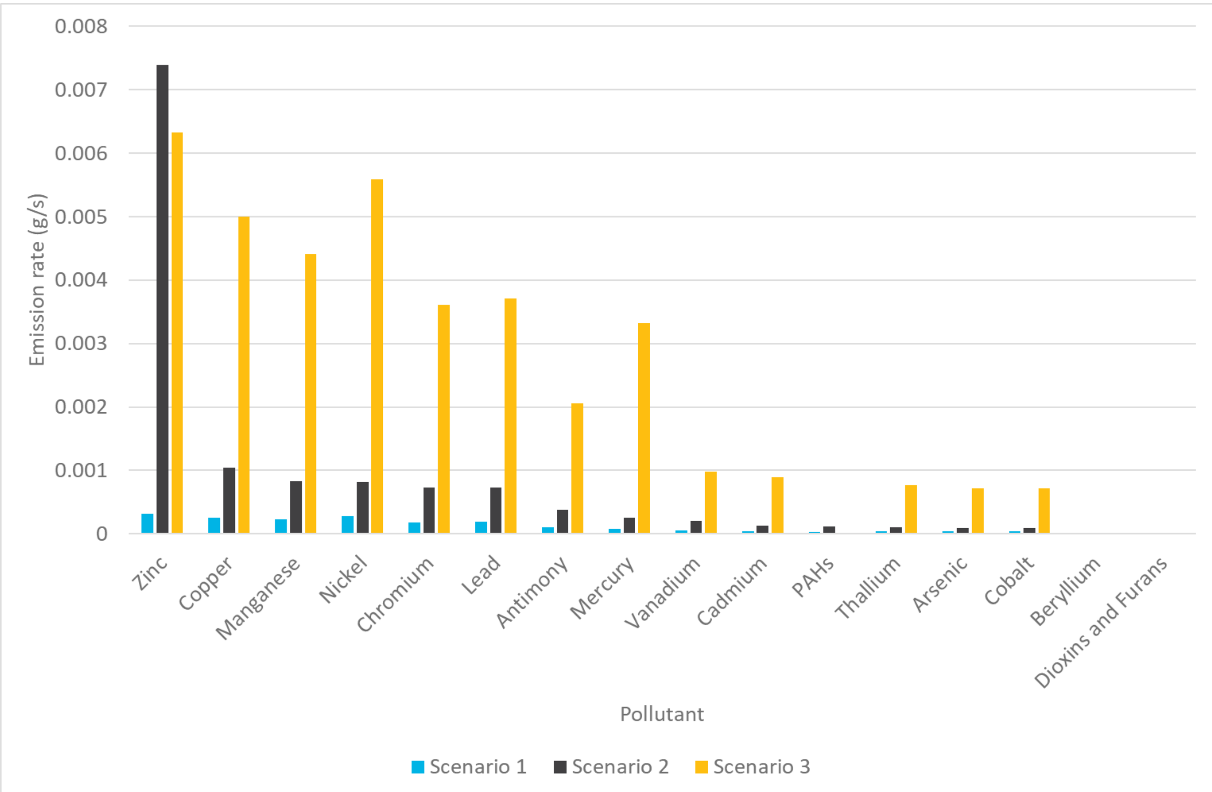


Figure 7.11 **Emission rate comparison – Scenario 1, 2 and 3 – metals/metalloids, PAHs and dioxins and furans**

7.2.5 Other than normal operating conditions

The SEARs for the project specifically request the modelling of 'worst case' emission scenarios associated with unexpected conditions such as a system trip or emergency shutdown. These periods are referred to as "other than normal operating conditions" (OTNOC).

i System shut downs

As discussed in Section 7.2.1, the reference case emissions data adopted from Staffordshire ERF for 2017 is sourced from 30 minute average CEMS data. The periods of time during 2017 when the Staffordshire reference facility was offline are illustrated in Figure 7.12.

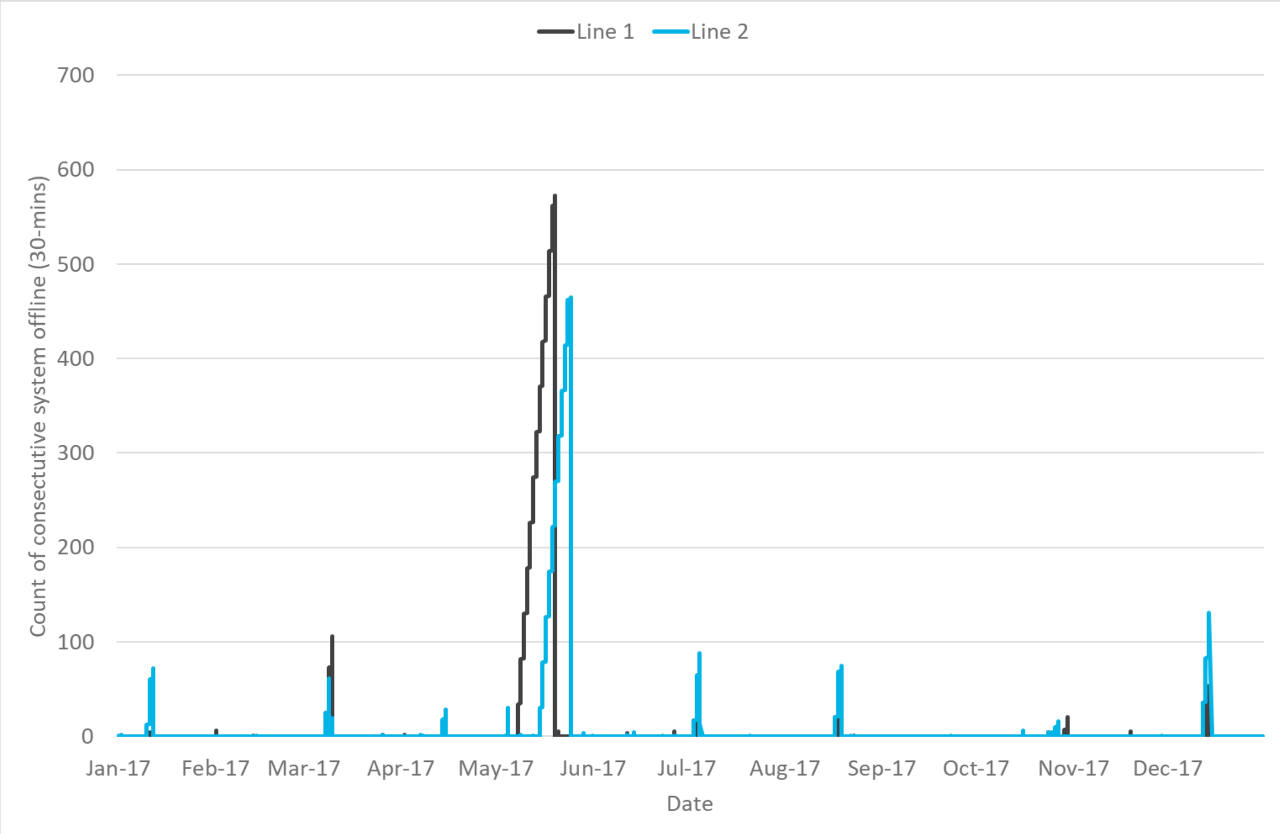


Figure 7.12 Staffordshire ERF – count of consecutive system offline (30 minute data)

The periodic system shutdowns illustrated in Figure 7.12 range from one to two hours out to 300 hours. The causes for system shutdowns are classified into the following categories:

- mechanical and electrical faults;
- operational issues;
- insurance testing requirements; and
- external electrical grid issues.

A summary of system outages at Staffordshire ERF during 2017, and the proposed mitigation measures for the project, are detailed in Table 7.7.

Table 7.7 Staffordshire ERF outages and mitigation for project

System shutdown type	Occurrences at Staffordshire ERF (2017)	Mitigation measures for Woodlawn ARC
Operational issues	• Eight blockages by large items in ash discharges.	• Considered avoidable due to waste sorting controls at Banksmeadow and Clyde terminals. • Veolia are considering installing two ash dischargers for the single line plant.
Electrical and mechanical	• Two events associated with unplanned equipment redundancy. • Three external electrical grid faults.	• Electrical and Mechanical failures – a Critical Failure Study will be completed during detailed design stage to provide sufficient redundancy in the electrical/mechanical selection of the equipment. • Electrical Grid Faults – Veolia will complete studies to understand the requirements and the specifications on the high voltage network that the project will be connect to understand potential exposure to electrical faults.
Insurance testing	• Two insurance testing events occurred.	• Unavoidable as the insurance engineer will be required to test the Safety Valve. However, Veolia notes that at Staffordshire ERF, a test that simulates the shutdown response rather than having to trigger the safety mechanism is completed. The viability of this measure would be investigated.
System servicing outage	• Nine system servicing outages occurred.	• Considered to be unavoidable, however will be planned to run in parallel with other outages to minimise occurrences.

Consequently, Veolia consider that there were fourteen unavoidable downtime events at the Staffordshire ERF in 2017 and that these events could occur at the project. However, Veolia consider that the likelihood of occurrence can be controlled and minimised at the project through the consideration of equipment redundancy and good operation and maintenance practices. Veolia will prepare a detailed Business Management System document for the project, containing management practices and procedures relating to the system shutdown events.

ii ARC building – OTNOC period emissions

Regarding emissions during system shutdown and start-up and the Staffordshire ERF CEMS data, the following points are noted:

- the CEMS data covers any period of emission when waste is present on the grate (ie CEMS data accounts for initial shut-down phase emissions);
- when waste is not present on the grate, the CEMS is not operational with emissions associated with the combustion of diesel by auxiliary burners (ie CEMS data does not account for shut-down and initial start-up phase emissions, therefore specific discussion on auxiliary diesel-fired burner emissions is provided in Section 7.2.5iii);
- once the combustion chamber temperature stabilises at 850°C, the waste feed to the grate resumes and the CEMS is restarted (ie CEMS data accounts for stable start-up phase emissions); and
- potential abnormal operating conditions occur infrequently, and are considered to be represented by the observed spikes in the CEMS data, such as for NO_x (Figure 7.2) (ie the results from Scenario 2 account for abnormal operating conditions).

The 2017 Staffordshire CEMS data therefore captures periods of emissions during some phases of OTNOC (eg initial system shutdown, stabilised start-up and abnormal spikes due to waste feed). Therefore, it is considered that the conservative assumptions in the emission calculations included in Scenario 2 (reference case – maximum emissions) provides an appropriate representation of emissions during OTNOC periods. This scenario utilises the 100th percentile emission rate for each pollutant from the 2017 Staffordshire data, then scaled upwards to account for interannual variability, and therefore is a highly conservative scenario.

Further discussion regarding auxiliary diesel-fired burner emissions is provided in Section 7.2.5iii.

It is noted that the FGT, including the fabric filter system, remains operational during start-up and shut-down periods. Further, there is no bypass stack designed into the ERF for an alternate point of emissions release. Therefore, all emissions generated during periods of start-up and shutdown, including those using the auxiliary diesel burner, are captured and controlled by the FGT and represented in the emission rates derived for modelling.

Because waste would only be present on the grate when temperatures are sufficient for thermal destruction, odour emissions from the ARC building stack under OTNOC would not occur.

iii ARC building – auxiliary diesel-fired burner emissions

As detailed in Section 2.2.2ii, the project design will feature diesel-fired auxiliary burners to assist with raising and maintaining furnace temperature at 850°C during start-up/shut-down periods.

While the activation of the diesel fired auxiliary burners will be very infrequent (see Section 7.2.5), emissions during this period have been reviewed for comparison with the quantified emission rates from the ARC building stack.

Based on input from Veolia and operational details for Staffordshire ERF, the expected hourly diesel consumption rate is 1,392 kg diesel/burner/hour. Assuming two burners in operation per hour at the project and through adopting emission factors for diesel combustion sourced from the NPI (Table 29, NPI 2008), the hourly emission rate from the project under diesel-fired auxiliary burner conditions were quantified for CO, NO_x, PM_{10}, $PM_{2.5}$, PAHs, SO_2 and VOCs.

The quantified emission rates for diesel burner operation relative to the emission rates quantified for Scenario 1, 2 and 3 are illustrated in Figure 7.13.

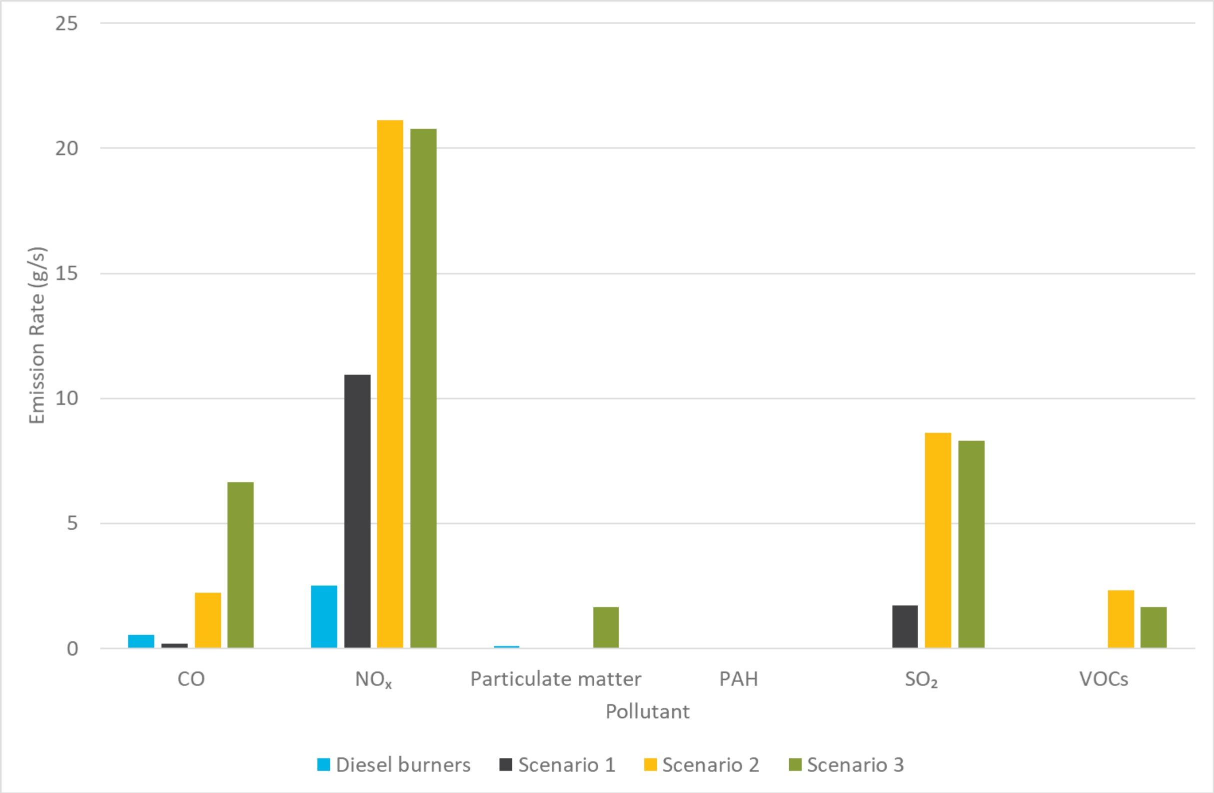


Figure 7.13 Emission rate comparison – auxiliary diesel-fired burners vs Scenario 1, 2 and 3

As can be seen from Figure 7.13, the hourly emission rates presented for diesel combustion are notably lower than the equivalent emission rates quantified for the three ARC building stack scenarios. Therefore, the dispersion modelling results obtained from the three scenarios for ARC building stack emissions (see Chapter 9) are suitably conservative to account for potential impacts under diesel-fired auxiliary burner conditions.

It is reiterated that there is no bypass stack associated with the project design. Consequently, furnace emission under diesel-fired auxiliary burner conditions will pass through the same FGT as regular operations.

7.2.6 Project fugitive particulate matter emissions

In addition to the emissions from the ARC building described above, other sources of fugitive particulate matter emissions from the project include the following:

- wheel generated dust from waste trucks entering the site (sealed access road);
- wheel generated dust from trucks transporting stabilised APCr from the ARC to the APCr encapsulation cell (unsealed internal movements);
- material handling, including waste tipping, unloading and spreading stabilised APCr, transfer and handling of IBA and IBAA;
- screening/processing of IBA;
- loading and dispatch of IBAA; and
- wind erosion from the APCr encapsulation cell.

Full details on emission calculations for existing and approved emission sources is presented in Appendix C.

7.2.7 Project odour emissions

The operation of the ARC is not expected to add to the existing odour emissions from the site. Because the ARC would divert 380,000 tpa of the approved 1.13 Mtpa from the Bioreactor, project does not introduce additional annual waste tonnage to the Eco Precinct. Consequently, there would be no increase in odour emissions from the Bioreactor or MBT due to the ARC. The diversion of waste from the Bioreactor may reduce the potential for the generation of landfill gas, and subsequently odour emissions, however no specific detail of the benefits for odour emission reduction can be quantified for this AQIA. The continual improvement of fugitive gas capture rates from the Bioreactor is expected to continue, with additional gas engines approved to be installed in the future.

As stated in Section 2.2, the tipping hall is an enclosed hall where waste feedstock is received by truck from the Crisps Creek IMF. It will be equipped with automatically operated fast closing doors for truck entry and exit to minimise escape of odour. During operations the tipping hall will be maintained under negative air pressure, with air from the hall being drawn into the combustion chamber. The tipping hall will also be equipped with an extraction system and an odour filter system for use when the negative air pressure is not operational (ie during periods of system shut-down). The design parameters for the tipping hall air extraction system and size/type of odour filtration system will be confirmed following contract award to an engineering, procurement and construction contractor and completion of the detailed design for the project. It is anticipated that the system will extract air at a rate of approximately 10,000m^3 per hour from above the waste bunker, discharging via a filtration system to a stack to ensure that odours from the reception hall and bunker are dispersed in a manner that will ensure that the relevant odour assessment criteria and requirements of BAT 21 are met. The project would be designed to meet the requirements of BAT 21 (Neuwahl et al 2019), relating to prevention or reduction diffuse emissions, including odour emissions. Further discussion relating to emission mitigation for the project is provided in Section 10.1.2.

The combination of negative pressure, air extraction and filtration and fast closing truck bay doors will minimise the potential for release of odour to the environment.

Provision has also been made for an external container handling area. In this location any containers containing waste would remain sealed, until they are transported inside the tipping hall for unloading into the waste bunker. Consequently this area should not generate any odour emissions.

However, in the interests of conservatism, an additional odour source associated with the ARC has been modelled to account for potential fugitive odour from trucks entering the tipping hall.

Odour emission rates from the tipping hall were calculated based on the average measured odour concentration for fresh waste (5,640 odour units (ou)) taken from the most recent independent odour audit (TOU 2021). It is conservatively assumed that doors would be open for 20 minutes in each hour and a nominal air flow rate of 2.5 m^3/s[8] through the open doors.

The odour emission rate (OER) is derived as follows:

$$5{,}640\ ou\ \times 2.5m^3/s\ \ \div (60mins/20mins) = 4{,}700\ ou.m^3/s$$

To assess the potential odour impacts from the ARC, a future cumulative scenario is presented, which adds the potential additional odour from the ARC to the existing operations of the Bioreactor and MBT facility. The odour emission inventory for existing sources is described in Appendix C.

[8] A nominal air flow rate is derived based on an assumed minimal velocity of 0.1 m/s through an opening of 25 m^2

7.3 Approved emission sources

In addition to the project emission sources, emissions inventories were developed for the following approved emission sources at or adjacent to the Eco Precinct:

- fugitive dust emissions from approved Eco Precinct operations, based on approved waste throughput for the Bioreactor (1.13 Mtpa) and MBT (280,000 tpa);
- fuel combustion emissions from the approved expanded BioEnergy power station and flare, based on the operation of up to 10 landfill gas engines (seven existing engines at Hub 1 and three additional future engines at Hub 2) accounting for increased landfill gas capture at the time of ARC operation in 2025;
- fugitive dust emissions from the Woodlawn Mine, based on approved underground ore production (350,000 tpa) and tailings recovery (1.15 Mtpa); and
- fugitive odour emissions from all existing emission sources at the Eco Precinct, based on emissions data from odour measurements in the most recent independent odour audit (TOU 2021).

Full details on emission calculations for existing and approved emission sources is presented in Appendix C.

7.4 Emissions summary

The annual emission totals by source category and air pollutant are presented in Table 7.8. The total annual emissions by air pollutant from the Eco Precinct for approved operations and future Eco Precinct operations with the project (Scenario 1, 2 and 3) are illustrated in Figure 7.14 and Figure 7.15.

The emission totals show the following key points:

- Emissions of TSP, PM_{10} and $PM_{2.5}$ decrease for the two future reference case project scenarios (Scenario 1 and 2), which is associated with a reduction in wheel-generated unpaved road emissions due to the diversion of waste to the ARC building instead of the Bioreactor.
- Emissions of particulate matter and metals/metalloids are notably higher for Scenario 3 due to the application of the EfW Policy emission standards for total particles and Type 1 and 2 substances in aggregate as the emission concentrations. These two NSW EfW Policy emission standards are substantially higher than the equivalent measured concentrations from the Staffordshire ERF.
- Emissions of several combustion pollutants (ie NO_x, SO_2 and benzene) and NH_3 increase with the introduction of the ARC building, in particular for Scenario 2 (reference case – maximum emissions), which is based on abnormal operating condition emissions occurring on a continual basis throughout a year.

Table 7.8 Annual emissions summary – all source categories

Air pollutant	Annual emissions by source type (kg/year)								
	Bioreactor – approved	Bioreactor - future	MBT - approved	Woodlawn Mine	BioEnergy power station	ARC fugitives	ARC building – Scenario 1	ARC building – Scenario 2	ARC building – Scenario 3
TSP	203,837.6	151,576.5	50,600.8	85,183.2	5,057.3	19,775.9	102.9	2,360.4	52,453.6
PM_{10}	55,799.7	41,577.6	13,956.3	28,295.2	5,057.3	6,057.5	102.9	2,360.4	52,453.6
$PM_{2.5}$	6,074.7	4,500.2	1,532.6	5,634.2	5,057.3	927.2	102.9	2,360.4	52,453.6
Dioxins and furans	-	-	-	-	-	-	3.7E-05	1.6E-04	2.6E-04
SO_2	-	-	-	-	75,055.7	-	54,242.4	382,789.2	262,268.1
NO_x	-	-	-	-	147,812.3	-	344,784.7	740,033.1	655,670.2
CO	-	-	-	-	414,342.0	-	5,724.6	129,341.9	209,814.5
HCl	-	-	-	-	-	-	15,145.5	74,761.5	131,134.0
HF	-	-	-	-	-	-	56.5	196.7	10,490.7
Benzene	-	-	-	-	36.4	-	139.5	28,591.9	20,606.8
NH_3	-	-	-	-	-	-	9,822.8	130,063.1	13,113.4
PAHs	-	-	-	-	-	-	0.9	3.8	-
Antimony	-	-	-	-	-	2.0E-01	3.3	12.1	65.0
Arsenic	3.6E-01	2.7E-01	9.2E-02	3.4E-01	1.1E+00	-	1.1	3.0	22.5
Beryllium	-	-	-	-	1.1E+00	-	1.1E-02	2.5E-01	2.1E-01
Cadmium	4.5E-02	3.3E-02	1.1E-02	4.1E-02	-	4.8E-02	1.4	3.9	28.1
Chromium	2.7E-01	2.0E-01	6.7E-02	2.5E-01	9.3E-01	5.7E-02	5.8	23.1	113.8
Cobalt	-	-	-	-	8.3E-01	8.4E-03	1.1	3.0	22.5

Table 7.8 Annual emissions summary – all source categories

Air pollutant	Annual emissions by source type (kg/year)								
	Bioreactor – approved	Bioreactor - future	MBT - approved	Woodlawn Mine	BioEnergy power station	ARC fugitives	ARC building – Scenario 1	ARC building – Scenario 2	ARC building – Scenario 3
Copper	3.7E+00	2.8E+00	9.4E-01	3.5E+00	1.2E+01	7.6E-01	8.0	33.0	157.6
Lead	9.1E+00	6.7E+00	2.3E+00	8.4E+00	2.0E+00	1.1E+00	6.0	23.1	117.1
Manganese	-	-	-	-	2.7E+00	2.3E-01	7.1	26.2	139.0
Mercury	1.7E-03	1.3E-03	4.3E-04	1.6E-03	-	1.9E-03	2.6	7.9	104.9
Nickel	8.4E-02	6.2E-02	2.1E-02	7.7E-02	1.0E+01	2.7E-02	9.0	25.7	176.2
Thallium	-	-	-	-	-	2.0E-04	1.2	3.4	24.3
Vanadium	-	-	-	-	3.9E+00	1.6E-02	1.6	6.3	31.1
Zinc	9.1E+00	6.7E+00	2.3E+00	8.4E+00	1.8E+01	3.3E+00	10.2	232.9	199.5

Note: Annual totals for ARC building reference case are based on upscaled 100th percentile concentration emissions occurring continually throughout a 12 month period.

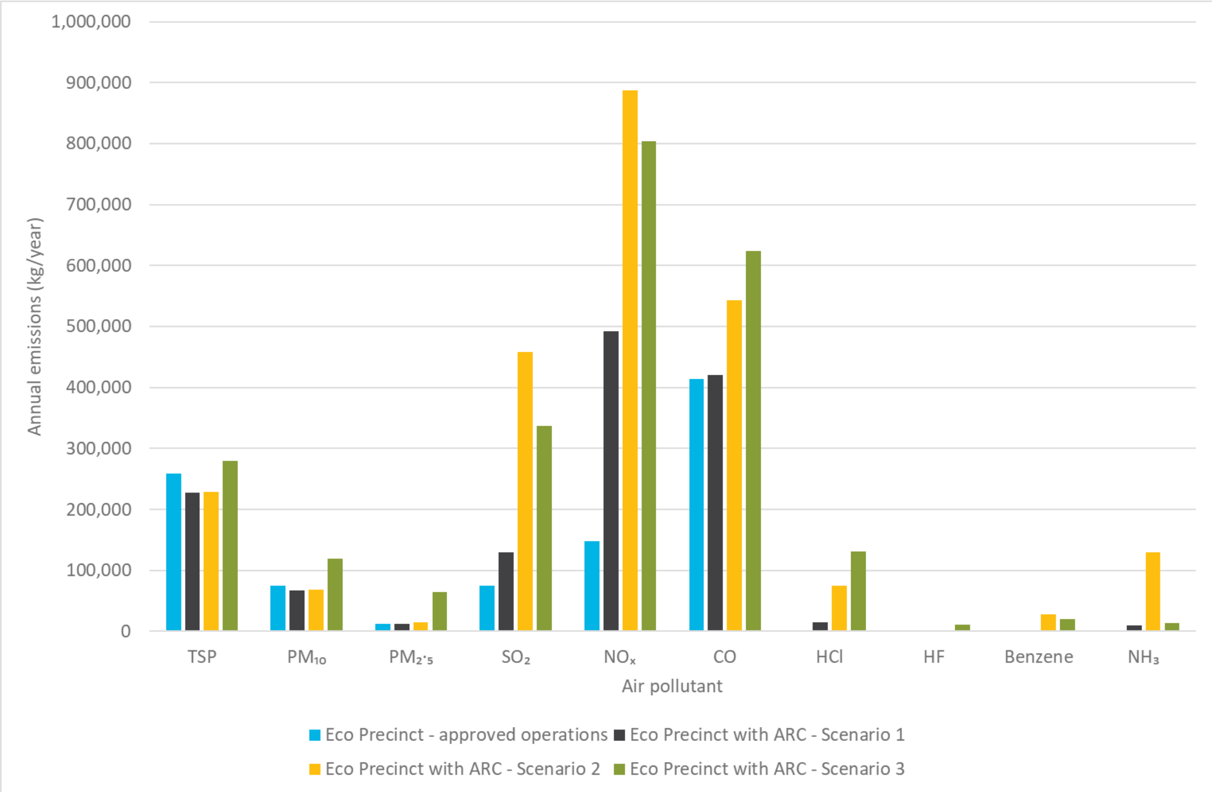


Figure 7.14 **Comparison of annual emissions – Eco Precinct approved and future cumulative (Eco Precinct + Scenario 1, 2 or 3) – particulate matter, SO_2, NO_x, CO, HCl, HF, benzene and NH_3**

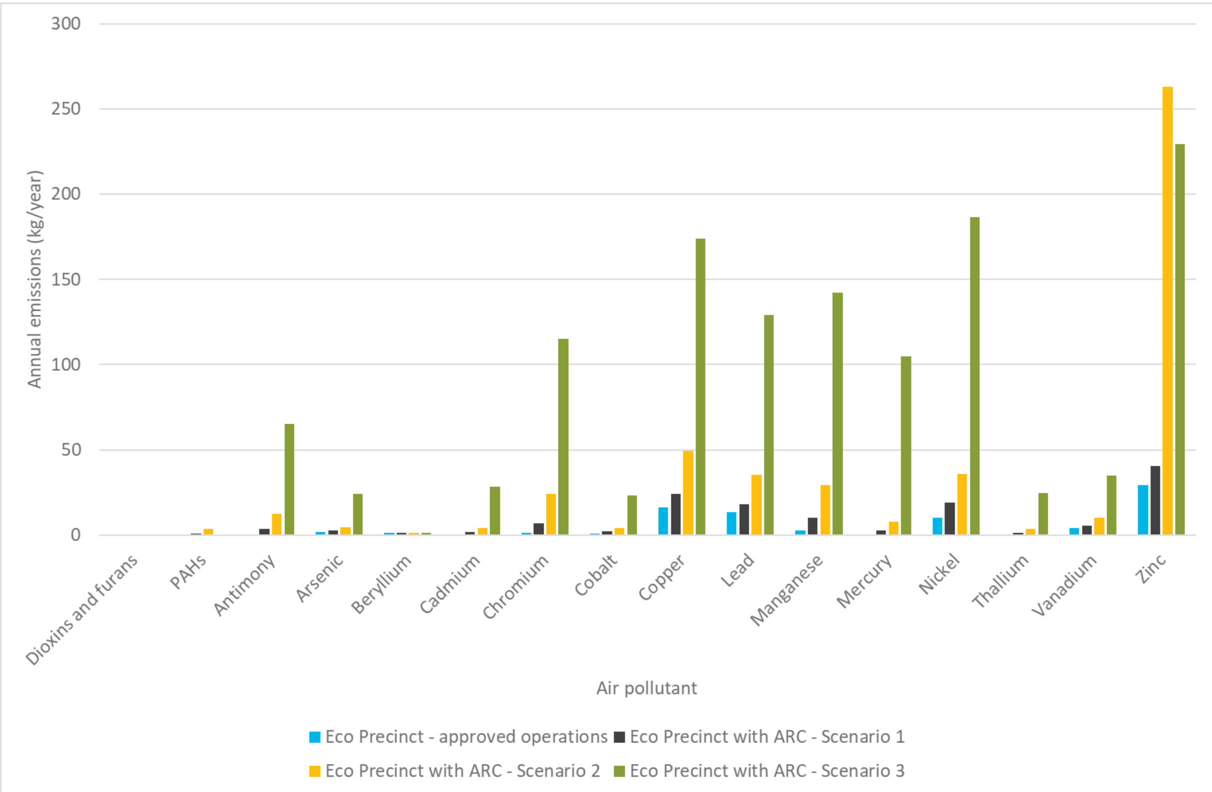


Figure 7.15 **Comparison of annual emissions – Eco Precinct approved and future cumulative (Eco Precinct + Scenario 1, 2 or 3) – dioxins and furans, PAHs and metals/metalloids**

8 Dispersion modelling

8.1 Dispersion modelling methodology

Dispersion modelling for this assessment uses the CALPUFF modelling system, which is commonly used in NSW for applications where non-steady state conditions may occur (ie complex terrain or coastal locations) or where calm conditions are important (ie for the assessment of odour).

Dispersion modelling has been conducted for the following configurations of emission sources:

- current approved Eco Precinct operations (to provide a comparison point for future scenarios);
- Scenario 1 (reference case – expected emissions) ARC building stack emissions plus ARC fugitive emissions plus approved Eco Precinct operations;
- Scenario 2 (reference case – maximum emissions) ARC building stack emissions plus ARC fugitive emissions plus approved Eco Precinct operations;
- Scenario 3 (regulatory case emissions) ARC building stack emissions plus ARC fugitive emissions plus approved Eco Precinct operations; and
- Woodlawn Mine (for cumulative assessment purposes only).

Emissions associated with the ARC building stack, along with the approved BioEnergy engines and flares, are modelled as conventional point sources.

For modelling of fugitive dust sources, the activities and sources described in Appendix C are represented by a series of volume, point and area sources, as follows:

- material handling and haulage is modelled as a series of volume sources, positioned across the active areas of the Bioreactor, MBT, Woodlawn Mine and proposed ARC;
- wind erosion is modelled as an area source, for exposed ground and stockpiles at the Bioreactor, MBT, Woodlawn Mine and proposed ARC; and
- emissions from the Woodlawn Mine ventilation shaft are modelled as a point source.

Odour sources are represented by a series of volume and area sources, as follows:

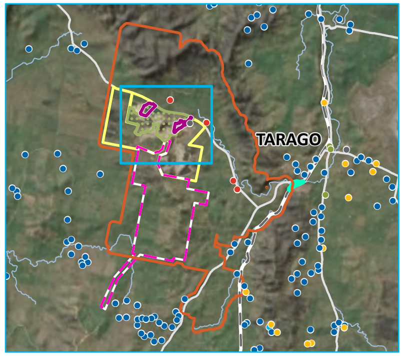
- odour emissions from the Bioreactor, leachate ponds, leachate treatment, evaporation dams and MBT stockpiles are modelled as area sources; and
- fugitive odour from buildings at the MBT, biofilter at the MBT and the proposed ARC building are modelled as volume sources.

Model source location maps are presented in Appendix C.

Model calculation points for the prediction of project increment and cumulative ground level concentrations (GLCs) and deposition rates were configured as follows:

- the 215 individual sensitive assessment locations described in Section 3.2 and listed in Appendix A;
- boundary receptors were allocated at 50 m intervals along the boundary of Veolia integrated waste management operations (Figure 1.2) (224 points in total), with these boundary locations used to extract the 'beyond boundary' concentration predictions where applicable (beyond boundary relevant pollutants are discussed in Section 4.2);
- an additional 885 boundary receptors are allocated along the boundary of total Veolia-owned land for the Eco Precinct at 100 m intervals;
- total gridded model domain centred over the ARC building stack (totalling 909 receptor points):
  - 10 km by 10 km at 500 m grid cell resolution;
  - 20 km by 20 km at 1 km grid cell resolution; and
  - 30 km by 30 km at 2 km grid cell resolution;
- sub-grid domain centred over Tarago village (totalling 169 receptor points):
  - 2 km by 2 km at 250 m grid cell resolution.

CALPUFF was configured in accordance with the recommended settings of TRC (2011) where relevant to do so. The calm wind threshold was set to 0.1 m/s, while the minimum sigma-z values were to 0.2 m/s.



KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

Model source locations

- Point
- Line
- Area

Model source locations – approved operations

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 8.1

EMM creating opportunities

Source: EMM (2022); Veolia (2022); DFSI (2017)

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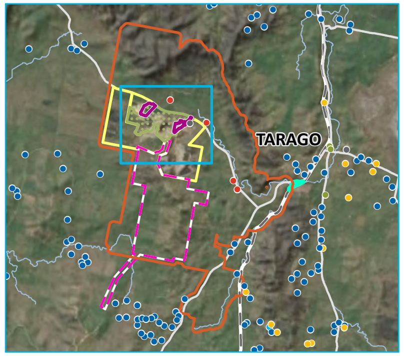

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- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

Model source locations

- Point
- Line
- Area
- Volume

Model source locations – project only sources

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 8.2

EMM creating opportunities

Source: EMM (2022); Veolia (2022); DFSI (2017)

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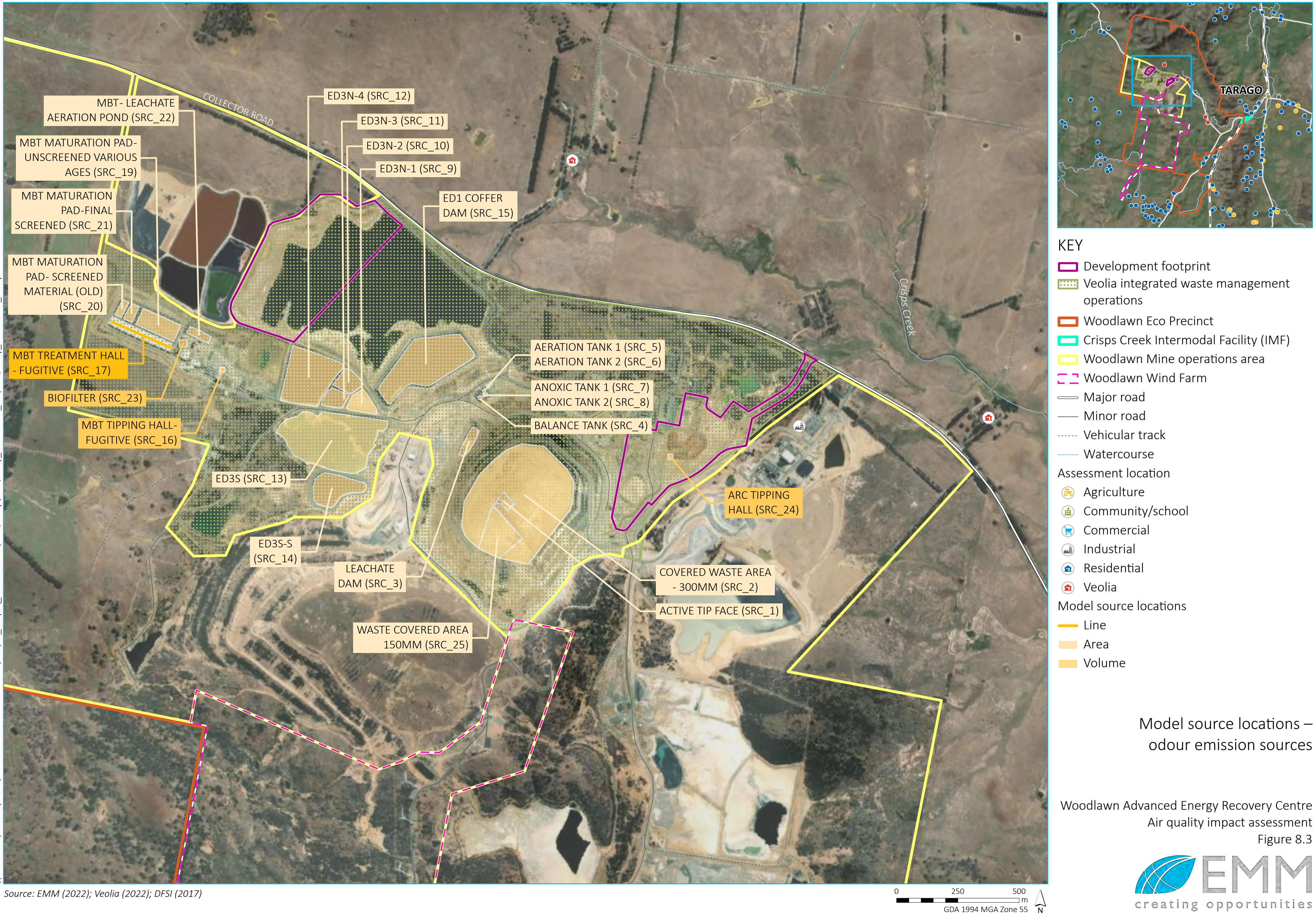

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Source: EMM (2022); Veolia (2022); DFSI (2017)

Model source locations – odour emission sources

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 8.3

EMM creating opportunities

8.2 Building downwash

The influence of the proposed ARC building and neighbouring existing structures is accounted for in the CALPUFF dispersion modelling through the Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) downwash module.

The heights and corner locations of buildings in the vicinity of the plume are accounted for in the BPIP-PRIME model to simulate the effective height and width of the structures. The downwash algorithm calculates effective building dimensions relative to the plume, resolved down to 10° intervals. CALPUFF then accounts for the potential influence of these surrounding structures on plume dispersion and resultant GLCs.

A three-dimensional representation of ARC and Eco Precinct structures within CALPUFF is presented in Figure 8.4.

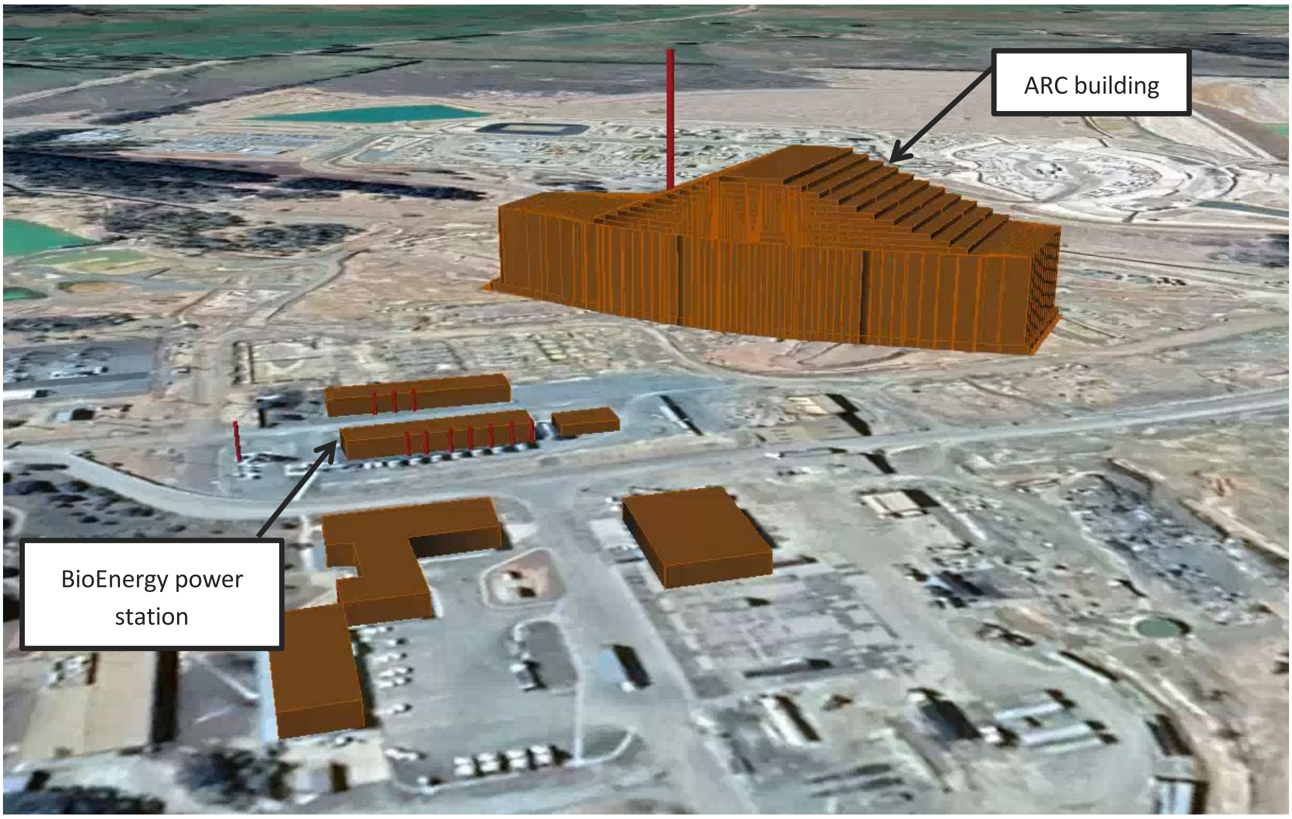


Figure 8.4 CALPUFF three-dimensional representation of ARC building and stack, BioEnergy power station stacks and flare, and Eco Precinct administration buildings (view facing south-east)

8.3 NO_x to NO_2 conversion

NO_X emissions from with combustion sources are primarily emitted as nitric oxide (NO) and, at the point of emission, would typically consist of 90%–95% NO and 5%–10% NO_2. Impact assessment criteria are prescribed for NO_2, therefore it is necessary to account for the transformation of NO to NO_2 as the plume travels from the source. The dominant short-term conversion of NO to NO_2 is through oxidation with atmospheric ozone (O_3).

The NSW EPA's Approved Methods for Modelling prescribes three methods to account for the oxidation of NO to NO_2, as follows:

- Method 1: assume 100% conversion of NO to NO_2;
- Method 2: the ozone limiting method (OLM), which is a conservative approach that assumes all available ozone in the atmosphere will react with NO in the plume until either all the ozone or all the NO is used up; and
- Method 3: an empirical equation developed by Janssen et al. (1988) for estimating the oxidation rate of NO in power plant plumes.

For this assessment, the ozone limiting method (OLM) has been applied to convert model-predicted GLCs of NO_x to NO_2 for comparison with the applicable impact assessment criteria. The OLM is listed as Method 2 for NO_2 assessment in the Approved Methods for Modelling.

Reference has been made to the hourly-varying O_3 concentrations recorded at the ACT Government air quality monitoring stations during 2018, consistent with the regional average background dataset discussed in Section 6.2.

The equation used to calculate NO_2 concentrations from predicted NO_X concentrations is as follows:

$$[NO_2]_{TOTAL} = \{0.1 \times [NO_x]_{PRED}\} + MIN\{(0.9) \times [NO_x]_{PRED} \text{ or } (46/48) \times [O_3]_{BKGD}\} + [NO_2]_{BKGD}$$

Where:

$[NO_2]_{TOTAL}$ = The predicted concentration of NO_2 in $\mu g/m^3$;

$[NO_x]_{PRED}$ = The CALPUFF prediction of ground level NO_X concentrations in $\mu g/m^3$;

MIN = The minimum of the two quantities within the braces;

$[O_3]_{BKGD}$ = The background ambient O_3 concentration – hourly varying regional average dataset in $\mu g/m^3$;

46/48 = the molecular weight of NO_2 divided by the molecular weight of O_3; and

$[NO_2]_{BKGD}$ = The background ambient NO_2 concentration – hourly varying regional average dataset in $\mu g/m^3$.

The OLM assumes that all available O_3 in the atmosphere will react with NO in the plume until either all the O_3 or all the NO is used up. As stated in the Approved Methods for Modelling, the approach assumes that the atmospheric reaction is instant. In reality, the reaction takes place over a number of hours. The OLM will therefore tend to overestimate concentrations at near-source locations. Therefore, the NO_2 GLCs calculated using the OLM approach are considered conservative.

9 Dispersion modelling results

9.1 Project only incremental results

For the purpose of this AQIA, the predicted incremental concentrations for the project are defined as the combination of ARC building stack, ARC fugitive emissions (IBA and APCr related emissions) and emissions from approved Eco Precinct operations (ie Bio Reactor, MBT, BioEnergy Power Station and flare). As indicated in Section 7.3, particulate matter emissions from approved Eco Precinct operations are expected to reduce with the introduction of the ARC building.

The maximum incremental concentrations and deposition rates for criteria pollutants across all assessment locations are presented in Table 9.1, for the three emission scenarios. In addition, predicted concentrations and deposition rates from emissions generated by approved Eco Precinct operations are presented in Table 9.1.

The maximum predictions in Table 9.1 are presented as the highest across all '*sensitive*' assessment locations (excluding Veolia owned properties and the adjacent Woodlawn Mine). The exception is HF, which is presented as the highest across agricultural and vineyard assessment locations. For further detail, the predicted incremental concentrations across all assessment locations are tabulated in Appendix D.

The maximum predicted concentration of each pollutant and modelling scenario across the sensitive assessment locations, expressed as a percentage of the relevant impact assessment criterion, is illustrated in Figure 9.1 and shows the following key points:

- across all presented pollutants and scenarios, the predicted incremental concentration from the project (and approved Eco Precinct sources) is well below the applicable impact assessment criterion at all sensitive assessment locations;
- for the majority of pollutants, the maximum incremental concentration from the project is not predicted to change relative to the increment predicted for approved Eco Precinct operations;
- the predicted PM_{10} and $PM_{2.5}$ concentrations for the three future scenarios show a slight reduction relative to the approved Eco Precinct emissions, which is attributed to the project-related reduction in unpaved haul truck movements (discussed in Section 7.4);
- 1 hour SO_2 concentrations under Scenario 2 are predicted to increase by approximately 5% relative to approved Eco Precinct emissions, however it is reiterated that Scenario 2 is assumes upscaled maximum emission concentrations on a continual basis and is therefore highly conservative; and
- relative to the other emission scenarios, the predicted HF concentrations under Scenario 3 show a notable increase, however this is attributable to the modelling of ARC Building stack emissions at the NSW EfW Policy emission standard.

The results presented in Table 9.1 and Figure 9.1 show that the introduction of the project to the Eco Precinct will not significantly change air quality impacts relative to those experienced under the current approved operations.

The same increment vs criterion analysis is presented for industrial receptors in Figure 9.2, with the closest being the neighbouring Woodlawn Mine. The incremental concentrations are higher relative to the impact assessment criterion, as would be expected given the location within the Eco Precinct, however the same points observed at the sensitive assessment locations remain applicable (ie results are below applicable impact assessment criterion, an observed reduction in PM_{10}/$PM_{2.5}$, no significant change relative to current approved operations).

It is noted that compliance with the impact assessment criteria for the pollutants listed in Table 9.1 is evaluated against the cumulative modelling results, which are presented in Section 9.2.

Table 9.1 Predicted incremental ground level concentrations (µg/m³) and deposition rates (g/m²/month) for criteria air pollutants – sensitive assessment locations

Pollutant	Averaging period	Highest predicted concentration (µg/m³) /deposition rate (g/m²/month) across all sensitive assessment locations							
		Approved Eco Precinct	% of criterion	Scenario 1 + Eco Precinct	% of criterion	Scenario 2+ Eco Precinct	% of criterion	Scenario 3 + Eco Precinct	% of criterion
CO	Maximum 1 hour	241.7	0.8%	241.7	0.8%	241.7	0.8%	241.7	0.8%
	Maximum 8 hour	42.2	0.4%	42.2	0.4%	42.2	0.4%	42.2	0.4%
NO_2	Maximum 1 hour	43.6	26.6%	43.6	26.6%	43.6	26.6%	43.6	26.6%
	Annual	0.24	0.8%	0.45	1.4%	0.66	2.1%	0.61	2.0%
SO_2	Maximum 1 hour	33.1	11.6%	33.1	11.6%	46.3	16.2%	33.1	11.6%
	Maximum 24 hour	2.0	3.5%	2.0	3.5%	2.4	4.3%	2.0	3.5%
PM_{10}	Maximum 24 hour	1.71	3.4%	1.30	2.6%	1.30	2.6%	1.32	2.6%
	Annual	0.12	0.5%	0.09	0.4%	0.09	0.4%	0.11	0.4%
$PM_{2.5}$	Maximum 24 hour	0.44	1.8%	0.34	1.4%	0.35	1.4%	0.37	1.5%
	Annual	0.03	0.4%	0.02	0.3%	0.03	0.3%	0.05	0.6%
TSP	Annual	0.17	0.2%	0.13	0.1%	0.13	0.1%	0.15	0.2%
Dust deposition (g/m²/month)	Annual	0.02	1.2%	0.02	1.0%	0.02	1.2%	0.02	1.0%

Table 9.1 Predicted incremental ground level concentrations (µg/m³) and deposition rates (g/m²/month) for criteria air pollutants – sensitive assessment locations

Pollutant	Averaging period	Highest predicted concentration (µg/m³) /deposition rate (g/m²/month) across all sensitive assessment locations							
		Approved Eco Precinct	% of criterion	Scenario 1 + Eco Precinct	% of criterion	Scenario 2+ Eco Precinct	% of criterion	Scenario 3 + Eco Precinct	% of criterion
HF	Maximum 24 hour	-	-	2.96E-04	0.02%	4.93E-04	0.03%	6.57E-02	4.38%
	7 day	-	-	1.35E-04	0.02%	1.77E-04	0.02%	2.35E-02	2.94%
	30 day	-	-	8.81E-05	0.02%	1.13E-04	0.03%	1.51E-02	3.77%
	90 day	-	-	6.46E-05	0.03%	8.45E-05	0.03%	1.13E-02	4.51%
Lead	Annual	2.43E-04	0.05%	1.86E-04	0.04%	1.93E-04	0.04%	4.48E-04	0.09%

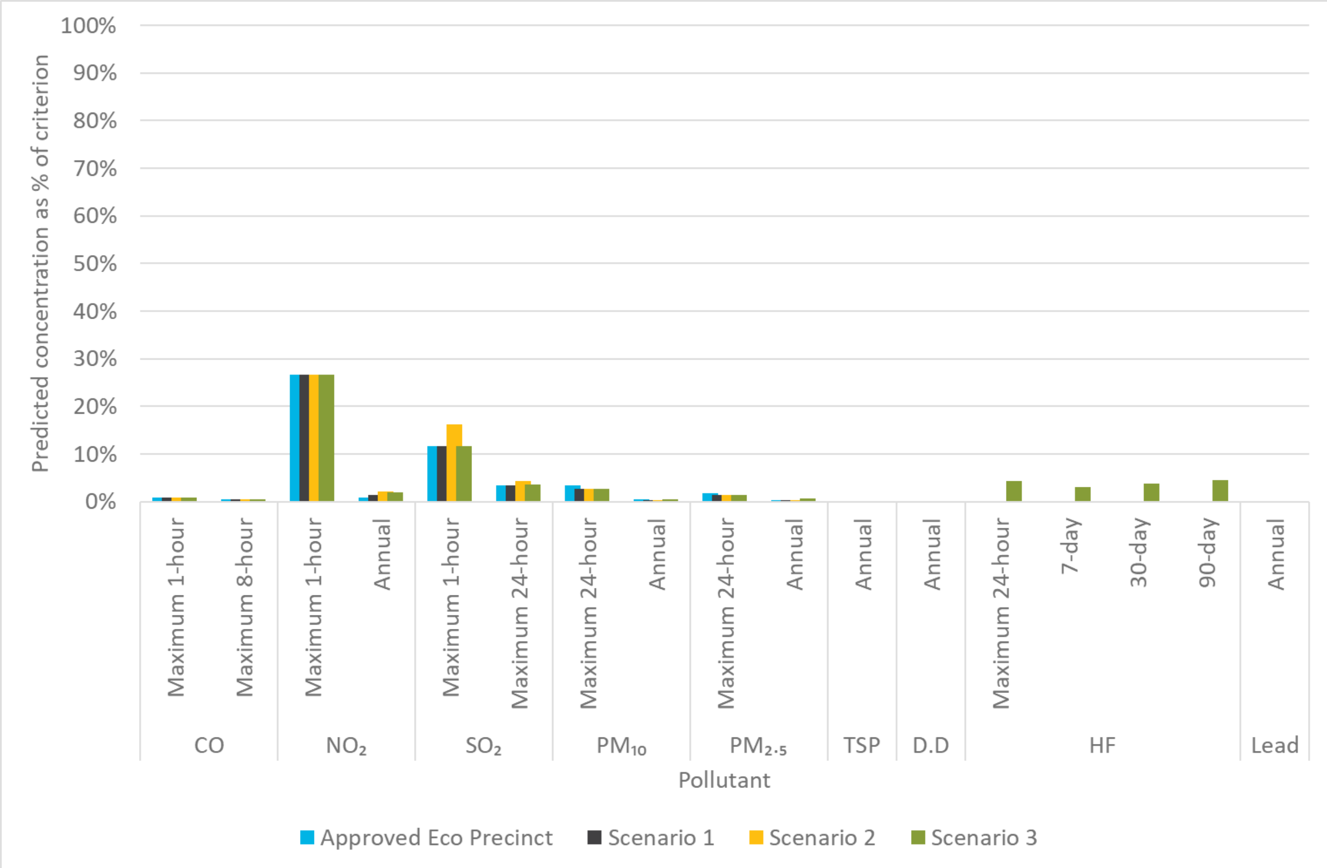


Figure 9.1 **Maximum predicted incremental concentrations (ARC building stack + ARC fugitives + approved Eco Precinct sources) across sensitive assessment locations by criteria pollutant, expressed as percentage of relevant impact assessment criterion**

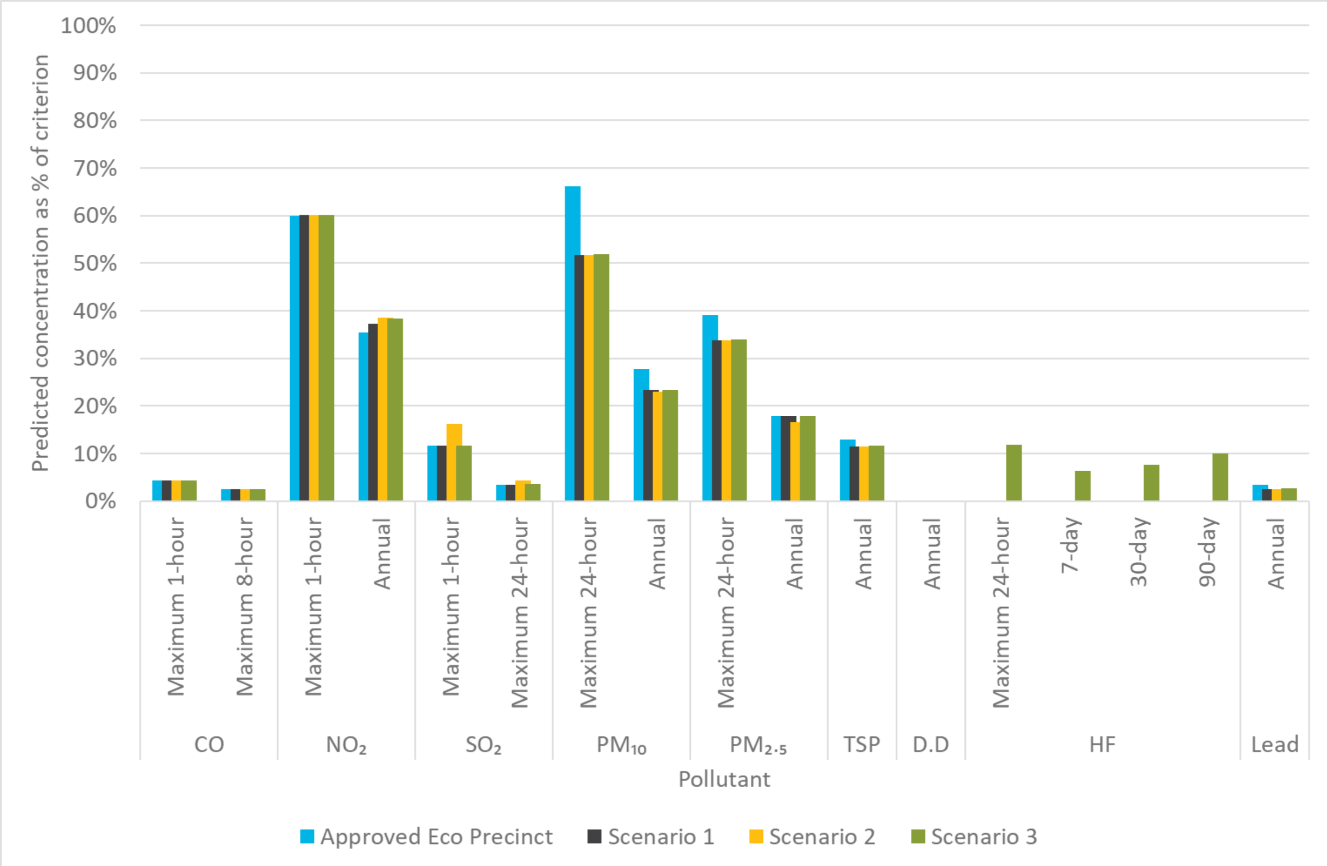


Figure 9.2 **Maximum predicted incremental concentrations (ARC building stack + ARC fugitives + approved Eco Precinct sources) across industrial assessment locations by criteria pollutant, expressed as percentage of relevant impact assessment criterion**

To provide an indication of the significance of contributing sources to the predicted incremental particulate matter concentrations at the neighbouring Woodlawn Mine, a source apportionment analysis has been conducted and is presented in Figure 9.3.

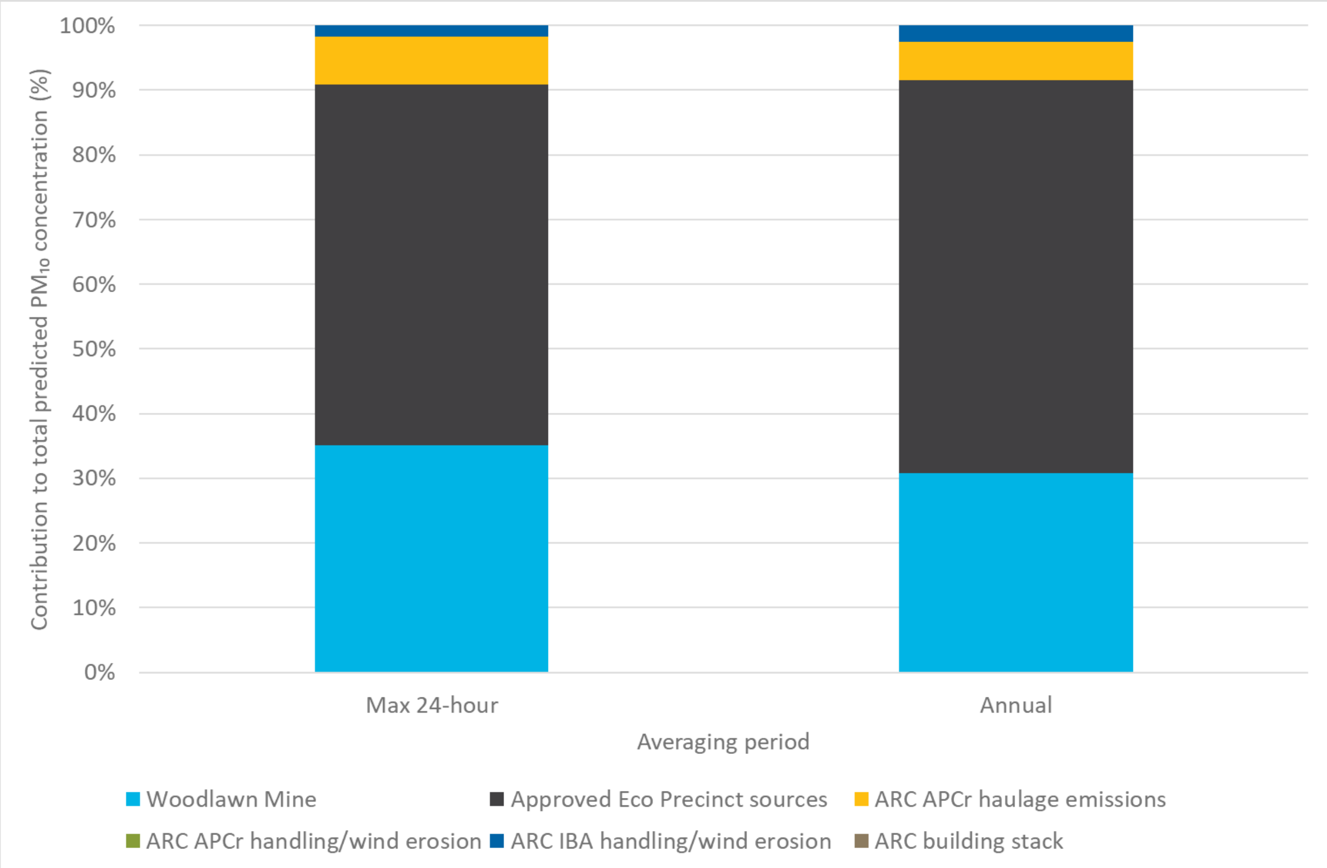


Figure 9.3 **Source contribution to incremental PM_{10} concentrations – maximum 24-hour average and annual average – Woodlawn Mine (R88)**

The results of the source apportionment analysis for the maximum 24-hour average PM_{10} concentration and annual average PM_{10} concentration at assessment location R88 highlights the following:

- the approved operations at the Eco Precinct (eg unpaved haulage, Bio Reactor, MBT etc) and the Woodlawn Mine contribute over 90% of PM_{10} concentrations at the Woodlawn Mine;
- the haulage of APCr material from the ARC building to the encapsulation cell contributes approximately 6% to 7% of predicted concentrations;
- emissions from the handling and wind erosion of IBA material contributes approximately 2% to 3% of predicted concentrations; and
- a negligible contribution from the ARC building stack is predicted.

The maximum predicted incremental concentrations for principal and individual toxic air pollutants across all assessment locations are presented in Table 9.2. The maximum predictions in Table 9.2 are presented as the highest prediction at or beyond the boundary of Veolia integrated waste management operations.

Table 9.2 Predicted incremental ground level concentrations (µg/m³) for principal and individual air toxics – maximum at or beyond the boundary of Veolia integrated waste management operations

Pollutant	Averaging period	Highest predicted concentration (µg/m³) at or beyond the boundary of Veolia integrated waste management operations							
		Approved Eco Precinct	% of criterion	Scenario 1 + Eco Precinct	% of criterion	Scenario 2+ Eco Precinct	% of criterion	Scenario 3 + Eco Precinct	% of criterion
Benzene	99.9th percentile 1 hour	6.22E-02	0.2%	6.22E-02	0.2%	4.55E+00	15.7%	3.28E+00	11.3%
NH_3	99.9th percentile 1 hour	-	-	1.64E+00	0.5%	2.07E+01	6.3%	2.09E+00	0.6%
Dioxins and furans	99.9th percentile 1 hour	-	-	6.21E-09	0.3%	2.50E-08	1.3%	4.17E-08	2.1%
HCl	99.9th percentile 1 hour	-	-	2.53E+00	1.8%	1.19E+01	8.5%	2.09E+01	14.9%
Antimony	99.9th percentile 1 hour	-	-	1.02E-02	0.1%	1.05E-02	0.1%	4.28E-02	0.5%
Arsenic	99.9th percentile 1 hour	9.54E-03	10.6%	6.95E-03	7.7%	7.07E-03	7.9%	1.23E-02	13.6%
Beryllium	99.9th percentile 1 hour	1.85E-03	46.3%	1.85E-03	46.3%	1.86E-03	46.6%	2.17E-03	54.3%
Cadmium	99.9th percentile 1 hour	1.03E-03	5.7%	2.35E-03	13.0%	2.43E-03	13.5%	1.40E-02	77.5%
Chromium	99.9th percentile 1 hour	7.06E-03	7.8%	6.47E-03	7.2%	7.47E-03	8.3%	8.28E-02	92.1%
Copper	99.9th percentile 1 hour	9.75E-02	2.6%	9.62E-02	2.6%	9.77E-02	2.6%	1.33E-01	3.6%
Manganese	99.9th percentile 1 hour	4.50E-03	<0.1%	1.32E-02	0.1%	1.44E-02	0.1%	9.61E-02	0.5%

Table 9.2 Predicted incremental ground level concentrations (µg/m³) for principal and individual air toxics – maximum at or beyond the boundary of Veolia integrated waste management operations

Pollutant	Averaging period	Highest predicted concentration (µg/m³) at or beyond the boundary of Veolia integrated waste management operations							
		Approved Eco Precinct	% of criterion	Scenario 1 + Eco Precinct	% of criterion	Scenario 2+ Eco Precinct	% of criterion	Scenario 3 + Eco Precinct	% of criterion
Mercury	99.9th percentile 1 hour	3.97E-05	<0.1%	1.04E-04	<0.1%	1.25E-03	0.1%	2.78E-02	1.5%
Nickel	99.9th percentile 1 hour	1.74E-02	9.7%	1.77E-02	9.8%	1.86E-02	10.4%	1.02E-01	56.9%
Zinc	99.9th percentile 1 hour	2.27E-01	1.3%	1.90E-01	1.1%	2.00E-01	1.1%	8.51E-01	4.7%

The maximum predicted concentration for each principal and individual air toxics pollutant and modelling scenario at or beyond the boundary of Veolia integrated waste management operations, expressed as a percentage of the relevant impact assessment criterion, is illustrated in Figure 9.4 and shows the following key points:

- across all presented pollutants and scenarios, the predicted increment from the project (in combination with approved Eco Precinct sources) are below the applicable impact assessment criterion at or beyond the boundary of Veolia integrated waste management operations;
- for the majority of pollutants, the maximum increment from the project scenarios is not predicted to change relative to the increment predicted for approved Eco Precinct operations;
- the predicted concentrations for cadmium, chromium and nickel in Scenario 3 are high relative to the applicable criterion and the results for the other modelling scenarios, however it is reiterated that the Scenario 3 emission rates are based on the NSW EfW Policy emission standard for Type 1 and 2 substances in aggregate which is an order of magnitude greater than the equivalent concentrations recorded at the Staffordshire ERF;
- the predicted concentrations for benzene, NH_3 and HCl increase relative to approved operations, yet are predicted to remain well below applicable impact assessment criterion; and
- the predicted incremental concentrations of NH_3 are predicted to be less than 7% of the applicable NSW EPA impact assessment criterion for Scenario 2, despite the fact that the emissions adopted from the Staffordshire ERF were well above the NSW EfW Policy standard.

The same increment vs criterion analysis has been completed for the 215 sensitive receptor locations, with a summary presented in Figure 9.5. In comparison with the predictions at or beyond the boundary of Veolia integrated waste management operations (Figure 9.4), the predicted incremental concentrations are shown to be notably lower across all sensitive assessment locations relative to relevant impact assessment criterion. It is considered that Figure 9.5 illustrates that:

- predicted impacts at sensitive assessment locations from emissions of principal and individual air toxics from approved operations of the Eco Precinct are very low relative to the relevant impact assessment criterion; and
- the introduction of the project to the Eco Precinct will not significantly change impacts relative to approved operations.

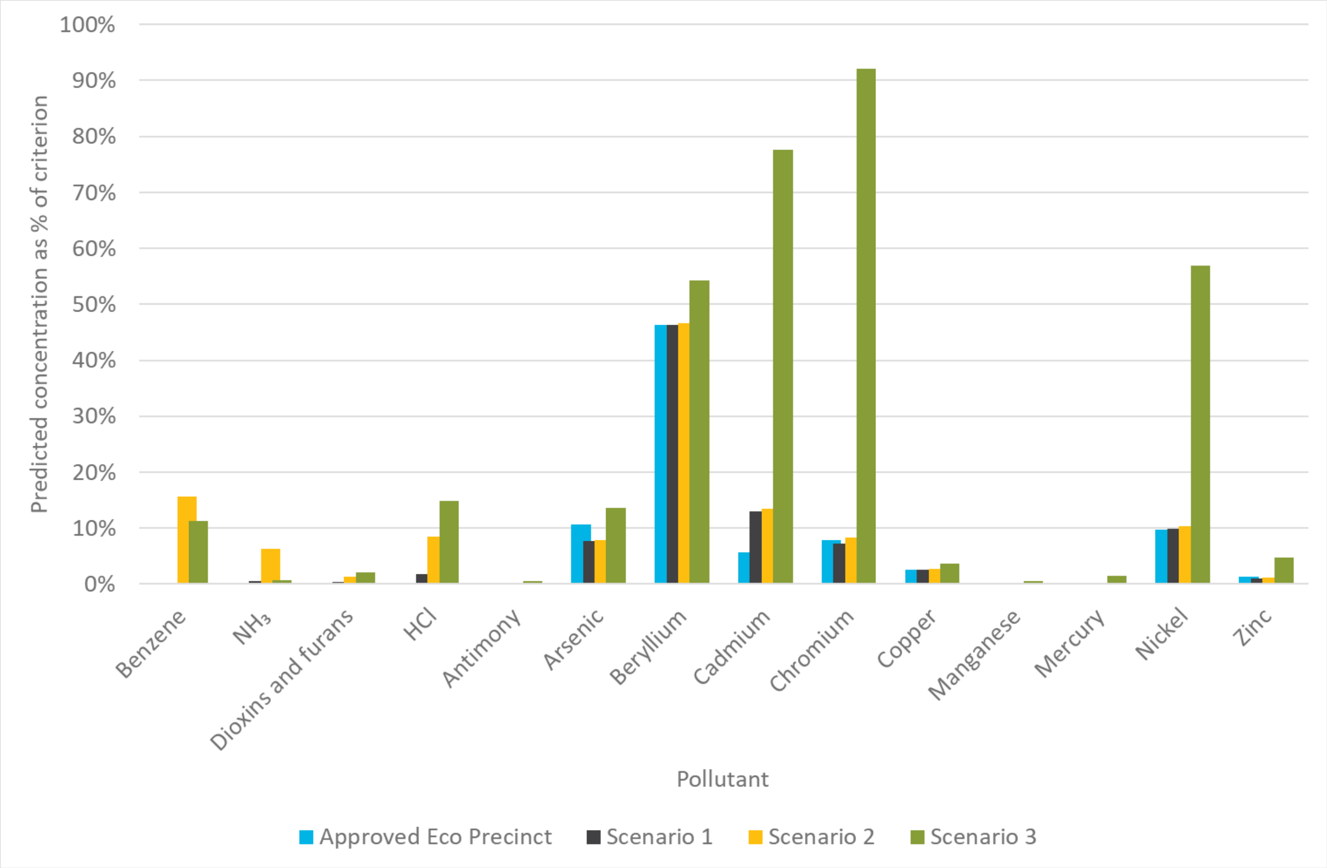


Figure 9.4 Maximum predicted incremental concentrations (ARC building stack + ARC fugitives + approved Eco Precinct sources) at or beyond the boundary of Veolia integrated waste management operations for principal and individual air toxics, expressed as percentage of relevant impact assessment criterion

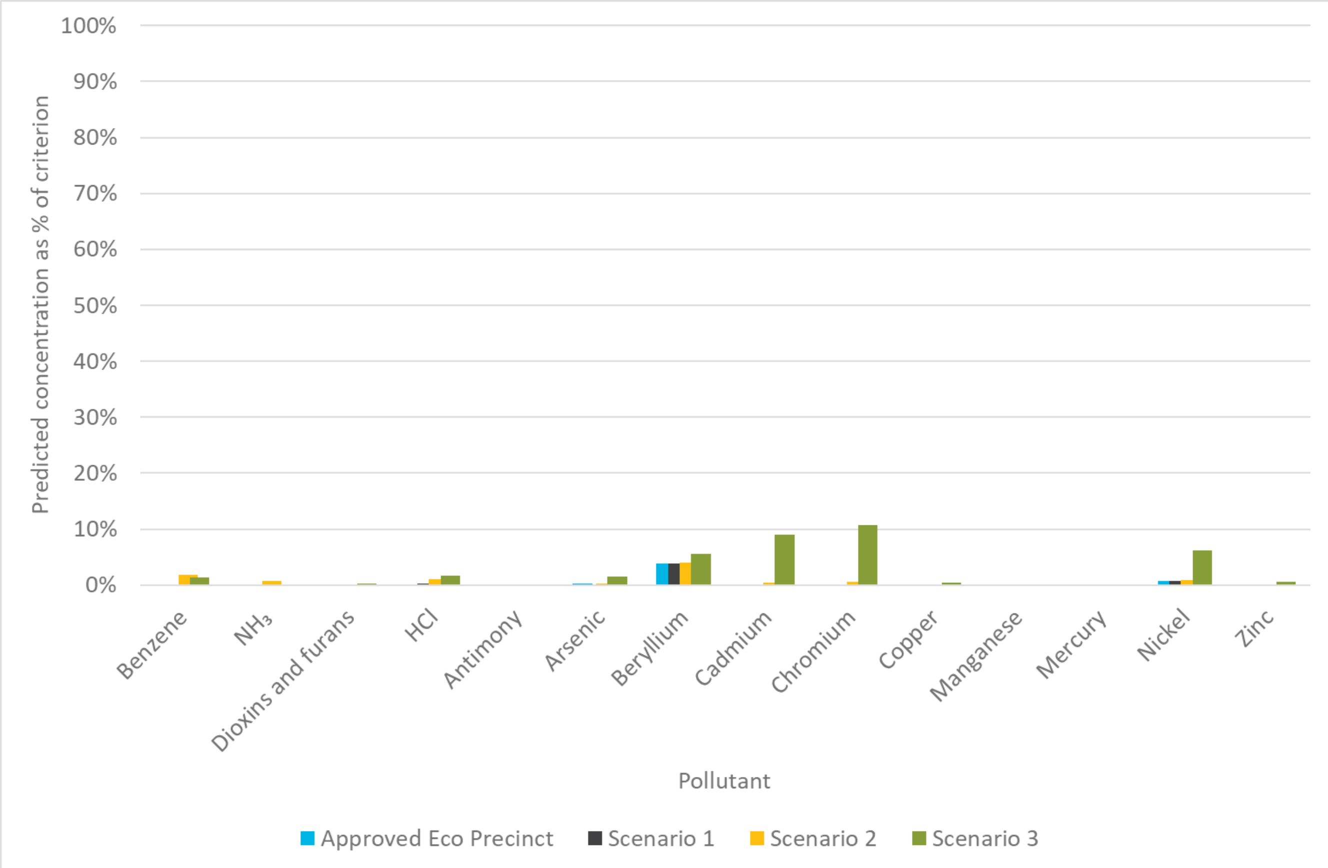
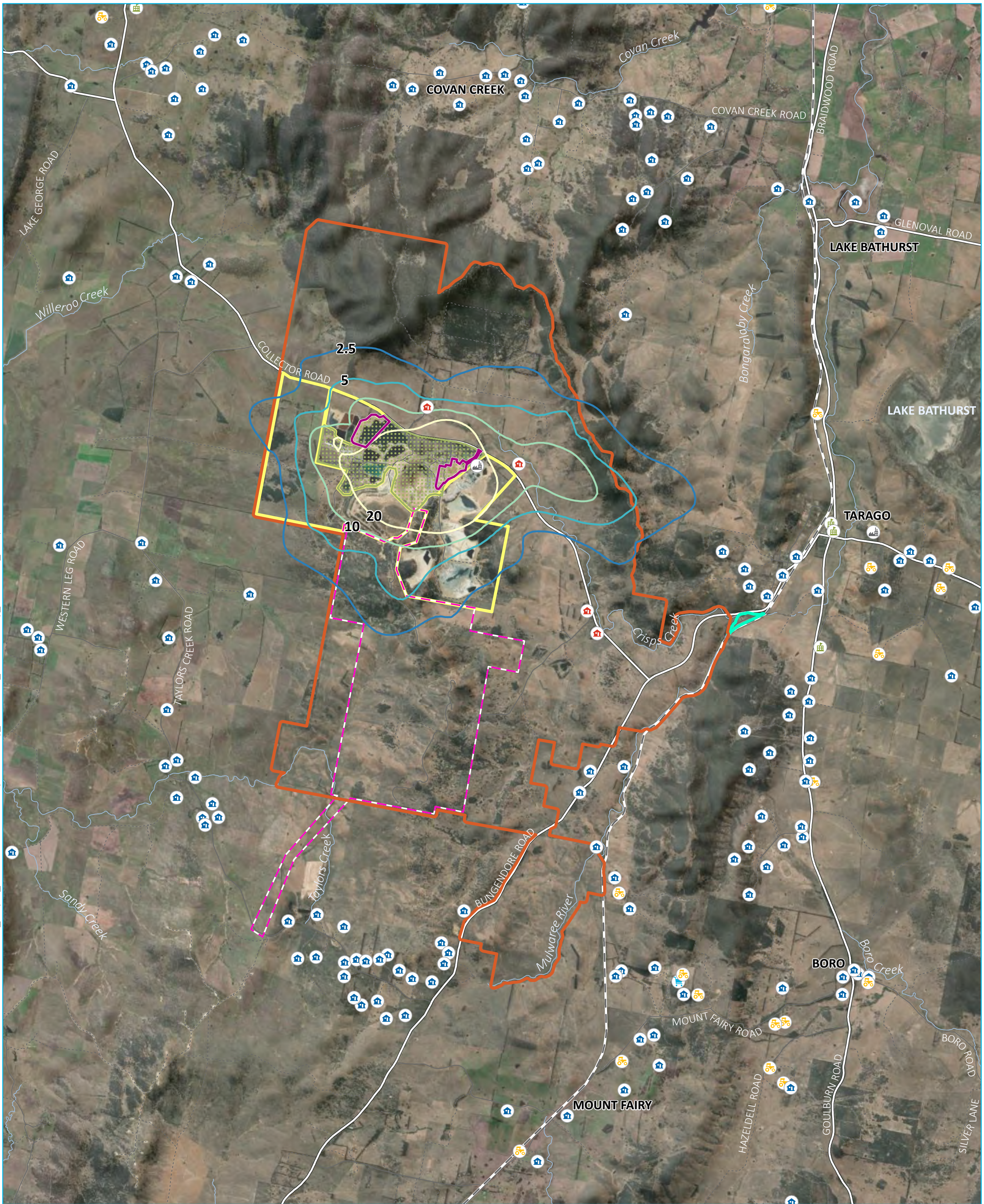


Figure 9.5 Maximum predicted incremental concentrations (ARC building stack + ARC fugitives + approved Eco Precinct sources) at sensitive assessment locations for principal and individual air toxics, expressed as percentage of relevant impact assessment criterion

Contour plots for project-only incremental concentrations of particulate matter, NO_2, SO_2 and NH_3 are presented in Figure 9.6 to Figure 9.15 for Scenario 1 and Figure 9.16 to Figure 9.25 for Scenario 2. These figures all illustrate that the predicted concentrations from the project emission sources are small and generally contained within Veolia-owned land.



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Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

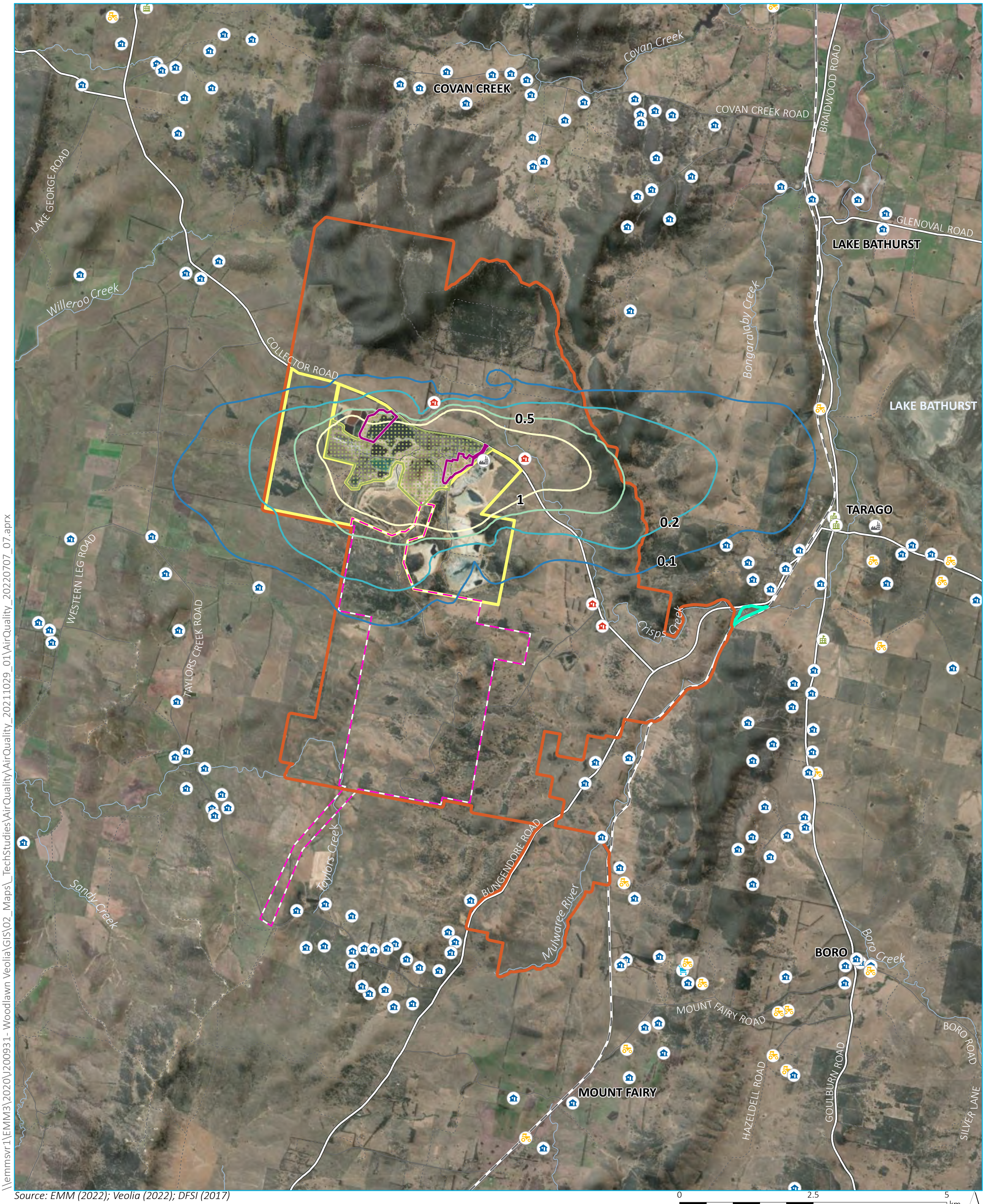
24-hour PM_{10} concentration

- 2.5 $\mu g/m^3$
- 5 $\mu g/m^3$
- 10 $\mu g/m^3$
- 20 $\mu g/m^3$

Maximum predicted 24-hour average PM_{10} concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.6

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

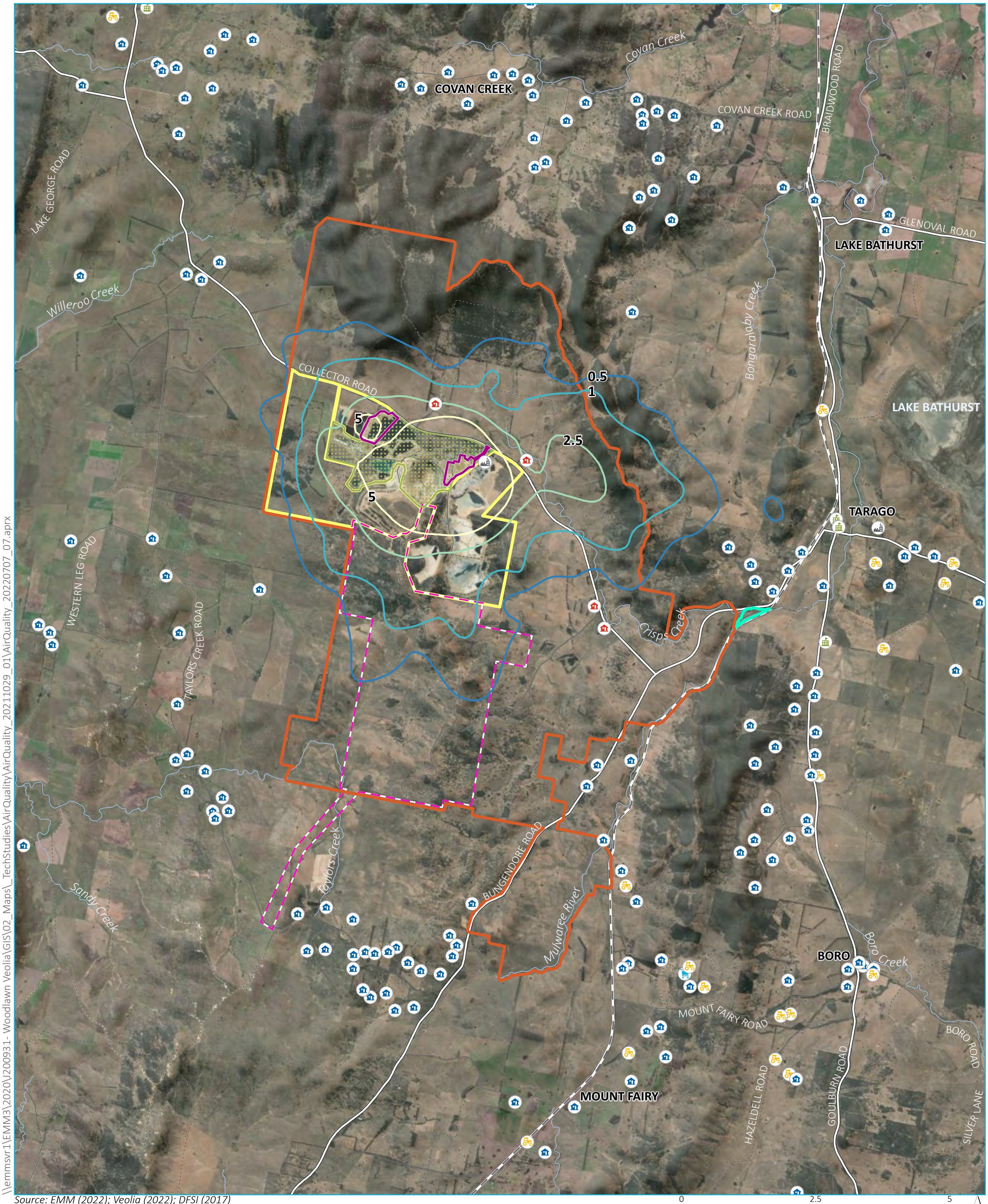
Annual PM_{10} concentration

- 0.1 $\mu g/m^3$
- 0.2 $\mu g/m^3$
- 0.5 $\mu g/m^3$
- 1 $\mu g/m^3$

Predicted annual average PM_{10} concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.7

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

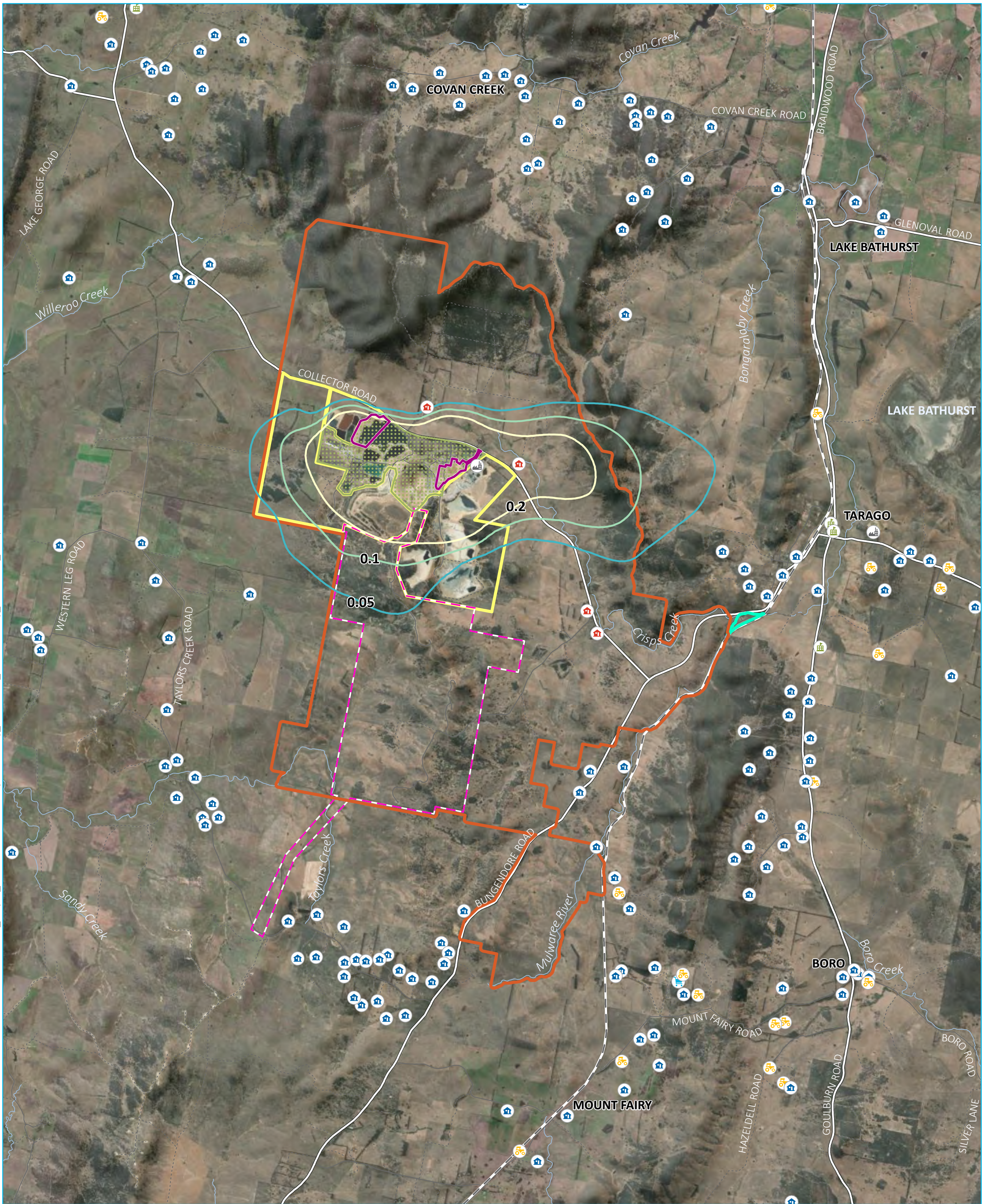
24-hour $PM_{2.5}$ concentration

- 0.5 µg/m^3
- 1 µg/m^3
- 2.5 µg/m^3
- 5 µg/m^3

Maximum predicted 24-hour average $PM_{2.5}$ concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.8

EMM
creating opportunities



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Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

Development footprint
Veolia integrated waste management operations
Woodlawn Eco Precinct
Crisps Creek Intermodal Facility (IMF)
Woodlawn Mine operations area
Woodlawn Wind Farm
Rail line
Major road
Minor road
Vehicular track
Watercourse

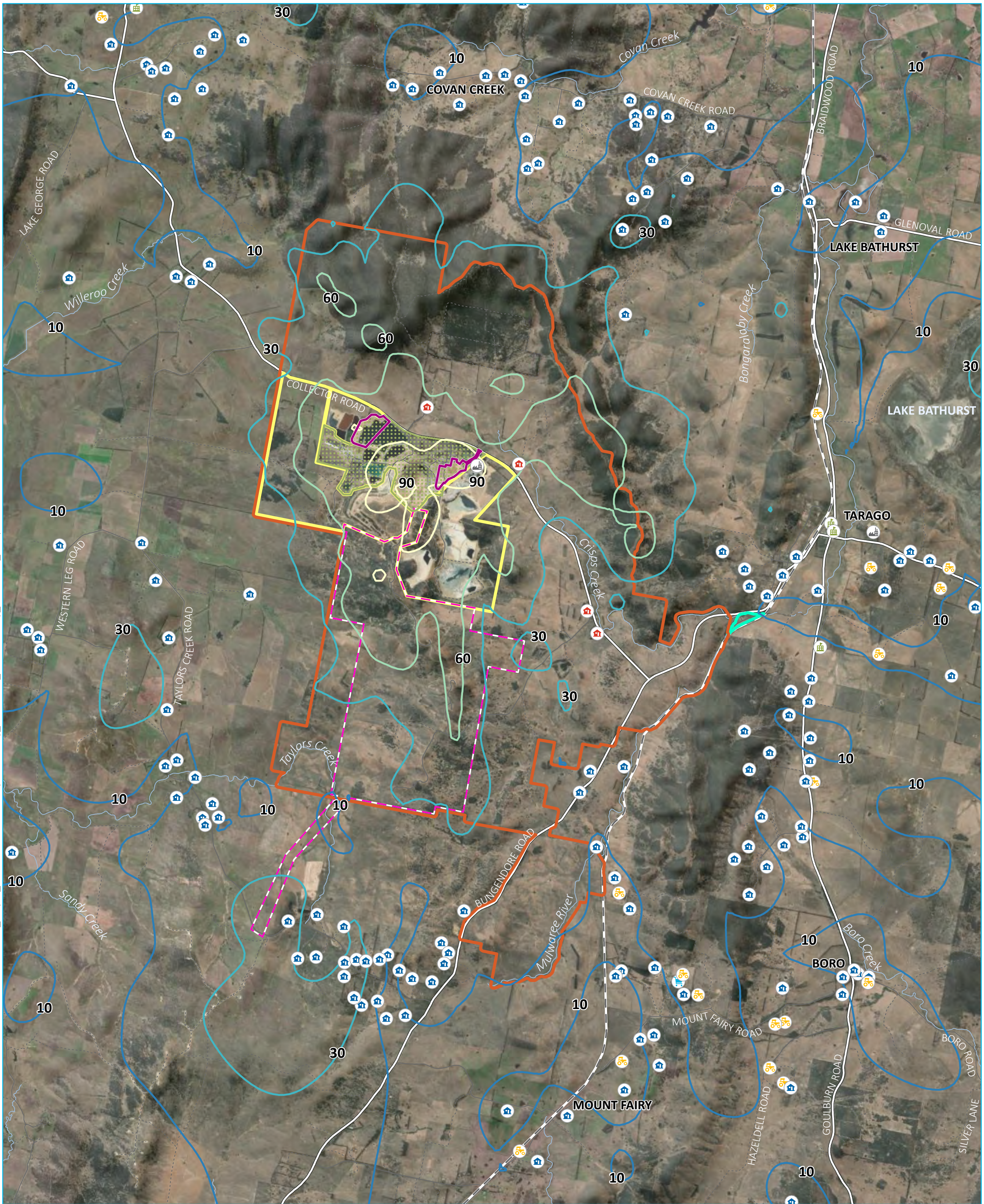
Assessment location
Agriculture
Community/school
Commercial
Industrial
Residential
Veolia

Annual $PM_{2.5}$ concentration
0.05 µg/m^3
0.1 µg/m^3
0.2 µg/m^3

Predicted annual average $PM_{2.5}$ concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.9

EMM
creating opportunities



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Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
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- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

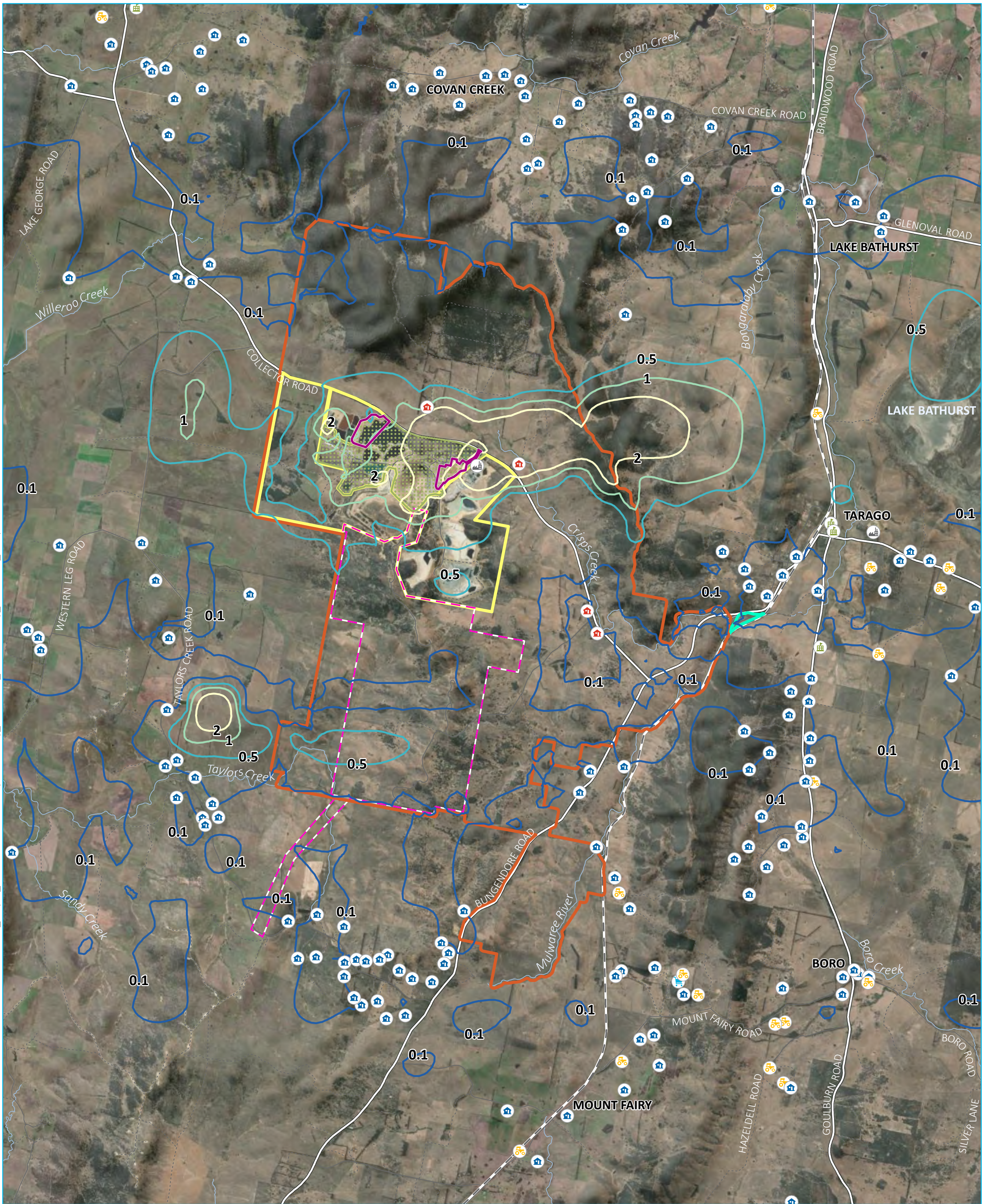
1-hour NO_2 concentration

- 10 µg/m^3
- 30 µg/m^3
- 60 µg/m^3
- 90 µg/m^3

Maximum predicted 1-hour average NO_2 concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.10

EMM
creating opportunities



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Source: EMM (2022); Veolia (2022); DFSI (2017)

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- Major road
- Minor road
- Vehicular track
- Watercourse

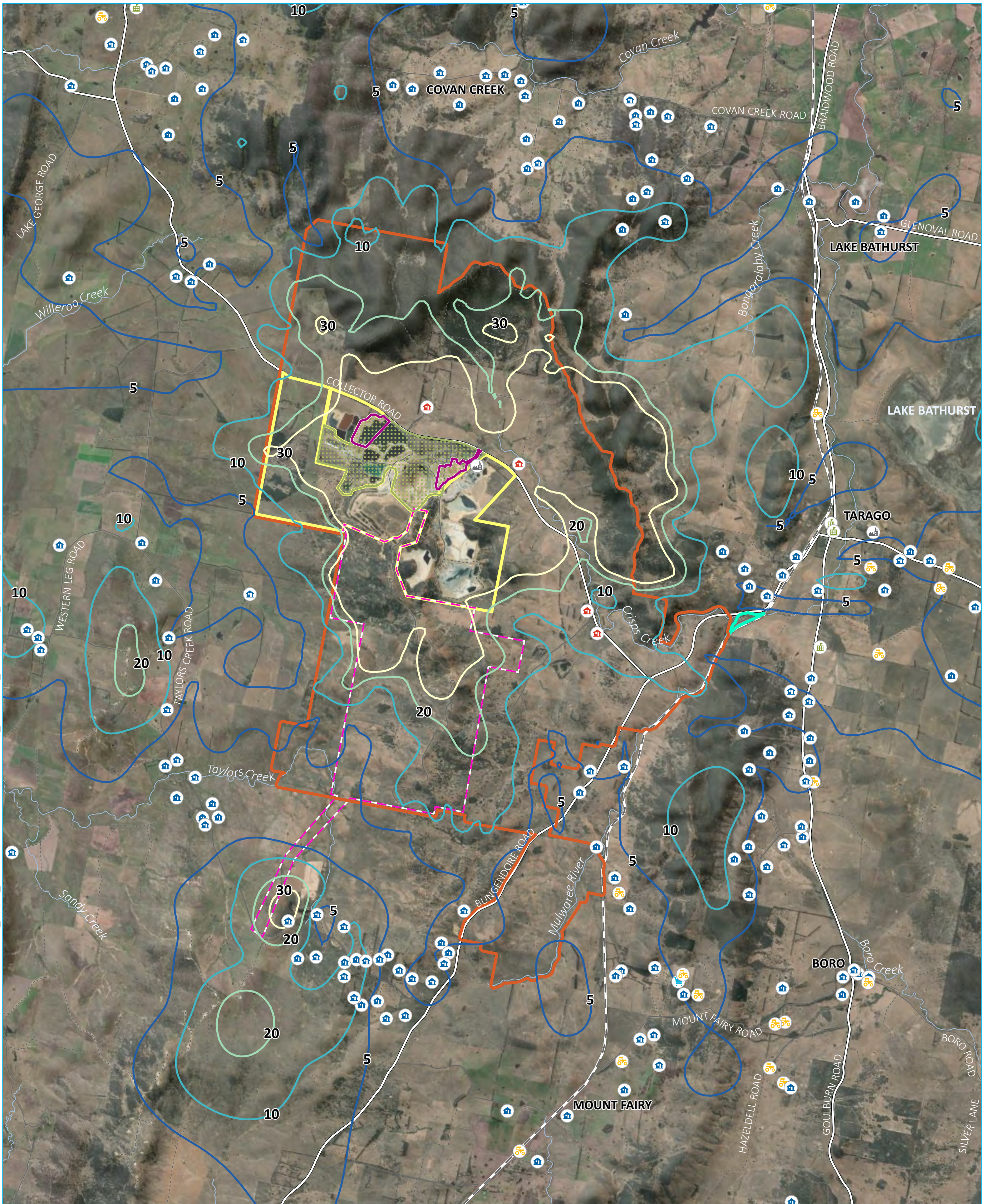
Assessment location
- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

Annual NO_2 concentration
- 0.1 µg/m^3
- 0.5 µg/m^3
- 1 µg/m^3
- 2 µg/m^3

Predicted annual average NO_2 concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.11

EMM creating opportunities



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Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

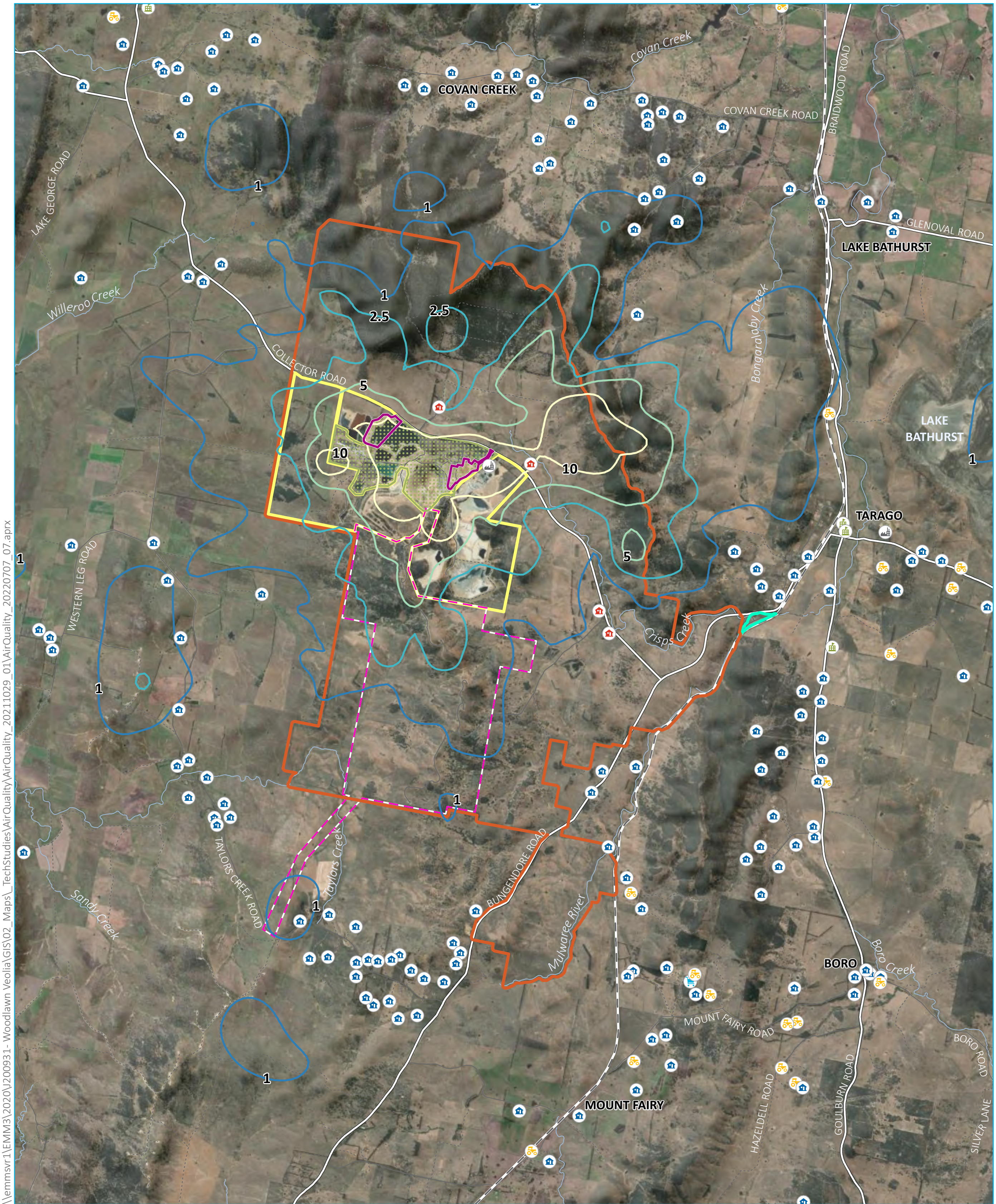
1-hour SO_2 concentration

- 5 $\mu g/m^3$
- 10 $\mu g/m^3$
- 20 $\mu g/m^3$
- 30 $\mu g/m^3$

Maximum predicted 1-hour average SO_2 concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.12

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

Development footprint
Veolia integrated waste management operations
Woodlawn Eco Precinct
Crisps Creek Intermodal Facility (IMF)
Woodlawn Mine operations area
Woodlawn Wind Farm
Rail line
Major road
Minor road
Vehicular track
Watercourse

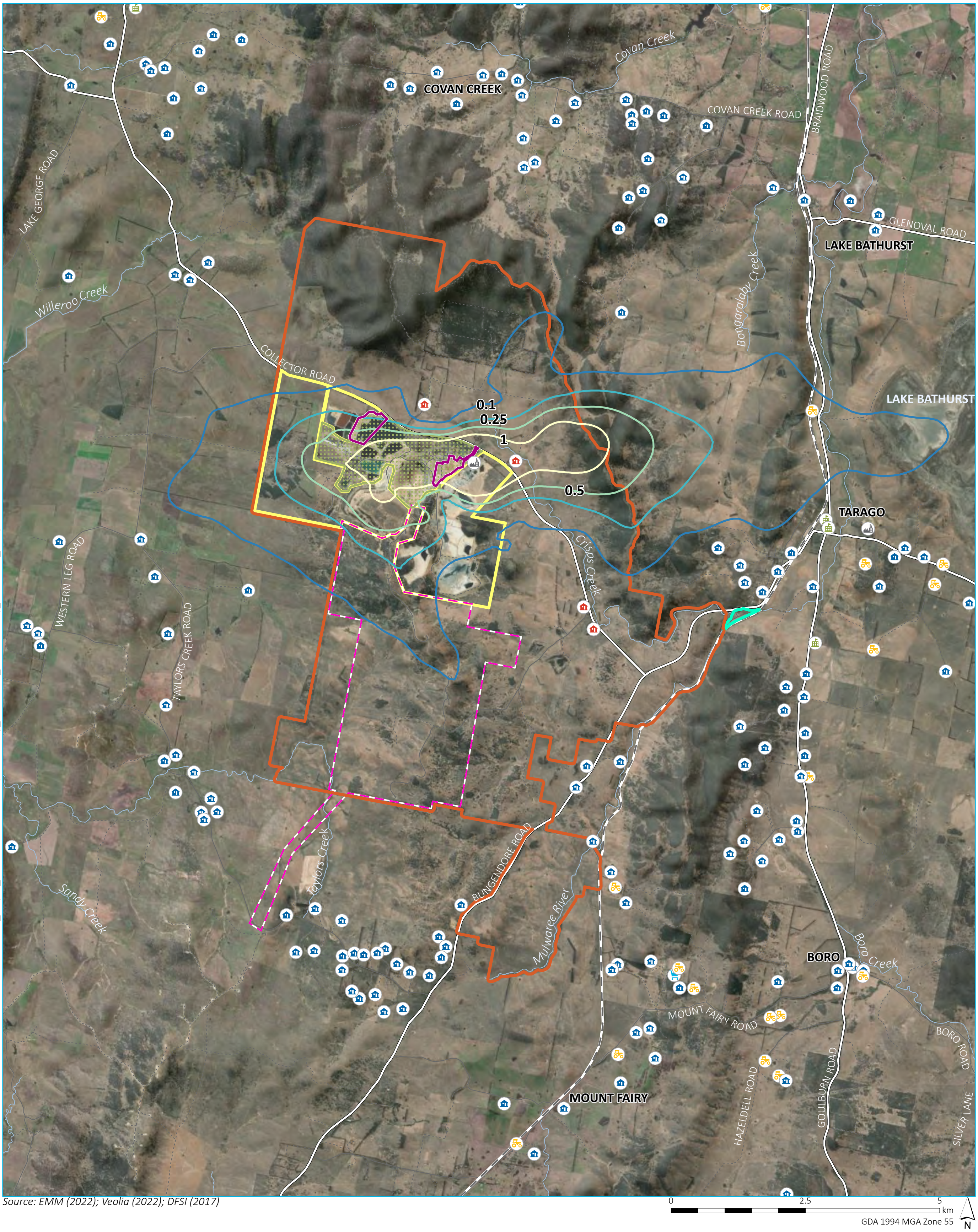
Assessment location
- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

24-hour SO_2 concentration
- 1 μg/m^3
- 2.5 μg/m^3
- 5 μg/m^3
- 10 μg/m^3

Maximum predicted 24-hour average SO_2 concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.13

EMM
creating opportunities



\\emmsvr1\EMM3\2020\J200931 - Woodlawn Veolia\GIS\02_Maps_TechStudies\AirQuality\AirQuality_20211029_01\AirQuality_20220707_07.aprx

Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

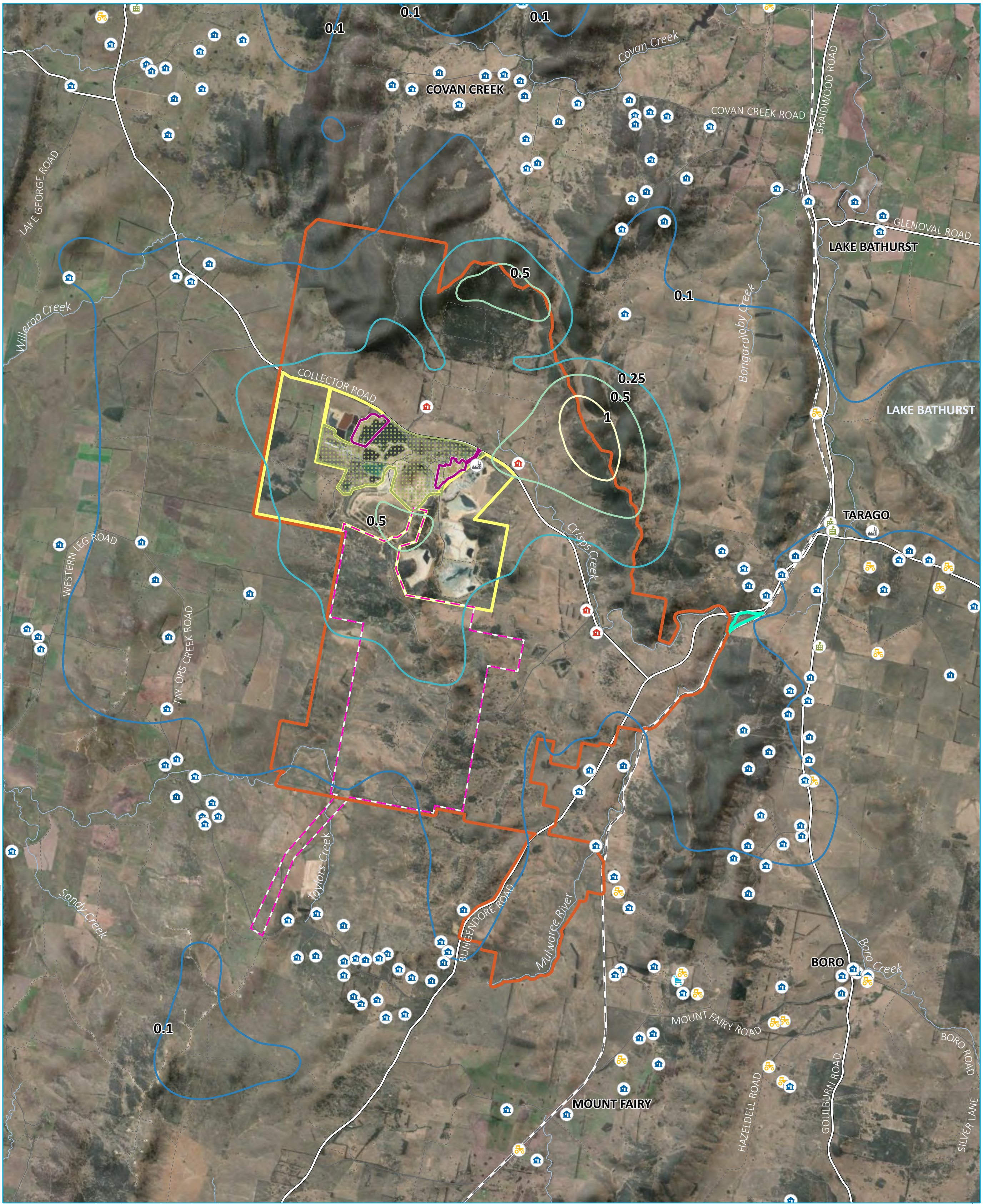
Annual SO_2 concentration

- 0.1 µg/m^3
- 0.25 µg/m^3
- 0.5 µg/m^3
- 1 µg/m^3

Predicted annual average SO_2 concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.14

EMM creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

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KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

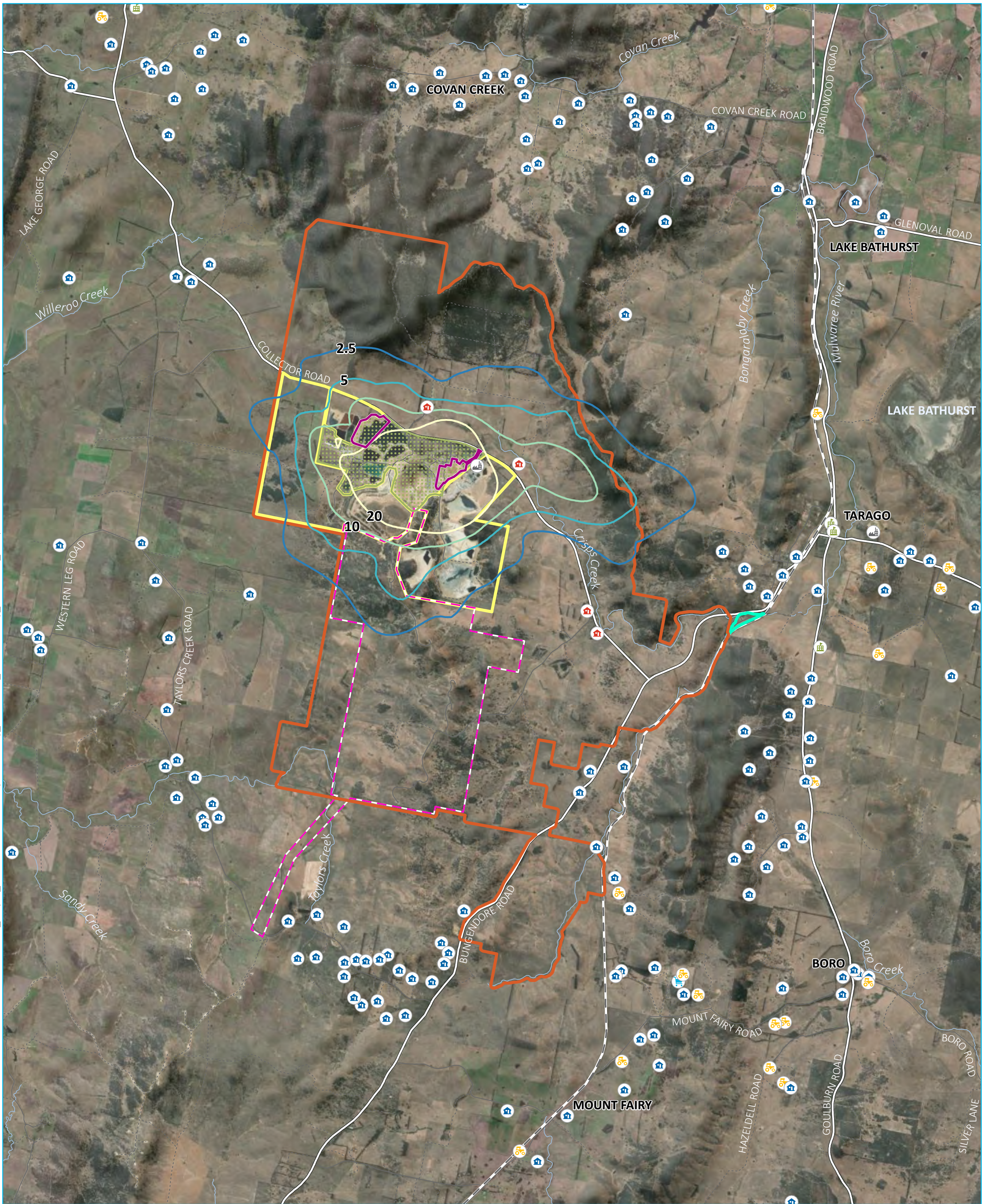
1-hour NH_3 concentration

- 0.1 µg/m^3
- 0.25 µg/m^3
- 0.5 µg/m^3
- 1 µg/m^3

Predicted 99.9th percentile 1-hour average NH_3 concentrations – Scenario 1 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.15

EMM
creating opportunities



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Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

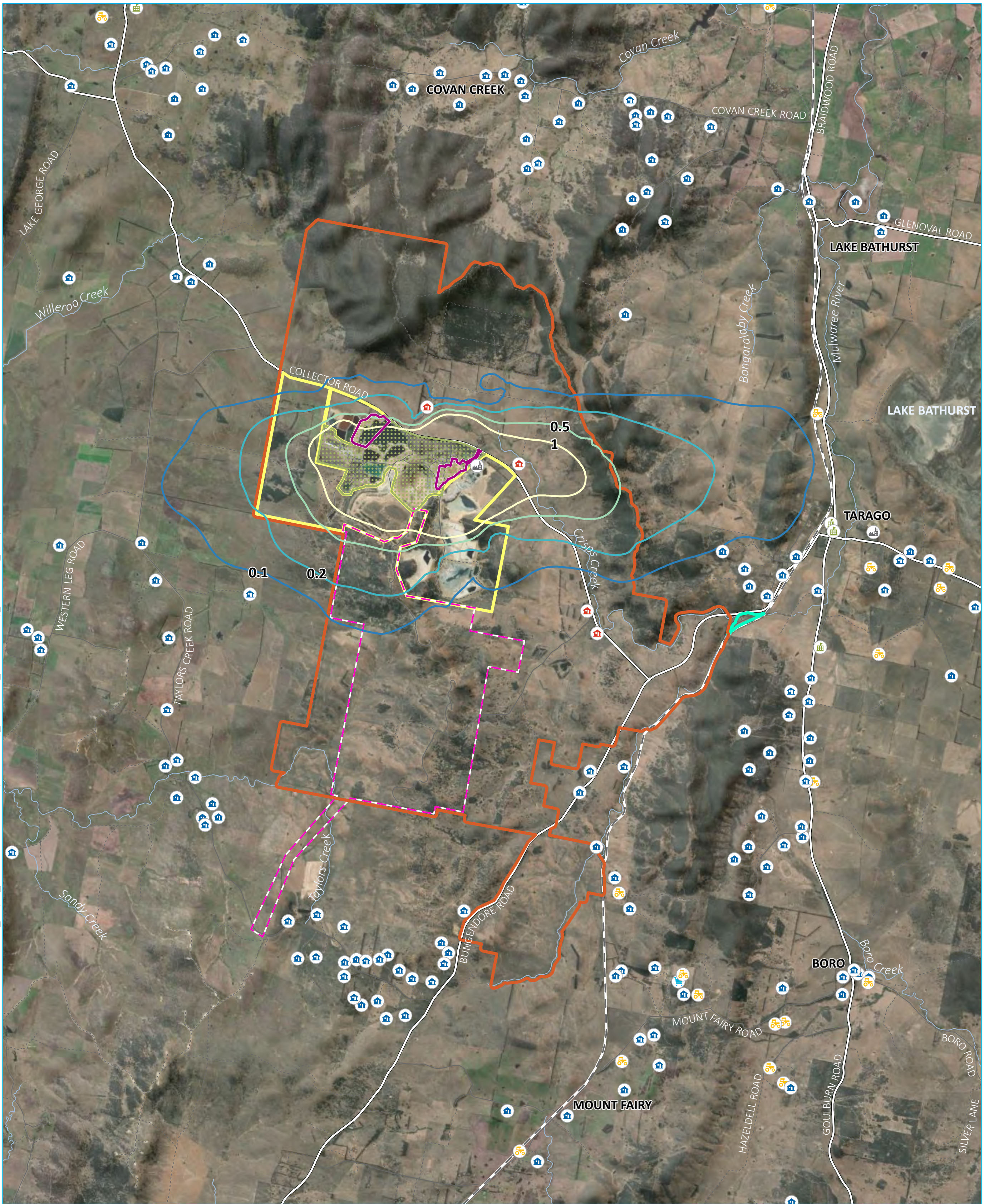
24-hour PM_{10} concentration

- 2.5 μg/m^3
- 5 μg/m^3
- 10 μg/m^3
- 20 μg/m^3

Maximum predicted 24-hour average PM_{10} concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.16

EMM
creating opportunities



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Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

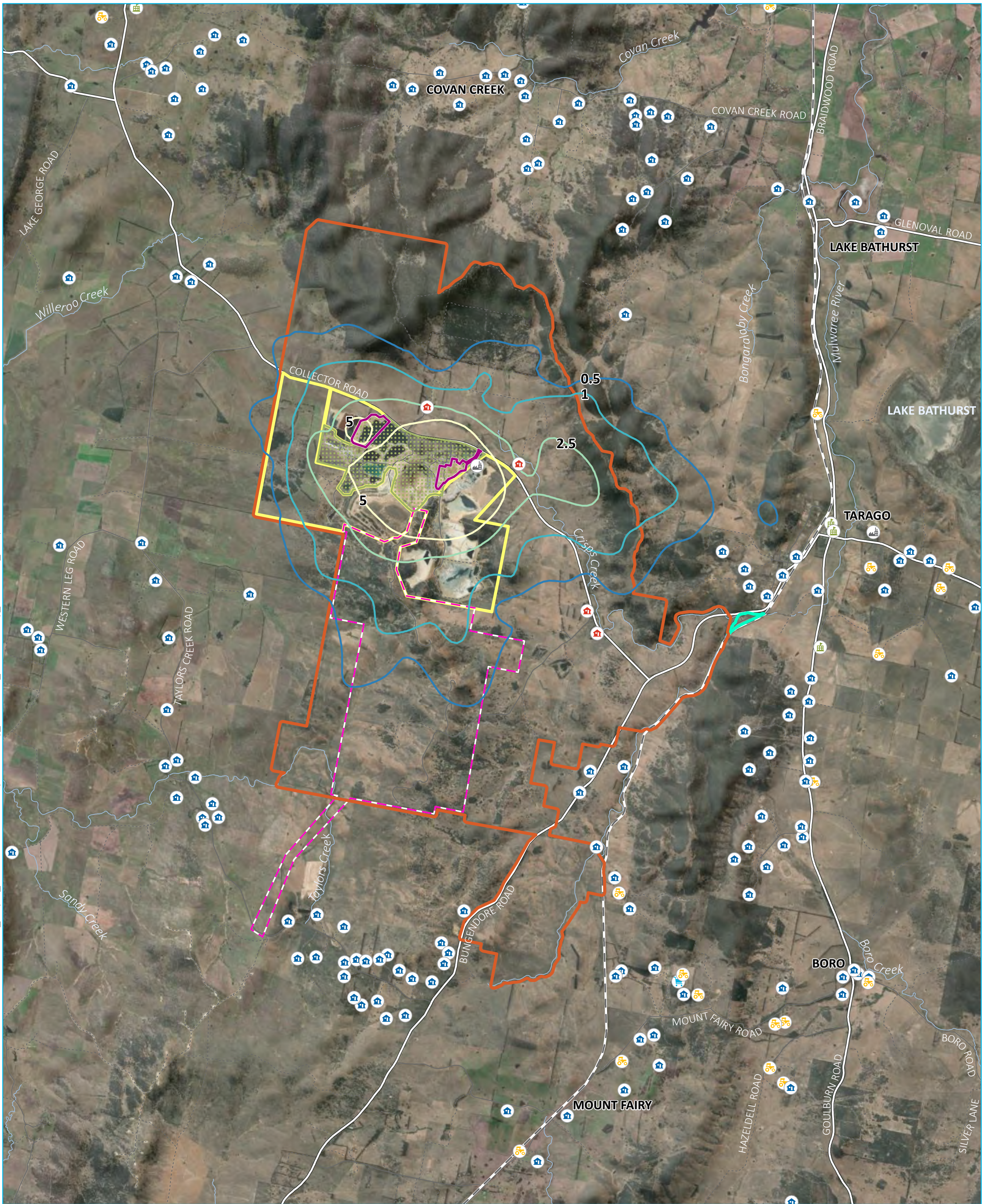
Annual PM_{10} concentration

- 0.1 µg/m^3
- 0.2 µg/m^3
- 0.5 µg/m^3
- 1 µg/m^3

Predicted annual average PM_{10} concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.17

EMM
creating opportunities



\\emmsvr1\EMM3\2020\J200931 - Woodlawn Veolia\GIS\02_Maps_TechStudies\AirQuality\AirQuality_20211029_01\AirQuality_20220707_07.aprx

Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

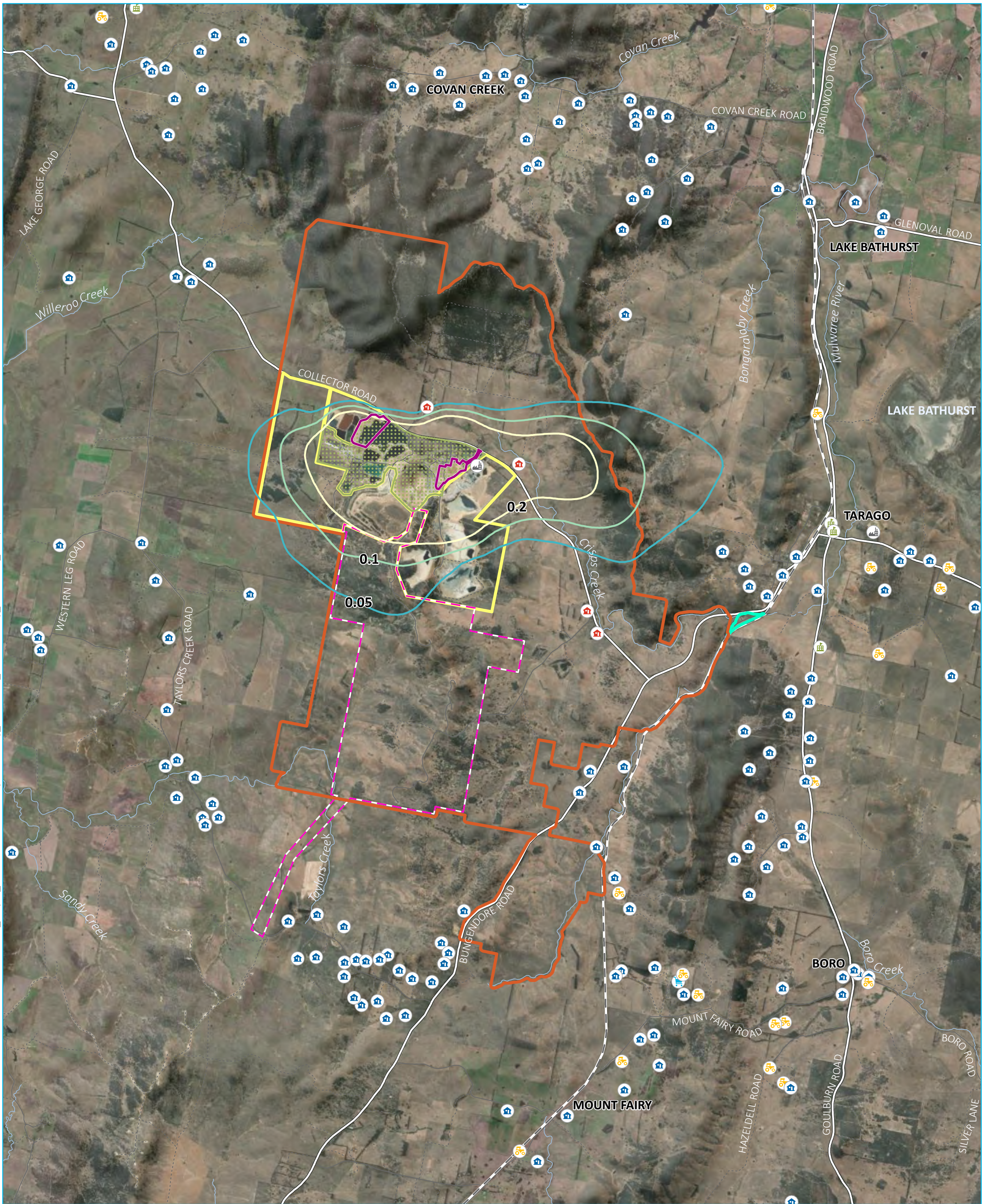
24-hour $PM_{2.5}$ concentration

- 0.5 $\mu g/m^3$
- 1 $\mu g/m^3$
- 2.5 $\mu g/m^3$
- 5 $\mu g/m^3$

Maximum predicted 24-hour average $PM_{2.5}$ concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.18

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

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KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

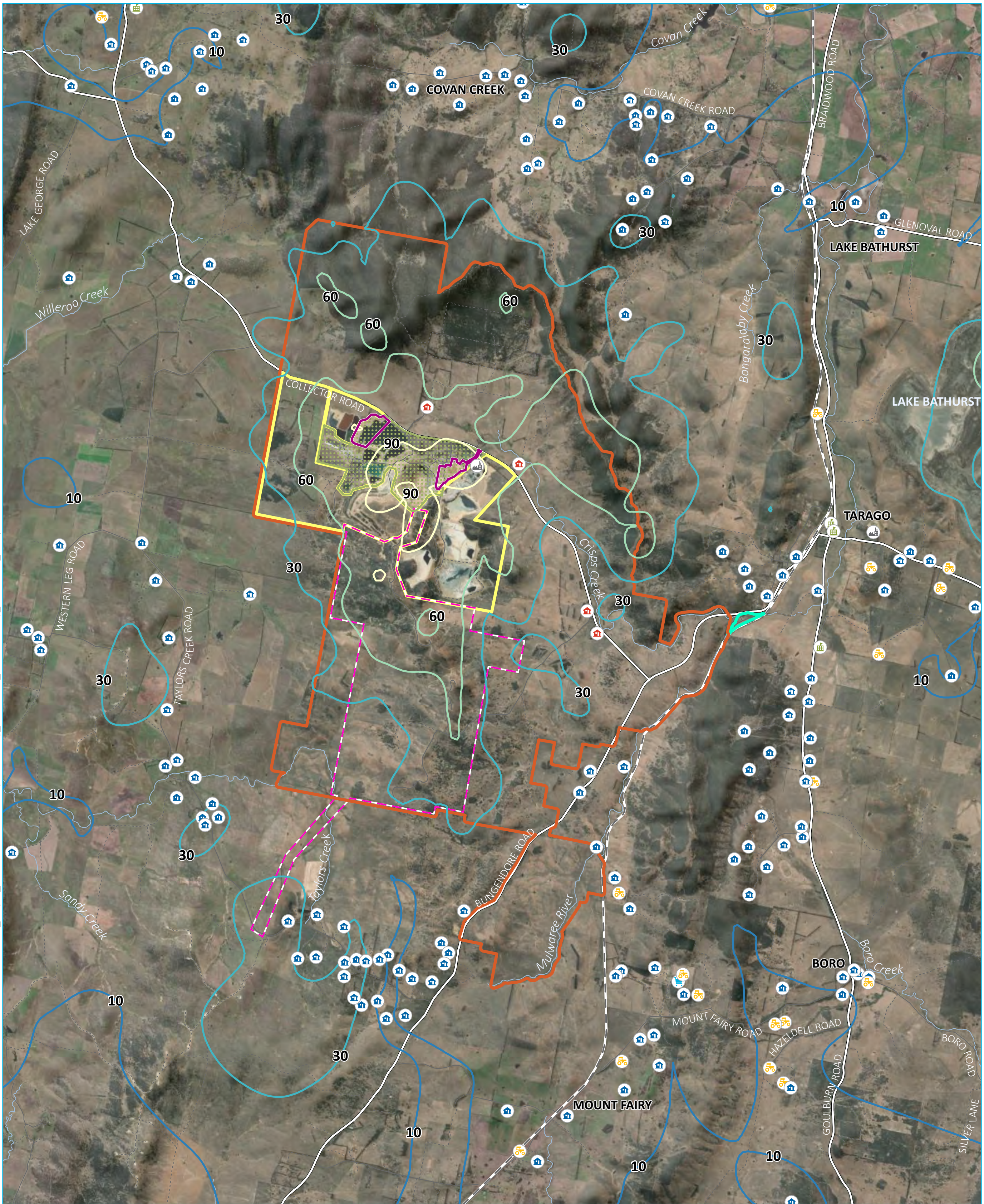
Annual $PM_{2.5}$ concentration

- 0.05 µg/m^3
- 0.1 µg/m^3
- 0.2 µg/m^3

Predicted annual average $PM_{2.5}$ concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.19

EMM creating opportunities



\\emmsvr1\EMM3\2020\J200931 - Woodlawn Veolia\GIS\02_Maps_TechStudies\AirQuality\AirQuality_20211029_01\AirQuality_20220707_07.aprx

Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

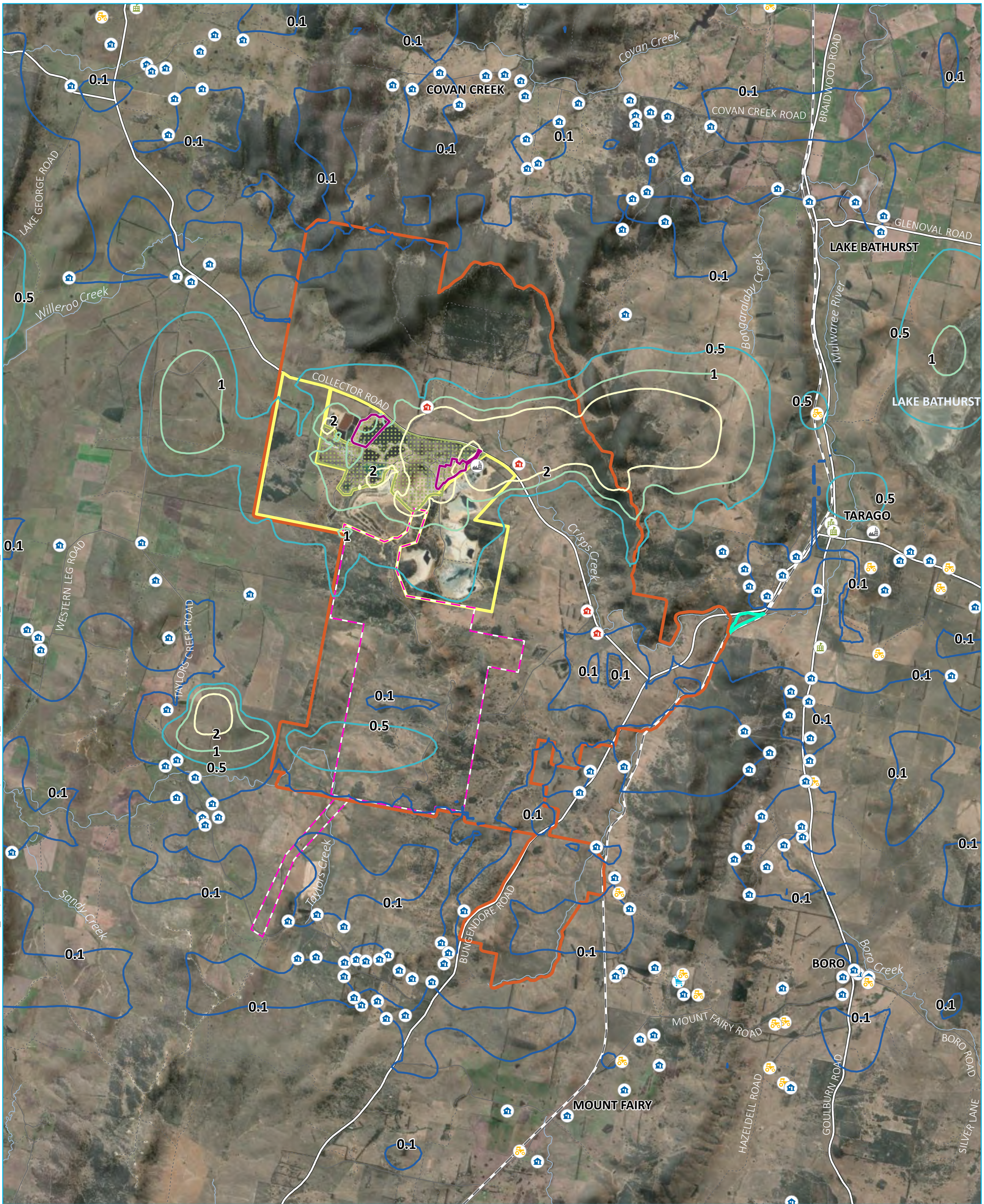
1-hour NO_2 concentration

- 10 µg/m^3
- 30 µg/m^3
- 60 µg/m^3
- 90 µg/m^3

Maximum predicted 1-hour average NO_2 concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.20

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55 N

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

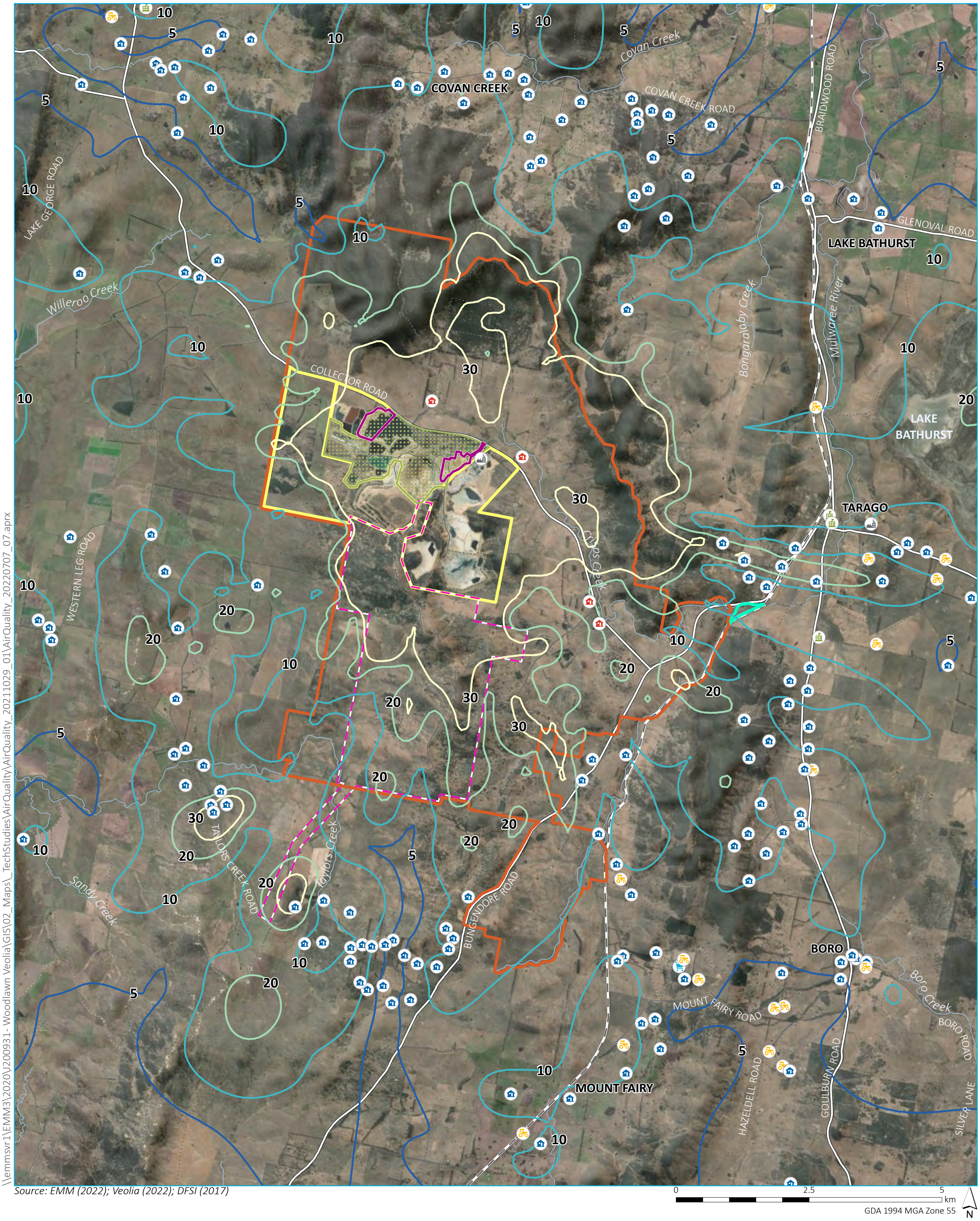
Annual NO_2 concentration

- 0.1 µg/m^3
- 0.5 µg/m^3
- 1 µg/m^3
- 2 µg/m^3

Predicted annual average NO_2 concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.21

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

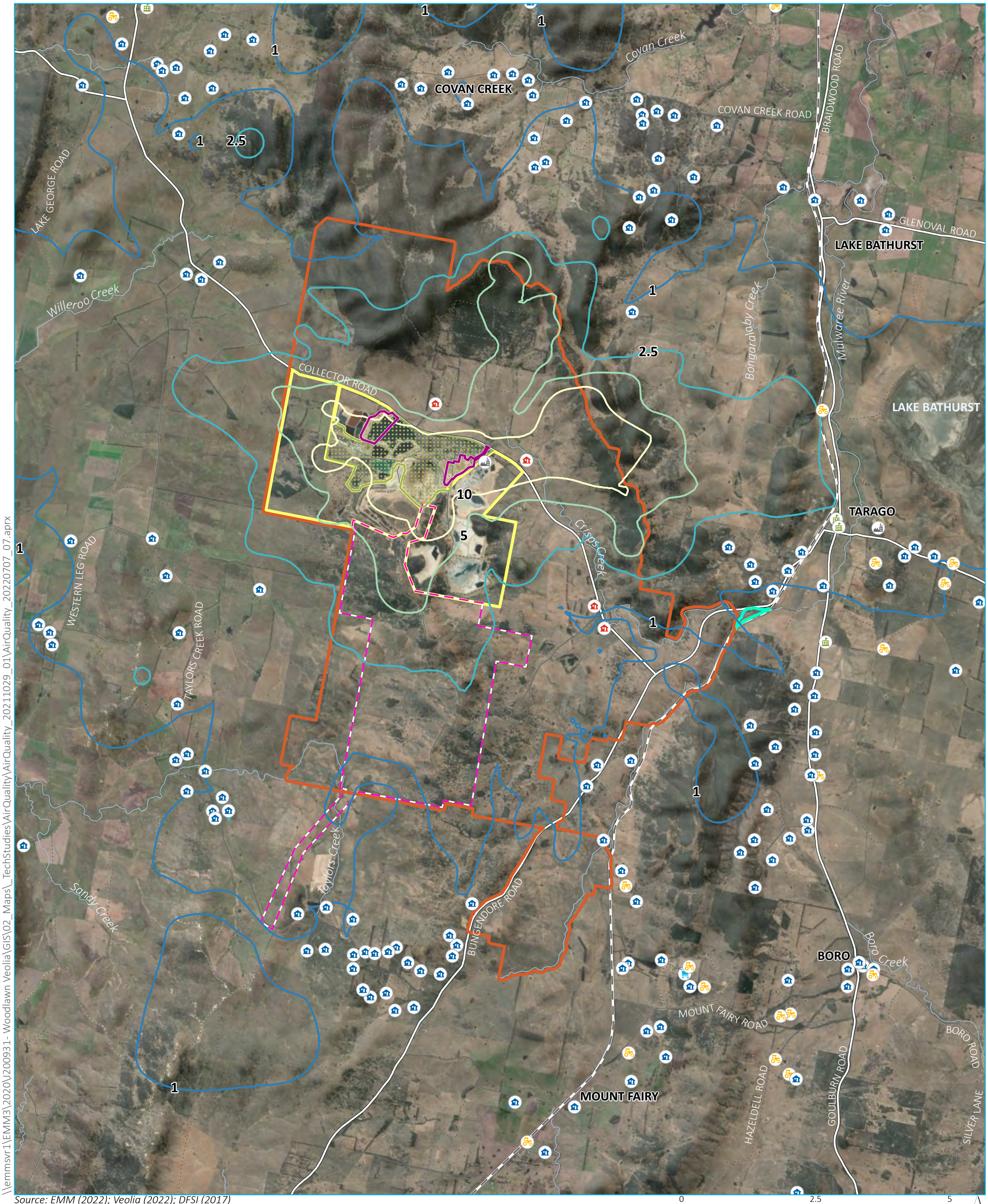
1-hour SO_2 concentration

- 5 µg/m^3
- 10 µg/m^3
- 20 µg/m^3
- 30 µg/m^3

Maximum predicted 1-hour average SO_2 concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.22

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY
- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

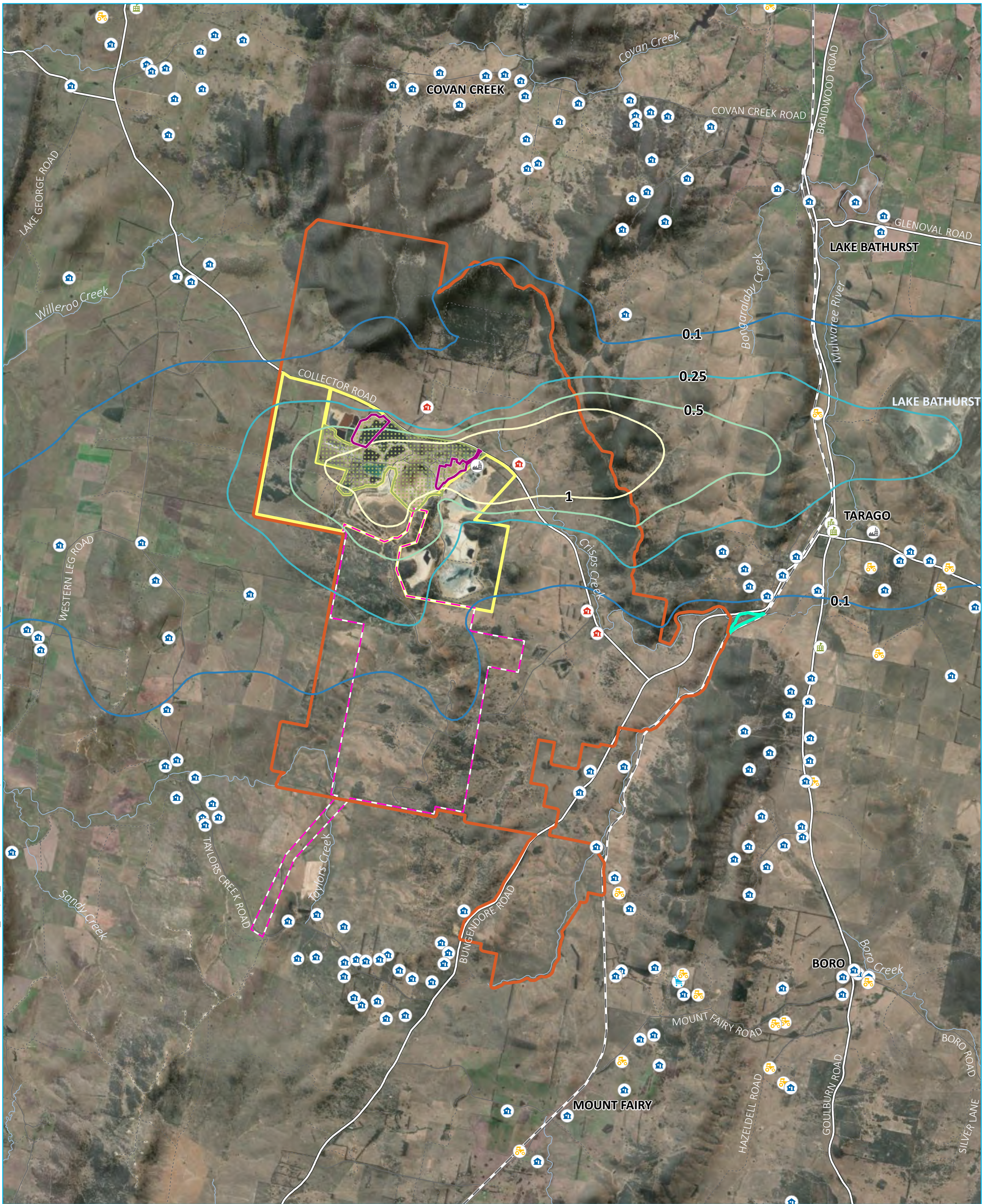
Assessment location
- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

24-hour SO_2 concentration
- 1 $\mu g/m^3$
- 2.5 $\mu g/m^3$
- 5 $\mu g/m^3$
- 10 $\mu g/m^3$

Maximum predicted 24-hour average SO_2 concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.23

EMM
creating opportunities



\\emmsvr1\EMM3\2020\J200931 - Woodlawn Veolia\GIS\02_Maps_TechStudies\AirQuality\AirQuality_20211029_01\AirQuality_20220707_07.aprx

Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

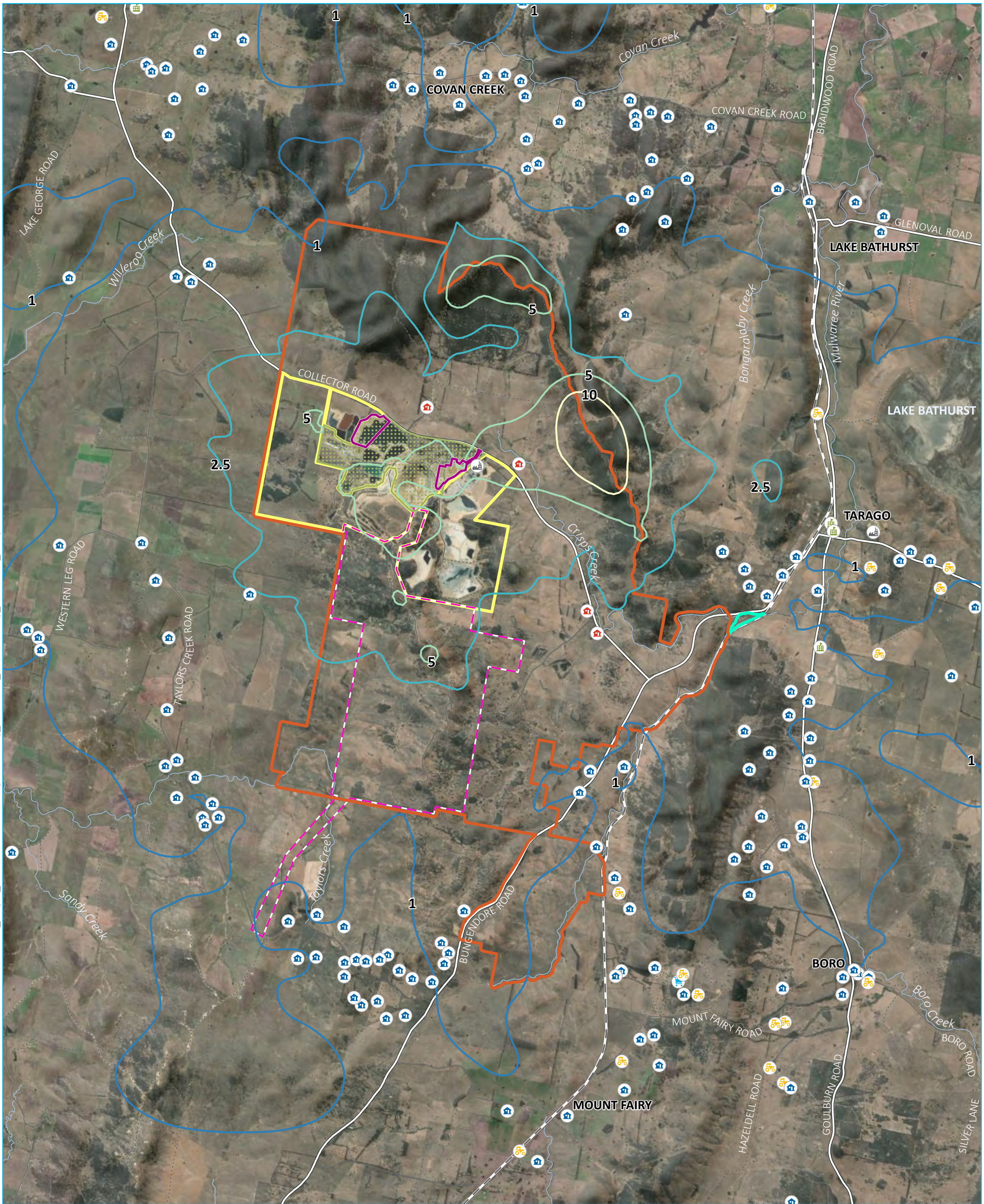
Annual SO_2 concentration

- 0.1 $\mu g/m^3$
- 0.25 $\mu g/m^3$
- 0.5 $\mu g/m^3$
- 1 $\mu g/m^3$

Predicted annual average SO_2 concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.24

creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

0 2.5 5 km

GDA 1994 MGA Zone 55

N

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location

- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

1-hour NH_3 concentration

- 1 µg/m^3
- 2.5 µg/m^3
- 5 µg/m^3
- 10 µg/m^3

Predicted 99.9th percentile 1-hour average NH_3 concentrations – Scenario 2 + Approved Eco Precinct increment

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.25

EMM
creating opportunities

9.2 Cumulative impacts

The impact assessment criteria relevant to the air pollutants presented listed in Table 9.1 are applicable to cumulative concentrations. To assess cumulative impacts, the project-only increments (ARC building stack + ARC fugitives + approved Eco Precinct) have been combined with model predictions for the neighbouring Woodlawn Mine and the ambient background concentrations (Section 6.9). Cumulative impacts are presented in the following sections.

For PM_{10}, $PM_{2.5}$ and NO_2, cumulative concentrations were derived following the contemporaneous assessment approach outlined in the Approved Methods for Modelling (NSW EPA 2022). For each pollutant and averaging period, the coincident model predictions and corresponding background value were combined to derive a cumulative concentration at each receptor location. For example, in the case of 24 hour average PM_{10}, at each assessment location the background concentration on the 1st January 2018 was paired with the model prediction on the 1st January 2018 and repeated for the entire modelling period.

For SO_2 and CO, cumulative concentrations were derived by combining the maximum predicted concentration with the maximum concentration in the respective regional background datasets.

Predicted cumulative concentrations and deposition rates from the modelled scenario configurations (described in Section 8.1) were then collated, and the maximum predicted results across the surrounding sensitive assessment locations were extracted.

As stated in Section 6.3, the adopted 24 hour average PM_{10} and $PM_{2.5}$ background datasets contain three days and one day respectively above the applicable NSW EPA impact assessment criterion. For cumulative impact assessment purposes, these are therefore classed as existing exceedances. To demonstrate that no additional exceedances of the applicable criteria will occur as a result of emissions from the project, the cumulative analysis presents the 4th highest and 2nd highest cumulative 24 hour average PM_{10} and $PM_{2.5}$ concentrations, respectively. Data has not been removed from the analysis but simply, the next highest result not affected by background above the criterion is shown in this section.

The SEARs for the project specifically request the assessment of cumulative impacts with emissions from the proposed Jerrara Power Energy from Waste Facility (SSD22879238). However, at the time of reporting, it is understood that approval is no longer being sought for the facility at Jerrara Rd in Bungonia and therefore no cumulative impact assessment is required.

The maximum cumulative concentrations and deposition rates for criteria pollutants are presented in Table 9.3 for the three future emission scenarios. In addition, predicted cumulative concentrations and deposition rates from emissions generated by approved Eco Precinct operations are presented in Table 9.3.

The maximum cumulative predictions are presented as the highest across all '*sensitive*' assessment locations (excluding Veolia owned properties and the adjacent Woodlawn Mine).

Table 9.3 Predicted cumulative ground level concentrations (µg/m³) and deposition rates (g/m²/month) for criteria air pollutants – sensitive assessment locations

Pollutant	Averaging period	Highest predicted cumulative concentration (µg/m³)/deposition rate (g/m²/month) across all sensitive assessment locations							
		Approved Eco Precinct + Mine + background	% of criterion	Scenario 1 + Eco Precinct + Mine + background	% of criterion	Scenario 2 + Eco Precinct + Mine + background	% of criterion	Scenario 3 + Eco Precinct + Mine + background	% of criterion
CO	Maximum 1 hour	3,017.4	10.1%	3,017.4	10.1%	3,017.4	10.1%	3,017.4	10.1%
	Maximum 8 hour	63.6	0.6%	63.6	0.6%	63.6	0.6%	63.6	0.6%
NO_2	Maximum 1 hour	69.7	42.5%	69.7	42.5%	69.7	42.5%	69.7	42.5%
	Annual	8.94	28.8%	9.15	29.5%	9.36	30.2%	9.31	30.0%
SO_2	Maximum 1 hour	61.7	21.6%	61.7	21.6%	74.9	26.2%	61.7	21.6%
	Maximum 24 hour	8.4	14.8%	8.4	14.8%	8.9	15.5%	8.4	14.8%
PM_{10}	Maximum 24 hour	46.1	92.2%	46.1	92.2%	46.1	92.2%	46.2	92.3%
	Annual	12.5	50.1%	12.5	50.0%	12.5	50.0%	12.5	50.1%
$PM_{2.5}$	Maximum 24 hour	23.1	92.6%	23.1	92.6%	23.1	92.6%	23.2	92.8%
	Annual	7.1	89.2%	7.1	89.2%	7.1	89.2%	7.2	89.5%
TSP	Annual	24.0	26.7%	24.0	26.7%	24.0	26.7%	24.0	26.7%
Dust deposition (g/m²/month)	Annual	1.2	30.8%	1.2	30.7%	1.2	30.7%	1.2	30.7%

Table 9.3 Predicted cumulative ground level concentrations (µg/m³) and deposition rates (g/m²/month) for criteria air pollutants – sensitive assessment locations

Pollutant	Averaging period	Highest predicted cumulative concentration (µg/m³)/deposition rate (g/m²/month) across all sensitive assessment locations							
		Approved Eco Precinct + Mine + background	% of criterion	Scenario 1 + Eco Precinct + Mine + background	% of criterion	Scenario 2 + Eco Precinct + Mine + background	% of criterion	Scenario 3 + Eco Precinct + Mine + background	% of criterion
HF	Maximum 24 hour	-	-	2.96E-04	0.02%	4.93E-04	0.03%	6.57E-02	4.38%
	7 day	-	-	1.35E-04	0.02%	1.77E-04	0.02%	2.35E-02	2.94%
	30 day	-	-	8.81E-05	0.02%	1.13E-04	0.03%	1.51E-02	3.77%
	90 day	-	-	6.46E-05	0.03%	8.45E-05	0.03%	1.13E-02	4.51%
Lead	Annual	3.47E-04	0.07%	2.90E-04	0.06%	2.98E-04	0.06%	5.18E-04	0.10%

The maximum predicted concentration of each pollutant and modelling scenario across the sensitive assessment locations, expressed as a percentage of the relevant impact assessment criterion, is illustrated in Figure 9.26. The same cumulative impact vs criterion analysis is presented for industrial receptors in Figure 9.27, with the closest being the neighbouring Woodlawn Mine. When compared to the sensitive assessment locations, the cumulative concentrations at the Woodlawn Mine are higher relative to the impact assessment criterion, as would be expected given the location within the Eco Precinct.

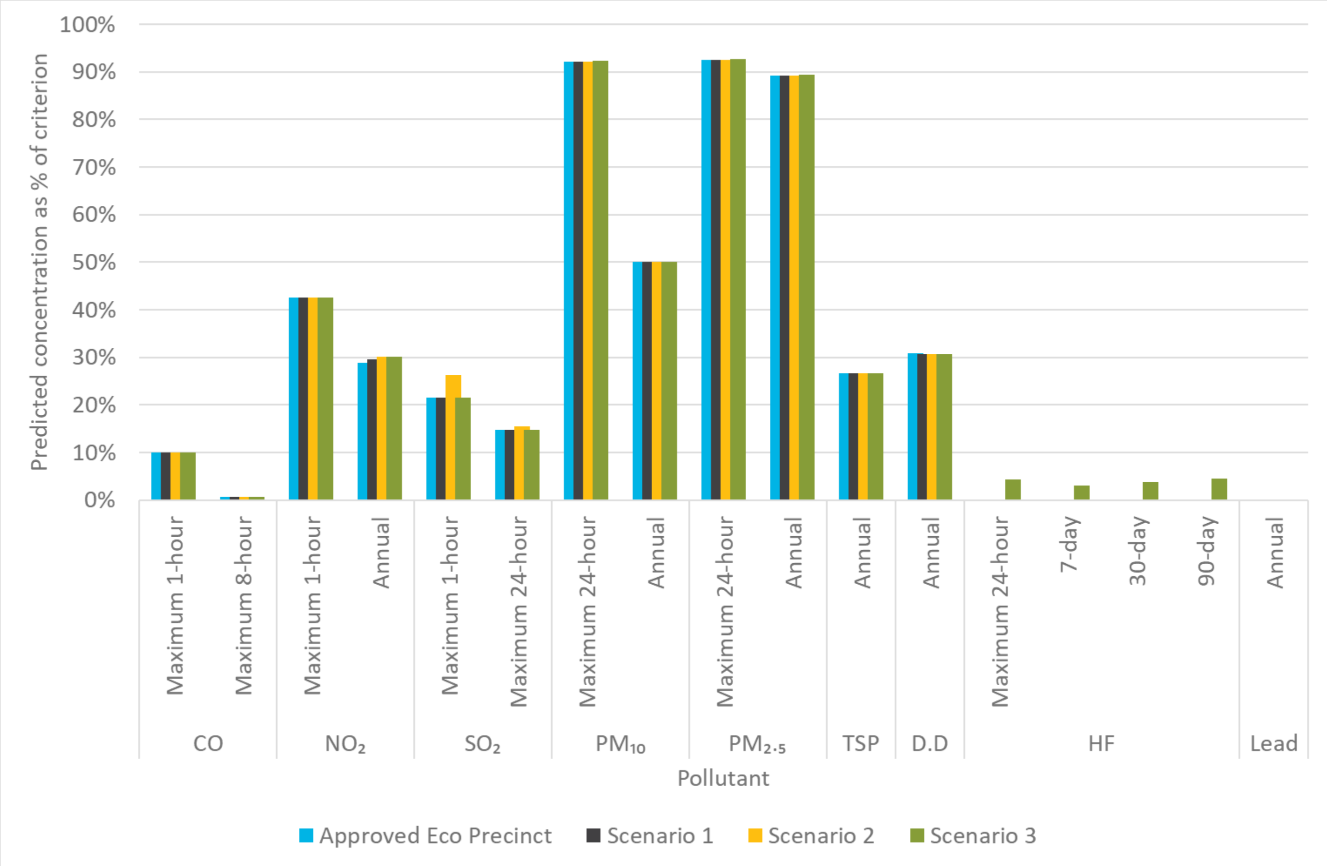


Figure 9.26 **Maximum predicted cumulative concentrations (ARC building stack + ARC fugitives + approved Eco Precinct sources + Woodlawn Mine + background) across sensitive assessment locations by criteria pollutant, expressed as percentage of relevant impact assessment criterion**

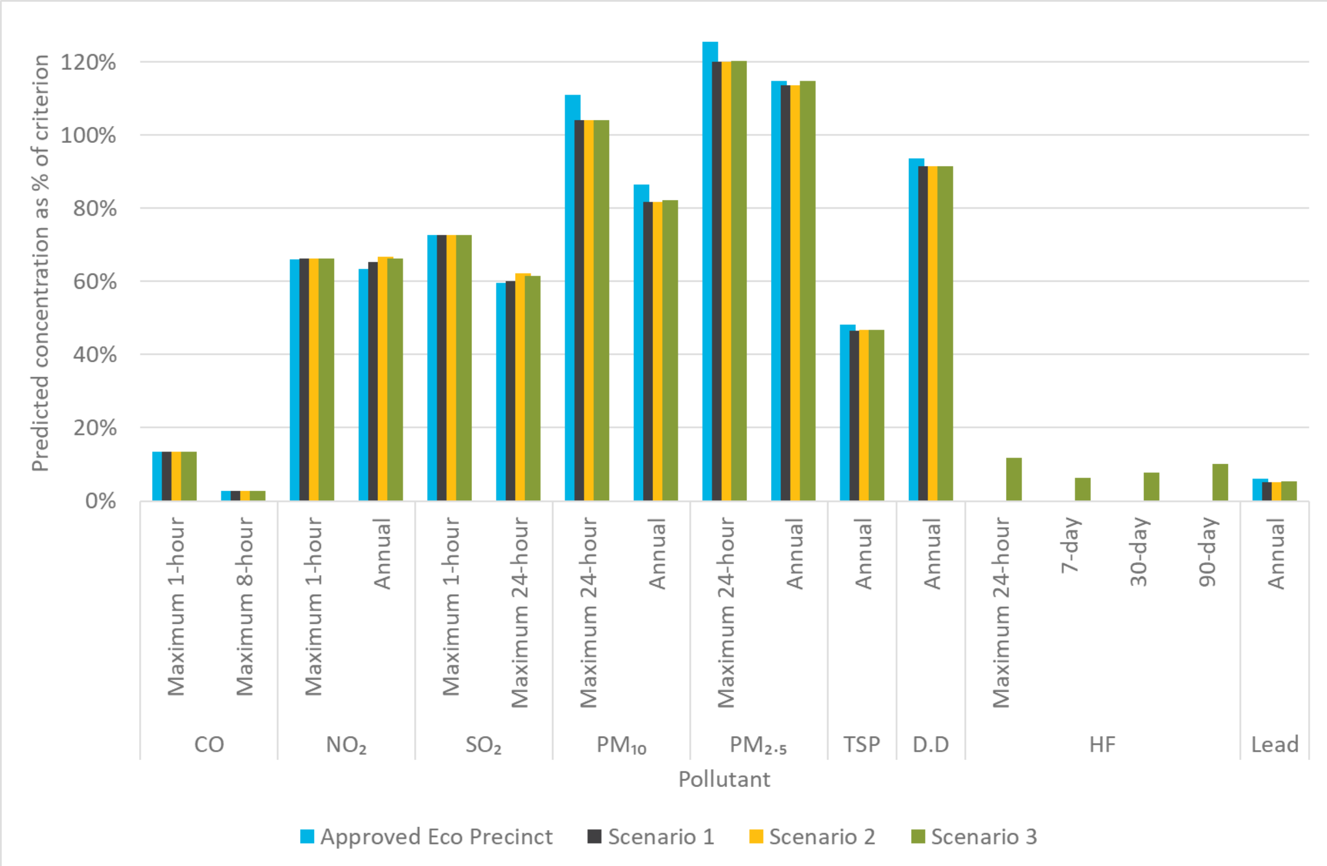


Figure 9.27 Maximum predicted cumulative concentrations (ARC building stack + ARC fugitives + approved Eco Precinct sources + Woodlawn Mine + background) across industrial assessment locations by criteria pollutant, expressed as percentage of relevant impact assessment criterion

The following points are noted from Figure 9.26 and Figure 9.27:

- for sensitive assessment locations (Figure 9.26) the predicted cumulative concentrations for all presented pollutants and scenarios are below the applicable impact assessment criterion;
- for industrial assessment locations (Figure 9.27) the predicted cumulative concentrations for all presented pollutants and scenarios are below the applicable impact assessment criterion, with the exception of PM_{10} (24 hour average only) and $PM_{2.5}$ (24 hour and annual average);
- regarding these predicted exceedances, it is noted that the industrial assessment location in question is the Woodlawn Mine and that the cumulative concentrations presented includes the contribution from the Woodlawn Mine; and
- Figure 9.27 shows a decrease in cumulative PM_{10} and $PM_{2.5}$ concentrations at the Woodlawn Mine with the introduction of the project relative to approved Eco Precinct operations.

Overall, the results presented in Table 9.3, Figure 9.26 and Figure 9.27 show that the introduction of the project to the Eco Precinct will not significantly change air quality impacts relative to those experienced under the current approved operations.

In the case of 24 hour average PM_{10} and $PM_{2.5}$ where the background conditions contain existing regional exceedances of the applicable criteria, the addition of the project will not worsen impacts relative to approved Eco Precinct operations.

To illustrate the contribution to the predicted cumulative 24 hour average PM_{10} concentration exceedances at the neighbouring Woodlawn Mine assessment location, the contribution by mine, Eco Precinct, ARC project and background for the eight highest cumulative concentration days are illustrated in Figure 9.28 (without the project) and Figure 9.29 (with the project).

The two figures show that the ambient background is a key contributor to the predicted cumulative exceedances and that relative to existing impacts (Figure 9.28), the introduction of the project reduces the cumulative concentrations at the neighbouring Woodlawn Mine (Figure 9.29). This is attributable to the improvement in wheel-generated dust emissions achieved through the reduction in waste transported to the Bioreactor.

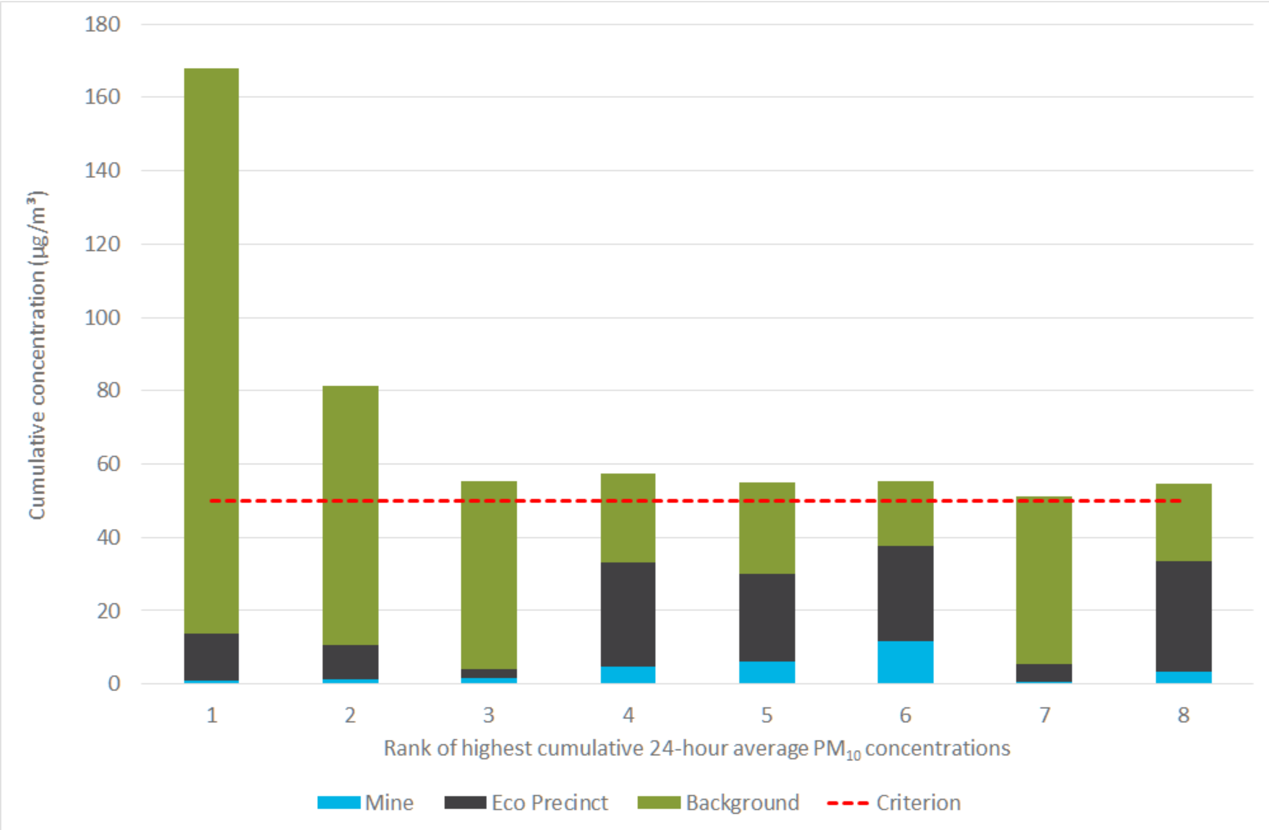


Figure 9.28 **Contribution to eight highest 24 hour PM_{10} concentrations at Woodlawn Mine assessment location – Mine plus Eco Precinct plus background**

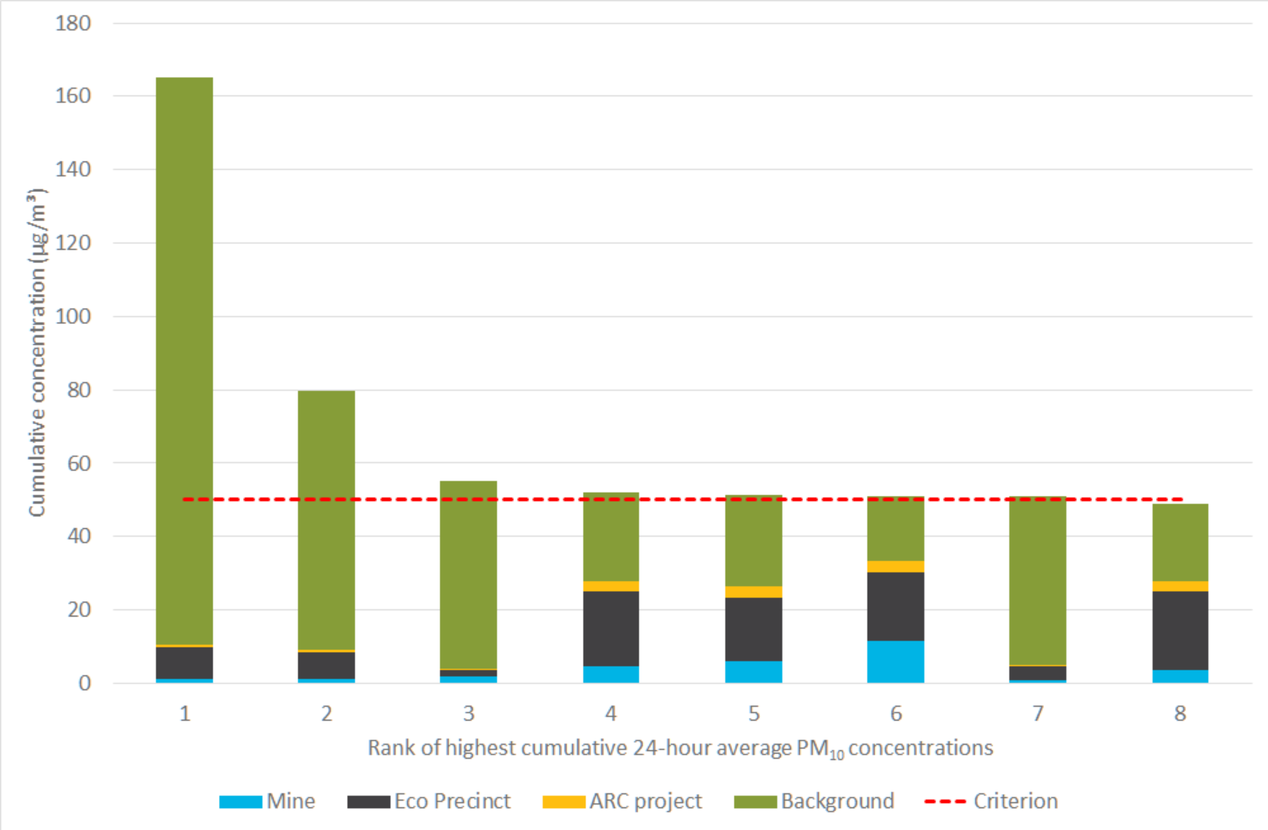


Figure 9.29 Contribution to eight highest 24 hour PM_{10} concentrations at Woodlawn Mine assessment location – Mine plus Eco Precinct plus Scenario 2 plus background

Furthermore, it is noted that the presented cumulative impact results presented for the future project scenarios are not significantly different from the results presented for approved operations at the Eco Precinct. This indicates the following key points:

- the introduction of the project will not significantly change air quality impacts currently associated with the Eco Precinct; and
- relative to ambient background concentrations, air quality impacts associated with the Eco Precinct are minor at surrounding sensitive assessment locations.

9.3 Odour

9.3.1 Peak-to-mean ratios

The instantaneous perception of odours by the human nose occurs over very short timescales (~ 1 second), but dispersion model predictions are typically made for a one hour averaging period. To estimate the effects of plume meandering and concentration fluctuations perceived by the human nose, the dispersion model predictions are multiplied by a correction factor called a “peak-to-mean ratio”. The peak-to-mean ratio (P/M60) is defined as the ratio of peak 1 second concentrations to mean 1 hour average concentrations.

CALPUFF has been modelled at hourly time-steps. To estimate peak 1 second concentrations from hourly averaged odour concentrations, peak-to-mean ratios (P/M60) are applied in accordance with Table 6.1 of the Approved Methods for Modelling, as follows:

- far-field P/M60 of 2.3 applied for area sources for all stability classes A-D and 1.9 for stability classes E and F; and
- far-field P/M60 of 2.3 applied for volume sources (for all stability classes).

9.3.2 Odour modelling results

It is noted that, in the absence of an approved methods for ambient measurement of odour concentrations, odour dispersion modelling is the only means by which odour concentrations at sensitive receptors can be quantified. The predicted ground level odour concentrations are presented in Table 9.4, with the maximum concentration across each assessment location type shown.

Table 9.4 Predicted ground level concentrations of odour (1 second average [nose response])

Assessment location type	Highest predicted 99th percentile 1-second average (nose response) by assessment location type and percentile (ou)						Impact assessment criterion 99th percentile
	Approved operations (Bioreactor and MBT)		ARC only		Future operations (Bioreactor, MBT and ARC)		
	99th percentile	Maximum	99th percentile	Maximum	99th percentile	Maximum	
Residential	1	7	<1	<1	1	7	6
Veolia-owned	8	22	<1	1	8	22	6
Industrial – Woodlawn mine	16	31	<1	3	16	33	6
Agriculture	<1	3	<1	<1	<1	3	6
Commercial	<1	1	<1	<1	<1	1	6
Community	<1	2	<1	<1	<1	2	6
Church	<1	<1	<1	<1	<1	<1	6
School	<1	3	<1	<1	<1	3	6
Preschool	<1	4	<1	<1	<1	4	6
Vineyard	<1	1	<1	<1	<1	1	6

Results are presented for the 99th percentile and maximum of the 1-second average modelling predictions. It is noted that, in accordance with the Approved Methods for Modelling (NSW EPA 2022), the predicted 99th percentile concentrations are used to compare against the impact assessment criteria for odour (6 ou). The 99th percentile corresponds to the 88th highest modelling predictions for a full year of hourly predictions. In other words, there will be 88 hours in the modelled year where the odour may be higher (as demonstrated by the maximum predictions show in Table 9.4).

All assessment locations are below the odour impact assessment criterion of 6 ou for both approved and future operations. Further, it is noted that across all sensitive assessment locations, the predicted odour concentrations would also comply with a more conservative odour impact assessment criterion of 2 ou.

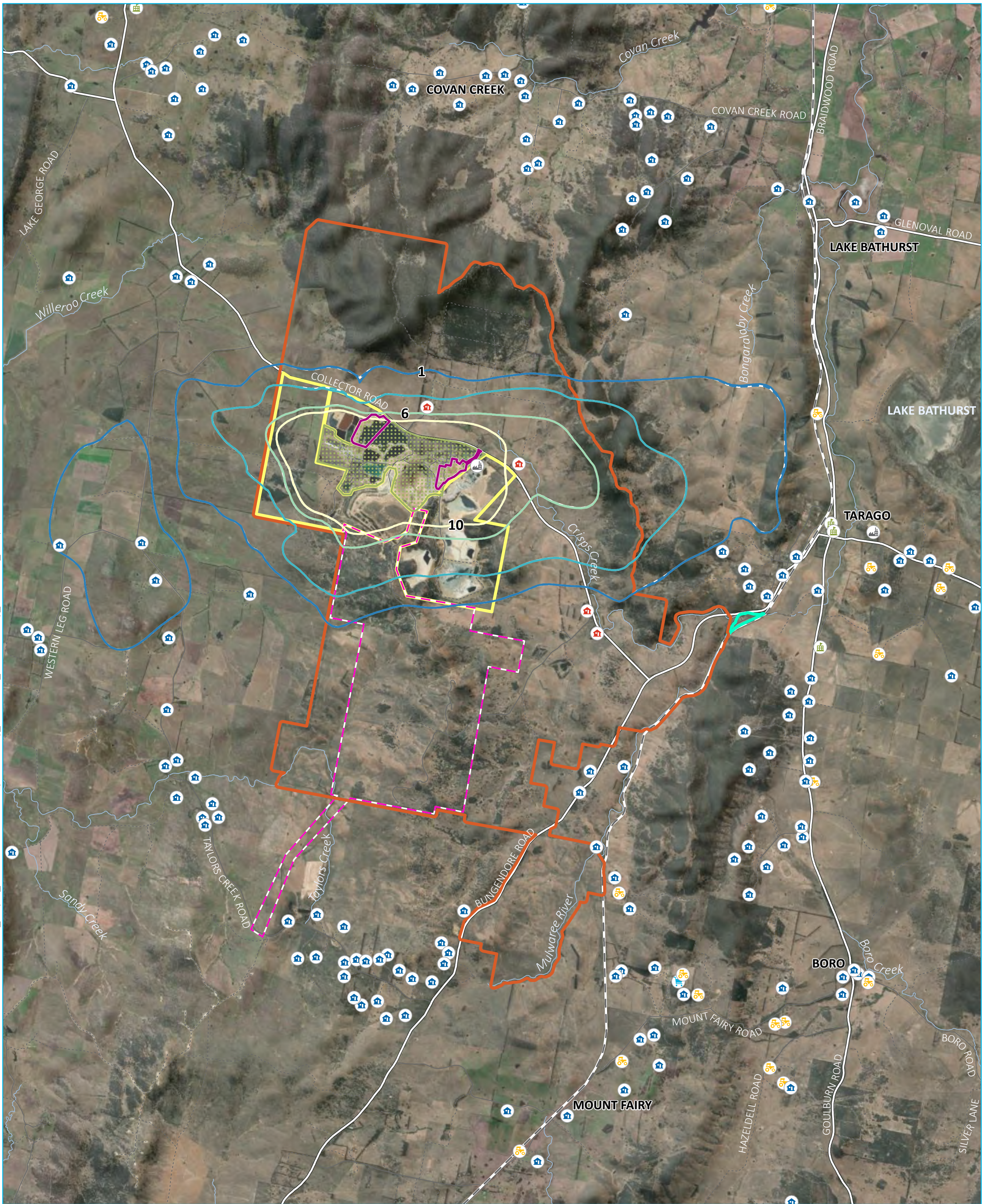
The predicted odour concentrations in Table 9.4 for the ARC only show that relative to odour emissions from approved operations of the Eco Precinct (eg Bioreactor, MBT, leachate treatment etc), the predicted odour from the ARC is negligible at surrounding sensitive receptor locations. Therefore, the modelling results show that the addition of the ARC does not increase the predicted odour for future operations.

Contour plots of predicted 99th percentile 1 second nose response odour concentrations for approved operations and future operations are presented in Figure 9.30. There is negligible difference between the contours for the two presented scenarios.

The predicted odour concentrations at the four complaints locations discussed in Section 6.8 were interrogated. While compliance with the applicable 99th percentile 1-second average odour criterion is predicted at all surrounding assessment locations, the maximum predicted odour concentrations at the Taylors Creek Road (south-west of the Eco Precinct), Tarago (east of the Eco Precinct) and Lake Bathurst (north-east of the Eco Precinct) complaints locations ranged from 2 ou to 7 ou. As stated in Section 4.4, these concentrations are in the range where odour could be experienced at sensitive assessment locations.

The CALPUFF-predicted odour concentrations (approved plus project emission sources) at the four complaints locations discussed in Section 6.8, have been paired in time with the corresponding CALMET-predicted wind speed and direction data at each location to produce polar plots which illustrate the relationship between wind conditions and predicted odour concentrations. The four polar plots produced for Lake Bathurst (north-east of the Eco Precinct), Tarago (east of the Eco Precinct), Mount Fairy/Boro (north-east of the Eco Precinct) and Taylors Creek Road (south-west of the Eco Precinct) are overlayed in Figure 9.31. These plots show that predicted odour concentrations are highest when winds are blowing from the Eco Precinct in the direction of each location and wind speeds are lower than 3 m/s.

The predicted odour concentrations were compared with the equivalent results presented in the IOA#9 (TOU 2021). The predicted odour concentrations are higher in this modelling assessment relative to IOA#9. While the exact reasons for this difference are unknown, EMM consider that a key contributing factor is the adoption of site-specific meteorological data in the current dispersion modelling undertaken for the Eco Precinct (IOA#9 based meteorological predictions on inputs from the BoM Goulburn Airport station).



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY
- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Assessment location
- Agriculture
- Community/school
- Commercial
- Industrial
- Residential
- Veolia

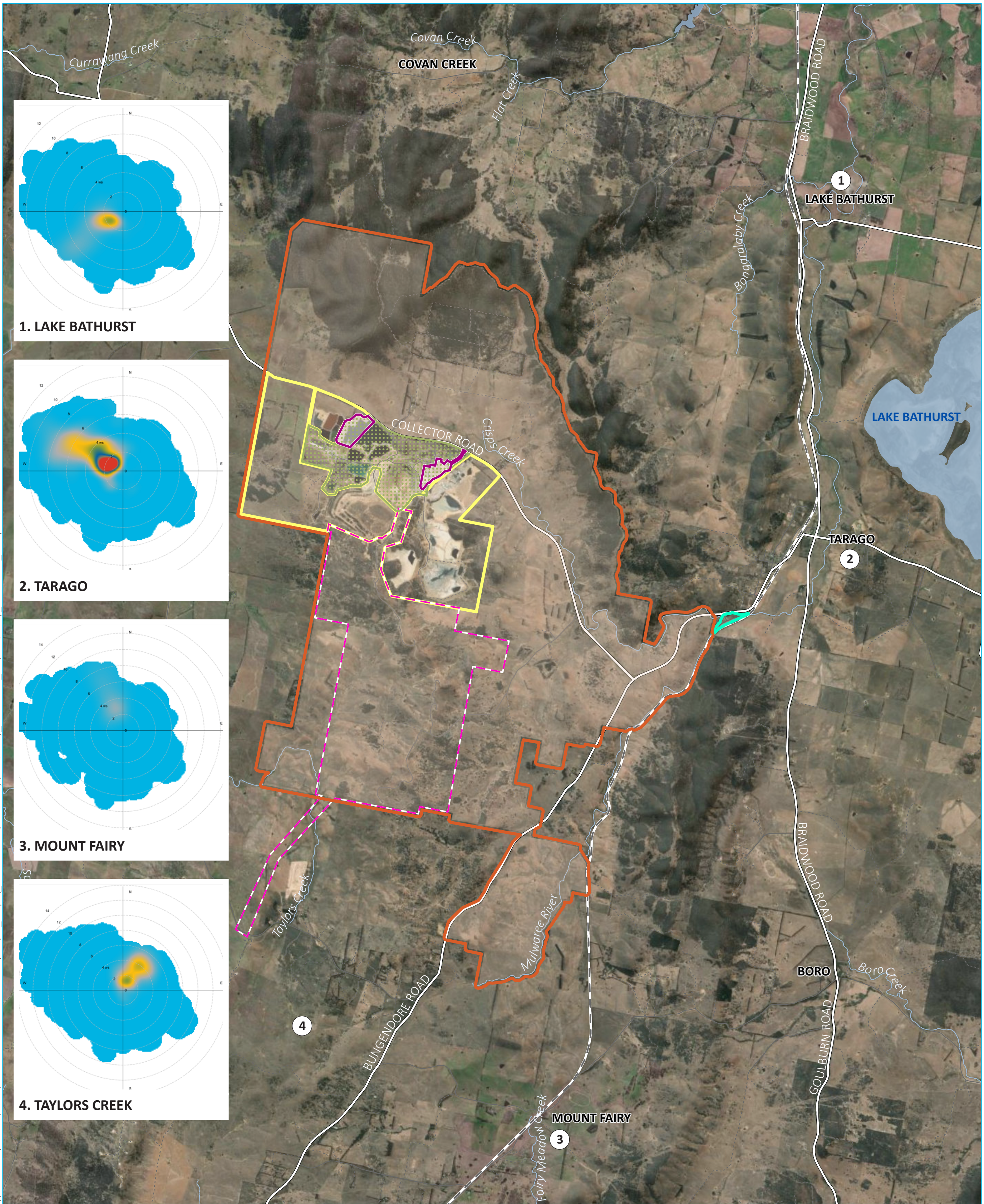
Odour concentration- approved
- 1 ou
- 2 ou
- 6 ou
- 10 ou

Odour concentration- approved plus ARC
- 1 ou
- 2 ou
- 6 ou
- 10 ou

Predicted 99th percentile 1-second nose response odour concentration – approved only and approved plus project

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.30

EMM
creating opportunities



Source: EMM (2022); Veolia (2022); DFSI (2017)

KEY

- Development footprint
- Veolia integrated waste management operations
- Woodlawn Eco Precinct
- Crisps Creek Intermodal Facility (IMF)
- Woodlawn Mine operations area
- Woodlawn Wind Farm
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse

Odour (ou)

0.4
0.3
0.2
0.1
0

Predicted odour concentration by wind speed and direction – approved plus project

Woodlawn Advanced Energy Recovery Centre
Air quality impact assessment
Figure 9.31

EMM
creating opportunities

9.4 Plume rise assessment

The SEARs require a plume rise assessment prepared in accordance with relevant Civil Aviation Safety Authority (CASA) guidelines. A plume rise assessment was completed in consultation with CASA and is provided in Appendix E. The assessment concluded that there would be no risks to airspace safety and no mitigation measures would be required.

10 Mitigation and monitoring

10.1 Emissions mitigation

10.1.1 Construction phase emissions

A construction environmental management plan (CEMP) will be prepared for the project construction phase which will outline measures to manage dust. These will include but not limited to the measures listed in Table 10.1.

Table 10.1 Mitigation measures – construction phase dust emissions

Impact	Mitigation measure	Responsibility	Timing
Reporting and record keeping	Develop appropriate communications to notify the potentially impacted residences of the project (duration, types of works, etc), relevant contact details for environmental complaints reporting. A complaints register should be maintained throughout the construction phase which should include any complaints related to dust. Where a dust complaint is received, the details of the response actions to the complaint should be detailed in the register. 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 register. Carry out regular site inspections, record inspection results, and make the logbook available for review as requested.	Contractor	Establish communications and register prior to the commencement of construction. Ongoing reporting and record keeping throughout the duration of construction activities.
Dust generation – general	Provide an adequate water supply on the construction site for effective dust/particulate matter suppression/mitigation. Avoid site runoff of water or mud. Temporary cessation of non-essential dust generating activities during high winds.	Contractor	Throughout the duration of construction activities.
Materials handling	Prevention of truck overloading to reduce spillage during loading/unloading and hauling. Minimise drop heights from loading or handling equipment.	Contractor	Throughout the duration of construction activities.
Soil stripping	Soil stripping will be limited to areas required for extraction/construction of foundations etc.	Contractor	Throughout the duration of construction activities.
Exposed areas	Only the minimum area necessary will be disturbed. Exposed areas will be stabilised as soon as practicable. Long-term soil stockpiles will be revegetated.	Contractor	Throughout the duration of construction activities.
Dust generation from vehicles moving on unpaved roads	Watering of main material haulage routes as required. Routes to be clearly marked and speed limits enforced. Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	Contractor	Throughout the duration of construction activities.
Vehicle fuel combustion emissions	Ensure proper maintenance and tuning of all equipment engines. Ensure vehicles switch off engines when stationary.	Contractor	Throughout the duration of construction activities.

10.1.2 Operational phase emissions

The European Union Industrial Emissions Directive (IED) 2010/75/EU (Integrated Pollution Prevention and Control) *Best Available Techniques Reference Document for Waste Incineration* (Neuwahl et al 2019) documents best available techniques (BAT) for the management of environmental impacts, including air pollution, from the waste incineration industry.

Section 2.2 details the stages of the project ERF process, including an overview of proposed air pollutant mitigation measures. These include:

- fully enclosed tipping hall with fast opening doors, negative pressure extraction and odour filtration to minimise odour emission release;
- the control of NO_x emissions by SNCR;
- the injection of NH_3 in the post-combustion chamber to control NO_x emissions;
- the injection of hydrated lime to neutralising acid gas formation;
- the injection of activated carbon to adsorb dioxins/furans and other contaminants including heavy metals;
- diversion of all flue gas through a baghouse containing fabric filter bags to remove particulates (as APCr); and
- the handling and processing of IBA material within a semi enclosed building.

A detailed review of the mitigation measures proposed for the project has been undertaken as part of the EIS (Appendix L1, Ricardo 2021 and Appendix L2, Fichtner 2021). The reviews concluded that the measures proposed for implementation at the project are aligned with accepted BAT measures for air pollutant emission control wherever practicable to do so.

10.2 Monitoring

The future monitoring for the project will comprise of two primary components:

- ambient air quality monitoring; and
- stack emissions monitoring.

10.2.1 Ambient air quality monitoring

Following approval of the project and prior to construction, Veolia will install and operate at least three real-time ambient air quality monitoring stations with the following parameters (at a minimum):

- particulate matter (PM_{10} and $PM_{2.5}$);
- NO_X/NO_2;
- VOCs;
- H_2S (for landfill gas odour from Eco Precinct, rather than project); and
- meteorological conditions (wind speed and direction minimum).

The exact locations of the monitoring stations will be confirmed following a thorough field investigation taking relevant siting, mains power supply and instrumentation requirements into consideration. Indicative locations, subject to investigation findings, would include:

- one fixed station to the east of the Eco Precinct in Tarago (downwind under dominant westerly winds);
- one fixed station to the west of the Eco Precinct (downwind under dominant easterly winds); and
- a mobile station that could be located outside the dominant east-west wind alignment to provide background air quality monitoring results outside the influence of project or positioned at specific locations.

The existing meteorological and dust deposition monitoring equipment at the Eco Precinct will continue to form part of the ambient air quality monitoring network.

Results of ambient air quality monitoring will be published on a website for access by the community and will be summarised in annual environmental reporting.

10.2.2 ERF emissions monitoring

The EfW Policy presents air pollutant monitoring requirements for ERF, which are reproduced in Table 10.2.

In addition to the pollutants listed in Table 10.2, the EfW Policy also requires that the following operational parameters are also measured for ERF:

- temperature – continuous basis at representative points in combustion chamber and discharge stack;
- oxygen content – continuous basis at discharge stack;
- moisture content – continuous basis at discharge stack; and
- pressure – continuous basis at discharge stack.

As stated in Section 2.2, the ARC will feature a CEMS for the continuous monitoring of process air pollutants. The final specifications of the CEMS will be determined in the accordance with the EfW Policy. In the event that certain parameters cannot be accommodated as specified by the EfW Policy, agreement will be sought for alternative options with the NSW EPA.

As per the requirements of the EfW Policy, as far as practicable to do so, validated emission monitoring data will be made available publicly within 24 hours following the end of a weekday and the following weekday after weekends and public holidays. Emission monitoring data will be made available to the EPA in real time graphical publication and a weekly summary of continuous monitoring data and compliance with emissions limits published on the internet.

A comprehensive air quality management plan, addressing the CEMS and management procedures in response to recorded concentrations, will be developed following approval of the project and prior to the commencement of construction.

Table 10.2 EfW Policy emissions monitoring requirements

Pollutant	Unit of measure	Frequency
NO_x	mg/m^3	Continuous
CO	mg/m^3	Continuous
Total solid particles	mg/m^3	Continuous
TOC	mg/m^3	Continuous
HCl	mg/m^3	Continuous
HF[1]	mg/m^3	Continuous
SO_2	mg/m^3	Continuous
NH_3	mg/m^3	Continuous[2]
Type 1 and 2 substances	mg/m^3	Every three months
Mercury	mg/m^3	Every three months
Cadmium and thallium (total)	mg/m^3	Every three months
PAHs	mg/m^3	Every three months for the first 12 months of operation. Two measurements per year after that.
Dioxins and furans	ng/m^3	Every three months for the first 12 months of operation. Two measurements per year after that.
Carbon dioxide (CO_2)	mg/m^3	Continuous
Nitrous oxide (N_2O)	mg/m^3	Continuous[2]

Note 1: The continuous measurement of HF may not be required if treatment stages for HCl are used which ensure that the emission limit value for HCl is not being exceeded.
Note 2: Or as otherwise agreed to by written notice from the EPA.

11 Conclusions

This report presents a quantitative modelling assessment of potential air quality impacts for the operation of the project, prepared in accordance with the Approved Methods for Modelling.

Emissions from the ARC building stack were quantified for three scenarios:

- Scenario 1 – reference case emissions – expected emissions;
- Scenario 2 – reference case emissions – maximum emissions; and
- Scenario 3 – NSW EfW Policy regulatory case emissions.

Scenario 1 is considered to be representative of likely emissions and impacts from the operation of the project. The calculated emissions from the ARC building stack for Scenario 2 and Scenario 3 are considered to be highly conservative for the following reasons:

- Scenario 2 adopts the maximum (100^{th} percentile) measured concentrations from the Staffordshire ERF and applies emission upscaling factors to account for potential inter-annual variability;
- Scenario 3 adopts the NSW EfW Policy emission standards as the emission concentration for each pollutant; and
- both Scenario 2 and 3 adopt maximum projected flow rates for all hours and applies the calculated maximum emission rates for every hour of the modelling period.

In addition to the ARC building, the project will introduce the following air pollutant emissions sources to the Eco Precinct:

- truck movements – including the transportation of stabilised APCr from the ARC building to the APCr encapsulation cell, transfer of IBAA to the bioreactor and the diversion of up to 380,000 tpa of incoming waste deliveries to the ARC tipping hall and away from the Bioreactor;
- fugitive dust emissions from the handling and storage of material at the IBA area and APCr encapsulation cell; and
- diesel fuel combustion by mobile plant and equipment and the auxiliary diesel burners and generator.

Emissions from all existing and approved operations at the Eco Precinct and the neighbouring Woodlawn Mine were also quantified for inclusion in the dispersion modelling to predict cumulative air quality impacts.

Other contributing sources of air pollutant emissions to existing background air quality include:

- dust entrainment due to vehicle movements along unsealed roads and sealed roads with high silt loadings;
- dust emissions from agricultural activities, in particular livestock operations;
- fuel combustion-related emissions from on-road and non-road engines;
- wind generated dust from exposed areas within the surrounding region; and
- seasonal emissions from household wood burning for heating during winter.

The results obtained from the dispersion modelling show that all predicted concentrations and deposition rates are below the applicable impact assessment criterion at all surrounding sensitive assessment locations. Furthermore, it is noted that the cumulative impact results presented for the three project scenarios are not significantly different from the results presented for existing operations at the Eco Precinct. This indicates the following key points:

- the introduction of the project will not significantly change air quality impacts currently associated with the Eco Precinct;
- the diversion of waste to the ARC and away from the Bioreactor will reduce particulate matter emissions associated with the movement of trucks on unpaved roads; and
- relative to ambient background concentrations, air quality impacts associated with the Eco Precinct and the project are minor at surrounding sensitive assessment locations.

It is reiterated that the adopted emission rates for the ARC building stack are based on a highly conservative set of assumptions, in particular for Scenario 2 (reference case – maximum emissions) and Scenario 3 (regulatory case), therefore the results from the dispersion modelling completed should be viewed as a conservative upper bound of potential air quality impacts from the project.

To provide context to the modelling results, a comparison between concentrations of $PM_{2.5}$, NO_2 and CO recorded at the ACT Government and DPE Goulburn air quality monitoring stations and the maximum predicted concentrations across all sensitive assessment locations is made. The peak concentrations recorded on a day heavily influenced by bushfire emissions (1 January 2020), the average recorded concentration between 2014 and 2021 across the region and the maximum predicted concentration from the project (approved Eco Precinct and Scenario 2) are presented in Figure 11.1. The predicted concentrations from the project are equivalent to approved Eco Precinct impacts, well below typical ambient air pollutant concentrations for the region and negligible relative to a bushfire affected day.

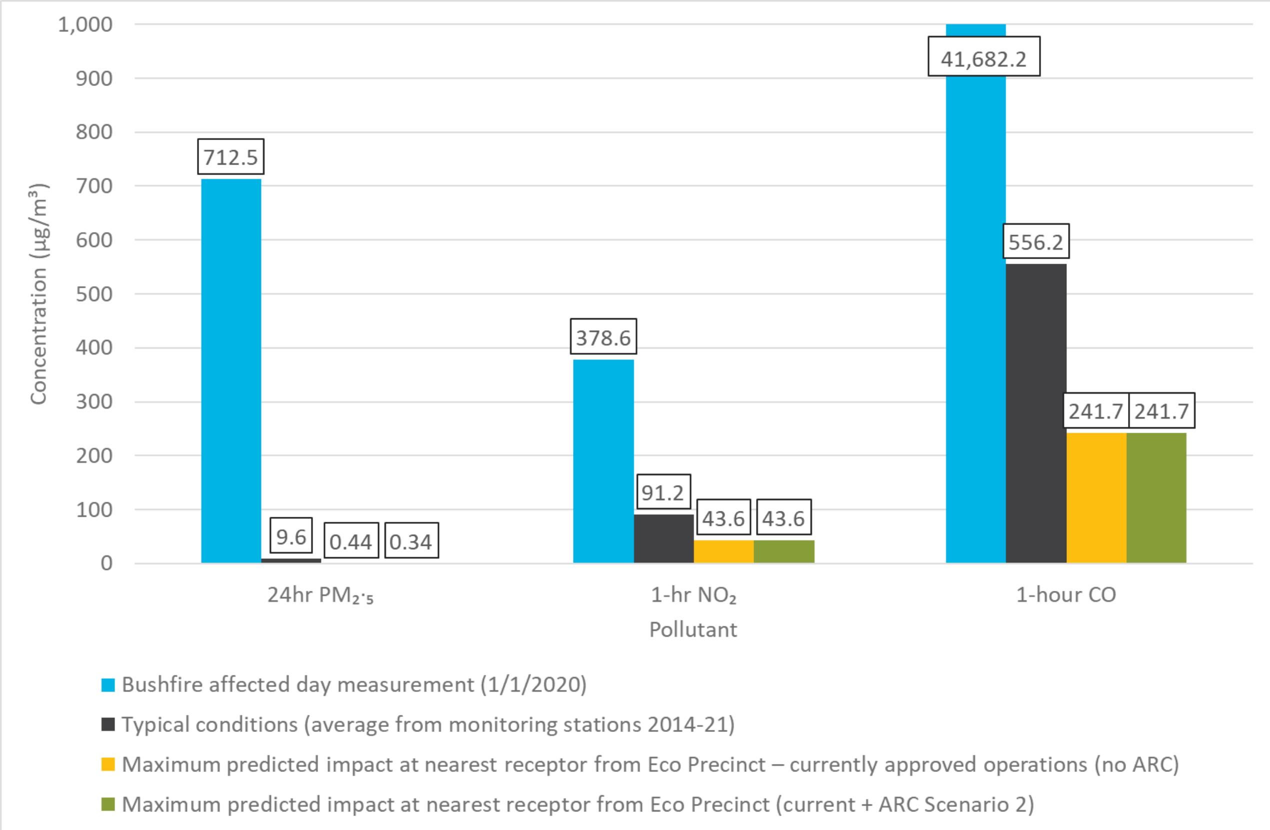


Figure 11.1 Comparison of measured regional ambient concentrations and predicted concentrations from the approved Eco Precinct and project (Scenario 2)

Note: Y-axis is cropped at 1,000 µg/m^3 for data visualisation purposes. The maximum 1-hour CO concentration from the dataset was 41,682.2 µg/m^3.

Dispersion modelling was completed for odour emissions from existing sources at the Eco Precinct and the ARC building tipping hall. Relative to existing operations of the Eco Precinct, the addition of the ARC does not increase the predicted odour impacts for future operations.

Veolia will implement a range of air pollution emission mitigation technologies and practices to minimise air pollutant emissions from the project. A review of proposed mitigation measures for the project relative to BAT was undertaken, with the review highlighting that the project is well aligned with BAT for the control of air pollutant emissions.

Veolia will implement a comprehensive CEMS in accordance with the requirements of the EfW Policy and will establish an ambient air quality monitoring program for the project.

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Abbreviations

AAQ NEPM	Ambient Air Quality National Environment Protection Measure
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
APC	air pollution control
APCr	air pollution control residues
AQMS	air quality monitoring station
AQIA	air quality impact assessment
ARC	Woodlawn Advanced Energy Recovery Centre
AWS	automatic weather station
BAT	best available techniques
Bioreactor	Woodlawn Bioreactor
BoM	Bureau of Meteorology
BPIP-PRIME	Building Profile Input Program - Plume Rise Model Enhancements
C&I	commercial and industrial
CEMP	construction environmental management plan
CEMS	Continuous emission monitoring system
CO	carbon monoxide
CH_4	methane
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DDG	dust deposition gauges
DPE	Department of Planning and Environment
Eco Precinct	Woodlawn Eco Precinct
EIS	Environmental Impact Statement
EfW	Energy from Waste
EMM	EMM Consulting Pty Limited
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environment Protection Authority
ERF	energy recovery facility
FGT	flue gas treatment
GLC	ground level concentration
H_2S	hydrogen sulphide
HCl	hydrogen chloride
HF	hydrogen fluoride
IBA	incinerator bottom ash

IBAA	incinerator bottom ash aggregate
IED	Industrial Emissions Directive
IMF	Crisps Creek Intermodal Facility
LFG	landfill gas
LGA	Local government area
LPB	liquid paperboard
LTP	Leachate Treatment Plant
kL	kilolitres
kW	kilowatt
kWhr	kilowatt hour
MBT	Woodlawn Mechanical Biological Treatment Facility
MRF	materials recycling facility
MSW	municipal solid waste
Mtpa	million tonnes per annum
MW	mega watt
MWth	mega watt thermal
Mtpa	million tonnes per annum
NEPC	National Environment Protection Council
N_2O	nitrous oxide
NH_3	ammonia
NO_x	oxides of nitrogen
NO_2	nitrogen dioxide
NPI	National Pollution Inventory
NSW	New South Wales
O_3	ozone
PAHs	polycyclic aromatic hydrocarbons
PFAS	Per- and polyfluoroalkyl substances
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
POEO Act	Protection of the Environment Operations Act 1997
POEO (Clean Air) 2010	Protection of the Environment Operations (Clean Air) Regulation Clean Air Regulation
ROI	radius of influence
SEARs	Secretary's Environmental Assessment Requirements
SNCR	selective non-catalytic reduction

SO_2	sulfur dioxide
SSC	state suburbs
SSD	state significant development
TAPM	The Air Pollution Model
tpa	tonnes per annum
TSP	total suspended particulate matter
US-EPA	United States Environmental Protection Agency
VOC	volatile organic compounds
Veolia	Veolia Environmental Services (Australia) Pty Ltd
Veolia UKI	Veolia United Kingdom & Ireland Pty Ltd

Appendix A
Assessment locations

Table A.1 Assessment locations

ID	Location (m, MGA55)		Type	Distance from ARC stack (km)	ID	Location (m, MGA55)		Type	Distance from ARC stack (km)
	Easting	Northing				Easting	Northing		
1	733978	6124338	Residential	7.2	109	739360	6107527	Residential	10.6
2	734340	6124265	Residential	7.1	110	741204	6103109	Residential	15.4
3	734848	6124567	Residential	7.3	111	737435	6111259	Residential	6.4
4	736467	6122796	Residential	5.7	112	742697	6099535	Residential	19.3
5	736668	6122893	Residential	5.8	113	738362	6109109	Residential	8.8
6	737057	6123662	Residential	6.7	114	738827	6108020	Residential	10.0
7	735211	6123979	Residential	6.7	115	738085	6109682	Residential	8.1
8	737414	6124002	Residential	7.1	116	738164	6109400	Vineyard	8.4
9	735700	6124511	Residential	7.3	117	737746	6110253	Residential	7.5
10	736383	6125870	Residential	8.7	118	741810	6100501	Residential	18.0
11	736049	6124533	Residential	7.3	119	741403	6101322	Residential	17.1
12	736346	6124417	Residential	7.3	120	741592	6100735	Residential	17.7
13	738367	6124058	Residential	7.5	121	741022	6101969	Residential	16.4
14	738468	6123773	Residential	7.3	122	741022	6101969	Residential	16.4
15	738478	6123611	Residential	7.2	123	741455	6100101	Residential	18.3
16	736426	6124138	Residential	7.0	124	738808	6106774	Residential	11.1
17	738746	6123839	Residential	7.5	125	738907	6106216	Residential	11.7
18	739065	6123760	Residential	7.6	126	738205	6107960	Residential	9.8
19	736451	6123340	Residential	6.2	127	740537	6101776	Residential	16.4
20	738769	6122958	Residential	6.8	128	741093	6100171	Residential	18.1
21	738415	6122236	Residential	6.0	129	740675	6100977	Residential	17.2
22	738227	6121668	Residential	5.4	130	738554	6106696	Residential	11.1
23	738683	6122363	Residential	6.2	131	738100	6107864	Residential	9.9
24	740953	6125797	Agriculture	10.3	132	738217	6106287	Agriculture	11.4
25	739860	6123572	Residential	7.9	133	738263	6105757	Residential	11.9
26	739426	6122612	Residential	6.9	134	737206	6105282	Residential	12.2
27	739016	6121814	Residential	6.0	135	736656	6104435	Residential	12.9
28	738282	6120097	Residential	4.3	136	736326	6104626	Agriculture	12.7
29	741098	6122422	Residential	7.9	137	736097	6105370	Residential	11.9
30	741684	6122184	Residential	8.2	138	735296	6109069	Residential	8.2

Table A.1 Assessment locations

ID	Location (m, MGA55)		Type	Distance from ARC stack (km)	ID	Location (m, MGA55)		Type	Distance from ARC stack (km)
	Easting	Northing				Easting	Northing		
31	742539	6122175	Residential	8.9	139	735010	6108293	Residential	9.0
32	743059	6121918	Residential	9.2	140	734928	6108093	Residential	9.2
33	743008	6121626	Residential	9.0	141	734878	6108477	Residential	8.8
34	734613	6118383	Veolia	1.2	142	734704	6107756	Residential	9.5
35	741831	6118264	Agriculture	6.8	143	734337	6107816	Residential	9.5
36	742085	6116234	School	7.0	144	734210	6107137	Residential	10.2
37	742869	6116072	Industrial	7.8	145	734098	6107971	Residential	9.3
38	742132	6116087	Preschool	7.1	146	733858	6107079	Residential	10.3
39	743553	6115713	Residential	8.6	147	733883	6108256	Residential	9.1
40	743913	6115545	Residential	9.0	148	733696	6107401	Residential	10.0
41	744268	6115410	Agriculture	9.3	149	733734	6108174	Residential	9.2
42	743361	6115546	Residential	8.4	150	733400	6107328	Residential	10.1
43	736311	6117332	Veolia	1.2	151	733481	6108141	Residential	9.3
44	742820	6115417	Agriculture	7.9	152	733262	6107464	Residential	10.0
45	744108	6115034	Agriculture	9.3	153	733307	6108170	Residential	9.3
46	744753	6114686	Residential	10.0	154	733078	6107858	Residential	9.6
47	741443	6115619	Residential	6.5	155	733088	6108118	Residential	9.4
48	743079	6114999	Residential	8.3	156	733074	6108779	Residential	8.7
49	745016	6114324	Residential	10.3	157	733074	6108779	Residential	8.7
50	741187	6115275	Residential	6.4	158	732559	6108217	Residential	9.4
51	741842	6114994	Residential	7.1	159	732578	6109002	Residential	8.6
52	745047	6113676	Residential	10.6	160	732218	6108190	Residential	9.5
53	740079	6115714	Residential	5.2	161	732044	6108878	Residential	8.9
54	740488	6115390	Residential	5.7	162	732044	6108879	Residential	8.9
55	744313	6113416	Residential	10.0	163	730323	6111539	Residential	7.5
56	740575	6115071	Residential	5.9	164	729980	6111164	Residential	8.0
57	740904	6114891	Residential	6.3	165	729985	6111859	Residential	7.4
58	742970	6113817	Agriculture	8.6	166	729772	6111749	Residential	7.7
59	741886	6113943	Community	7.5	167	730754	6110800	Residential	7.8
60	741719	6113372	Residential	7.7	168	731336	6114924	Residential	4.4

Table A.1 Assessment locations

ID	Location (m, MGA55)		Type	Distance from ARC stack (km)	ID	Location (m, MGA55)		Type	Distance from ARC stack (km)
	Easting	Northing				Easting	Northing		
61	741676	6112943	Residential	7.8	169	730507	6110657	Residential	8.0
62	741344	6113128	Residential	7.5	170	729802	6112790	Residential	6.9
63	741309	6112691	Residential	7.7	171	730458	6110792	Residential	8.0
64	741702	6112267	Residential	8.3	172	730640	6111050	Residential	7.6
65	741688	6111848	Residential	8.5	173	726934	6110152	Residential	10.8
66	741767	6111451	Agriculture	8.8	174	729836	6114119	Residential	6.1
67	741619	6111467	Residential	8.7	175	726186	6111822	Agriculture	10.5
68	740949	6111994	Residential	7.9	176	729593	6115180	Residential	5.9
69	740482	6112393	Residential	7.2	177	727467	6113894	Residential	8.4
70	742783	6107847	Residential	12.1	178	727420	6114125	Residential	8.3
71	737760	6114200	Residential	4.0	179	727215	6114268	Residential	8.4
72	737760	6114200	Veolia	4.0	180	729334	6115875	Residential	5.9
73	742770	6107743	Agriculture	12.2	181	726531	6114750	Residential	8.9
74	740896	6109886	Residential	9.4	182	727815	6115830	Residential	7.4
75	742585	6107908	Residential	12.0	183	725656	6119944	Residential	9.8
76	740559	6110258	Residential	8.9	184	725522	6121172	Agriculture	10.4
77	742512	6107974	Residential	11.9	185	727992	6120774	Residential	7.9
78	741538	6110631	Residential	9.2	186	730250	6120701	Residential	6.0
79	740573	6111684	Residential	7.8	187	729972	6120801	Residential	6.2
80	741558	6110437	Residential	9.4	188	730587	6121027	Residential	5.9
81	742305	6107848	Residential	11.8	189	728029	6124323	Residential	10.0
82	742295	6107524	Residential	12.1	190	729827	6123418	Residential	8.1
83	740298	6110024	Residential	8.9	191	728021	6125986	Agriculture	11.3
84	741215	6110287	Residential	9.3	192	728766	6125091	Residential	10.1
85	740799	6110821	Residential	8.6	193	728596	6125597	Agriculture	10.6
86	740572	6109372	Residential	9.6	194	729427	6124719	Residential	9.4
87	737575	6114614	Veolia	3.6	195	729520	6124594	Residential	9.2
88	735539	6117298	Industrial	0.4	196	729942	6124084	Residential	8.6
89	741188	6107641	Residential	11.4	197	729779	6124650	Residential	9.1
90	738257	6111735	Residential	6.3	198	729237	6125768	Church	10.3

Table A.1 Assessment locations

ID	Location (m, MGA55)		Type	Distance from ARC stack (km)	ID	Location (m, MGA55)		Type	Distance from ARC stack (km)
	Easting	Northing				Easting	Northing		
91	741233	6107012	Agriculture	11.9	199	728795	6126721	Residential	11.4
92	741051	6106975	Agriculture	11.9	200	730454	6124266	Residential	8.4
93	741340	6105800	Residential	13.0	201	729227	6127025	Residential	11.4
94	741208	6105889	Agriculture	12.9	202	729311	6127162	Residential	11.5
95	740952	6106166	Agriculture	12.5	203	730414	6124960	Residential	9.0
96	742743	6102268	Residential	16.8	204	729427	6127166	Residential	11.4
97	742379	6102778	Residential	16.2	205	730684	6125266	Residential	9.2
98	737631	6111652	Residential	6.1	206	731209	6125171	Residential	8.8
99	742067	6102779	Residential	16.1	207	730652	6126922	Residential	10.7
100	741928	6103023	Residential	15.8	208	730748	6127020	Residential	10.7
101	739627	6107516	Agriculture	10.7	209	730729	6127208	Agriculture	10.9
102	739345	6107895	Agriculture	10.3	210	731348	6126276	Residential	9.8
103	741355	6103685	Residential	14.9	211	731635	6126777	Residential	10.1
104	742071	6102104	Residential	16.7	212	731925	6126058	Agriculture	9.4
105	742120	6101888	Residential	16.9	213	731977	6126430	Residential	9.7
106	741337	6103453	Residential	15.1	214	732201	6126039	Residential	9.3
107	739261	6107764	Commercial	10.4	215	732063	6127234	Residential	10.4
108	741554	6102972	Residential	15.7					

Appendix B
Meteorological processing and modelling

EMM
creating opportunities

B.1 Meteorological data analysis for the onsite AWS, 2016-2020

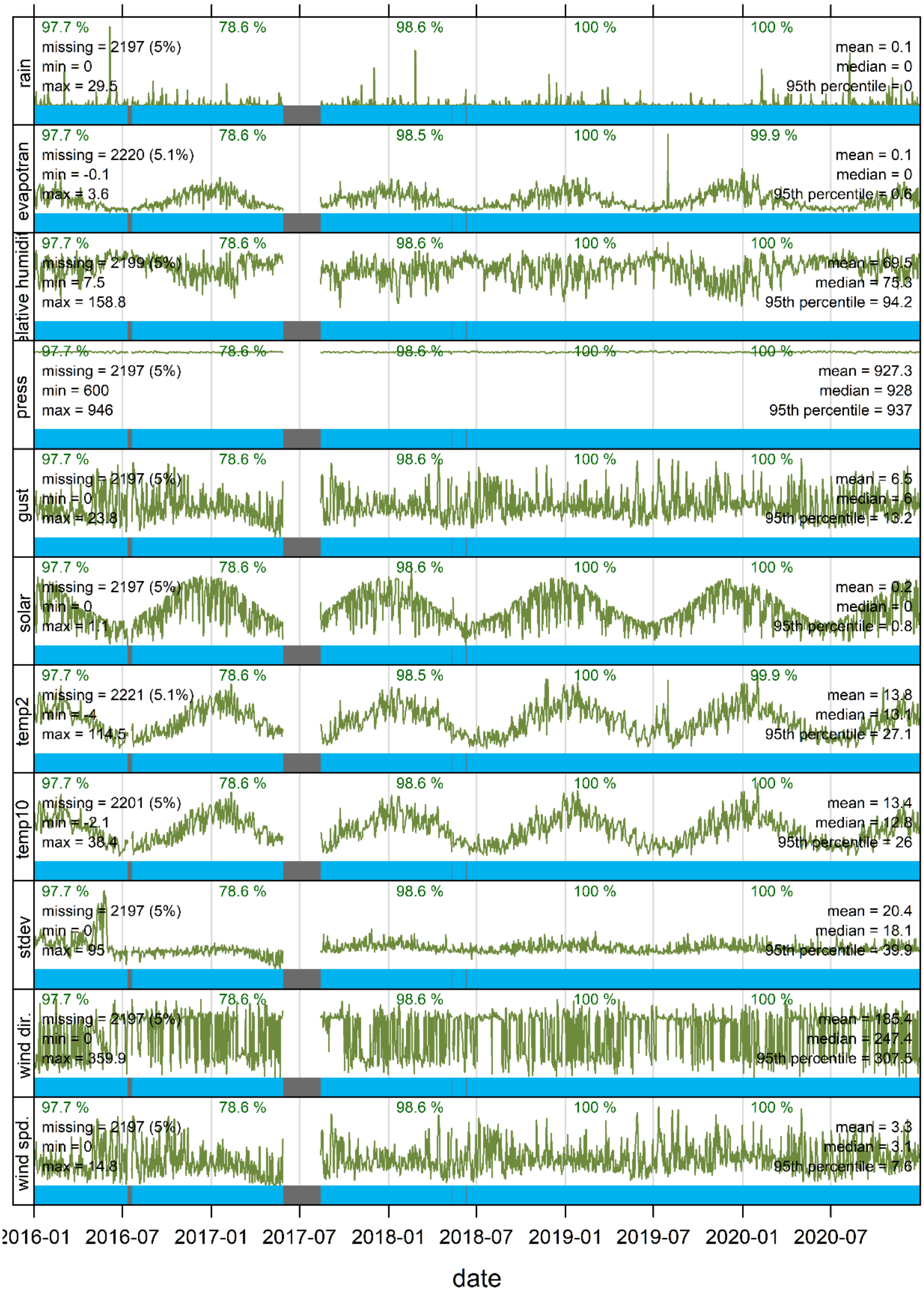

Figure B.1 Data completeness analysis plot – EP AWS – 2016 to 2020

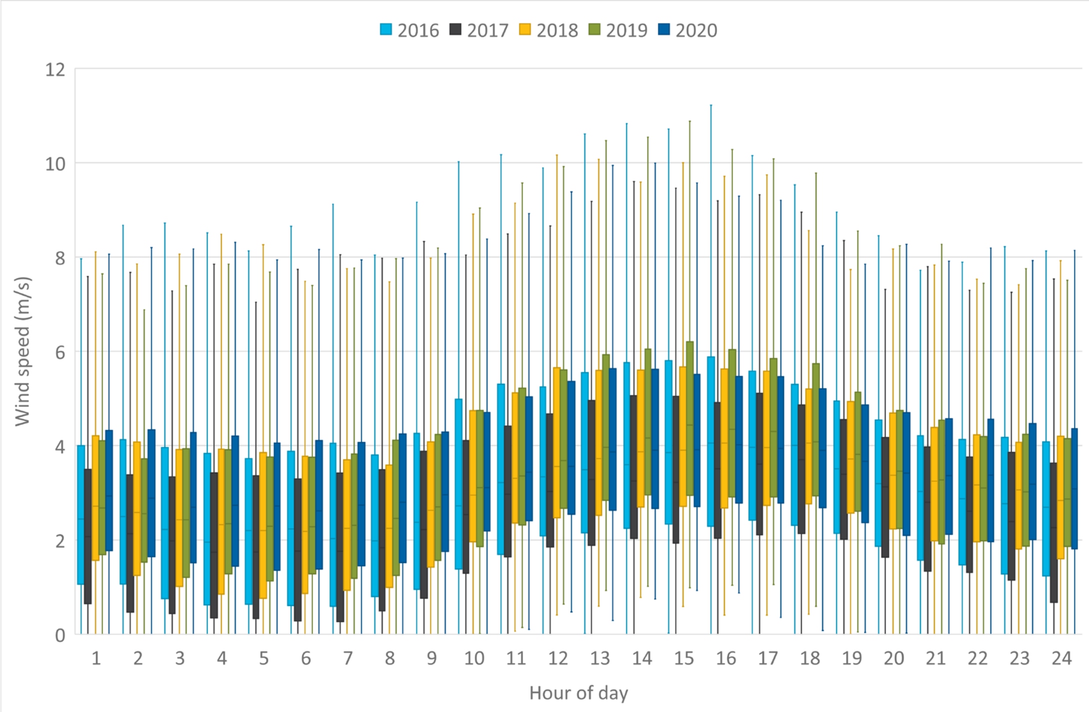

Figure B.2 **Inter-annual variability in diurnal wind speed – EP AWS – 2016 to 2020**

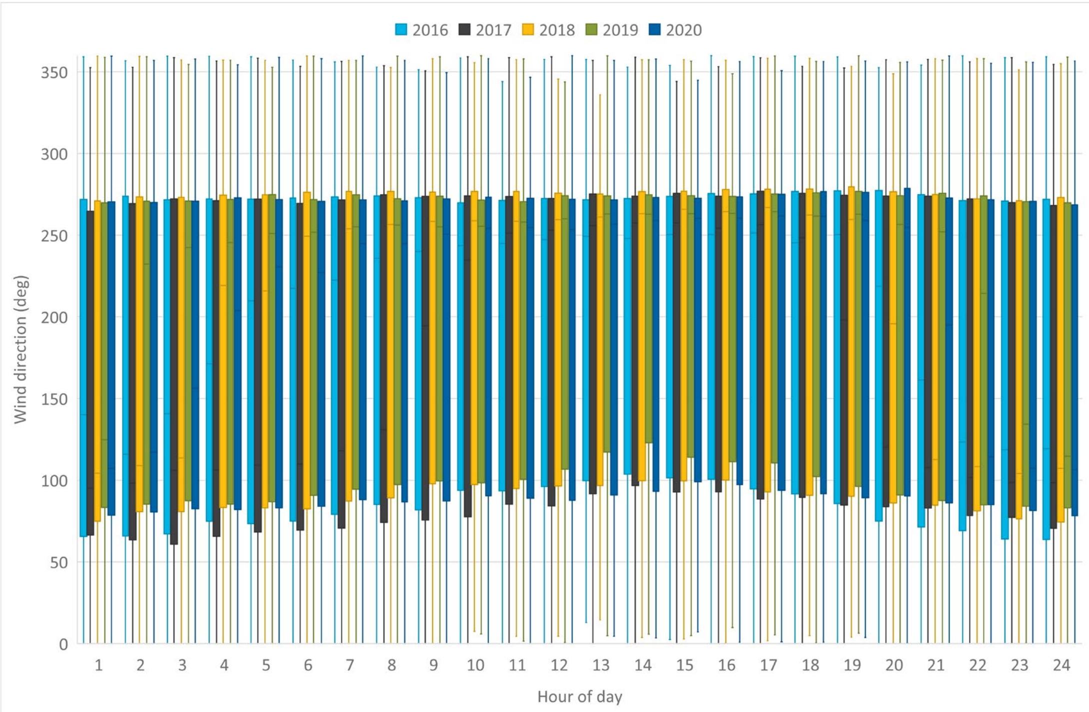

Figure B.3 **Inter-annual variability in diurnal wind direction – EP AWS – 2016 to 2020**

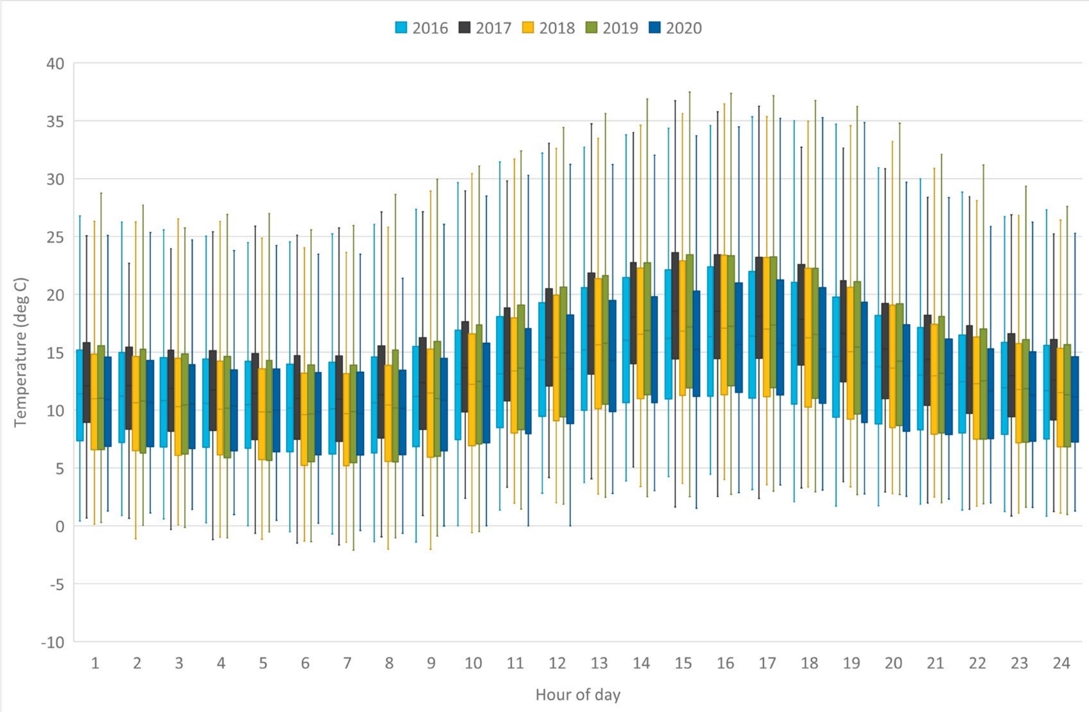

Figure B.4 Inter-annual variability in diurnal air temperature – EP AWS – 2016 to 2020

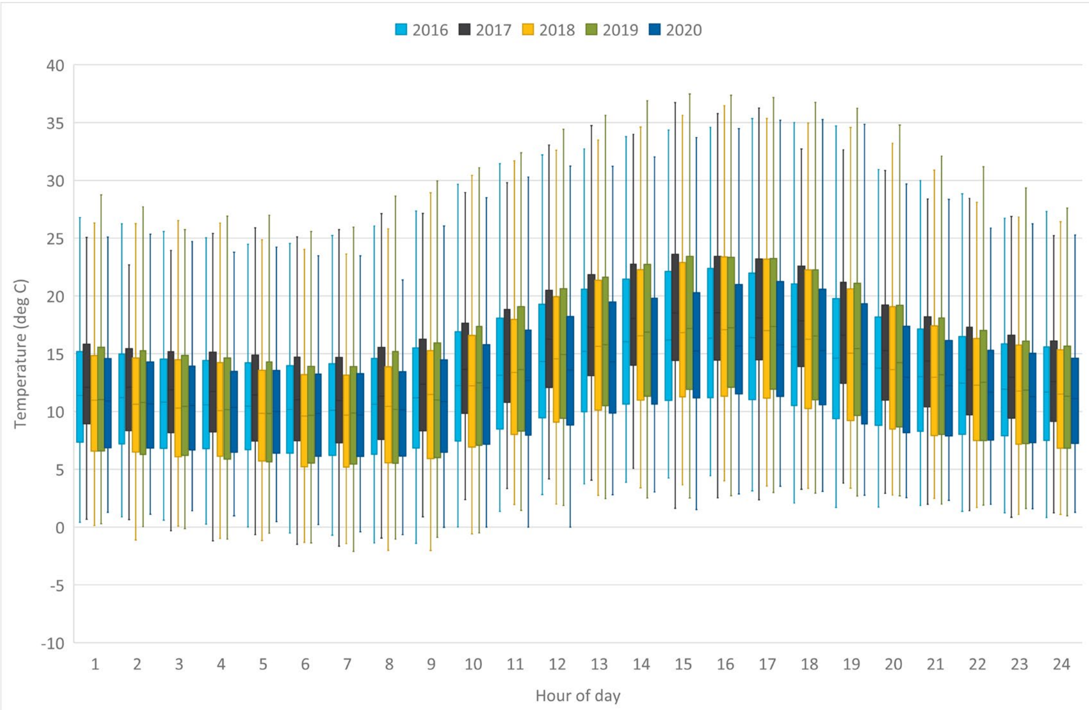

Figure B.5 Inter-annual variability in diurnal relative humidity – EP AWS – 2016 to 2020

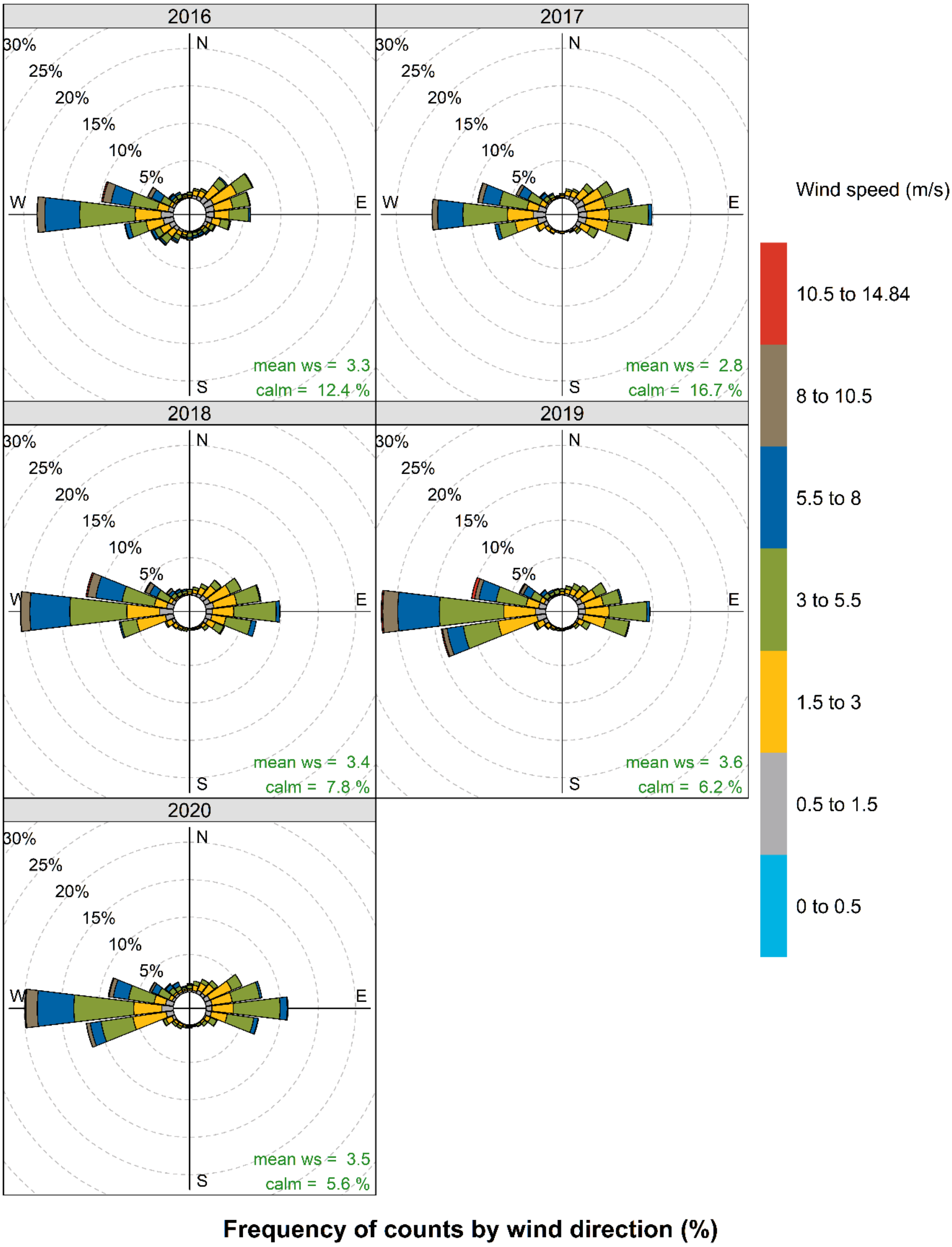

Figure B.6 Inter-annual comparison of recorded wind speed and direction – EP AWS – 2016 to 2020

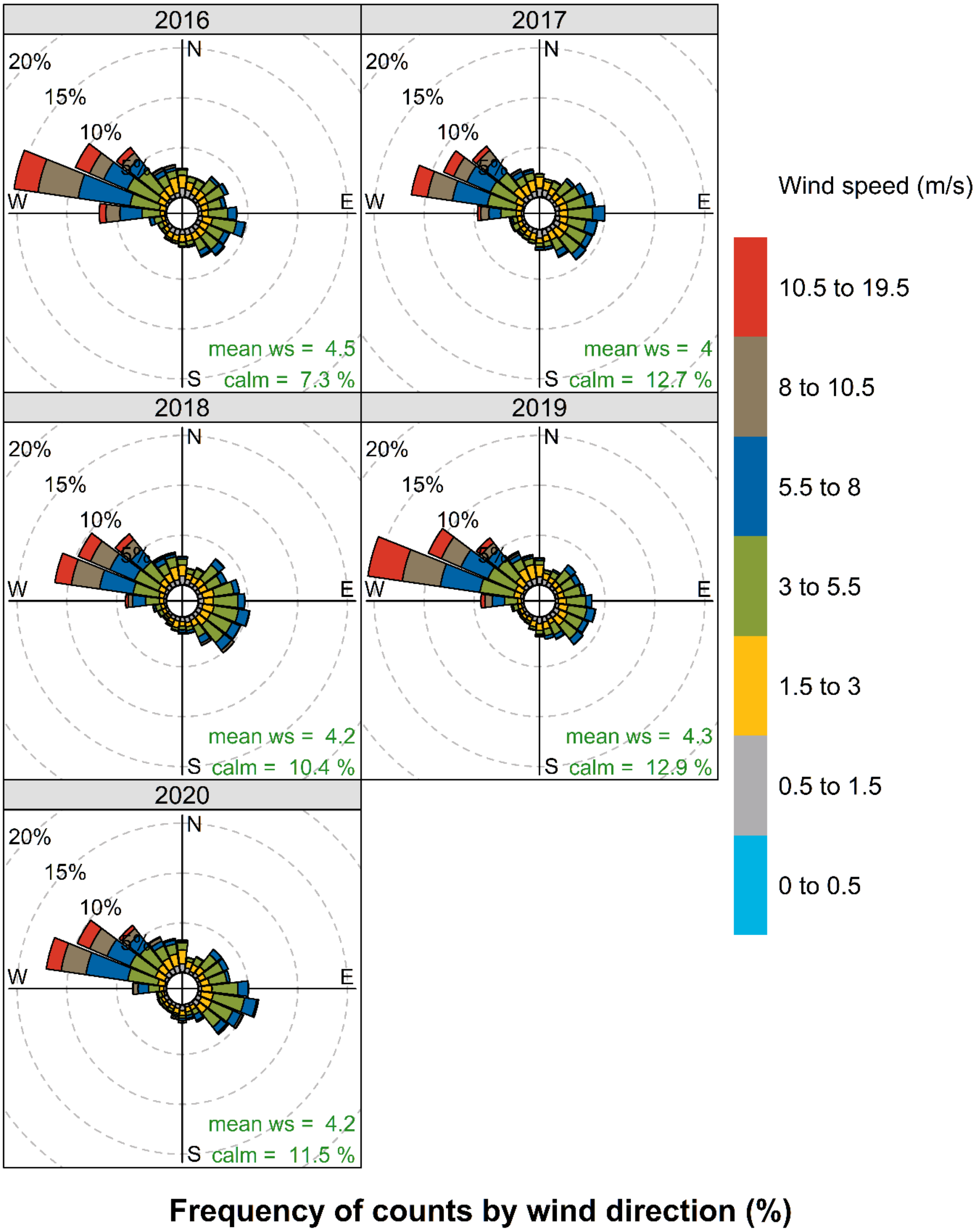

Figure B.7 Inter-annual comparison of recorded wind speed and direction – BoM Goulburn Airport AWS – 2016 to 2020

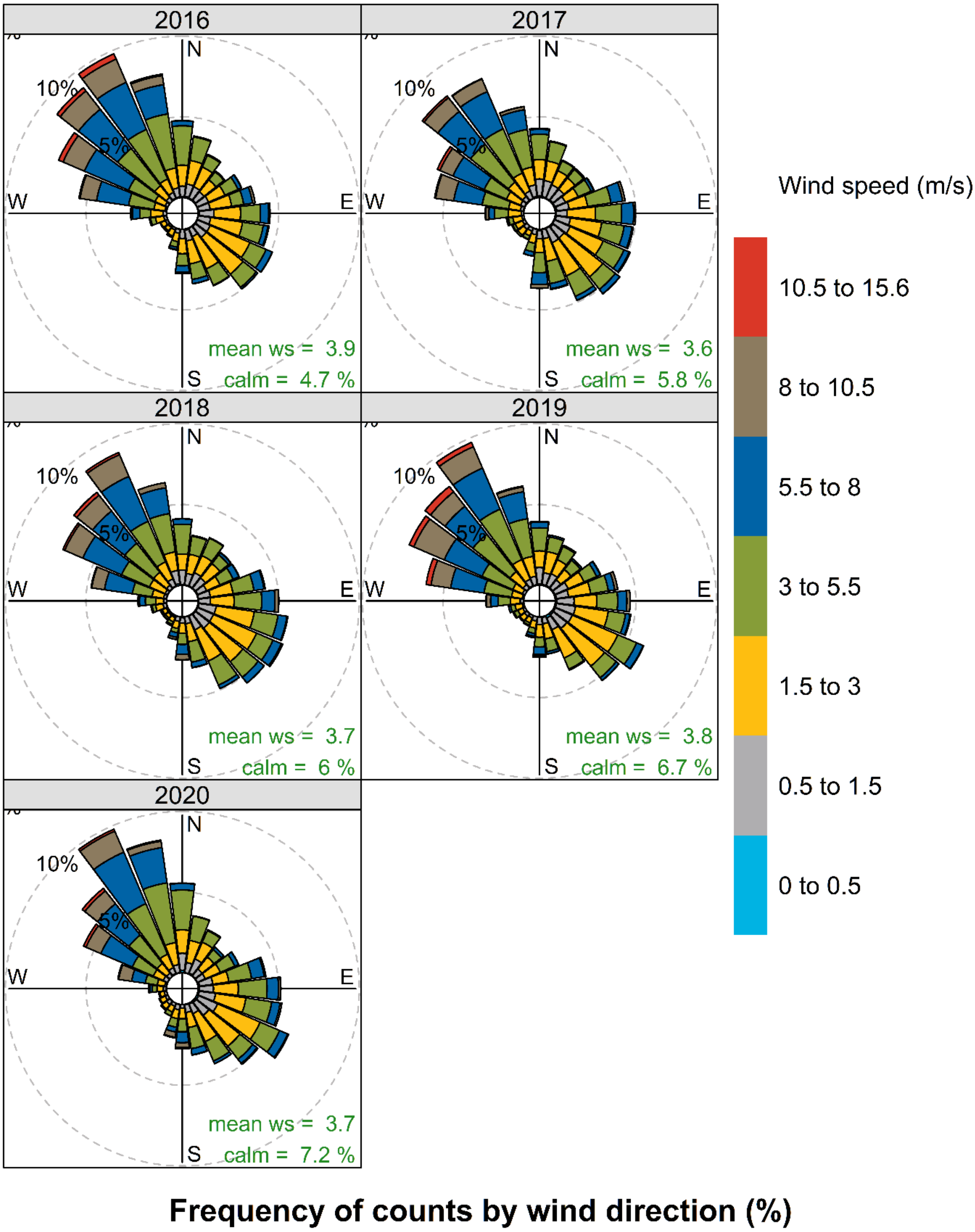

Figure B.8 Inter-annual comparison of recorded wind speed and direction – BoM Canberra Airport AWS – 2016 to 2020

B.2 Meteorological modelling

B.2.1 TAPM modelling

To supplement the meteorological monitoring datasets adopted for this assessment, the Commonwealth Scientific and Industry Research Organisation (CSIRO) prognostic meteorological model The Air Pollution Model (TAPM) was used to generate required parameters that are not routinely measured, specifically cloud content and height data.

TAPM was configured and run as follows:

- TAPM version 4.0.5;
- inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data);
- grid domains with cell resolutions of 30 km, 10 km, 3 km, 1 km and 0.3 km. Each grid domain features 37 x 37 horizontal grid points and 25 vertical levels;
- TAPM default databases for land use, synoptic analyses and sea surface temperature;
- TAPM defaults for advanced meteorological inputs;
- surface meteorological data from the EP AWS and BoM AWS locations at Goulburn Airport and Canberra Airport were incorporated into the modelling; and
- two 'spin-up' days allowed at the beginning and end of the run.

Where necessary, the TAPM predictions at 0.3 km cell resolution were used to extract parameters not recorded by the EP AWS, specifically cloud cover and mixing height.

B.2.2 CALMET

The CALMET/CALPUFF model suite was chosen for this study. CALMET was used to produce 3-dimensional meteorological fields for use in the CALPUFF model.

In the absence of upper air measurements, CALMET can be run using prognostic upper air data (as a three-dimensional '3D.dat' file), which is used to derive an initial wind field (known as the Step 1 wind field in the CALMET model). The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and is adopted for this assessment. TAPM was used to generate gridded upper air data for each hour of the model run period, for input into CALMET.

Two CALMET modelling domains were configured, both centred over the Eco Precinct:

- An outer CALMET grid of 90 km (x axis) by 90 km (y axis) was run with a resolution of 1 km. Surface meteorological data from the EP AWS and BoM AWS locations at Goulburn Airport and Canberra Airport were incorporated into the modelling. TAPM-generated 3D.dat file with 3 km grid resolution was used as prognostic input file to Step 1 wind field calculations.
- An inner CALMET grid of 35 km (x axis) by 35 km (y axis) was run with a resolution of 0.25 km. Surface meteorological data from the EP AWS and BoM AWS locations at Goulburn Airport and Canberra Airport were incorporated into the modelling. TAPM-generated 3D.dat file with 1 km grid resolution was used as prognostic input file to Step 1 wind field calculations.

The observations at the surface stations provided the dominant influence on the derived wind field and the resultant dispersion meteorology within the model. The distance at which the observation influences the model (radius of influence) is determined by the CALMET setting 'RMAX'. The relative importance of the observation in the model (relative weighting of the Step 1 wind field and the observation) is determined by the CALMET setting 'R1'.

An RMAX value of 10 km was selected to allow for the influence of each meteorological observation stations on the surrounding area in CALMET calculations. More importantly, a weighting value of 3 km was selected for R1 based on the distance from the EP AWS site to the dominant ridgeline, reducing the weighting of the observations in calculations relative to Step 1 calculations beyond this distance.

To resolve the local topography in wind field calculations, consistent with Section 3.2.3 of TRC (2011), the radius of influence of terrain features (TERRAD) value was calculated based on the ridge-to-ridge dimension of the dominant valley surrounding the Eco Precinct (measured at approximately 4 km) divided by two, plus 2 km. This returned a TERRAD value of 4 km.

The detailed CALMET model options used are presented in Table B.1. These were selected in accordance with recommendations in in TRC (2011). Surface observations were included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind fields.

Table B.1 CALMET model options used

Flag	Descriptor	Default	Value used	
			Inner grid	Outer grid
IEXTRP	Extrapolate surface wind observations to upper layers.	Similarity theory	Similarity theory	Similarity theory
BIAS (NZ)	Relative weighting given to vertically extrapolated surface observations versus upper air data.	No default	-1, -0.9, -0.7, -0.5, 0, 0, 0, 0, 0, 0	-1, -0.9, -0.7, -0.5, 0, 0, 0, 0, 0, 0
TERRAD	Radius of influence of terrain.	No default	4	4
RMAX1 and RMAX2	Maximum radius of influence over land observations in layer 1 and aloft.	No default	10 (RMAX1) and 20 (RMAX2)	10 (RMAX1) and 20 (RMAX2)
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind field are weighted equally.	No default	3 (R1) and 20 (R2)	3 (R1) and 20 (R2)

Appendix C

Emissions inventory background

C.1 Fugitive dust emissions

C.1.1 Introduction

The approach for cumulative assessment is to model existing sources of fugitive dust emissions and add this to the regional background dataset to derive a site-specific ambient background for the local area. The following sections describe how existing sources of fugitive dust were estimated and modelled.

C.1.2 Emissions inventory overview

An emissions inventory was developed for the following fugitive dust scenarios:

- approved Veolia operations, based on approved waste throughput for the bioreactor (1.13 Mtpa) and MBT (280,000 tpa);
- existing Woodlawn Mine, based on approved underground ore production (350,000 tpa) and tailings recovery (1.15 Mtpa); and
- future operations, incorporating the additional fugitive dust sources associated with the ARC precinct.

For the future scenario emissions from the MBT and Woodlawn Mine project are assumed to be the same as the approved scenario; however, emissions for the Bioreactor are revised to account for the reduced waste throughput (with 380,000 tpa of approved throughput diverted from the Bioreactor to the ARC).

Emission estimates for the existing scenario include the main dust generating activity at each site, including:

- wheel generated dust from trucks entering, traversing and existing each site;
- material handling, including truck loading and unloading, re-handle and transfers;
- front end loaders spreading waste and managing stockpiles;
- processing/crushing of material (Woodlawn Mine only);
- ventilation shaft emissions (Woodlawn Mine only); and
- wind erosion from exposed ground and stockpiles;

Emission estimates for future operations at the ARC include:

- wheel generated dust from waste trucks entering the site (sealed access road);
- wheel generated dust from trucks transporting residues from the ARC (ARCr) to the encapsulation cell (unsealed internal movements);
- material handling, including waste tipping, unloading and spreading ARCr, transfer and handling of IBA/IBAA;
- screening/processing of IBA;
- loading and dispatch of IBAA; and
- wind erosion from encapsulation cell.

Fugitive dust emissions during the construction of the ARC would be less than operations, therefore the modelling focuses on an operational scenario only.

C.1.3 Emission reduction factors

The following dust mitigation measures have been incorporated into the emission inventory based on emission reduction factors reported by the National Pollution Inventory (NPI) (NPI 2011) and Katestone (2011):

- wheel generated dust emissions from internal unsealed road are controlled by 75%, based on level 2 watering (application rate >2 litres per m^2 per hour);
- wheel generated dust emissions from internal sealed road are controlled by 70%, based on an assumption that the road surface would be regularly cleaned by sweeping or water flushing, such that the silt loading would be maintained in the region of 2 g/m^2 (ie 70% reduction on the adopted silt content of 7.4 g/m^2);
- emissions occurring within buildings that are not completely sealed are controlled by 70% for enclosure; and
- emissions occurring within structures that are sealed are controlled by 100%, including:
  - loading trucks with ARCr and IBA at the ARC;
  - screening/processing in the MBT; and
  - loading trucks with residual waste at the MBT;
- emissions occurring within the tipping halls are controlled by 70% for enclosure, including:
  - waste unloading to the tipping floor of the ARC and MBT;
- tailings extraction is not included as a dust source (100% control), as the extraction process works by producing a wet slurry and pumping to the processing plant;
- wind erosion at the maturation pad is controlled by 50% to account for the operation of the existing water sprays; and
- wheel generated dust emissions from front end loaders pushing waste within the bioreactor are controlled by 50% to account for water sprays keeping travel routes moist (also noting the high residual moisture content of the surface material across the active tip face).

C.1.4 Emissions from the combustion of diesel fuel

Emissions generated by diesel combustion in plant and equipment would not contribute to ground level concentrations, based on separation distances of over 4 km to the nearest residences. Accordingly, with the exception of PM, diesel combustion emissions have not been quantitatively assessed. The emission factors developed for fugitive dust emission inventories do not separate PM emissions from mechanical processes (ie handling material) and diesel exhaust (combustion). However, to be conservative, the contribution from diesel combustion has been inventoried separately and assessed.

C.1.5 Summary of emissions

The estimated annual emissions for approved operations at the Bioreactor, MBT Facility and Herron Mine are presented in Table C.1, Table C.2 and Table C.3. The estimated annual emissions for the future operation of the ARC and Bioreactor are presented in Table C.4 and Table C.5. The estimated annual emissions are presented as controlled emissions, based on the control measures documented in Section C.1.3.

Table C.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for the Bioreactor (approved)

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wheel generated dust – MSW trucks in – unsealed	80,949	21,853	2,185
Unloading at tip face	251	119	18
Unloading MBT residual at tip face	12.5	5.9	0.9
FEL spreading – wheel generated dust	46,152	12,459	1,246
Wheel generated dust – MSW trucks out – unsealed	55,973	15,110	1,511
Exposed ground wind erosion – active tip face	1,275	638	96
Grader (road maintenance)	512	179	16
Wheel generated dust – in pit movements	18,187	4,910	491
Diesel consumption – nonroad equipment	527.0	527.0	511.2
Total	**203,838**	**55,800**	**6,075**

Table C.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for the MBT (approved)

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wheel generated dust - MBT trucks in – unsealed	17,323	4,676	468
Unloading	0.0	0.0	0.0
Screening	0	0	0
Wheel generated dust – MBT trucks out – unsealed	11,978	3,234	323
Loading trucks with MBT residual for bioreactor	0.0	0.0	0.0
Wheel generated dust – residual trucks to Bioreactor – unsealed	8,730	2,357	236
Unloading to maturation pad	132	62	9
Wheel generated dust – FEL to maturation pad	11,538	3,115	311
FEL handling on maturation pad	132	62	9
Exposed ground wind erosion – maturation pad	638	319	48
Diesel consumption – nonroad equipment	132	132	128
Total	**50,601**	**13,956**	**1,533**

Table C.3 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for the Woodlawn Mine Project (approved)

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Loading trucks with ore at portal	0	0	0
Wheel generated dust – portal to ROM pad	23,108	6,238	624
Unloading UG ore to ROM pad	741.1	350.5	53.1
Loading UG ore to crusher	741.1	350.5	53.1
Crushing UG ore	2,187.5	210.0	38.9
Rehandle UG ore	741.1	350.5	53.1
Tailing extraction (slurry)	0.0	0.0	0.0
Feeding mill with tailings (slurry)	0.0	0.0	0.0
Loading trucks with waste	529	250	38
Wheel generated dust – waste to waste dump	8,253	2,228	223
Unloading waste to waste dump	22.2	10.5	1.6
Wheel generated dust – tailings to paste fill plant	23,108	6,238	624
Loading trucks with concentrate	0.0	0.0	0.0
Wheel generated dust – concentrate trucks offsite	2,622	503	122
Exposed ground wind erosion – ROM pad	425	213	32
Exposed ground wind erosion – waste rock dump	1,530	765	115
Exposed ground wind erosion – TSF4	9,350	4,675	701
Exposed ground wind erosion – TDN	0	0	0
Exposed ground wind erosion – TDS	0	0	0
Exposed ground wind erosion – TDW	0	0	0
Ventilation shaft	11,826	5,913	2,957
Total	**85,183**	**28,295**	**5,634**

Table C.4 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for the ARC Precinct (future)

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wheel generated dust – MSW trucks in – sealed	4,724	907	219
Unloading feedstock to tip floor	25	12	2
Loading trucks with IBA	0	0	0
Conveyor/transfer – IBA to processing pad	127	60	9
Drop from conveyor to pile	425	201	30
Screening/processing	950	327	2
Transfer to IBA maturation area	425	201	30
Unload to IBA maturation area	425	201	30
Exposed ground wind erosion – IBA maturation area	595	298	45
Loading trucks with IBAA product	425	201	30
Wheel generated dust – IBAA trucks to bioreactor – unsealed	3,912	1,056	106
Loading trucks with APCr	0	0	0
Wheel generated dust – APCr trucks to encapsulation cell – unsealed	1,227	331	33
Unload APCr to encapsulation cell	64	30	5
FEL on encapsulation cell	4,615	1,246	125
Exposed ground wind erosion – encapsulation cell	1,700	850	128
Diesel consumption – nonroad equipment	137	137	133
Total	**19,776**	**6,058**	**927**

Table C.5 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for the Bioreactor (future)

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wheel generated dust – MSW trucks in – unsealed	53,727	14,504	1,450
Unloading at tip face	167	79	12
Unloading MBT residual at tip face	12	6	1
Unload IBA to containment cell	161	76	12
FEL spreading – wheel generated dust	46,152	12,459	1,246
Wheel generated dust – MSW trucks out – unsealed	37,150	10,029	1,003
Exposed ground wind erosion – active tip face	1,275	638	96
Grader (road maintenance)	512	179	16
Wheel generated dust – in pit movements	12,071	3,259	326
Diesel consumption – nonroad equipment	350	350	339
Total	**151,577**	**41,578**	**4,500**

A summary of the contribution to annual PM_{10} and $PM_{2.5}$ emissions by source group is provided in Figure C.1 and Figure C.2, for the approved and future scenarios. As shown, emissions from the ARC represents a small addition, while the reduction in emissions for the Bioreactor for the future scenario results in an overall reduction in total PM_{10} and $PM_{2.5}$.

Figure C.1 Contribution to annual fugitive PM_{10} emissions by emissions project component

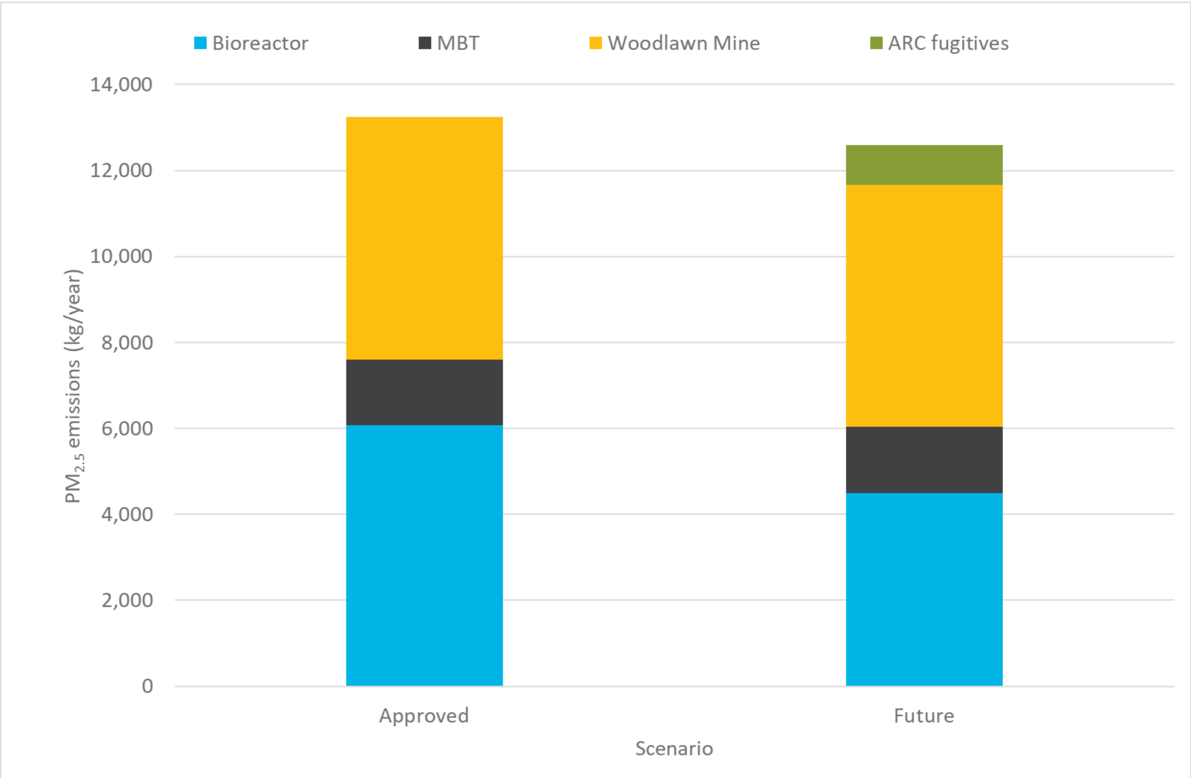

Figure C.2 Contribution to annual fugitive $PM_{2.5}$ emissions by emissions project component

C.2 Emissions inventory inputs and assumptions

Fugitive dust emissions for all activities were quantified using United States Environmental Protection Agency (US EPA) AP-42 emission factor equations (US EPA 1995), as follows:

- AP-42 Chapter 13.2.1 – Paved Roads (US-EPA 2011) – emission factor equation for wheel generated dust on paved road;
- AP-42 Chapter 13.2.1 – Unpaved Roads (US-EPA 2011) – emission factor equation for wheel generated dust on paved road;
- AP-42 Chapter 11.9 – Western Surface Coal Mining (US-EPA 1998) - emission factor for wind erosion from exposed surfaces;
- AP-42 Chapter 13.2.4 – Aggregate Handling and Storage Piles (US-EPA 2006) – emission factor equation for material handling; and
- AP-42 Chapter 11.19.2 – Crushed Stone Processing and Pulverized Mineral Processing (US-EPA 2004) – emission factor equation for screening.

It is noted that fugitive dust emission factors are also provided in the NPI emission estimation technique manuals published by the Australian Government (eg NPI 2011); however, the NPI emission factors are largely based on the AP-42 documentation and the use of the AP-42 emission factors for fugitive dust emission inventories is therefore accepted by the NSW EPA for use in NSW.

Particulate matter emissions were quantified for the three size fractions identified in Section 4, with the TSP fraction also used to model dust deposition. Emission rates for coarse particles (PM_{10}) and fine particles ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available in the literature (principally the US EPA AP-42).

The basis for some of the input assumptions is summarised in Table C.6 with all activity data and inputs assumptions shown in Table C.7 through to Table C.11.

Table C.6 Assumptions for emission estimation

Material properties	Value	Source of information
Paved road silt loading	7.4 g/m^2	AP-42 Chapter 13.2.1, Table 13.2.1-3, mean value for Municipal solid waste landfill.
Unpaved silt content (%)	6.4%	AP-42 Chapter 13.2.2, Table 13.2.2-1, mean value for Municipal solid waste landfill.
Waste moisture content (%)	10%	10% adopted as a conservative estimate. Moisture content of waste would vary, with MSW waste significantly higher and C&D likely to be slightly lower.
IBA moisture content (%)	1%	1% selected as a conservative estimate.
ARCr moisture content (%)	1%	1% selected as a conservative estimate.
Ore and waste rock moisture content (%)	2%	Taken from Herron Mine Air Quality Impact Assessment (PAEHolmes, 2012).
Concentration product content (%)	10%	Taken from Herron Mine Air Quality Impact Assessment (PAEHolmes, 2012).
Average wind speed (m/s)	3.4	Onsite measurements, average for 2018.

Diesel emissions were calculated based on the annual diesel consumption for 2019–2020 (taken from NGERs data) and scaled for the difference in waste throughput, for the approved (1.13 Mtpa) and future (750,000 tpa) scenarios. US EPA emission factors for off-road diesel equipment (Tier 2 for engines between 75–130 kW) were used. The emission standard is assumed to correspond to TSP and PM_{10}. $PM_{2.5}$ emissions are assumed to comprise 97% of PM_{10} emissions.

Table C.7 Emission inventory inputs – Bioreactor approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – MSW trucks in – unsealed	106,239	VKT/y	3.05	0.82	0.08	kg/VKT	6.4	% silt content	2.2	km	48,291	Loads/y	42	Loaded weight (t)	23.4	Average truck load (t)	0.75	Water sprays
Unloading at tip face	1,130,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)	132.303							
Unloading MBT residual at tip face	56,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)								
FEL spreading – wheel generated dust	28,000	VKT/y	3.30	0.89	0.09	kg/VKT	6.4	% silt content	,3500	FEL hours	8	speed in km/h	50.0	FEL weight (t)			0.5	Water sprays
Wheel generated dust – MSW trucks out – unsealed	106,239	VKT/y	2.11	0.57	0.06	kg/VKT	6.4	% silt content	2.2	km	48,291	Loads/y	18.5	Empty weight (t)			0.75	Water sprays
Exposed ground wind erosion – active tip face	1.5	Area (ha)	850	425	64	kg/ha/y												
Grader (road maintenance)	3,328	VKT/y	0.62	0.22	0.02	kg/km	8	speed of graders in km/h	416	grader hours							0.75	Water sprays
Wheel generated dust – in pit movements	26,250	VKT/y	2.77	0.75	0.07	kg/VKT	6.4	% silt content	1,750	trucks hours	15	speed in km/h	34	Average weight (t)	24	Truck capacity (t)	0.75	Water sprays

Table C.7 Emission inventory inputs – Bioreactor approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables	Control	Control type
Diesel consumption – non-road equipment	798	kl/y	0.66	0.66	0.64	kg/kL			

Table C.8 Emission inventory inputs – MBT approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – MBT trucks in – unsealed	22,735	VKT/y	3.05	0.82	0.08	kg/VKT	6.4	% silt content	1.9	km	11,966	Loads/y	42	Loaded weight (t)	23.4	Average truck load (t)	0.75	Water sprays
Unloading	280,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)							1	Enclosure and high mc
Screening	280,000	t/y	0.0125	0.0043	0.000025	kg/t											1	Enclosure
Wheel generated dust – MBT trucks out – unsealed	22,735	VKT/y	2.11	0.57	0.06	kg/VKT	6.4	% silt content	1.9	km	11,966	Loads/y	18.5	Empty weight (t)			0.75	Water sprays
Loading trucks with MBT residual for bioreactor	56,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)							1	Enclosure and high mc

Table C.8 Emission inventory inputs – MBT approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – residual trucks to Bioreactor – unsealed	12,600	VKT/y	2.77	0.75	0.07	kg/VKT	6.4	% silt content	5.4	km/return trip	2,333	Loads/y	34	Average weight (t)	24	Truck capacity (t)	0.75	Water sprays
Unloading to maturation pad	224,000	t/y	0.0006	0.0003	0.00004	kg/t	3.4	wind speed (m/s)	5	Moisture content (%)								
Wheel generated dust – FEL to maturation pad	7,000	VKT/y	3.30	0.89	0.09	kg/VKT	6.4	% silt content	875	FEL hours	8	speed in km/h	50.0	FEL weight (t)			0.5	Water sprays
FEL handling on maturation pad	224,000	t/y	0.0006	0.0003	0.00004	kg/t	3.4	wind speed (m/s)	5	Moisture content (%)								
Exposed ground wind erosion – maturation pad	1.5	Area (ha)	850	425	64	kg/ha/y											0.5	Water sprays
Diesel consumption – nonroad equipment	200	kl/y	0.66	0.66	0.64	kg/kL												

Table C.9 Emission inventory inputs – Woodlawn Mine Project approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Loading trucks with ore at portal	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)							1	underground
Wheel generated dust – portal to ROM pad	29,400	VKT/y	3.14	0.85	0.08	kg/VKT	6.4	% silt content	4.2	km/return trip	7,000	Loads/y	45	Average weight (t)	50	Truck capacity (t)	0.75	Water sprays
Unloading UG ore to ROM pad	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								
Loading UG ore to crusher	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								
Crushing UG ore	350,000	t/y	0.0125	0.0012	0.00022	kg/t								8.4			0.5	Water sprays
Rehandle UG ore	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)				0.084				
Tailing extraction (slurry)	1,150,000	t/y	0.0000	0.0000	0.00000	kg/t	3.4	wind speed (m/s)	40	Moisture content (%)							1	Slurry
Feeding mill with tailings (slurry)	1,150,000	t/y	0.0000	0.0000	0.00000	kg/t	3.4	wind speed (m/s)	40	Moisture content (%)							1	Slurry
Loading trucks with waste	250,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								

Table C.9 Emission inventory inputs – Woodlawn Mine Project approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – waste to waste dump	10,500	VKT/y	3.14	0.85	0.08	kg/VKT	6.4	% silt content	2.1	km/ return trip	5,000	Loads/y	45	Average weight (t)	50	Truck capacity (t)	0.75	Water sprays
Unloading waste to waste dump	10,500	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								
Wheel generated dust – tailings to paste fill plant	29,400	VKT/y	3.14	0.85	0.08	kg/VKT	6.4	% silt content	4.2	km/ return trip	7,000	Loads/y	45	Average weight (t)	50	Truck capacity (t)	0.75	Water sprays
Loading trucks with concentrate	120,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)							1	Enclosure
Wheel generated dust – concentrate trucks offsite	12,000	VKT/y	0.73	0.14	0.03	kg/VKT	7.4	road surface silt loading (g/m2)	2.0	km	6,000	Loads/y	34	Average weight (t)	20	Truck capacity (t)	0.7	Sweeping
Exposed ground wind erosion – ROM pad	0.5	Area (ha)	850	425	64	kg/ha/y												
Exposed ground wind erosion – waste rock dump	1.8	Area (ha)	850	425	64	kg/ha/y												
Exposed ground wind erosion – TSF4	11.0	Area (ha)	850	425	64	kg/ha/y												

Table C.9 Emission inventory inputs – Woodlawn Mine Project approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Exposed ground wind erosion - TDN	32.0	Area (ha)	850	425	64	kg/ha/y											1	
Exposed ground wind erosion – TDS	40.0	Area (ha)	850	425	64	kg/ha/y											1	
Exposed ground wind erosion – TDW	22.0	Area (ha)	850	425	64	kg/ha/y											1	
Ventilation shaft	8,760	h/yr	1.4	0.7	0.3	kg/hr	150	m3/s	2.5	mg/m3 (TSP)								
Loading trucks with ore at portal	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)							1	Under-ground
Wheel generated dust – portal to ROM pad	29,400	VKT/y	3.14	0.85	0.08	kg/VKT	6.4	% silt content	4.2	km/retur n trip	7,000	Loads/y	45	Average weight (t)	50	Truck capacity (t)	0.75	Water sprays
Unloading UG ore to ROM pad	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								
Loading UG ore to crusher	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								
Crushing UG ore	350,000	t/y	0.0125	0.0012	0.00022	kg/t								8.4			0.5	Water sprays
Rehandle UG ore	350,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)				0.084				

Table C.9 Emission inventory inputs – Woodlawn Mine Project approved operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Tailing extraction (slurry)	1,150,000	t/y	0.0000	0.0000	0.00000	kg/t	3.4	wind speed (m/s)	40	Moisture content (%)							1	Slurry
Feeding mill with tailings (slurry)	1,150,000	t/y	0.0000	0.0000	0.00000	kg/t	3.4	wind speed (m/s)	40	Moisture content (%)							1	Slurry
Loading trucks with waste	250,000	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								
Wheel generated dust – waste to waste dump	10,500	VKT/y	3.14	0.85	0.08	kg/VKT	6.4	% silt content	2.1	km/ return trip	5,000	Loads/y	45	Average weight (t)	50	Truck capacity (t)	0.75	Water sprays
Unloading waste to waste dump	10,500	t/y	0.0021	0.0010	0.00015	kg/t	3.4	wind speed (m/s)	2	Moisture content (%)								

Table C.10 Emission inventory inputs – ARC Precinct future operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – MSW trucks in – sealed	24,359	VKT/y	0.65	0.12	0.03	kg/VKT	7.4	road surface silt loading (g/m2)	1.5	km/ return trip	16,239	Loads/y	30	Average weight (t)	23	Average truck load (t)	0.7	Sweeping /cleaning
Unloading feedstock to tip floor	380,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)							0.7	Enclosure and high mc
Conveyor/ transfer – IBA to processing pad	76,000	t/y	0.0056	0.0026	0.00040	kg/t	3.4	wind speed (m/s)	1	Moisture content (%)		2.22					0.7	Enclosure
Drop from conveyor to pile	76,000	t/y	0.0056	0.0026	0.00040	kg/t	3.4	wind speed (m/s)	1	Moisture content (%)								
Screening/ processing	76,000	t/y	0.0125	0.0043	0.000025	kg/t												
Transfer to IBA maturation area	76,000	t/y	0.0056	0.0026	0.00040	kg/t	3.4	wind speed (m/s)	1	Moisture content (%)								
Unload to IBA maturation area	76,000	t/y	0.0056	0.0026	0.00040	kg/t	3.4	wind speed (m/s)	1	Moisture content (%)								
Exposed ground wind erosion – IBA maturation area	0.7	Area (ha)	850	425	64	kg/ha/y												
Loading trucks with IBAA product	76,000	t/y	0.0056	0.0026	0.00040	kg/t	3.4	wind speed (m/s)	1	Moisture content (%)								

Table C.10 Emission inventory inputs – ARC Precinct future operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – IBAA product trucks out - unsealed	5,573	VKT/y	2.81	0.76	0.08	kg/VKT	6.4	% silt content	2.2	km	2,533	Loads/y	35	Average weight (t)	30	Truck capacity (t)	0.75	Water sprays
Wheel generated dust – APCr trucks to encapsulation cell - unsealed	1,748	VKT/y	2.81	0.76	0.08	kg/VKT	6.4	% silt content	4.6	km/return trip	380	Loads/y	35	Average weight (t)	30	Truck capacity (t)	0.75	Water sprays
Unload APCr to encapsulation cell	11,400	t/y	0.0056	0.0026	0.00040	kg/t	3.4	wind speed (m/s)	1	Moisture content (%)								
FEL on encapsulation cell	2,800	VKT/y	3.30	0.89	0.09	kg/VKT	6.4	% silt content	350	FEL hours	8	speed in km/h	50.0	FEL weight (t)			0.5	Water sprays
Exposed ground wind erosion – encapsulation cell	2.0	Area (ha)	850	425	64	kg/ha/y												
Diesel consumption – nonroad equipment	208	kl/y	0.66	0.66	0.64	kg/kL												

Table C.11 Emission inventory inputs - Bioreactor future operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables										Control	Control type
Wheel generated dust – MSW trucks in – unsealed	70,513	VKT/y	3.05	0.82	0.08	kg/VKT	6.4	% silt content	2.2	km	32,051	Loads/y	42	Loaded weight (t)	23.4	Average truck load (t)	0.75	Water sprays
Unloading at tip face	750,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)								
Unloading MBT residual at tip face	56,000	t/y	0.0002	0.0001	0.00002	kg/t	3.4	wind speed (m/s)	10	Moisture content (%)								
FEL spreading – wheel generated dust	28,000	VKT/y	3.30	0.89	0.09	kg/VKT	6.4	% silt content	3500	FEL hours	8	speed in km/h	50.0	FEL weight (t)			0.5	Water sprays
Wheel generated dust – MSW trucks out – unsealed	70,513	VKT/y	2.11	0.57	0.06	kg/VKT	6.4	% silt content	2.2	km	32,051	Loads/y	18.5	Empty weight (t)			0.75	Water sprays
Exposed ground wind erosion – active tip face	1.5	Area (ha)	850	425	64	kg/ha/y												
Grader (road maintenance)	3,328	km/y	0.62	0.22	0.02	kg/km	8	speed of graders in km/h	416	grader hours							0.75	Water sprays
Wheel generated dust – in pit movements	17,423	VKT/y	2.77	0.75	0.07	kg/VKT	6.4	% silt content					34	Average weight (t)	24	Truck capacity (t)	0.75	Water sprays

Table C.11 Emission inventory inputs - Bioreactor future operations

Activities	Activity rate	Units	TSP EF	PM_{10} EF	$PM_{2.5}$ EF	Units	Variables	Control	Control type
Diesel consumption – nonroad equipment	530	kl/y	0.66	0.66	0.64	kg/kL			

C.2.1 Metals profiles for fugitive emissions from the ARC

Profiles for fugitive metal emissions from the ARC are based on sampling from the Staffordshire ERF reference facility. Analysis data for IBA and ARCr residues in mg/kg were used to derive a weight percent of total dust emissions to predict metal concentrations.

Fugitive metal emissions associated with the haulage of APCr to the encapsulation cell (ie wheel generated dust) is also assessed, based on a speciation profile derived from soil analysis presented in Golder (2021).

The derived average weight percentages for the compounds included in this assessment is shown in Table C.12.

Table C.12 Metals speciation profile for fugitive dust

Compound	Weight percent (of $PM_{2.5}$)		
	IBA	APCr	Wheel generated dust
Antimony	0.007%	0.073%	0.000%
Arsenic	0.001%	0.005%	0.006%
Beryllium	0.000%	0.000%	0.000%
Cadmium	0.001%	0.017%	0.001%
Chromium	0.009%	0.007%	0.004%
Cobalt	0.004%	0.001%	0.000%
Copper	0.187%	0.049%	0.061%
Lead	0.062%	0.108%	0.334%
Manganese	0.067%	0.043%	0.000%
Mercury	0.000%	0.001%	0.000%
Nickel	0.008%	0.002%	0.002%
Thallium	0.000%	0.000%	0.000%
Vanadium	0.005%	0.003%	0.000%
Zinc	0.195%	0.869%	1.827%

C.3 BioEnergy power station and flares

Annual stack testing at the Bioenergy power station is a requirement of Environment Protection Licence (EPL) number 11436. Emission rates for the engines were derived from measurements taken at the Engine 2 stack between 2015 and 2020, as provided by Veolia. The measured in-stack concentration and derived emission rates are summarised in Table C.13.

Table C.13 Emission measurements from the BioEnergy Power Station

Pollutant	Measured concentration (mg/Nm^3)	Measured flow rate (Nm^3/s)	Emission rate (g/s)
NO_x	355.3	1.54	0.55
CO	804.7	1.54	1.23
SO_2	116.0	1.54	0.18
VOCs	13.1	1.54	0.02

Monitoring of $PM_{2.5}$ is not a requirement of the EPL, as emission rates for particles from gas combustion are very low. However, for completeness, emissions of $PM_{2.5}$ are included in the modelling, with emission rates derived from the NPI *Emission estimation technique (EET) manual for Combustion Engines* (NPI 2008). NPI emission factors (EFs) are provided for gas engines burning natural gas and biogas; however when the emission rates derived from the NPI EFs are compared to the measurements for CO and NO_x, the EFs estimates are significantly higher. The NPI EFs for gas turbines are lower than for gas engines, however when compared to the measurements (for CO and NO_x), the EFs estimates were significantly lower. Using an average of the engine and turbine EFs resulted in an emission rate (for CO and NO_x) that was the closest match to the stack measurements, therefore the average emission rate for $PM_{2.5}$ is used for modelling. An emission rate of 0.01 g/s is derived per engine, based on a gas flow rate of 3,500 m^3/hour (total gas flow to the power station).

C.3.1 Speciation profiles for organic compounds and trace elements

Emission factors for organic gases and trace elements are derived using speciation profiles from SPECIATE, the US EPA repository of speciation profiles of air pollution sources. For organic species, speciation profile 1001 was used (internal combustion engine – natural gas). Profile 1001 consists of 59 organic species for gas combustion, a sample of which are presented in Table C.14. Benzene, the proxy VOC selected for this assessment, has a weight percent of 0.11%, which is applied to the modelling results for total VOCs (99.9th percentile 1 hour average) to predict the benzene concentration.

Table C.14 Organic speciation profile for gas combustion

Compound	Weight percent (of total VOCs)
Acetaldehyde	0.03%
Benzene	0.11%
Cyclohexane	0.01%
Ethylbenzene	0.01%
Ethylene (or ethene)	0.63%
Formaldehyde	0.81%
Isomers of hexane	0.02%
Isomers of pentane	0.13%
Toluene	0.04%
Isomers of xylene	0.02%

For trace elements, a profile was derived based on the average weight percentage for three different profiles (3195 (gas combustion), 5669 (gas fired boilers) and 5671 (gas fired CCGT). The derived average weight percentages for the compounds included in this assessment is shown in Table C.15.

Table C.15 Metals speciation profile for gas combustion

Compound	Weight percent (of total PM)
Antimony	0.00%
Arsenic	0.02%
Beryllium	0.02%
Cadmium	0.00%
Chromium	0.02%
Copper	0.21%
Cobalt	0.01%
Lead	0.04%
Manganese	0.05%
Mercury	0.00%
Nickel	0.18%
Thallium	0.00%
Vanadium	0.07%
Zinc	0.31%

C.4 Flaring

Emissions from flaring were estimated based on emission factors published for flaring in the US EPA AP-42 Chapter 2.4 Municipal Solid Waste Landfills. The emission factors and emission rates are presented in Table C.16, derived for an estimated future flaring rate of 3,255,300 m^3/year or 6.2 m^3/min. Emission of benzene are estimated based on a measured VOC content of 13,000 mg/m^3 (Ektimo 2020) and the ratio of benzene to total non-methane organic compounds in landfill gas, also taken from US EPA AP-42 Chapter 2.4.

Table C.16 Emission estimates for flaring

Pollutant	Emission factor (kg/hour per m^3/min CH_4)	Emission factor (kg/hour)	Emission rate (g/s)
NO_x	0.039	0.24	0.07
CO	0.72	4.46	1.24
PM	0.016	0.10	0.03
Benzene			0.00012

C.5 Odour emission inventory

An odour emission inventory was derived for existing operations, based on the latest set of on-site measurements taken as part of the 2021 independent odour audit (number 9) (IOA#9) (TOU 2021). The landfill gas collection system operated by Veolia is continually improved and expanded to improve gas capture as waste filling progresses around the void. Therefore, the odour monitoring results from the latest odour audit are considered the most accurate representation of existing (and future) odour emissions from the Bioreactor.

Odour monitoring was conducted as part of IOA#9 in March 2021. Generally, odour emission rates (OERs) and specific odour emission rates (SOERs) reported in TOU (2021) are used directly for modelling. Where several measurements were taken for a source, the average is taken as the emission rates for modelling (for example, six samples were taken across the waste covered area).

A summary of the adopted SOERs and OERs are presented in Table C.17. Differences from the odour model presented in the IOA#9 are noted.

Odour sources are represented by a series of area and volume sources. Odour emissions from the Bioreactor, leachate ponds, leachate treatment, evaporation dams and MBT stockpiles are modelled as area sources with the emission rates (SOERs) expressed as odour unit volumes per square meter per second (ou.m^3/m^2/s). The areas for each source are taken from TOU (2021). Fugitive odour from buildings at the MBT, biofilter at the MBT and the proposed ARC building are modelled as volume sources, with the emission rates (OERs) expressed as odour unit volumes per second (ou.m^3/s).

Table C.17 Odour emission inventory

Emission source	Area (m^2)	SOER ($ou.m^3/m^2/s$	OER ($ou.m^3/s$)	Comment
Bioreactor				
Active tipping face	2,000	3.23	6,467	Consistent with IOA#9
Waste covered area – 150 mm	23,850	0.09	2,218	Differs from IOA#9 which uses 75th percentile of 12 samples from previous IOAs
Waste covered area – 300 mm	135,150	0.06	8,334	
ED1	60,100	0.41	24,881	Consistent with IOA#9
ED3N-1	7,500	0.41	3,105	Not modelled in IOA#9 (empty). Additional source for this assessment (SOER from ED1-Coffer Dam used)
ED3N-2	6,080	0.09	529	Consistent with IOA#9 (ED#N-2 and 3 are combined in IOA#9)
ED3N-3	6,230	0.63	3,954	
ED3N-4	36,600	0.53	19,215	Consistent with IOA#9
ED3S	71,500	0.10	6,864	Consistent with IOA#9
ED3S-S	20,100	2.20	44,220	Consistent with IOA#9
Leachate Treatment Dam (aerated zone)	4,090	3.10	12,663	Consistent with IOA#9
Leachate Treatment Dam (anoxic zone)				
Leachate Treatment Plant – Balance Tank	227	2.05	465	Consistent with IOA#9
Leachate Treatment Plant – Anoxic Tank1	28	1.30	36	Consistent with IOA#9
Leachate Treatment Plant – Anoxic Tank2	28	1.17	33	Consistent with IOA#9
Leachate Treatment Plant – Aeration Tank1	141	0.87	123	Consistent with IOA#9
Leachate Treatment Plant – Aeration Tank2	141	0.53	75	Consistent with IOA#9
MBT Facility				
MBT tipping hall	NA	NA	14,100	Not modelled in IOA#9. Additional source for this assessment
MBT treatment building	NA	NA	15,800	Not modelled in IOA#9. Additional source for this assessment
Leachate Aeration Pond	2,960	3.07	9,087	Consistent with IOA#9
Biofilter 1	NA	NA	5,300	Consistent with IOA#9
Biofilter 2	NA	NA	59,870	Consistent with IOA#9
Final screened	11,400	2.67	2,257	Consistent with IOA#9

Table C.17 Odour emission inventory

Emission source	Area (m^2)	SOER ($ou.m^3/m^2/s$)	OER ($ou.m^3/s$)	Comment
Screened – old		0.20		Consistent with IOA#9
Unscreened various ages		0.20		Consistent with IOA#9
Total – Bioreactor and MBT Facility			**242,275**	The total OER is slightly higher than total OER reported in IOA#9 (226,000), due to the additional sources added.
ARC				
ARC tipping hall	NA	NA	4,700	Additional source for future operations

Appendix D
Modelling results tables

EMM
creating opportunities

Table D.1 Scenario 1 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
1	13.5	4.4	9.9	0.0	0.3	0.0	0.1	0.0	0.0	0.0	1.1E-04	2.0E-05	6.2E-06	3.9E-06	0.0	3.9E-04	5.8E-06
2	17.4	3.9	8.7	0.0	0.2	0.0	0.1	0.0	0.0	0.0	8.8E-05	2.3E-05	7.5E-06	4.6E-06	0.0	4.3E-04	6.3E-06
3	16.9	2.9	8.5	0.0	0.2	0.0	0.1	0.0	0.0	0.0	9.8E-05	2.6E-05	1.1E-05	5.7E-06	0.0	4.3E-04	6.3E-06
4	22.0	6.5	8.7	0.0	0.5	0.0	0.2	0.0	0.1	0.0	1.8E-04	3.3E-05	1.3E-05	8.1E-06	0.0	1.0E-03	1.3E-05
5	33.4	8.8	9.0	0.0	0.5	0.0	0.3	0.0	0.1	0.0	1.5E-04	2.2E-05	9.8E-06	7.5E-06	0.0	1.0E-03	1.3E-05
6	33.3	11.7	8.9	0.0	0.6	0.0	0.3	0.0	0.1	0.0	1.4E-04	2.0E-05	7.9E-06	5.8E-06	0.0	8.2E-04	1.0E-05
7	16.9	2.9	17.2	0.0	0.2	0.0	0.1	0.0	0.0	0.0	1.4E-04	3.2E-05	1.4E-05	6.9E-06	0.0	5.6E-04	7.6E-06
8	30.4	10.5	8.8	0.0	0.5	0.0	0.2	0.0	0.1	0.0	1.3E-04	1.8E-05	7.9E-06	5.2E-06	0.0	7.6E-04	9.4E-06
9	18.9	2.7	10.5	0.0	0.2	0.0	0.1	0.0	0.0	0.0	7.9E-05	2.3E-05	9.8E-06	5.4E-06	0.0	5.0E-04	6.6E-06
10	32.2	4.6	20.6	0.0	0.3	0.0	0.1	0.0	0.0	0.0	1.2E-04	2.4E-05	1.0E-05	5.7E-06	0.0	4.5E-04	5.0E-06
11	29.1	3.9	13.8	0.0	0.2	0.0	0.1	0.0	0.0	0.0	8.2E-05	1.9E-05	8.2E-06	5.1E-06	0.0	5.3E-04	6.7E-06
12	27.2	5.4	11.3	0.0	0.3	0.0	0.1	0.0	0.0	0.0	1.1E-04	2.1E-05	8.6E-06	5.3E-06	0.0	5.8E-04	7.4E-06
13	24.0	7.0	5.7	0.0	0.4	0.0	0.2	0.0	0.1	0.0	6.9E-05	1.8E-05	6.7E-06	5.0E-06	0.0	6.3E-04	8.2E-06
14	19.6	7.0	8.6	0.0	0.4	0.0	0.2	0.0	0.1	0.0	8.7E-05	1.7E-05	6.7E-06	5.0E-06	0.0	6.4E-04	8.4E-06
15	30.2	7.4	13.3	0.0	0.4	0.0	0.2	0.0	0.1	0.0	9.6E-05	1.6E-05	6.7E-06	5.0E-06	0.0	6.6E-04	8.7E-06
16	21.8	5.4	8.9	0.0	0.3	0.0	0.1	0.0	0.0	0.0	1.2E-04	2.2E-05	8.9E-06	5.5E-06	0.0	6.4E-04	8.1E-06
17	26.6	5.9	11.9	0.0	0.3	0.0	0.2	0.0	0.1	0.0	9.8E-05	1.8E-05	6.1E-06	4.7E-06	0.0	5.8E-04	7.8E-06
18	24.8	5.7	7.5	0.0	0.3	0.0	0.1	0.0	0.0	0.0	8.8E-05	1.8E-05	5.7E-06	4.6E-06	0.0	5.4E-04	7.5E-06
19	17.8	4.8	6.8	0.0	0.4	0.0	0.2	0.0	0.0	0.0	1.6E-04	2.9E-05	1.1E-05	6.8E-06	0.0	8.4E-04	1.1E-05

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
20	34.9	10.8	9.4	0.0	0.5	0.0	0.2	0.0	0.1	0.0	8.7E-05	1.8E-05	6.0E-06	5.1E-06	0.0	7.0E-04	9.6E-06
21	46.6	19.5	11.6	0.1	0.9	0.0	0.2	0.0	0.1	0.0	9.1E-05	2.0E-05	7.3E-06	5.9E-06	0.0	9.3E-04	1.3E-05
22	94.0	34.1	40.7	0.1	1.6	0.0	0.3	0.0	0.2	0.0	1.3E-04	2.8E-05	9.6E-06	7.1E-06	0.0	1.2E-03	1.7E-05
23	46.3	16.4	12.2	0.0	0.8	0.0	0.2	0.0	0.1	0.0	8.7E-05	2.0E-05	7.2E-06	5.6E-06	0.0	8.5E-04	1.2E-05
24	25.7	4.4	11.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	5.6E-05	1.2E-05	4.3E-06	3.1E-06	0.0	2.6E-04	4.3E-06
25	23.9	5.7	10.0	0.0	0.3	0.0	0.1	0.0	0.0	0.0	7.9E-05	1.6E-05	5.9E-06	4.1E-06	0.0	4.9E-04	7.6E-06
26	49.5	11.3	20.8	0.1	0.6	0.0	0.2	0.0	0.1	0.0	9.0E-05	1.8E-05	6.8E-06	5.3E-06	0.0	7.0E-04	1.1E-05
27	100.7	42.2	20.0	0.1	2.0	0.0	0.2	0.0	0.2	0.0	1.5E-04	2.5E-05	1.0E-05	7.6E-06	0.0	9.7E-04	1.5E-05
28	49.7	11.5	17.1	0.1	0.6	0.0	0.2	0.0	0.1	0.0	1.5E-04	3.6E-05	1.2E-05	1.1E-05	0.0	2.8E-03	3.4E-05
29	51.4	9.0	17.1	0.0	0.4	0.0	0.1	0.0	0.0	0.0	1.1E-04	2.2E-05	6.2E-06	5.2E-06	0.0	7.6E-04	1.1E-05
30	21.5	5.6	8.7	0.0	0.3	0.0	0.2	0.0	0.1	0.0	9.6E-05	2.0E-05	5.5E-06	4.9E-06	0.0	8.8E-04	1.2E-05
31	25.8	9.2	10.8	0.1	0.5	0.0	0.2	0.0	0.1	0.0	7.4E-05	1.7E-05	5.6E-06	4.6E-06	0.0	9.3E-04	1.3E-05
32	37.4	7.0	14.2	0.1	0.6	0.0	0.2	0.0	0.1	0.0	6.1E-05	1.6E-05	7.0E-06	5.0E-06	0.0	1.1E-03	1.6E-05
33	47.9	9.4	16.0	0.1	0.6	0.0	0.2	0.0	0.1	0.0	7.0E-05	1.7E-05	8.1E-06	5.6E-06	0.0	1.2E-03	1.8E-05
34	226.7	28.6	63.1	0.2	2.9	0.1	7.4	0.2	2.5	0.0	3.5E-04	8.6E-05	3.3E-05	1.5E-05	0.3	2.8E-02	3.9E-04
35	50.7	10.3	15.8	0.4	0.8	0.1	0.7	0.1	0.2	0.0	3.0E-04	1.3E-04	8.8E-05	6.5E-05	0.1	1.6E-02	1.6E-04
36	65.0	9.6	17.7	0.3	0.6	0.1	0.7	0.1	0.2	0.0	2.5E-04	6.9E-05	3.4E-05	2.7E-05	0.1	1.6E-02	1.5E-04
37	41.0	10.4	13.4	0.3	0.6	0.1	0.8	0.1	0.2	0.0	2.2E-04	6.4E-05	3.2E-05	2.4E-05	0.1	1.2E-02	1.2E-04
38	65.9	8.9	17.7	0.3	0.6	0.1	0.8	0.1	0.2	0.0	2.0E-04	5.5E-05	3.1E-05	2.5E-05	0.1	1.4E-02	1.4E-04

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
39	36.9	7.6	15.6	0.2	0.4	0.1	0.7	0.0	0.2	0.0	1.4E-04	4.1E-05	2.6E-05	2.0E-05	0.1	8.9E-03	9.4E-05
40	26.1	6.9	11.0	0.2	0.4	0.0	0.6	0.0	0.2	0.0	1.3E-04	3.7E-05	2.3E-05	1.8E-05	0.1	7.7E-03	8.1E-05
41	26.8	6.2	11.6	0.2	0.4	0.0	0.5	0.0	0.1	0.0	1.2E-04	3.5E-05	2.2E-05	1.7E-05	0.1	6.8E-03	7.2E-05
42	32.2	7.9	13.6	0.2	0.5	0.1	0.8	0.0	0.2	0.0	1.5E-04	3.8E-05	2.4E-05	1.9E-05	0.1	8.6E-03	9.2E-05
43	411.1	103.5	65.4	5.3	11.3	1.6	11.1	1.8	2.4	0.4	1.9E-03	8.0E-04	5.7E-04	4.5E-04	2.9	3.7E-01	3.9E-03
44	50.2	8.1	14.6	0.2	0.6	0.1	0.9	0.1	0.2	0.0	1.6E-04	3.6E-05	2.3E-05	1.9E-05	0.1	8.8E-03	9.8E-05
45	36.9	6.0	11.0	0.2	0.3	0.0	0.6	0.0	0.2	0.0	1.3E-04	3.1E-05	1.8E-05	1.5E-05	0.0	6.1E-03	6.5E-05
46	27.7	4.9	10.6	0.1	0.4	0.0	0.5	0.0	0.1	0.0	1.1E-04	2.8E-05	1.6E-05	1.3E-05	0.0	4.9E-03	5.4E-05
47	59.3	7.7	17.5	0.2	0.6	0.1	0.7	0.1	0.2	0.0	1.7E-04	4.1E-05	2.5E-05	2.2E-05	0.1	1.3E-02	1.3E-04
48	52.9	9.9	15.6	0.2	0.7	0.1	0.6	0.0	0.2	0.0	1.8E-04	3.4E-05	2.0E-05	1.7E-05	0.1	7.0E-03	8.2E-05
49	23.4	4.4	8.0	0.1	0.3	0.0	0.4	0.0	0.1	0.0	1.2E-04	2.6E-05	1.4E-05	1.2E-05	0.0	4.3E-03	4.8E-05
50	64.0	8.6	13.0	0.2	0.5	0.0	0.7	0.1	0.2	0.0	1.7E-04	3.6E-05	2.0E-05	1.9E-05	0.1	1.1E-02	1.1E-04
51	58.1	7.7	12.0	0.2	0.4	0.0	0.7	0.0	0.2	0.0	1.3E-04	3.1E-05	1.7E-05	1.6E-05	0.1	8.2E-03	8.9E-05
52	24.5	4.2	7.6	0.1	0.3	0.0	0.3	0.0	0.1	0.0	9.4E-05	1.9E-05	1.1E-05	9.7E-06	0.0	3.6E-03	4.2E-05
53	49.4	13.7	17.1	0.3	0.8	0.1	1.3	0.1	0.3	0.0	2.4E-04	5.5E-05	3.1E-05	2.8E-05	0.1	1.9E-02	1.9E-04
54	54.7	10.8	14.5	0.2	0.7	0.1	0.8	0.1	0.2	0.0	1.7E-04	4.2E-05	2.4E-05	2.1E-05	0.1	1.3E-02	1.3E-04
55	34.4	5.2	7.1	0.1	0.3	0.0	0.3	0.0	0.1	0.0	5.4E-05	1.8E-05	1.1E-05	7.9E-06	0.0	3.6E-03	4.1E-05
56	31.0	7.7	11.7	0.2	0.5	0.0	0.7	0.1	0.2	0.0	1.2E-04	3.6E-05	2.2E-05	1.7E-05	0.1	1.1E-02	1.0E-04
57	26.2	5.8	10.3	0.1	0.4	0.0	0.6	0.0	0.2	0.0	1.1E-04	3.4E-05	2.0E-05	1.5E-05	0.1	8.9E-03	8.9E-05

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
58	61.6	8.6	7.6	0.1	0.4	0.0	0.6	0.0	0.2	0.0	8.6E-05	2.5E-05	1.4E-05	8.6E-06	0.0	4.4E-03	5.3E-05
59	57.1	7.4	14.1	0.1	0.4	0.0	0.5	0.0	0.2	0.0	7.8E-05	2.5E-05	1.2E-05	8.6E-06	0.0	4.9E-03	5.1E-05
60	48.9	7.0	15.7	0.1	0.4	0.0	0.3	0.0	0.1	0.0	1.0E-04	2.0E-05	1.0E-05	7.4E-06	0.0	3.5E-03	3.6E-05
61	17.6	3.4	15.7	0.1	0.2	0.0	0.2	0.0	0.1	0.0	1.3E-04	2.0E-05	1.0E-05	6.9E-06	0.0	2.8E-03	2.8E-05
62	27.7	4.1	15.8	0.1	0.2	0.0	0.2	0.0	0.1	0.0	1.3E-04	2.2E-05	1.1E-05	7.3E-06	0.0	3.2E-03	3.1E-05
63	28.8	4.0	7.8	0.1	0.2	0.0	0.2	0.0	0.1	0.0	8.0E-05	1.8E-05	8.0E-06	6.0E-06	0.0	2.5E-03	2.5E-05
64	35.5	4.9	7.7	0.1	0.2	0.0	0.2	0.0	0.1	0.0	6.4E-05	1.7E-05	7.3E-06	5.4E-06	0.0	1.9E-03	2.1E-05
65	39.2	5.8	11.2	0.1	0.3	0.0	0.2	0.0	0.1	0.0	6.7E-05	1.7E-05	8.6E-06	5.2E-06	0.0	1.5E-03	1.7E-05
66	33.8	5.3	12.7	0.1	0.3	0.0	0.2	0.0	0.1	0.0	1.1E-04	1.6E-05	9.3E-06	5.6E-06	0.0	1.2E-03	1.5E-05
67	34.9	4.9	12.6	0.1	0.3	0.0	0.2	0.0	0.1	0.0	9.3E-05	1.6E-05	8.6E-06	5.7E-06	0.0	1.2E-03	1.5E-05
68	39.2	5.4	13.0	0.1	0.3	0.0	0.1	0.0	0.1	0.0	8.8E-05	2.1E-05	9.9E-06	6.4E-06	0.0	1.8E-03	1.8E-05
69	36.3	7.0	15.4	0.1	0.3	0.0	0.2	0.0	0.1	0.0	1.0E-04	2.4E-05	1.1E-05	6.8E-06	0.0	2.3E-03	2.0E-05
70	16.8	2.9	11.3	0.0	0.3	0.0	0.1	0.0	0.0	0.0	6.7E-05	1.3E-05	6.7E-06	3.6E-06	0.0	4.3E-04	6.9E-06
71	134.1	19.2	19.9	0.1	1.0	0.0	0.7	0.0	0.3	0.0	1.4E-04	3.2E-05	1.5E-05	9.3E-06	0.0	5.5E-03	6.2E-05
72	134.1	19.2	19.9	0.1	1.0	0.0	0.7	0.0	0.3	0.0	1.4E-04	3.2E-05	1.5E-05	9.3E-06	0.0	5.5E-03	6.2E-05
73	16.9	3.0	13.5	0.0	0.3	0.0	0.1	0.0	0.0	0.0	6.1E-05	1.2E-05	6.4E-06	3.6E-06	0.0	4.2E-04	6.8E-06
74	23.6	4.7	13.8	0.0	0.4	0.0	0.2	0.0	0.1	0.0	8.3E-05	1.4E-05	7.6E-06	4.4E-06	0.0	7.0E-04	1.0E-05
75	16.6	3.2	14.3	0.0	0.3	0.0	0.1	0.0	0.0	0.0	6.2E-05	1.3E-05	6.3E-06	3.7E-06	0.0	4.4E-04	7.1E-06
76	29.0	7.1	14.8	0.1	0.6	0.0	0.3	0.0	0.1	0.0	8.6E-05	1.5E-05	8.3E-06	5.0E-06	0.0	8.4E-04	1.2E-05

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
77	16.5	3.1	14.4	0.0	0.3	0.0	0.2	0.0	0.0	0.0	6.3E-05	1.3E-05	6.3E-06	3.8E-06	0.0	4.4E-04	7.2E-06
78	22.2	3.4	9.6	0.1	0.2	0.0	0.1	0.0	0.0	0.0	7.8E-05	1.4E-05	8.6E-06	4.9E-06	0.0	8.3E-04	1.2E-05
79	36.0	6.9	11.3	0.1	0.7	0.0	0.2	0.0	0.1	0.0	8.3E-05	2.1E-05	9.7E-06	6.4E-06	0.0	1.5E-03	1.6E-05
80	20.1	3.1	9.5	0.0	0.2	0.0	0.1	0.0	0.0	0.0	8.0E-05	1.4E-05	8.3E-06	4.6E-06	0.0	7.7E-04	1.1E-05
81	14.4	3.2	10.4	0.0	0.3	0.0	0.2	0.0	0.0	0.0	6.4E-05	1.3E-05	6.1E-06	3.4E-06	0.0	4.3E-04	7.1E-06
82	14.6	3.1	8.1	0.0	0.2	0.0	0.2	0.0	0.0	0.0	6.6E-05	1.3E-05	5.9E-06	2.8E-06	0.0	3.9E-04	6.8E-06
83	62.5	13.1	21.5	0.1	0.6	0.0	0.3	0.0	0.1	0.0	7.7E-05	1.4E-05	7.4E-06	4.0E-06	0.0	8.1E-04	1.2E-05
84	15.8	4.0	8.3	0.0	0.3	0.0	0.2	0.0	0.0	0.0	7.8E-05	1.6E-05	7.9E-06	4.3E-06	0.0	7.5E-04	1.1E-05
85	18.3	5.6	8.6	0.1	0.4	0.0	0.2	0.0	0.1	0.0	9.0E-05	1.7E-05	8.2E-06	4.7E-06	0.0	9.8E-04	1.2E-05
86	43.0	8.8	18.6	0.0	0.4	0.0	0.3	0.0	0.1	0.0	7.2E-05	1.3E-05	6.0E-06	3.1E-06	0.0	6.6E-04	1.0E-05
87	114.9	16.3	19.8	0.1	0.8	0.0	0.7	0.0	0.3	0.0	1.6E-04	3.2E-05	1.7E-05	1.1E-05	0.1	8.3E-03	8.6E-05
88	1266.4	253.5	98.5	11.6	27.8	5.1	25.9	5.7	8.4	1.3	1.2E-03	3.2E-04	2.3E-04	1.8E-04	10.3	1.3E+00	1.2E-02
89	13.5	4.0	5.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	3.5E-05	6.9E-06	4.6E-06	2.6E-06	0.0	3.8E-04	6.9E-06
90	39.9	6.1	11.1	0.1	0.3	0.0	0.4	0.0	0.1	0.0	8.4E-05	1.6E-05	7.6E-06	4.4E-06	0.0	1.3E-03	2.0E-05
91	13.0	2.8	3.9	0.0	0.1	0.0	0.2	0.0	0.0	0.0	3.8E-05	7.3E-06	3.9E-06	2.3E-06	0.0	3.3E-04	6.3E-06
92	11.4	2.4	4.1	0.0	0.1	0.0	0.2	0.0	0.0	0.0	3.9E-05	7.6E-06	3.7E-06	2.2E-06	0.0	3.3E-04	6.4E-06
93	13.0	2.6	5.6	0.0	0.2	0.0	0.1	0.0	0.0	0.0	3.4E-05	7.0E-06	3.6E-06	2.2E-06	0.0	2.9E-04	5.6E-06
94	13.6	2.9	5.9	0.0	0.2	0.0	0.1	0.0	0.0	0.0	3.4E-05	7.2E-06	3.6E-06	2.3E-06	0.0	2.9E-04	5.7E-06
95	14.2	3.4	6.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	3.5E-05	7.9E-06	3.7E-06	2.3E-06	0.0	3.0E-04	5.8E-06

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO$_2$		SO$_2$		PM$_{10}$		PM$_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
96	11.1	1.7	4.6	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.7E-05	4.1E-06	2.0E-06	1.7E-06	0.0	2.1E-04	3.0E-06
97	16.2	2.1	6.8	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.6E-05	4.7E-06	2.3E-06	1.9E-06	0.0	2.3E-04	3.3E-06
98	43.4	9.6	18.8	0.1	0.5	0.0	0.2	0.0	0.1	0.0	1.3E-04	2.2E-05	9.2E-06	5.2E-06	0.0	1.2E-03	1.7E-05
99	25.7	3.2	10.8	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.8E-05	5.3E-06	2.4E-06	1.8E-06	0.0	2.4E-04	3.4E-06
100	27.7	3.5	11.7	0.0	0.2	0.0	0.1	0.0	0.0	0.0	2.8E-05	5.4E-06	2.4E-06	1.8E-06	0.0	2.5E-04	3.5E-06
101	55.3	9.2	23.7	0.0	0.4	0.0	0.1	0.0	0.0	0.0	5.7E-05	1.6E-05	5.9E-06	3.7E-06	0.0	3.5E-04	7.1E-06
102	53.9	9.5	23.1	0.0	0.4	0.0	0.1	0.0	0.0	0.0	5.4E-05	1.4E-05	5.5E-06	3.4E-06	0.0	3.8E-04	7.4E-06
103	34.0	4.3	14.4	0.0	0.2	0.0	0.1	0.0	0.0	0.0	3.5E-05	6.4E-06	2.5E-06	1.9E-06	0.0	2.7E-04	4.0E-06
104	20.2	2.5	8.5	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.9E-05	5.4E-06	2.1E-06	1.4E-06	0.0	2.2E-04	2.9E-06
105	17.9	2.2	7.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	2.9E-05	5.3E-06	2.0E-06	1.4E-06	0.0	2.1E-04	2.8E-06
106	27.0	3.4	11.4	0.0	0.2	0.0	0.1	0.0	0.0	0.0	3.6E-05	6.4E-06	2.4E-06	1.7E-06	0.0	2.6E-04	3.8E-06
107	42.8	7.9	18.3	0.0	0.4	0.0	0.1	0.0	0.0	0.0	5.9E-05	1.1E-05	4.8E-06	3.2E-06	0.0	3.7E-04	7.2E-06
108	19.8	2.5	8.4	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.7E-05	5.1E-06	1.9E-06	1.4E-06	0.0	2.5E-04	3.4E-06
109	39.1	7.4	16.8	0.0	0.3	0.0	0.1	0.0	0.0	0.0	6.8E-05	1.1E-05	5.0E-06	3.5E-06	0.0	3.5E-04	6.9E-06
110	10.7	2.0	4.5	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.6E-05	4.9E-06	1.8E-06	1.4E-06	0.0	2.4E-04	3.4E-06
111	21.5	5.7	9.4	0.0	0.3	0.0	0.2	0.0	0.1	0.0	6.7E-05	2.0E-05	9.6E-06	5.3E-06	0.0	9.5E-04	1.5E-05
112	2.8	0.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6E-05	2.3E-06	8.2E-07	7.0E-07	0.0	9.3E-05	1.2E-06
113	16.7	3.8	7.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0	5.2E-05	8.6E-06	5.5E-06	3.3E-06	0.0	5.2E-04	9.3E-06
114	14.3	3.4	6.2	0.0	0.2	0.0	0.1	0.0	0.0	0.0	4.6E-05	9.2E-06	4.7E-06	3.0E-06	0.0	3.9E-04	7.3E-06

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
115	15.9	3.9	6.9	0.0	0.2	0.0	0.2	0.0	0.1	0.0	5.5E-05	9.6E-06	6.1E-06	3.6E-06	0.0	6.0E-04	1.0E-05
116	16.8	3.6	7.4	0.0	0.2	0.0	0.2	0.0	0.1	0.0	5.0E-05	9.1E-06	6.1E-06	3.5E-06	0.0	5.6E-04	9.8E-06
117	16.2	3.6	7.4	0.0	0.2	0.0	0.2	0.0	0.1	0.0	4.7E-05	1.2E-05	7.6E-06	4.2E-06	0.0	6.9E-04	1.1E-05
118	7.6	1.4	3.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	2.7E-05	3.9E-06	1.7E-06	1.0E-06	0.0	1.4E-04	1.9E-06
119	9.8	1.7	4.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.5E-05	4.4E-06	2.1E-06	1.2E-06	0.0	1.8E-04	2.4E-06
120	8.8	1.6	3.6	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.6E-05	3.8E-06	2.2E-06	1.1E-06	0.0	1.5E-04	2.0E-06
121	10.0	1.6	4.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.1E-05	4.3E-06	2.6E-06	1.3E-06	0.0	1.9E-04	2.6E-06
122	10.0	1.6	4.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.1E-05	4.3E-06	2.6E-06	1.3E-06	0.0	1.9E-04	2.6E-06
123	7.2	1.1	3.7	0.0	0.1	0.0	0.1	0.0	0.0	0.0	3.7E-05	6.3E-06	3.1E-06	1.3E-06	0.0	1.2E-04	1.6E-06
124	25.6	3.5	7.3	0.0	0.2	0.0	0.1	0.0	0.0	0.0	7.8E-05	1.4E-05	6.6E-06	3.1E-06	0.0	2.8E-04	5.4E-06
125	28.3	3.9	7.6	0.0	0.2	0.0	0.1	0.0	0.0	0.0	8.4E-05	1.5E-05	6.6E-06	3.1E-06	0.0	2.5E-04	4.8E-06
126	17.0	3.8	9.2	0.0	0.2	0.0	0.1	0.0	0.1	0.0	7.8E-05	1.5E-05	7.9E-06	3.7E-06	0.0	3.6E-04	6.8E-06
127	7.2	1.4	5.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	4.2E-05	7.3E-06	4.1E-06	1.7E-06	0.0	1.6E-04	2.4E-06
128	6.0	1.1	3.5	0.0	0.1	0.0	0.1	0.0	0.0	0.0	3.9E-05	6.6E-06	3.4E-06	1.4E-06	0.0	1.2E-04	1.7E-06
129	6.2	1.3	4.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	4.2E-05	7.3E-06	3.6E-06	1.5E-06	0.0	1.5E-04	2.1E-06
130	21.2	3.9	9.9	0.0	0.2	0.0	0.1	0.0	0.0	0.0	8.7E-05	1.5E-05	7.7E-06	3.5E-06	0.0	2.7E-04	5.1E-06
131	18.6	4.1	12.7	0.0	0.2	0.0	0.1	0.0	0.1	0.0	9.4E-05	1.8E-05	9.3E-06	4.2E-06	0.0	3.5E-04	6.6E-06
132	16.7	3.4	16.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	1.0E-04	1.9E-05	1.1E-05	4.5E-06	0.0	2.5E-04	4.7E-06
133	17.9	3.2	13.7	0.0	0.2	0.0	0.1	0.0	0.0	0.0	9.0E-05	1.7E-05	9.9E-06	4.2E-06	0.0	2.3E-04	4.3E-06

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
134	18.1	4.2	6.4	0.0	0.2	0.0	0.1	0.0	0.0	0.0	6.9E-05	1.5E-05	7.1E-06	3.8E-06	0.0	2.1E-04	4.2E-06
135	17.8	3.5	6.2	0.0	0.2	0.0	0.1	0.0	0.0	0.0	9.7E-05	1.4E-05	6.3E-06	3.7E-06	0.0	2.0E-04	3.9E-06
136	17.3	3.0	7.8	0.0	0.2	0.0	0.1	0.0	0.0	0.0	1.0E-04	1.5E-05	8.2E-06	4.0E-06	0.0	2.1E-04	4.3E-06
137	19.7	3.3	12.6	0.0	0.2	0.0	0.1	0.0	0.0	0.0	1.5E-04	2.2E-05	9.9E-06	4.8E-06	0.0	2.4E-04	4.9E-06
138	57.5	9.1	24.6	0.1	0.5	0.0	0.3	0.0	0.1	0.0	1.3E-04	1.9E-05	7.9E-06	6.0E-06	0.0	4.9E-04	1.1E-05
139	22.0	8.6	11.0	0.0	0.5	0.0	0.2	0.0	0.1	0.0	1.1E-04	1.7E-05	7.3E-06	5.7E-06	0.0	4.7E-04	9.7E-06
140	30.5	8.3	13.0	0.0	0.5	0.0	0.2	0.0	0.1	0.0	9.4E-05	1.4E-05	6.8E-06	5.5E-06	0.0	4.7E-04	9.4E-06
141	48.0	8.9	20.5	0.1	0.5	0.0	0.2	0.0	0.1	0.0	9.4E-05	1.4E-05	7.6E-06	6.0E-06	0.0	5.1E-04	1.0E-05
142	60.0	10.6	25.3	0.0	0.6	0.0	0.2	0.0	0.1	0.0	6.4E-05	1.2E-05	6.6E-06	4.6E-06	0.0	4.8E-04	9.3E-06
143	52.4	10.7	22.1	0.0	0.6	0.0	0.2	0.0	0.1	0.0	6.9E-05	1.2E-05	5.8E-06	4.2E-06	0.0	5.5E-04	1.0E-05
144	22.4	5.5	9.5	0.0	0.3	0.0	0.2	0.0	0.1	0.0	6.0E-05	1.0E-05	5.5E-06	3.6E-06	0.0	5.0E-04	9.1E-06
145	21.5	4.6	9.1	0.0	0.3	0.0	0.2	0.0	0.0	0.0	6.1E-05	1.0E-05	6.1E-06	4.1E-06	0.0	5.9E-04	1.0E-05
146	15.8	3.9	6.6	0.0	0.2	0.0	0.1	0.0	0.0	0.0	4.5E-05	8.4E-06	4.8E-06	3.3E-06	0.0	5.2E-04	9.1E-06
147	22.1	4.5	9.3	0.0	0.2	0.0	0.2	0.0	0.1	0.0	5.3E-05	1.1E-05	6.6E-06	4.1E-06	0.0	6.4E-04	1.1E-05
148	19.9	3.7	8.4	0.0	0.2	0.0	0.1	0.0	0.0	0.0	4.6E-05	9.2E-06	5.3E-06	3.4E-06	0.0	5.5E-04	9.6E-06
149	27.6	4.4	11.9	0.0	0.2	0.0	0.2	0.0	0.1	0.0	6.0E-05	1.1E-05	6.1E-06	4.0E-06	0.0	6.3E-04	1.1E-05
150	63.0	8.3	27.0	0.1	0.4	0.0	0.2	0.0	0.0	0.0	8.2E-05	1.3E-05	5.9E-06	4.1E-06	0.0	5.6E-04	9.7E-06
151	78.3	10.3	33.8	0.1	0.5	0.0	0.2	0.0	0.1	0.0	6.3E-05	1.2E-05	5.8E-06	4.2E-06	0.0	6.4E-04	1.1E-05
152	87.8	11.5	37.7	0.1	0.6	0.0	0.2	0.0	0.0	0.0	7.9E-05	1.3E-05	6.4E-06	4.4E-06	0.0	5.8E-04	1.0E-05

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
153	85.8	11.2	37.1	0.1	0.5	0.0	0.2	0.0	0.1	0.0	5.5E-05	1.3E-05	6.7E-06	4.7E-06	0.0	6.6E-04	1.1E-05
154	87.2	10.9	37.6	0.1	0.5	0.0	0.2	0.0	0.1	0.0	5.9E-05	1.3E-05	7.2E-06	5.2E-06	0.0	6.3E-04	1.1E-05
155	75.4	10.2	32.6	0.1	0.6	0.0	0.2	0.0	0.1	0.0	6.5E-05	1.4E-05	8.0E-06	5.3E-06	0.0	6.6E-04	1.2E-05
156	68.3	13.0	29.2	0.1	0.7	0.0	0.3	0.0	0.1	0.0	9.9E-05	1.9E-05	9.7E-06	5.9E-06	0.0	7.6E-04	1.3E-05
157	68.3	13.0	29.2	0.1	0.7	0.0	0.3	0.0	0.1	0.0	9.9E-05	1.9E-05	9.7E-06	5.9E-06	0.0	7.6E-04	1.3E-05
158	36.0	6.3	15.4	0.1	0.4	0.0	0.4	0.0	0.1	0.0	1.3E-04	2.0E-05	7.9E-06	5.6E-06	0.0	7.1E-04	1.3E-05
159	18.8	4.4	8.0	0.1	0.2	0.0	0.4	0.0	0.1	0.0	1.5E-04	2.2E-05	9.1E-06	6.4E-06	0.0	8.3E-04	1.5E-05
160	53.3	7.4	22.5	0.1	0.3	0.0	0.4	0.0	0.1	0.0	1.5E-04	2.1E-05	9.3E-06	6.3E-06	0.0	7.1E-04	1.3E-05
161	241.5	31.3	43.6	0.1	1.4	0.0	0.3	0.0	0.1	0.0	1.3E-04	1.9E-05	1.2E-05	7.1E-06	0.0	8.2E-04	1.5E-05
162	241.7	31.3	43.6	0.1	1.4	0.0	0.3	0.0	0.1	0.0	1.3E-04	1.9E-05	1.2E-05	7.1E-06	0.0	8.2E-04	1.5E-05
163	18.8	6.1	10.3	0.1	0.4	0.0	0.3	0.0	0.1	0.0	1.4E-04	2.6E-05	1.8E-05	1.1E-05	0.0	2.3E-03	2.9E-05
164	21.8	5.4	9.8	0.1	0.4	0.0	0.3	0.0	0.1	0.0	1.3E-04	2.4E-05	1.6E-05	1.1E-05	0.0	2.0E-03	2.6E-05
165	20.9	7.7	7.3	0.1	0.4	0.0	0.3	0.0	0.1	0.0	1.2E-04	2.7E-05	1.6E-05	1.1E-05	0.0	2.6E-03	3.4E-05
166	21.6	8.0	7.8	0.1	0.4	0.0	0.2	0.0	0.1	0.0	1.0E-04	2.6E-05	1.5E-05	1.0E-05	0.0	2.5E-03	3.2E-05
167	24.7	7.2	10.5	0.1	0.4	0.0	0.3	0.0	0.1	0.0	1.1E-04	3.0E-05	1.4E-05	1.0E-05	0.0	1.6E-03	2.4E-05
168	30.2	12.2	13.2	0.2	0.8	0.1	0.8	0.1	0.2	0.0	2.2E-04	5.9E-05	3.9E-05	2.9E-05	0.1	1.3E-02	1.5E-04
169	27.7	6.1	11.8	0.1	0.4	0.0	0.3	0.0	0.1	0.0	1.2E-04	2.9E-05	1.4E-05	9.9E-06	0.0	1.6E-03	2.3E-05
170	60.3	17.0	26.4	0.2	0.8	0.0	0.4	0.0	0.2	0.0	1.5E-04	3.2E-05	1.8E-05	1.5E-05	0.0	3.6E-03	5.2E-05
171	25.3	5.5	19.6	0.1	0.4	0.0	0.3	0.0	0.1	0.0	2.0E-04	3.2E-05	1.6E-05	1.1E-05	0.0	1.7E-03	2.4E-05

Table D.1 Scenario 1 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
172	23.9	5.7	20.1	0.1	0.5	0.0	0.3	0.0	0.1	0.0	2.1E-04	3.3E-05	1.7E-05	1.1E-05	0.0	1.8E-03	2.6E-05
173	52.5	9.6	14.9	0.1	0.4	0.0	0.2	0.0	0.1	0.0	8.5E-05	1.6E-05	1.1E-05	8.1E-06	0.0	1.5E-03	2.0E-05
174	33.0	13.6	14.5	0.2	0.8	0.1	0.7	0.0	0.3	0.0	1.5E-04	4.1E-05	2.3E-05	1.7E-05	0.1	6.3E-03	8.9E-05
175	35.7	9.1	10.0	0.1	0.3	0.0	0.3	0.0	0.1	0.0	6.6E-05	1.6E-05	1.0E-05	8.1E-06	0.0	2.0E-03	2.9E-05
176	64.5	11.9	12.6	0.3	1.0	0.1	1.1	0.1	0.2	0.0	1.6E-04	5.0E-05	2.8E-05	2.2E-05	0.1	9.8E-03	1.4E-04
177	63.3	13.6	11.6	0.2	0.6	0.0	0.5	0.0	0.1	0.0	1.2E-04	2.9E-05	1.6E-05	1.2E-05	0.0	4.3E-03	6.6E-05
178	75.1	15.0	14.1	0.2	0.6	0.0	0.6	0.0	0.1	0.0	1.2E-04	3.2E-05	1.7E-05	1.4E-05	0.1	4.5E-03	7.1E-05
179	98.6	19.9	17.2	0.2	0.9	0.0	0.7	0.0	0.2	0.0	1.0E-04	3.1E-05	1.8E-05	1.4E-05	0.1	4.5E-03	7.2E-05
180	67.3	14.0	20.6	0.3	0.6	0.1	0.6	0.1	0.2	0.0	1.8E-04	6.0E-05	3.2E-05	2.5E-05	0.1	1.2E-02	1.5E-04
181	86.9	20.7	15.3	0.2	0.7	0.1	0.8	0.0	0.1	0.0	1.7E-04	4.9E-05	2.3E-05	1.6E-05	0.1	4.4E-03	7.4E-05
182	82.1	19.9	17.0	0.3	0.8	0.1	0.5	0.1	0.2	0.0	1.5E-04	5.0E-05	2.6E-05	2.0E-05	0.1	7.7E-03	1.1E-04
183	44.6	13.0	9.9	0.1	0.6	0.0	0.4	0.0	0.1	0.0	1.3E-04	4.4E-05	1.6E-05	9.9E-06	0.0	2.6E-03	3.6E-05
184	17.5	6.7	8.3	0.1	0.4	0.0	0.3	0.0	0.1	0.0	8.8E-05	2.6E-05	8.8E-06	5.6E-06	0.0	1.4E-03	1.7E-05
185	54.9	7.8	21.1	0.1	0.5	0.0	0.4	0.0	0.1	0.0	1.6E-04	4.2E-05	1.2E-05	7.0E-06	0.0	1.5E-03	2.2E-05
186	33.5	11.1	14.7	0.1	0.5	0.0	0.7	0.0	0.2	0.0	1.1E-04	2.4E-05	8.0E-06	6.5E-06	0.0	1.6E-03	2.5E-05
187	27.7	10.6	10.5	0.1	0.5	0.0	0.6	0.0	0.2	0.0	1.0E-04	2.4E-05	7.7E-06	6.2E-06	0.0	1.5E-03	2.3E-05
188	33.4	8.7	14.9	0.1	0.6	0.0	0.7	0.0	0.2	0.0	2.0E-04	3.6E-05	1.1E-05	8.0E-06	0.0	1.5E-03	2.3E-05
189	20.0	6.6	9.2	0.0	0.4	0.0	0.3	0.0	0.1	0.0	1.2E-04	1.9E-05	6.3E-06	5.0E-06	0.0	5.0E-04	7.4E-06
190	23.3	12.6	10.2	0.0	0.8	0.0	0.2	0.0	0.1	0.0	7.3E-05	1.3E-05	4.8E-06	4.6E-06	0.0	6.0E-04	8.9E-06

Table D.1 Scenario 1 increment modelling results for all receptors

Receptor ID	CO		NO2		SO2		PM10		PM2.5.5		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
191	13.4	8.0	6.0	0.0	0.5	0.0	0.2	0.0	0.1	0.0	7.0E-05	1.1E-05	4.1E-06	3.5E-06	0.0	3.6E-04	5.2E-06
192	20.6	10.6	9.0	0.0	0.7	0.0	0.2	0.0	0.1	0.0	7.1E-05	1.1E-05	4.3E-06	4.0E-06	0.0	3.9E-04	6.1E-06
193	18.4	10.0	8.0	0.0	0.6	0.0	0.1	0.0	0.1	0.0	6.9E-05	1.1E-05	4.3E-06	3.7E-06	0.0	3.6E-04	5.5E-06
194	20.6	10.8	9.0	0.0	0.7	0.0	0.1	0.0	0.1	0.0	5.6E-05	9.4E-06	5.5E-06	3.9E-06	0.0	3.9E-04	6.1E-06
195	21.2	11.0	9.2	0.0	0.7	0.0	0.1	0.0	0.1	0.0	5.7E-05	9.5E-06	5.6E-06	4.0E-06	0.0	4.0E-04	6.3E-06
196	25.1	11.7	11.0	0.0	0.8	0.0	0.2	0.0	0.1	0.0	6.4E-05	9.7E-06	6.5E-06	4.3E-06	0.0	4.5E-04	6.9E-06
197	14.0	8.0	9.5	0.0	0.5	0.0	0.1	0.0	0.1	0.0	1.0E-04	1.4E-05	7.5E-06	4.4E-06	0.0	3.7E-04	5.9E-06
198	13.5	6.3	9.7	0.0	0.5	0.0	0.1	0.0	0.0	0.0	1.0E-04	1.5E-05	8.1E-06	4.3E-06	0.0	2.9E-04	4.8E-06
199	14.3	5.0	9.5	0.0	0.4	0.0	0.1	0.0	0.0	0.0	7.9E-05	1.4E-05	7.2E-06	3.9E-06	0.0	2.5E-04	3.9E-06
200	29.2	7.1	12.7	0.0	0.4	0.0	0.1	0.0	0.0	0.0	9.6E-05	1.5E-05	7.7E-06	4.4E-06	0.0	3.8E-04	5.7E-06
201	29.5	5.4	12.7	0.0	0.3	0.0	0.1	0.0	0.0	0.0	1.3E-04	2.6E-05	6.7E-06	3.5E-06	0.0	2.1E-04	3.4E-06
202	22.7	4.9	9.6	0.0	0.4	0.0	0.1	0.0	0.0	0.0	1.3E-04	2.7E-05	6.9E-06	3.5E-06	0.0	2.0E-04	3.3E-06
203	18.0	6.3	8.1	0.0	0.4	0.0	0.1	0.0	0.0	0.0	1.2E-04	2.5E-05	6.8E-06	3.8E-06	0.0	2.9E-04	4.9E-06
204	19.2	5.0	8.3	0.0	0.4	0.0	0.1	0.0	0.0	0.0	1.3E-04	2.6E-05	6.8E-06	3.5E-06	0.0	1.9E-04	3.2E-06
205	20.2	4.3	7.8	0.0	0.3	0.0	0.1	0.0	0.1	0.0	1.1E-04	2.7E-05	7.1E-06	3.8E-06	0.0	2.5E-04	4.4E-06
206	45.6	9.1	14.1	0.0	0.4	0.0	0.1	0.0	0.1	0.0	7.8E-05	2.7E-05	7.3E-06	3.7E-06	0.0	2.5E-04	4.3E-06
207	57.9	9.0	10.9	0.0	0.4	0.0	0.1	0.0	0.0	0.0	9.0E-05	2.1E-05	5.8E-06	2.8E-06	0.0	1.7E-04	3.2E-06
208	41.7	7.0	10.2	0.0	0.3	0.0	0.1	0.0	0.0	0.0	8.1E-05	1.7E-05	4.7E-06	2.9E-06	0.0	1.7E-04	3.1E-06
209	26.9	4.9	9.6	0.0	0.2	0.0	0.1	0.0	0.0	0.0	6.9E-05	1.4E-05	4.0E-06	2.9E-06	0.0	1.6E-04	2.9E-06

Table D.1 Scenario 1 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hour	24 hour	Annual	24 hour	Annual	24 hour	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
210	51.6	7.8	17.6	0.0	0.3	0.0	0.1	0.0	0.0	0.0	9.3E-05	2.1E-05	5.1E-06	3.9E-06	0.0	1.9E-04	3.5E-06
211	71.0	13.5	30.4	0.0	0.7	0.0	0.1	0.0	0.1	0.0	1.7E-04	3.1E-05	7.4E-06	5.1E-06	0.0	1.8E-04	3.2E-06
212	75.7	15.6	32.4	0.0	0.7	0.0	0.1	0.0	0.1	0.0	1.9E-04	3.5E-05	8.3E-06	5.7E-06	0.0	2.1E-04	3.6E-06
213	71.3	16.6	30.6	0.1	0.8	0.0	0.1	0.0	0.1	0.0	1.5E-04	2.5E-05	8.9E-06	6.3E-06	0.0	1.9E-04	3.4E-06
214	77.7	19.6	31.4	0.1	0.9	0.0	0.1	0.0	0.1	0.0	2.2E-04	3.3E-05	1.4E-05	8.8E-06	0.0	2.1E-04	3.7E-06
215	36.8	10.0	10.6	0.0	0.4	0.0	0.1	0.0	0.0	0.0	1.3E-04	2.0E-05	8.8E-06	5.7E-06	0.0	1.7E-04	3.0E-06

Table D.2 Scenario 2 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
1	13.5	4.5	9.9	0.0	9.7	0.8	0.1	0.0	0.0	0.0	1.3E-04	2.4E-05	7.6E-06	4.9E-06	0.0	3.9E-04	6.6E-06
2	17.4	4.0	8.7	0.0	8.5	0.6	0.1	0.0	0.0	0.0	9.1E-05	2.8E-05	9.4E-06	5.9E-06	0.0	4.3E-04	7.2E-06
3	16.9	2.9	8.5	0.0	12.3	0.8	0.1	0.0	0.0	0.0	1.5E-04	3.4E-05	1.5E-05	7.8E-06	0.0	4.3E-04	7.4E-06
4	22.0	6.6	8.7	0.0	6.1	1.2	0.2	0.0	0.1	0.0	1.9E-04	3.4E-05	1.4E-05	1.0E-05	0.0	1.0E-03	1.4E-05
5	33.4	8.8	9.0	0.0	8.1	1.2	0.3	0.0	0.1	0.0	2.0E-04	2.9E-05	1.2E-05	9.6E-06	0.0	1.0E-03	1.4E-05
6	33.3	11.7	8.9	0.0	7.3	1.1	0.3	0.0	0.1	0.0	1.9E-04	2.6E-05	1.1E-05	7.6E-06	0.0	8.2E-04	1.1E-05
7	16.9	3.1	17.2	0.0	19.1	1.0	0.1	0.0	0.0	0.0	1.9E-04	3.7E-05	1.7E-05	9.0E-06	0.0	5.6E-04	8.8E-06
8	30.4	10.5	8.8	0.0	7.1	1.0	0.2	0.0	0.1	0.0	1.7E-04	2.4E-05	1.1E-05	6.9E-06	0.0	7.6E-04	1.0E-05
9	18.9	2.9	10.5	0.0	8.5	0.6	0.1	0.0	0.0	0.0	1.1E-04	2.6E-05	1.2E-05	6.9E-06	0.0	5.0E-04	7.5E-06
10	32.1	4.6	20.6	0.0	5.0	0.9	0.1	0.0	0.0	0.0	1.6E-04	3.1E-05	1.3E-05	7.8E-06	0.0	4.5E-04	5.9E-06
11	29.1	3.9	13.8	0.0	6.4	0.5	0.1	0.0	0.0	0.0	9.5E-05	2.5E-05	1.0E-05	6.7E-06	0.0	5.3E-04	7.6E-06
12	27.6	5.4	11.3	0.0	5.4	0.8	0.1	0.0	0.0	0.0	1.4E-04	2.6E-05	1.1E-05	6.9E-06	0.0	5.8E-04	8.2E-06
13	24.0	7.0	5.7	0.0	7.5	0.5	0.2	0.0	0.1	0.0	9.4E-05	2.3E-05	9.1E-06	6.7E-06	0.0	6.3E-04	9.1E-06
14	19.6	7.0	8.6	0.0	9.0	0.6	0.2	0.0	0.1	0.0	1.2E-04	2.0E-05	9.2E-06	6.6E-06	0.0	6.4E-04	9.4E-06
15	30.2	7.4	13.3	0.0	10.2	0.7	0.2	0.0	0.1	0.0	1.3E-04	2.3E-05	9.2E-06	6.6E-06	0.0	6.6E-04	9.7E-06
16	22.3	5.4	8.9	0.0	5.3	0.9	0.1	0.0	0.0	0.0	1.5E-04	2.7E-05	1.1E-05	7.1E-06	0.0	6.4E-04	9.0E-06
17	26.6	5.9	11.9	0.0	9.9	0.7	0.2	0.0	0.1	0.0	1.3E-04	2.5E-05	8.7E-06	6.4E-06	0.0	5.8E-04	8.8E-06
18	24.8	5.7	7.5	0.0	8.0	0.6	0.1	0.0	0.0	0.0	1.2E-04	2.2E-05	7.8E-06	6.3E-06	0.0	5.4E-04	8.5E-06
19	17.8	4.8	6.8	0.0	6.2	1.1	0.2	0.0	0.0	0.0	1.9E-04	3.3E-05	1.3E-05	8.7E-06	0.0	8.4E-04	1.2E-05

Table D.2 Scenario 2 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
20	34.9	10.8	9.4	0.0	7.5	0.7	0.2	0.0	0.1	0.0	1.2E-04	2.2E-05	8.2E-06	6.6E-06	0.0	7.1E-04	1.1E-05
21	46.6	19.5	11.6	0.1	7.6	1.0	0.2	0.0	0.1	0.0	1.2E-04	2.9E-05	9.9E-06	7.6E-06	0.0	9.3E-04	1.4E-05
22	94.0	34.1	40.7	0.1	13.3	1.7	0.3	0.0	0.2	0.0	1.8E-04	3.8E-05	1.3E-05	8.9E-06	0.0	1.2E-03	1.9E-05
23	46.3	16.4	12.2	0.0	6.4	0.9	0.2	0.0	0.1	0.0	1.3E-04	2.9E-05	1.0E-05	7.2E-06	0.0	8.5E-04	1.3E-05
24	25.7	4.4	11.0	0.0	3.9	0.4	0.1	0.0	0.0	0.0	7.9E-05	1.7E-05	6.1E-06	4.2E-06	0.0	2.6E-04	5.1E-06
25	23.9	5.7	10.0	0.0	4.3	0.6	0.1	0.0	0.0	0.0	1.1E-04	2.2E-05	7.9E-06	5.6E-06	0.0	4.9E-04	8.7E-06
26	49.5	11.3	20.8	0.1	7.7	0.7	0.2	0.0	0.1	0.0	1.3E-04	2.5E-05	1.1E-05	7.8E-06	0.0	7.1E-04	1.2E-05
27	100.7	42.2	20.0	0.1	14.2	2.0	0.2	0.0	0.2	0.0	1.9E-04	2.9E-05	1.5E-05	1.0E-05	0.0	9.7E-04	1.7E-05
28	49.7	11.6	17.1	0.1	11.2	1.2	0.2	0.0	0.1	0.0	2.1E-04	5.1E-05	1.7E-05	1.5E-05	0.0	2.8E-03	3.7E-05
29	51.4	9.0	17.1	0.0	12.1	0.9	0.1	0.0	0.0	0.0	1.6E-04	3.1E-05	8.7E-06	7.3E-06	0.0	7.6E-04	1.2E-05
30	21.5	5.6	8.7	0.0	7.4	0.8	0.2	0.0	0.1	0.0	1.3E-04	2.6E-05	7.2E-06	6.6E-06	0.0	8.9E-04	1.4E-05
31	25.8	9.2	10.8	0.1	6.3	0.8	0.2	0.0	0.1	0.0	9.7E-05	2.2E-05	7.2E-06	6.1E-06	0.0	9.3E-04	1.5E-05
32	37.4	7.0	14.2	0.1	5.8	0.6	0.2	0.0	0.1	0.0	8.2E-05	2.1E-05	9.0E-06	6.7E-06	0.0	1.1E-03	1.7E-05
33	47.9	9.4	16.0	0.1	6.1	0.7	0.2	0.0	0.1	0.0	8.8E-05	2.3E-05	1.0E-05	7.4E-06	0.0	1.2E-03	2.0E-05
34	226.7	28.6	63.1	0.2	32.1	3.1	7.4	0.2	2.5	0.0	4.8E-04	1.2E-04	4.2E-05	1.8E-05	0.3	2.8E-02	4.0E-04
35	50.7	10.3	15.8	0.4	10.8	2.3	0.7	0.1	0.2	0.0	3.7E-04	1.8E-04	1.1E-04	8.5E-05	0.1	1.6E-02	1.7E-04
36	65.0	9.6	17.7	0.3	11.5	2.0	0.7	0.1	0.2	0.0	3.3E-04	8.9E-05	4.4E-05	3.6E-05	0.1	1.6E-02	1.5E-04
37	41.0	10.4	13.4	0.3	10.1	1.8	0.8	0.1	0.2	0.0	3.0E-04	8.1E-05	4.1E-05	3.2E-05	0.1	1.2E-02	1.3E-04
38	65.9	8.9	17.7	0.3	10.7	1.6	0.8	0.1	0.2	0.0	2.6E-04	7.0E-05	4.0E-05	3.3E-05	0.1	1.4E-02	1.4E-04

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
39	36.9	7.6	15.6	0.2	6.6	1.1	0.7	0.0	0.2	0.0	1.8E-04	5.2E-05	3.3E-05	2.6E-05	0.1	8.9E-03	9.9E-05
40	26.1	7.0	11.0	0.2	5.9	1.0	0.6	0.0	0.2	0.0	1.7E-04	4.8E-05	3.0E-05	2.3E-05	0.1	7.7E-03	8.6E-05
41	26.8	6.3	11.6	0.2	5.9	1.0	0.5	0.0	0.1	0.0	1.6E-04	4.5E-05	2.8E-05	2.2E-05	0.1	6.8E-03	7.7E-05
42	32.2	7.9	13.6	0.2	6.4	1.2	0.8	0.0	0.2	0.0	2.0E-04	5.0E-05	3.1E-05	2.5E-05	0.1	8.6E-03	9.7E-05
43	411.1	103.8	65.4	5.3	58.9	16.3	11.1	1.8	2.4	0.4	2.4E-03	9.0E-04	6.5E-04	5.2E-04	2.9	3.7E-01	4.0E-03
44	50.2	8.1	14.6	0.2	12.8	1.2	0.9	0.1	0.2	0.0	2.1E-04	4.8E-05	2.9E-05	2.4E-05	0.1	8.8E-03	1.0E-04
45	36.9	6.1	11.0	0.2	10.3	1.0	0.6	0.0	0.2	0.0	1.7E-04	4.0E-05	2.4E-05	2.0E-05	0.0	6.1E-03	7.0E-05
46	27.7	5.0	10.6	0.1	9.9	0.9	0.5	0.0	0.1	0.0	1.4E-04	3.8E-05	2.1E-05	1.7E-05	0.0	4.9E-03	5.8E-05
47	59.3	7.7	17.5	0.2	9.9	1.4	0.7	0.1	0.2	0.0	2.2E-04	5.8E-05	3.2E-05	2.9E-05	0.1	1.3E-02	1.3E-04
48	52.9	9.9	15.6	0.2	18.4	1.3	0.6	0.0	0.2	0.0	2.2E-04	4.4E-05	2.6E-05	2.2E-05	0.1	7.0E-03	8.7E-05
49	24.6	4.5	8.0	0.1	6.9	0.9	0.4	0.0	0.1	0.0	1.5E-04	3.7E-05	1.8E-05	1.6E-05	0.0	4.3E-03	5.1E-05
50	64.0	8.7	13.0	0.2	29.8	1.3	0.7	0.1	0.2	0.0	2.5E-04	5.0E-05	2.7E-05	2.5E-05	0.1	1.1E-02	1.1E-04
51	58.1	7.8	12.0	0.2	20.5	1.1	0.7	0.0	0.2	0.0	1.7E-04	4.3E-05	2.3E-05	2.1E-05	0.1	8.2E-03	9.3E-05
52	24.5	4.2	7.6	0.1	6.1	0.8	0.3	0.0	0.1	0.0	1.2E-04	2.6E-05	1.5E-05	1.3E-05	0.0	3.6E-03	4.4E-05
53	49.4	13.8	17.1	0.3	25.7	1.9	1.3	0.1	0.3	0.0	3.1E-04	7.0E-05	4.1E-05	3.8E-05	0.1	1.9E-02	1.9E-04
54	54.7	10.8	14.5	0.2	27.6	1.4	0.8	0.1	0.2	0.0	2.2E-04	5.5E-05	3.1E-05	2.8E-05	0.1	1.3E-02	1.3E-04
55	34.4	5.2	7.1	0.1	5.0	0.6	0.3	0.0	0.1	0.0	7.4E-05	2.3E-05	1.3E-05	1.1E-05	0.0	3.6E-03	4.4E-05
56	31.0	7.8	11.7	0.2	6.1	1.1	0.7	0.1	0.2	0.0	1.6E-04	4.7E-05	2.7E-05	2.2E-05	0.1	1.1E-02	1.1E-04
57	26.2	5.8	10.3	0.1	6.5	0.9	0.6	0.0	0.2	0.0	1.4E-04	4.3E-05	2.5E-05	1.9E-05	0.1	8.9E-03	9.4E-05

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
58	61.6	8.6	7.6	0.1	8.2	0.6	0.6	0.0	0.2	0.0	9.7E-05	3.1E-05	1.7E-05	1.1E-05	0.0	4.4E-03	5.6E-05
59	57.1	7.4	14.1	0.1	7.5	0.7	0.5	0.0	0.2	0.0	1.3E-04	3.7E-05	1.7E-05	1.2E-05	0.0	4.9E-03	5.4E-05
60	48.9	7.0	15.7	0.1	13.9	0.8	0.3	0.0	0.1	0.0	1.4E-04	2.8E-05	1.3E-05	1.0E-05	0.0	3.5E-03	3.9E-05
61	22.3	3.6	15.7	0.1	16.7	0.9	0.2	0.0	0.1	0.0	1.6E-04	2.8E-05	1.4E-05	9.4E-06	0.0	2.8E-03	3.1E-05
62	27.7	4.4	15.8	0.1	18.3	1.0	0.2	0.0	0.1	0.0	1.9E-04	3.0E-05	1.5E-05	1.0E-05	0.0	3.2E-03	3.4E-05
63	29.0	4.2	7.8	0.1	6.4	0.6	0.2	0.0	0.1	0.0	1.0E-04	2.5E-05	1.1E-05	7.7E-06	0.0	2.6E-03	2.7E-05
64	35.7	5.0	7.7	0.1	6.7	0.5	0.2	0.0	0.1	0.0	8.8E-05	2.2E-05	1.0E-05	7.0E-06	0.0	1.9E-03	2.3E-05
65	39.7	5.8	11.2	0.1	8.6	0.4	0.2	0.0	0.1	0.0	7.5E-05	2.1E-05	1.2E-05	6.5E-06	0.0	1.5E-03	1.9E-05
66	34.5	5.3	12.7	0.1	18.1	0.8	0.2	0.0	0.1	0.0	1.5E-04	2.2E-05	1.3E-05	6.9E-06	0.0	1.2E-03	1.7E-05
67	35.8	5.1	12.6	0.1	16.5	0.7	0.2	0.0	0.1	0.0	1.4E-04	2.0E-05	1.2E-05	7.1E-06	0.0	1.3E-03	1.7E-05
68	40.5	5.7	13.0	0.1	15.9	0.7	0.1	0.0	0.1	0.0	1.3E-04	2.7E-05	1.3E-05	8.1E-06	0.0	1.8E-03	2.0E-05
69	36.3	7.1	15.4	0.1	18.8	0.8	0.2	0.0	0.1	0.0	1.6E-04	3.2E-05	1.4E-05	8.9E-06	0.0	2.3E-03	2.3E-05
70	18.0	2.9	11.3	0.0	8.8	0.5	0.1	0.0	0.0	0.0	9.8E-05	1.5E-05	7.6E-06	4.3E-06	0.0	4.3E-04	7.9E-06
71	134.1	19.4	19.9	0.1	19.8	1.3	0.7	0.0	0.3	0.0	1.9E-04	4.4E-05	1.9E-05	1.2E-05	0.0	5.5E-03	6.4E-05
72	134.1	19.4	19.9	0.1	19.8	1.3	0.7	0.0	0.3	0.0	1.9E-04	4.4E-05	1.9E-05	1.2E-05	0.0	5.5E-03	6.4E-05
73	18.8	3.0	13.5	0.0	8.3	0.5	0.1	0.0	0.0	0.0	9.0E-05	1.4E-05	7.5E-06	4.5E-06	0.0	4.2E-04	7.8E-06
74	24.6	4.8	13.8	0.0	10.9	0.5	0.2	0.0	0.1	0.0	9.6E-05	1.9E-05	1.0E-05	5.3E-06	0.0	7.0E-04	1.2E-05
75	18.8	3.2	14.3	0.0	9.2	0.5	0.1	0.0	0.0	0.0	9.0E-05	1.4E-05	7.5E-06	4.6E-06	0.0	4.4E-04	8.1E-06
76	29.0	7.1	14.8	0.1	11.4	0.7	0.3	0.0	0.1	0.0	1.0E-04	2.1E-05	1.1E-05	6.3E-06	0.0	8.4E-04	1.3E-05

Table D.2 Scenario 2 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
77	18.8	3.2	14.4	0.0	9.4	0.5	0.2	0.0	0.0	0.0	8.9E-05	1.4E-05	7.6E-06	4.7E-06	0.0	4.4E-04	8.2E-06
78	24.3	3.8	9.6	0.1	9.6	0.6	0.1	0.0	0.0	0.0	1.0E-04	2.0E-05	9.1E-06	5.7E-06	0.0	8.3E-04	1.3E-05
79	36.0	7.0	11.3	0.1	10.9	1.0	0.2	0.0	0.1	0.0	1.1E-04	2.7E-05	1.2E-05	7.9E-06	0.0	1.5E-03	1.8E-05
80	22.4	3.5	9.5	0.0	9.9	0.7	0.1	0.0	0.0	0.0	1.1E-04	1.9E-05	9.1E-06	5.3E-06	0.0	7.7E-04	1.3E-05
81	14.4	3.2	10.4	0.0	8.7	0.4	0.2	0.0	0.0	0.0	6.9E-05	1.2E-05	7.1E-06	4.5E-06	0.0	4.3E-04	8.0E-06
82	14.6	3.1	8.1	0.0	4.2	0.3	0.2	0.0	0.0	0.0	4.6E-05	1.0E-05	6.3E-06	3.7E-06	0.0	4.0E-04	7.6E-06
83	62.5	13.1	21.5	0.1	10.6	0.6	0.3	0.0	0.1	0.0	1.0E-04	2.0E-05	9.8E-06	5.2E-06	0.0	8.1E-04	1.3E-05
84	18.2	4.1	8.3	0.0	9.9	0.6	0.2	0.0	0.0	0.0	1.0E-04	2.2E-05	1.0E-05	5.2E-06	0.0	7.5E-04	1.2E-05
85	20.5	5.7	8.6	0.1	9.3	0.6	0.2	0.0	0.1	0.0	9.6E-05	2.4E-05	1.1E-05	5.7E-06	0.0	9.8E-04	1.4E-05
86	43.0	8.8	18.6	0.0	10.2	0.5	0.3	0.0	0.1	0.0	1.0E-04	1.8E-05	9.1E-06	4.5E-06	0.0	6.6E-04	1.1E-05
87	114.9	16.6	19.8	0.1	22.2	1.4	0.7	0.0	0.3	0.0	2.3E-04	5.3E-05	2.3E-05	1.5E-05	0.1	8.3E-03	8.9E-05
88	1266.4	254.0	98.5	11.6	179.4	29.1	25.9	5.7	8.4	1.3	1.3E-03	3.8E-04	2.3E-04	1.9E-04	10.4	1.3E+00	1.2E-02
89	13.5	4.0	5.0	0.0	4.0	0.3	0.2	0.0	0.0	0.0	4.9E-05	9.8E-06	5.2E-06	3.2E-06	0.0	3.8E-04	7.5E-06
90	39.9	6.1	11.1	0.1	10.5	0.8	0.4	0.0	0.1	0.0	1.2E-04	2.3E-05	1.0E-05	6.0E-06	0.0	1.3E-03	2.1E-05
91	13.0	2.8	3.9	0.0	3.3	0.3	0.2	0.0	0.0	0.0	5.1E-05	1.0E-05	4.7E-06	2.9E-06	0.0	3.3E-04	7.0E-06
92	11.4	2.4	4.1	0.0	3.6	0.3	0.2	0.0	0.0	0.0	5.3E-05	1.0E-05	4.8E-06	3.0E-06	0.0	3.3E-04	7.0E-06
93	13.0	2.8	5.6	0.0	2.5	0.3	0.1	0.0	0.0	0.0	4.0E-05	8.2E-06	4.0E-06	2.7E-06	0.0	2.9E-04	6.2E-06
94	13.6	3.1	5.9	0.0	2.6	0.3	0.1	0.0	0.0	0.0	4.0E-05	8.1E-06	4.0E-06	2.7E-06	0.0	2.9E-04	6.2E-06
95	14.2	3.5	6.1	0.0	2.7	0.3	0.1	0.0	0.0	0.0	4.0E-05	8.1E-06	4.1E-06	2.7E-06	0.0	3.0E-04	6.3E-06

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
96	11.1	1.8	4.6	0.0	4.2	0.2	0.1	0.0	0.0	0.0	3.7E-05	5.5E-06	2.6E-06	2.2E-06	0.0	2.1E-04	3.4E-06
97	16.2	2.1	6.8	0.0	4.1	0.2	0.1	0.0	0.0	0.0	3.4E-05	6.1E-06	2.9E-06	2.4E-06	0.0	2.3E-04	3.8E-06
98	43.4	9.6	18.8	0.1	19.3	0.9	0.2	0.0	0.1	0.0	1.7E-04	2.5E-05	1.2E-05	6.7E-06	0.0	1.2E-03	1.9E-05
99	25.7	3.2	10.8	0.0	3.5	0.2	0.1	0.0	0.0	0.0	3.8E-05	6.7E-06	3.0E-06	2.2E-06	0.0	2.4E-04	3.8E-06
100	27.7	3.5	11.7	0.0	3.8	0.2	0.1	0.0	0.0	0.0	3.8E-05	6.9E-06	3.0E-06	2.2E-06	0.0	2.5E-04	3.9E-06
101	55.3	9.2	23.7	0.0	7.6	0.4	0.1	0.0	0.0	0.0	7.6E-05	1.7E-05	6.7E-06	4.5E-06	0.0	3.5E-04	7.9E-06
102	53.9	9.5	23.1	0.0	7.5	0.5	0.1	0.0	0.0	0.0	6.9E-05	1.6E-05	6.7E-06	4.2E-06	0.0	3.8E-04	8.2E-06
103	34.0	4.3	14.4	0.0	4.7	0.3	0.1	0.0	0.0	0.0	4.6E-05	8.0E-06	3.2E-06	2.3E-06	0.0	2.7E-04	4.5E-06
104	20.2	2.5	8.5	0.0	2.7	0.2	0.1	0.0	0.0	0.0	3.8E-05	6.6E-06	2.5E-06	1.8E-06	0.0	2.2E-04	3.3E-06
105	17.9	2.2	7.5	0.0	2.4	0.2	0.0	0.0	0.0	0.0	3.7E-05	6.5E-06	2.4E-06	1.7E-06	0.0	2.1E-04	3.2E-06
106	27.0	3.4	11.4	0.0	3.7	0.3	0.1	0.0	0.0	0.0	4.6E-05	7.9E-06	3.0E-06	2.2E-06	0.0	2.6E-04	4.3E-06
107	42.8	7.9	18.3	0.0	6.1	0.4	0.1	0.0	0.0	0.0	7.1E-05	1.4E-05	6.4E-06	4.2E-06	0.0	3.7E-04	8.0E-06
108	19.8	2.5	8.4	0.0	2.7	0.2	0.1	0.0	0.0	0.0	3.4E-05	6.2E-06	2.3E-06	1.8E-06	0.0	2.5E-04	3.8E-06
109	39.1	7.4	16.8	0.0	5.8	0.5	0.1	0.0	0.0	0.0	8.3E-05	1.5E-05	6.4E-06	4.4E-06	0.0	3.5E-04	7.7E-06
110	10.7	2.0	4.5	0.0	3.4	0.2	0.1	0.0	0.0	0.0	3.1E-05	5.6E-06	2.7E-06	1.9E-06	0.0	2.4E-04	3.8E-06
111	21.5	5.7	9.4	0.0	10.6	0.5	0.2	0.0	0.1	0.0	8.5E-05	2.5E-05	1.2E-05	6.9E-06	0.0	9.6E-04	1.6E-05
112	2.8	0.6	2.5	0.0	2.1	0.1	0.0	0.0	0.0	0.0	2.0E-05	2.9E-06	1.4E-06	8.7E-07	0.0	9.4E-05	1.5E-06
113	16.7	3.8	7.3	0.0	8.3	0.4	0.2	0.0	0.1	0.0	6.7E-05	1.5E-05	8.7E-06	4.8E-06	0.0	5.2E-04	1.0E-05
114	14.3	3.4	6.2	0.0	6.4	0.3	0.1	0.0	0.0	0.0	5.1E-05	1.3E-05	7.5E-06	4.3E-06	0.0	3.9E-04	8.1E-06

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO$_2$		SO$_2$		PM$_{10}$		PM$_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
115	15.9	3.9	6.9	0.0	9.1	0.4	0.2	0.0	0.1	0.0	7.1E-05	1.6E-05	9.4E-06	5.2E-06	0.0	6.0E-04	1.1E-05
116	16.8	3.6	7.4	0.0	8.3	0.4	0.2	0.0	0.1	0.0	6.4E-05	1.6E-05	9.5E-06	5.1E-06	0.0	5.6E-04	1.1E-05
117	16.3	3.6	7.4	0.0	7.9	0.3	0.2	0.0	0.1	0.0	6.0E-05	1.9E-05	1.1E-05	5.8E-06	0.0	6.9E-04	1.2E-05
118	7.6	1.4	3.1	0.0	4.3	0.2	0.0	0.0	0.0	0.0	3.6E-05	6.5E-06	3.1E-06	1.5E-06	0.0	1.5E-04	2.2E-06
119	9.8	1.7	4.0	0.0	4.0	0.2	0.1	0.0	0.0	0.0	3.8E-05	7.2E-06	3.8E-06	1.8E-06	0.0	1.8E-04	2.8E-06
120	8.8	1.6	3.6	0.0	4.1	0.2	0.1	0.0	0.0	0.0	3.8E-05	7.0E-06	3.6E-06	1.7E-06	0.0	1.6E-04	2.4E-06
121	10.0	1.6	4.2	0.0	4.1	0.2	0.1	0.0	0.0	0.0	4.2E-05	8.1E-06	4.2E-06	1.9E-06	0.0	1.9E-04	3.0E-06
122	10.0	1.6	4.2	0.0	4.1	0.2	0.1	0.0	0.0	0.0	4.2E-05	8.1E-06	4.2E-06	1.9E-06	0.0	1.9E-04	3.0E-06
123	7.2	1.1	3.7	0.0	3.2	0.2	0.1	0.0	0.0	0.0	3.6E-05	6.2E-06	3.7E-06	1.6E-06	0.0	1.2E-04	1.9E-06
124	25.6	3.5	7.3	0.0	6.3	0.5	0.1	0.0	0.0	0.0	8.7E-05	1.6E-05	8.8E-06	4.2E-06	0.0	2.8E-04	6.1E-06
125	28.3	3.9	7.6	0.0	6.1	0.5	0.1	0.0	0.0	0.0	9.5E-05	1.7E-05	8.7E-06	4.1E-06	0.0	2.5E-04	5.5E-06
126	17.0	3.8	9.2	0.0	8.1	0.6	0.1	0.0	0.1	0.0	1.0E-04	2.0E-05	1.1E-05	5.3E-06	0.0	3.6E-04	7.6E-06
127	7.2	1.4	5.2	0.0	4.3	0.3	0.1	0.0	0.0	0.0	5.5E-05	9.6E-06	5.1E-06	2.2E-06	0.0	1.7E-04	2.8E-06
128	6.0	1.1	3.5	0.0	2.5	0.3	0.1	0.0	0.0	0.0	5.1E-05	8.7E-06	4.0E-06	1.7E-06	0.0	1.2E-04	2.0E-06
129	6.2	1.3	4.2	0.0	3.0	0.3	0.1	0.0	0.0	0.0	5.4E-05	9.4E-06	4.6E-06	2.0E-06	0.0	1.5E-04	2.4E-06
130	21.2	4.0	9.9	0.0	8.7	0.6	0.1	0.0	0.0	0.0	1.1E-04	2.0E-05	1.1E-05	5.0E-06	0.0	2.7E-04	5.9E-06
131	18.6	4.1	12.7	0.0	11.0	0.7	0.1	0.0	0.1	0.0	1.3E-04	2.4E-05	1.3E-05	5.9E-06	0.0	3.5E-04	7.4E-06
132	18.9	3.4	16.1	0.0	12.7	0.8	0.1	0.0	0.0	0.0	1.4E-04	2.6E-05	1.5E-05	6.3E-06	0.0	2.5E-04	5.6E-06
133	17.9	3.2	13.7	0.0	10.4	0.7	0.1	0.0	0.0	0.0	1.2E-04	2.3E-05	1.3E-05	5.7E-06	0.0	2.3E-04	5.1E-06

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
134	18.1	4.2	6.4	0.0	9.6	0.6	0.1	0.0	0.0	0.0	9.7E-05	1.8E-05	8.8E-06	5.1E-06	0.0	2.1E-04	5.0E-06
135	20.4	3.5	6.2	0.0	10.4	0.5	0.1	0.0	0.0	0.0	1.2E-04	1.8E-05	8.4E-06	5.2E-06	0.0	2.0E-04	4.7E-06
136	19.0	3.0	7.8	0.0	8.1	0.7	0.1	0.0	0.0	0.0	1.4E-04	2.1E-05	1.1E-05	5.4E-06	0.0	2.1E-04	5.2E-06
137	19.7	3.3	12.6	0.0	13.2	1.0	0.1	0.0	0.0	0.0	2.0E-04	3.0E-05	1.3E-05	6.3E-06	0.0	2.4E-04	5.9E-06
138	57.5	9.3	24.6	0.1	11.2	0.9	0.3	0.0	0.1	0.0	1.4E-04	2.1E-05	9.9E-06	8.1E-06	0.0	4.9E-04	1.2E-05
139	22.0	8.6	11.0	0.0	10.9	0.9	0.2	0.0	0.1	0.0	1.4E-04	2.1E-05	1.0E-05	7.7E-06	0.0	4.7E-04	1.1E-05
140	30.5	8.3	13.0	0.0	9.9	0.9	0.2	0.0	0.1	0.0	1.3E-04	1.9E-05	9.9E-06	7.5E-06	0.0	4.7E-04	1.1E-05
141	48.0	8.9	20.5	0.1	12.2	1.0	0.2	0.0	0.1	0.0	1.2E-04	2.0E-05	1.0E-05	8.1E-06	0.0	5.1E-04	1.2E-05
142	60.0	10.6	25.3	0.0	10.6	0.9	0.2	0.0	0.1	0.0	1.0E-04	1.7E-05	8.2E-06	6.4E-06	0.0	4.8E-04	1.0E-05
143	52.4	10.8	22.1	0.0	9.3	0.8	0.2	0.0	0.1	0.0	1.0E-04	1.5E-05	7.4E-06	5.4E-06	0.0	5.5E-04	1.1E-05
144	22.4	5.5	9.5	0.0	7.7	0.5	0.2	0.0	0.1	0.0	8.3E-05	1.2E-05	6.5E-06	4.6E-06	0.0	5.0E-04	1.0E-05
145	21.5	4.6	9.1	0.0	4.6	0.5	0.2	0.0	0.0	0.0	7.8E-05	1.2E-05	8.0E-06	5.2E-06	0.0	5.9E-04	1.2E-05
146	15.8	4.0	6.6	0.0	3.4	0.4	0.1	0.0	0.0	0.0	6.5E-05	1.1E-05	6.2E-06	4.4E-06	0.0	5.2E-04	1.0E-05
147	22.1	4.6	9.3	0.0	4.6	0.4	0.2	0.0	0.1	0.0	7.3E-05	1.3E-05	7.9E-06	5.1E-06	0.0	6.4E-04	1.2E-05
148	19.9	3.8	8.4	0.0	3.8	0.4	0.1	0.0	0.0	0.0	6.6E-05	1.1E-05	6.6E-06	4.6E-06	0.0	5.5E-04	1.1E-05
149	27.6	4.5	11.9	0.0	3.8	0.4	0.2	0.0	0.1	0.0	7.5E-05	1.4E-05	7.7E-06	5.3E-06	0.0	6.3E-04	1.2E-05
150	63.0	8.3	27.0	0.1	8.7	0.5	0.2	0.0	0.0	0.0	9.6E-05	1.5E-05	7.7E-06	5.3E-06	0.0	5.6E-04	1.1E-05
151	78.3	10.3	33.8	0.1	10.9	0.5	0.2	0.0	0.1	0.0	8.1E-05	1.4E-05	7.5E-06	5.5E-06	0.0	6.4E-04	1.2E-05
152	87.8	11.5	37.7	0.1	12.2	0.6	0.2	0.0	0.0	0.0	1.1E-04	1.7E-05	8.9E-06	6.0E-06	0.0	5.8E-04	1.1E-05

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
153	85.8	11.2	37.1	0.1	12.0	0.6	0.2	0.0	0.1	0.0	7.7E-05	1.5E-05	8.1E-06	6.0E-06	0.0	6.6E-04	1.3E-05
154	87.2	10.9	37.6	0.1	12.1	0.8	0.2	0.0	0.1	0.0	7.8E-05	1.5E-05	9.4E-06	6.6E-06	0.0	6.3E-04	1.2E-05
155	75.4	10.2	32.6	0.1	10.5	0.9	0.2	0.0	0.1	0.0	8.9E-05	1.7E-05	1.0E-05	6.8E-06	0.0	6.6E-04	1.3E-05
156	68.3	13.0	29.2	0.1	16.2	1.0	0.3	0.0	0.1	0.0	1.4E-04	2.4E-05	1.3E-05	8.1E-06	0.0	7.6E-04	1.5E-05
157	68.3	13.0	29.2	0.1	16.2	1.0	0.3	0.0	0.1	0.0	1.4E-04	2.4E-05	1.3E-05	8.1E-06	0.0	7.6E-04	1.5E-05
158	36.0	6.3	15.4	0.1	6.5	1.0	0.4	0.0	0.1	0.0	1.9E-04	2.8E-05	1.1E-05	7.7E-06	0.0	7.1E-04	1.4E-05
159	18.8	4.4	8.0	0.1	4.9	0.9	0.4	0.0	0.1	0.0	1.9E-04	2.7E-05	1.2E-05	8.5E-06	0.0	8.3E-04	1.7E-05
160	53.3	7.4	22.5	0.1	7.2	0.9	0.4	0.0	0.1	0.0	1.8E-04	2.6E-05	1.2E-05	8.2E-06	0.0	7.2E-04	1.4E-05
161	241.5	31.3	43.6	0.1	33.0	1.4	0.3	0.0	0.1	0.0	1.4E-04	2.3E-05	1.4E-05	9.1E-06	0.0	8.3E-04	1.7E-05
162	241.7	31.3	43.6	0.1	33.1	1.4	0.3	0.0	0.1	0.0	1.4E-04	2.3E-05	1.4E-05	9.1E-06	0.0	8.3E-04	1.7E-05
163	18.8	6.2	10.3	0.1	11.2	1.0	0.3	0.0	0.1	0.0	1.8E-04	3.6E-05	2.5E-05	1.5E-05	0.0	2.3E-03	3.2E-05
164	21.8	5.4	9.8	0.1	11.1	1.0	0.3	0.0	0.1	0.0	1.7E-04	3.3E-05	2.2E-05	1.4E-05	0.0	2.0E-03	2.9E-05
165	20.9	7.7	7.3	0.1	10.9	0.8	0.3	0.0	0.1	0.0	1.3E-04	3.7E-05	2.1E-05	1.6E-05	0.0	2.6E-03	3.6E-05
166	21.6	8.0	7.8	0.1	12.3	0.8	0.2	0.0	0.1	0.0	1.2E-04	3.5E-05	2.0E-05	1.6E-05	0.0	2.5E-03	3.5E-05
167	24.7	7.4	10.5	0.1	46.3	2.4	0.3	0.0	0.1	0.0	4.9E-04	7.5E-05	3.1E-05	1.7E-05	0.0	1.6E-03	2.7E-05
168	30.2	12.3	13.2	0.2	11.4	1.8	0.8	0.1	0.2	0.0	3.1E-04	7.4E-05	4.9E-05	3.6E-05	0.1	1.3E-02	1.6E-04
169	27.7	6.2	11.8	0.1	41.0	2.2	0.3	0.0	0.1	0.0	4.4E-04	6.7E-05	2.8E-05	1.7E-05	0.0	1.6E-03	2.6E-05
170	60.3	17.0	26.4	0.2	12.2	1.2	0.4	0.0	0.2	0.0	1.9E-04	4.3E-05	2.6E-05	1.9E-05	0.0	3.6E-03	5.6E-05
171	25.3	5.7	19.6	0.1	26.1	1.5	0.3	0.0	0.1	0.0	3.1E-04	4.8E-05	2.3E-05	1.5E-05	0.0	1.7E-03	2.7E-05

Table D.2 Scenario 2 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
172	23.9	5.9	20.1	0.1	15.6	1.1	0.3	0.0	0.1	0.0	2.2E-04	4.1E-05	2.1E-05	1.5E-05	0.0	1.8E-03	2.8E-05
173	52.5	9.6	14.9	0.1	10.4	0.7	0.2	0.0	0.1	0.0	1.1E-04	2.2E-05	1.5E-05	1.1E-05	0.0	1.5E-03	2.2E-05
174	33.0	13.7	14.5	0.2	7.9	1.2	0.7	0.0	0.3	0.0	1.8E-04	5.7E-05	3.1E-05	2.1E-05	0.1	6.3E-03	9.3E-05
175	35.7	9.1	10.0	0.1	6.5	0.7	0.3	0.0	0.1	0.0	1.1E-04	2.4E-05	1.3E-05	1.1E-05	0.0	2.0E-03	3.1E-05
176	64.5	11.9	12.6	0.3	7.8	1.8	1.1	0.1	0.2	0.0	2.3E-04	6.9E-05	3.9E-05	2.9E-05	0.1	9.8E-03	1.5E-04
177	63.3	13.6	11.6	0.2	8.1	1.1	0.5	0.0	0.1	0.0	1.5E-04	3.8E-05	2.0E-05	1.6E-05	0.0	4.3E-03	6.9E-05
178	75.1	15.0	14.1	0.2	9.8	1.1	0.6	0.0	0.1	0.0	1.4E-04	3.8E-05	2.2E-05	1.7E-05	0.1	4.5E-03	7.4E-05
179	98.6	19.9	17.2	0.2	13.1	1.1	0.7	0.0	0.2	0.0	1.3E-04	4.0E-05	2.4E-05	1.8E-05	0.1	4.5E-03	7.5E-05
180	67.3	14.0	20.6	0.3	10.1	1.3	0.6	0.1	0.2	0.0	2.3E-04	7.9E-05	3.9E-05	3.3E-05	0.1	1.2E-02	1.6E-04
181	86.9	20.7	15.3	0.2	11.3	0.9	0.8	0.0	0.1	0.0	1.6E-04	5.6E-05	2.9E-05	2.1E-05	0.1	4.4E-03	7.7E-05
182	82.1	19.9	17.0	0.3	7.5	1.0	0.5	0.1	0.2	0.0	1.9E-04	5.9E-05	3.1E-05	2.4E-05	0.1	7.7E-03	1.1E-04
183	44.6	13.0	9.9	0.1	8.3	1.1	0.4	0.0	0.1	0.0	1.6E-04	5.6E-05	2.1E-05	1.3E-05	0.0	2.6E-03	3.8E-05
184	17.8	6.8	8.3	0.1	4.6	0.9	0.3	0.0	0.1	0.0	1.3E-04	3.7E-05	1.3E-05	7.5E-06	0.0	1.4E-03	1.8E-05
185	54.9	7.9	21.1	0.1	13.8	1.1	0.4	0.0	0.1	0.0	2.2E-04	4.8E-05	1.4E-05	9.8E-06	0.0	1.5E-03	2.4E-05
186	33.5	11.1	14.7	0.1	9.2	1.1	0.7	0.0	0.2	0.0	2.2E-04	3.2E-05	1.4E-05	9.9E-06	0.0	1.6E-03	2.7E-05
187	27.7	10.6	10.5	0.1	9.0	1.1	0.6	0.0	0.2	0.0	2.2E-04	3.3E-05	1.3E-05	9.3E-06	0.0	1.5E-03	2.5E-05
188	33.4	8.7	14.9	0.1	8.5	1.5	0.7	0.0	0.2	0.0	2.4E-04	4.4E-05	1.3E-05	1.1E-05	0.0	1.5E-03	2.5E-05
189	20.0	6.7	9.2	0.0	4.2	0.8	0.3	0.0	0.1	0.0	1.5E-04	2.1E-05	7.0E-06	5.7E-06	0.0	5.0E-04	8.2E-06
190	23.3	12.8	10.2	0.0	5.3	1.2	0.2	0.0	0.1	0.0	1.3E-04	2.2E-05	7.3E-06	6.6E-06	0.0	6.0E-04	9.9E-06

Table D.2 Scenario 2 increment modelling results for all receptors

Receptor ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
191	13.4	8.0	6.0	0.0	4.7	0.8	0.2	0.0	0.1	0.0	1.1E-04	1.8E-05	5.6E-06	4.9E-06	0.0	3.6E-04	6.0E-06
192	20.6	10.7	9.0	0.0	4.8	0.9	0.2	0.0	0.1	0.0	1.2E-04	2.1E-05	6.4E-06	5.7E-06	0.0	3.9E-04	6.9E-06
193	18.4	10.1	8.0	0.0	5.0	0.7	0.1	0.0	0.1	0.0	8.8E-05	1.4E-05	5.3E-06	5.0E-06	0.0	3.6E-04	6.2E-06
194	20.6	10.8	9.0	0.0	6.1	0.8	0.1	0.0	0.1	0.0	7.5E-05	1.6E-05	6.8E-06	5.3E-06	0.0	3.9E-04	6.9E-06
195	21.2	11.0	9.2	0.0	6.3	0.8	0.1	0.0	0.1	0.0	7.5E-05	1.6E-05	7.0E-06	5.3E-06	0.0	4.0E-04	7.1E-06
196	25.1	11.8	11.0	0.0	6.9	0.9	0.2	0.0	0.1	0.0	8.6E-05	1.8E-05	8.1E-06	5.8E-06	0.0	4.5E-04	7.7E-06
197	14.0	8.0	9.5	0.0	10.5	0.6	0.1	0.0	0.1	0.0	1.3E-04	1.9E-05	9.3E-06	5.8E-06	0.0	3.8E-04	6.7E-06
198	13.5	6.3	9.7	0.0	14.2	0.7	0.1	0.0	0.0	0.0	1.4E-04	2.0E-05	1.0E-05	5.8E-06	0.0	2.9E-04	5.6E-06
199	14.3	5.4	9.5	0.0	12.1	0.7	0.1	0.0	0.0	0.0	1.2E-04	1.9E-05	9.3E-06	5.2E-06	0.0	2.5E-04	4.7E-06
200	29.2	7.4	12.7	0.0	13.2	0.8	0.1	0.0	0.0	0.0	1.2E-04	2.1E-05	9.3E-06	5.7E-06	0.0	3.8E-04	6.7E-06
201	29.5	5.8	12.7	0.0	4.6	0.9	0.1	0.0	0.0	0.0	1.5E-04	3.0E-05	7.9E-06	4.5E-06	0.0	2.1E-04	4.2E-06
202	22.7	5.5	9.6	0.0	4.7	1.0	0.1	0.0	0.0	0.0	1.6E-04	3.2E-05	8.3E-06	4.5E-06	0.0	2.0E-04	4.0E-06
203	18.0	6.9	8.1	0.0	4.5	0.9	0.1	0.0	0.0	0.0	1.4E-04	2.8E-05	8.1E-06	4.9E-06	0.0	2.9E-04	5.7E-06
204	19.2	5.2	8.3	0.0	4.9	0.9	0.1	0.0	0.0	0.0	1.5E-04	3.2E-05	8.4E-06	4.4E-06	0.0	1.9E-04	4.0E-06
205	20.2	4.8	7.8	0.0	4.9	0.8	0.1	0.0	0.1	0.0	1.3E-04	3.3E-05	8.9E-06	4.8E-06	0.0	2.5E-04	5.2E-06
206	45.6	9.1	14.1	0.0	8.4	0.5	0.1	0.0	0.1	0.0	1.0E-04	3.5E-05	9.7E-06	4.6E-06	0.0	2.5E-04	5.2E-06
207	57.9	9.0	10.9	0.0	7.9	0.5	0.1	0.0	0.0	0.0	9.3E-05	2.4E-05	6.8E-06	3.7E-06	0.0	1.7E-04	3.9E-06
208	41.8	7.0	10.2	0.0	5.7	0.5	0.1	0.0	0.0	0.0	8.6E-05	1.9E-05	5.5E-06	3.8E-06	0.0	1.7E-04	3.8E-06
209	26.9	4.9	9.6	0.0	4.4	0.4	0.1	0.0	0.0	0.0	7.3E-05	1.6E-05	4.6E-06	3.8E-06	0.0	1.6E-04	3.6E-06

Table D.2 Scenario 2 increment modelling results for all receptors

Recept or ID	CO		NO_2		SO_2		PM_{10}		$PM_{2.5.5}$		HF				TSP	DDep	Lead
	1 hour	8 hour	1 hour	Annual	1 hour	24 hr	24 hr	Annual	24 hr	Annual	24 hr	7 day	30 day	90 day	Annual	Annual	Annual
Criteria	**30,000**	**10,000**	**164**	**31**	**286**	**57**	**50**	**25**	**25**	**8**	**1.5**	**0.8**	**0.4**	**0.25**	**90**	**2**	**0.5**
210	51.6	7.8	17.6	0.0	6.9	0.5	0.1	0.0	0.0	0.0	1.0E-04	2.6E-05	6.3E-06	5.2E-06	0.0	1.9E-04	4.4E-06
211	71.0	13.5	30.4	0.0	9.8	1.1	0.1	0.0	0.1	0.0	1.9E-04	3.5E-05	9.6E-06	7.1E-06	0.0	1.8E-04	4.2E-06
212	75.7	15.6	32.4	0.0	10.7	1.3	0.1	0.0	0.1	0.0	2.2E-04	4.0E-05	1.0E-05	7.8E-06	0.0	2.1E-04	4.7E-06
213	71.3	16.6	30.6	0.1	9.9	1.1	0.1	0.0	0.1	0.0	2.1E-04	3.0E-05	1.1E-05	7.9E-06	0.0	1.9E-04	4.4E-06
214	77.7	19.6	31.4	0.1	12.5	1.6	0.1	0.0	0.1	0.0	3.0E-04	4.3E-05	1.5E-05	1.1E-05	0.0	2.2E-04	5.1E-06
215	36.8	10.0	10.6	0.0	5.1	1.0	0.1	0.0	0.0	0.0	1.7E-04	2.5E-05	8.6E-06	6.6E-06	0.0	1.7E-04	3.8E-06

Appendix E

Plume Rise Assessment

EMM
creating opportunities

Australian Government
Civil Aviation Safety Authority

Air Navigation, Airspace and Aerodromes

File Ref: F21/42626-1
Your Ref: Email 11/07/2022 latest in chain

21/07/2022

Scott Fishwick
Associate – National Technical Leader, Air Quality
EMM Consulting
By Email
sfishwick@emmconsulting.com.au

PLUME – WOODLAWN EARC

CASA has assessed the potential plume from the proposed Woodlawn EARC energy from waste facility project near Tarago.

Aviation Facilities in vicinity:

Goulburn Aerodrome: The site is approximately 31km SSW from Goulburn Aerodrome and not runway aligned.

Canberra Aerodrome: The site is approximately 39km east from Canberra Aerodrome and not runway aligned.

There are no strategic Helicopter Landing Sites in the area.

Regarding an Obstacle Limitation Surfaces (OLS) at the site, the site is a long way past the extremities of any OLS.

Parameters:

Number of stacks = 1

Exit velocity = 18.1 m/s (max) (average is 14.8m/sec)

Stack diameter = 2.7 m

Stack height = 85m AGL = 865m above AHD approximately

Temperature = 150°C

Using the CASA screening tool, the plume reduces to 4.3m/s at approximately 48m (38m at average velocity) above the stack top or approximately 133m AGL or approximately 913m above AHD.

And the plume reduces to 6.1m/s at 18m (16m at average velocity) above the stack top or approximately 103m AGL or approximately 883m above AHD.

And the plume reduces to 10.6m/s at 10m (9m at average velocity) above the stack top or approximately 95m AGL or approximately 875m above AHD.

<u>Discussion</u>

The Manual of Aviation Meteorology (2003) defines the classifications of turbulence intensity as: Light (1.5 - 6.1m/s) which can cause momentary changes in altitude and attitude.

The methodology is conservative and aligned to a cool calm day and doesn’t take the lateral dispersion and the 99.9th percentile case into account. As the site is not in the approach or take off areas close to the runways, 10.6m/sec would be an appropriate critical velocity in this case, but we will be ultra conservative and use 6.1m/sec

The result according to the theoretical calculations is that the plume dissipates to 6.1m/sec at approximately 103m above ground level.

Based on the information presented, the conservative nature of methodology and the height at which aircraft should be at or near the location; CASA considers that there will be an Acceptable Level of Safety regarding the plume. CASA has no objections to the proposal. No mitigations would be required.

Yours sincerely,

David Alder

David Alder
Aerodrome Engineer

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Level 2 Suite 2.04
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8 454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9 109 St Georges Terrace
Perth WA 6000

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au