APPENDIX P
Air quality and greenhouse gas impact assessment

Evolution MINING

EMM
creating opportunities

Cowal Gold Operations Open Pit Continuation Project

Air quality and greenhouse gas assessment

Prepared for Evolution Mining (Cowal) Pty Limited

April 2023

Cowal Gold Operations Open Pit Continuation Project

Air quality and greenhouse gas assessment

Evolution Mining (Cowal) Pty Limited

J190417 RP42

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Executive Summary

ES1 Introduction

Evolution Mining (Cowal) Pty Limited (Evolution) is the owner and operator of the Cowal Gold Operations (CGO), an existing open pit and underground gold mine approximately 38 kilometres (km) north-east of West Wyalong, in the Central West region of New South Wales (NSW).

Evolution is seeking approval for further open pit mining operations at CGO through the Open Pit Continuation Project (the Project). The Project primarily seeks to continue the open pit operations by approximately 10 years.

The Project will involve further development of the existing 'E42' pit and the development of open pit mining in three adjacent orebodies, known as 'E46', 'GR' and 'E41'. It is noted that the three adjacent ore bodies are within the existing mining lease (ML 1535). No change to the approved ore processing rate of 9.8 Mt per annum is proposed.

Other than the changes to existing approved activities as set out above, all activities that are currently approved under the existing Ministerial development consents are intended to continue.

This air quality and greenhouse gas assessment (AQGHGA) report presents a quantitative modelling assessment of potential air quality impacts from the Project, prepared in accordance with the NSW EPA *Approved Methods for Modelling and Assessment of Air Pollutants in NSW* (2022).

It is noted that a detailed air quality and greenhouse gas assessment was prepared by EMM for the CGO Underground Development and Modification 16 in August 2020 (the UG AQGHGA). To support consistency between the assessment of the CGO Underground Development/Modification 16 and the Project, resources developed for the UG AQGHGA have been retained in this report wherever practicable to do so.

ES2 Emissions inventory

Emissions from the Project were quantified for four future operational scenarios:

- Year 1
- Year 4
- Year 6
- Year 9.

Emissions were quantified for the following air pollutants:

- particulate matter (PM), specifically:
  - total suspended particulate matter (TSP)
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10})
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$)
- oxides of nitrogen (NO_x)[1], including nitrogen dioxide (NO_2).

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

Emissions from all existing and approved activities (e.g. underground operations) were included to predict cumulative air quality impacts in the surrounding environment. The following points are noted from review of the developed emissions inventories for the Project:

- mine Year 6 represents the highest potential emissions scenario of the four quantified years
- mine Year 9 represents the lowest potential emissions scenario of the four quantified years
- the difference between the minimum and maximum annual emission totals ranges between 9% for TSP, 14% for PM_{10} and 12% for $PM_{2.5}$
- relative to the total annual PM_{10} emissions assessed in the EMM 2020 (i.e. existing approved operations), the total annual PM_{10} emissions quantified for the four Project scenarios are between 3% lower and 11% higher than existing approved operations.

ES3 Dispersion modelling

Atmospheric dispersion modelling was undertaken using the US-EPA regulatory model, AERMOD. Hourly meteorological observations from 2018, collected primarily by the onsite meteorological station, were used as inputs into the dispersion modelling process.

The results of the modelling show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) and NO_2 are below the applicable impact assessment criteria at all assessment locations. The modelling results show the following key points:

- at each assessment location, the model predicted concentrations for Year 1 and Year 9 scenarios are lower than the predictions from the Year 4 and Year 6 scenarios
- the model predictions are typically highest for the Year 6 scenario across all assessment locations, in particular at the closest assessment locations to the north-west IWL construction area (i.e. 15, 20, 21, 22a–c, and 36b)
- relative to the equivalent predictions from the EMM 2020, the model predicted concentrations for the Year 1 and Year 9 scenarios are generally lower, while the predictions from the Year 4 and Year 6 scenarios are generally higher.

When background concentrations are added, the cumulative annual average concentrations for all pollutants were predicted to be below the relevant impact assessment criteria. Further, the maximum predicted cumulative 24 hour $PM_{2.5}$ concentrations and 1 hour NO_2 concentrations were below the impact assessment criterion at all assessment locations. However, the predicted cumulative 24 hour average PM_{10} is greater than the impact assessment criterion (50 µg/m³) at a number of private assessment locations across the four modelled scenarios. The following points are noted relevant to the paired in time analysis approach for cumulative 24 hour average PM_{10} concentrations from the Project:

- all assessment locations are predicted to have one additional exceedance in at least one of the four modelled scenarios (i.e. associated with the background concentration of 49.7 µg/m³, or 99% of the NSW EPA criterion of 50 µg/m³)
- assessment locations 6, 20, 36a, 38, 43b and 62 are predicted to experience up to two additional exceedance days in Year 6
- assessment locations 31a, 43a and 61aare predicted to experience up to three additional exceedance days in Year 6

- the Project is predicted to result in up to four additional exceedance days at assessment location 21 (Year 6).

Relative to the equivalent EMM 2020 predictions, the Project returns:

- up to three additional exceedance days at assessment location 21
- up to two additional exceedance days at assessment locations 31a and 43a
- between no additional days and one additional exceedance at the remainder of assessment locations.

Analysis of the predicted additional exceedance days illustrated that all coincided a background concentration greater than 40 µg/m³.

Additional cumulative analysis was undertaken to determine the likelihood of additional exceedances when a longer-term background dataset is paired with model predictions.

This additional cumulative frequency analysis showed that the likelihood of additional days above 50 µg/m³ is less than one additional day for each assessment location across all modelling scenarios.

It is noted that the quantified likelihood of less than one additional exceedance day is consistent with the results returned for the EMM 2020 results (i.e. existing approved operations plus underground operations). Consequently, the Project does not increase the likelihood of additional cumulative 24 hour average PM_{10} exceedances occurring relative to existing approved operations.

There are no private residences or land area where the 24 hour or annual average Voluntary Land Acquisition and Mitigation Policy (VLAMP) criteria are triggered for any of the assessed scenarios.

ES4 Greenhouse gas emissions

A greenhouse gas (GHG) assessment was also undertaken for the Project. The GHG assessment showed the following:

- emissions from the consumption of purchased electricity and diesel fuel are the dominant sources of GHG emissions from all years of the Project
- annual GHG emissions from the Project are projected to peak between Year 3 and Year 9 before decreasing year on year as open cut pit operations are completed
- on the basis that the calculated peak year Scope 1 and Scope 2 GHG emissions from the Project (291,271 t CO_2-e/year) are lower than the most recent operational year (FY22) at CGO (300,704 t CO_2-e/year), the Project is not anticipated to increase annual GHG emissions relative to existing approved operations.

Relative to 2020 emission inventory totals, annual Scope 1 and Scope 2 GHG emissions generated by the Project represent approximately 0.17% of NSW total emissions and 0.044% of national total emissions on an annual average basis; and approximately 0.22% of NSW total emissions and 0.059% of national total emissions when compared to the maximum Project year.

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1 Introduction

1.1 Background

Evolution Mining (Cowal) Pty Limited (Evolution) is the owner and operator of the Cowal Gold Operations (CGO), an existing open pit and underground gold mine approximately 38 kilometres (km) north-east of West Wyalong, in the Central West region of New South Wales (NSW).

The CGO is located on the traditional lands of the Wiradjuri People and is immediately adjacent to the western shore of Lake Cowal, which is an ephemeral waterbody. The existing CGO mine is shown at a regional scale in Figure 1.1.

CGO was first approved in 1999, and open pit mining operations commenced in 2005. Underground mining operations were approved in 2021, and development works to enable underground mining are underway.

1.2 Project overview

Evolution is seeking approval for further open pit mining operations at CGO through the Open Pit Continuation Project (the Project). The Project primarily seeks to continue the open pit operations by approximately 10 years to 2036 and extend the total mine life by approximately two years to 2042.

The Project will involve further development of the existing 'E42' pit and the development of open pit mining in three adjacent orebodies, known as 'E46', 'GR' and 'E41'. It is noted that the three adjacent ore bodies are within the existing mining lease (ML 1535). No change to the approved ore processing rate of 9.8 Mt per annum is proposed.

Other than the changes to existing approved activities as set out above, all activities that are currently approved under the existing Ministerial development consents are intended to continue. The existing activities approved under the consents are described in Chapter 3 of the environmental impact statement (EIS) for the Project.

A detailed description of the Project is contained in Chapter 4 of the EIS, and a conceptual Project layout is shown in Figure 1.2. The Project comprises the following key components:

- the continued operation of activities as approved under development application (DA) 14/98 and state significant development (SSD) 10367
- development of three new open satellite pits (the 'E46', 'GR' and 'E41' pits) to the north and south of the existing open pit, within the current approved mining lease
- extending the existing open pit to the east and south via a 'cutback' within the current approved mine lease
- extending open pit mining operations by approximately 10 years to 2036, and total mine life by approximately 2 years to 2042
- expansion of the Integrated Waste Landform (IWL) to accommodate Project tailings
- extension of the lake protection bund (LPB) system to provide continued separation and mutual protection between Lake Cowal and the mine
- backfilling of one of the new open satellite pits (E46) with waste rock, and establishment of a new waste rock emplacement (WRE) on the backfilled pit to minimise the additional area required for waste rock disposal

- expansion of the footprint of the existing WRE areas to accommodate additional waste rock
- development of additional topsoil and subsoil stockpiles to accommodate materials from pre-stripping, with materials to be reused during progressive mine rehabilitation
- upgrades to existing surface water drainage systems, to assist with on-site water management and maximise on-site water conservation
- modification of internal site access and haul roads
- development of new water storage, and relocation of some components of the surface water drainage system
- modification and relocation of some existing ancillary mining infrastructure.

The Project will not change existing ore processing rates or methods, tailings disposal methods, main site access, water supply sources or hours of operation. The Project will also retain the existing open pit mining workforce.

1.3 Assessment requirements

This air quality and greenhouse gas assessment (AQGHGA) report forms part of the EIS. It documents the assessment methods and results, and takes into account the initiatives built into the Project design to avoid and minimise air quality impacts.

This assessment has been prepared in accordance with requirements set out in the Secretary's Environmental Assessment Requirements (SEARs) for the Project. The SEARs identify matters which must be addressed in the EIS and form its terms of reference. Table 1.1 lists individual requirements relevant to this AQGHGA and the sections in this report where the requirements are addressed.

Table 1.1 Air quality and greenhouse gas technical assessment related SEARs

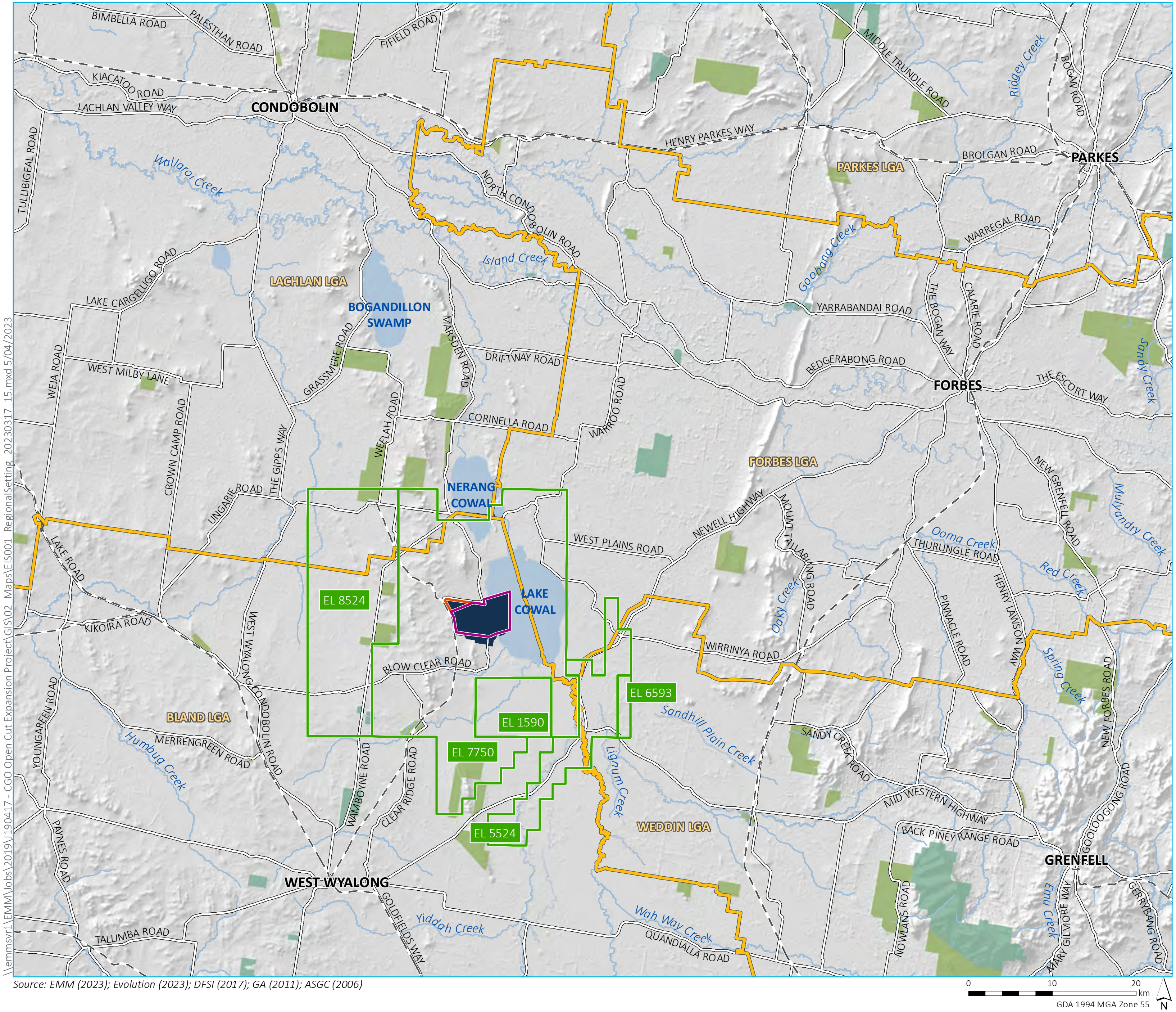
Requirement	Section addressed
Air Quality – including:	
• an assessment of the likely air quality impacts of the development, including cumulative impacts from nearby developments, in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (2016) (or its latest version[1]), and having regard to the NSW Government's *Voluntary Land Acquisition and Mitigation Policy*;	Chapter 8
• ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation 2010*;	Chapters 4 and 8
• an assessment of the likely greenhouse gas impacts of the development including measures to minimise emissions; and	Chapter 10
• a description of the measures that would be implemented to monitor and report on air emissions (including fugitive dust and greenhouse gases) of the development	Chapters 6, 9 and 10

Note 1: Latest version of *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* is dated September 2022.

1.4 Terminology

A summary of the key terminology used throughout this assessment is provided below. A full glossary and list of abbreviations are provided in the Glossary of this report.

- **Cowal Gold Operations (CGO)** – comprises both the existing open pit mine, underground mine, processing facility, IWL, WRE areas, ore stockpiles and ancillary infrastructure.
- **The Project area** – the area at the CGO mine site that is the subject of the development application as shown in Figure 1.3.
- **Existing and approved disturbance area** – areas that are disturbed and/or approved to be disturbed under the current development consents that apply to CGO.
- **Additional disturbance area** – the areas that will be disturbed by the Project that are outside the existing and approved disturbance area.
- **Project disturbance area** – this area is the combination of the additional disturbance area and the existing and approved disturbance area.



KEY

- Project area
- Mining lease (ML1535)
- Mining lease (ML1791)
- Exploration licence (EL)
- Rail line
- Main road
- Named watercourse
- Named waterbody
- Local government area
- NPWS reserve
- State forest

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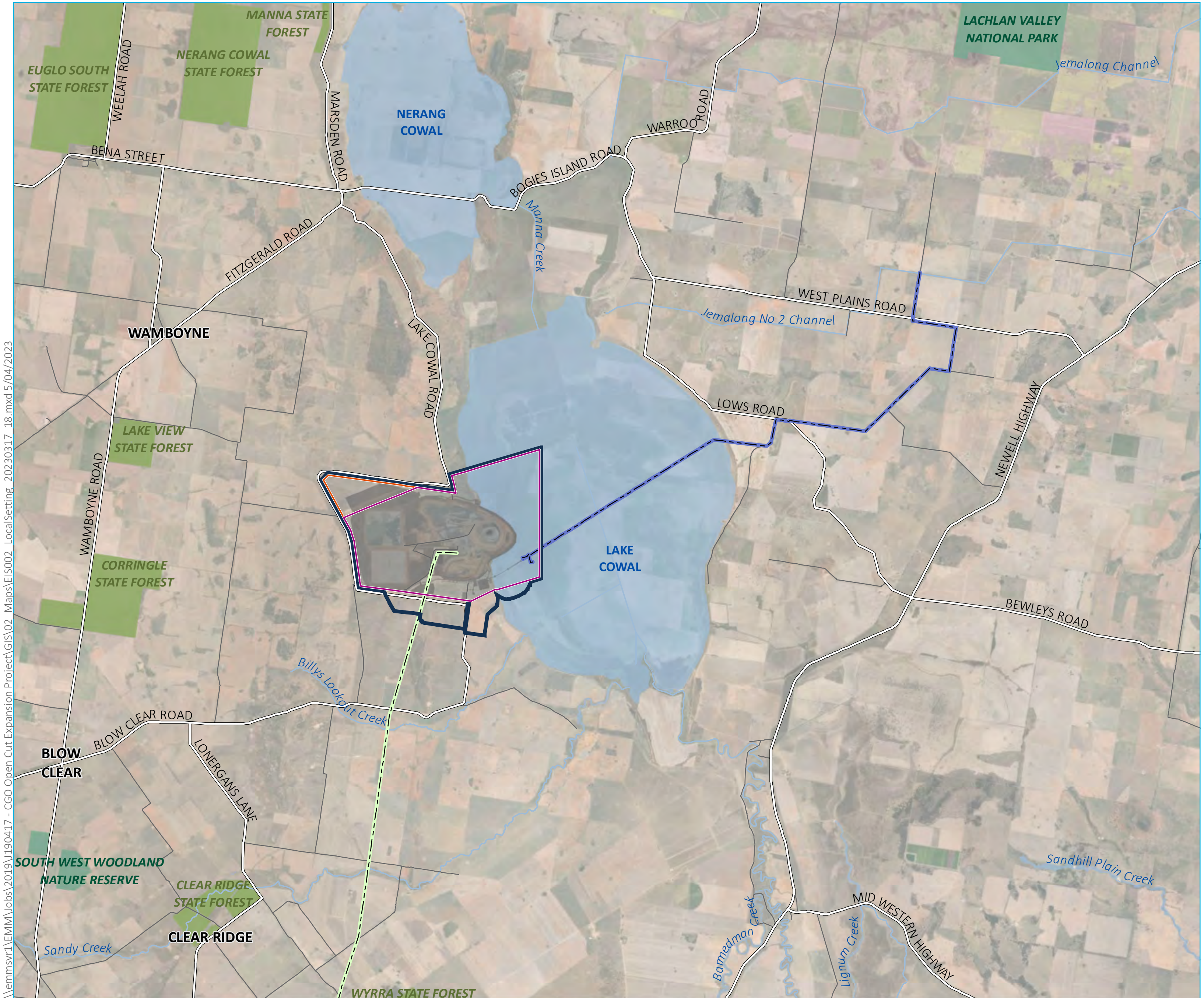
Source: EMM (2023); Evolution (2023); DFSI (2017); GA (2011); ASGC (2006)

Regional setting

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure 1.1

EMM creating opportunities



KEY
- Project area
- DA14/98 approved surface disturbance
- Mining lease (ML1535)
- Mining lease (ML1791)
- Water supply pipeline
- Electricity transmission line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Source: EMM (2023); Evolution (2023); DFSI (2017); ESRI (2023)

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GDA 1994 MGA Zone 55
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Local setting

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure 1.2

EMM
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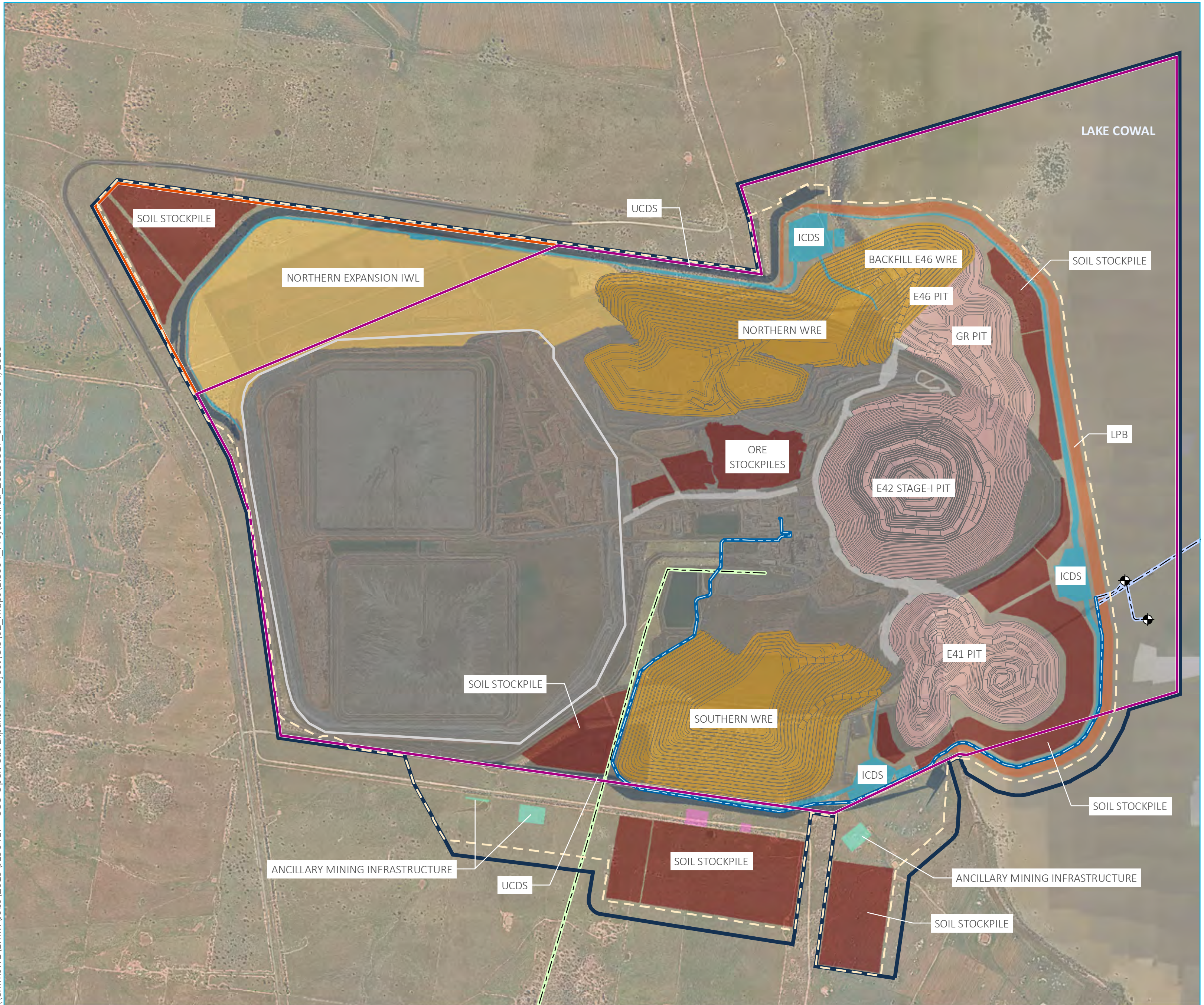

KEY
- Project area
- Proposed disturbance footprint
- DA14/98 approved surface disturbance
- Approved IWL footprint
- Mining lease (ML1535) (offset for clarity)
- Mining lease (ML1791) (offset for clarity)
- Saline groundwater supply bore
- Water supply pipeline
- Electricity transmission line

Conceptual project infrastructure
- Open cut pit footprint
- Northern expansion IWL
- Waste rock emplacement (WRE)
- Lake protection bund (LPB)
- Stockpile
- Up catchment diversion system (UCDS)
- Internal Catchment Drainage System (ICDS)
- Ancillary mining infrastructure
- Magazine
- Road
- Water supply pipeline realignment

Source: EMM (2023); Evolution (2023); DFSI (2017); Nearmap (2021)

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Project overview

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure 1.3

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2 Report overview

A detailed air quality and greenhouse gas assessment was prepared by EMM for the CGO Underground Development State Significant Development (SSD 10367) and Modification 16 (DA 14/98) in August 2020 (the UG AQGHGA). The UG AQGHG presented the following key sections:

- a review of applicable air quality impact assessment criteria
- an overview of the setting of the CGO, including a summary of topographical features and neighbouring sensitive residential locations
- a detailed analysis of the prevailing dispersion meteorology and background air quality concentrations recorded at the CGO
- the air pollutant emissions inventory for existing approved operations and the proposed underground development
- atmospheric dispersion modelling of the quantified emissions to predict potential air quality impacts at the neighbouring sensitive residential locations
- an assessment of GHG emissions from the operation of the CGO (existing approved plus proposed underground operations).

To support consistency between the assessment of the CGO Underground Development and the Project, resources developed for the UG AQGHGA have been retained in this report wherever practicable to do so. Specifically, this relates to the following:

- adoption of the same assessment locations (see Chapter 3)
- selection of dispersion meteorology year and meteorological modelling (see Chapter 5)
- analysis of background air quality (see Chapter 6)
- general emissions inventory methodology for air pollutant emissions (see Chapter 7) and GHG emissions (see Chapter 10)
- use of the same dispersion model (see Chapter 8).

Each of the above chapters provides a summary of the resources adopted from the UG AQGHGA and where variations have been made for the AQGHGA.

3 Project setting

3.1 Local setting, land use and topography

The CGO is located approximately 38 km to the north-east of West Wyalong in NSW. It is immediately adjacent to Lake Cowal in the Lachlan Catchment, an ephemeral inland wetland system.

The Cowal Gold Operations are situated on ML 1535 and ML 1791 and apart from the mining facilities, key infrastructure include the water supply pipeline from the Bland Creek Palaeochannel Borefield and Jemalong irrigation channel; high voltage power line and associated infrastructure.

The area surrounding the CGO is characterised by relatively flat terrain consisting predominantly of agricultural land, with the elevation ranging from approximately 203 m AHD to 260 m AHD. A three-dimensional representation of the local topography is presented in Figure 3.1.

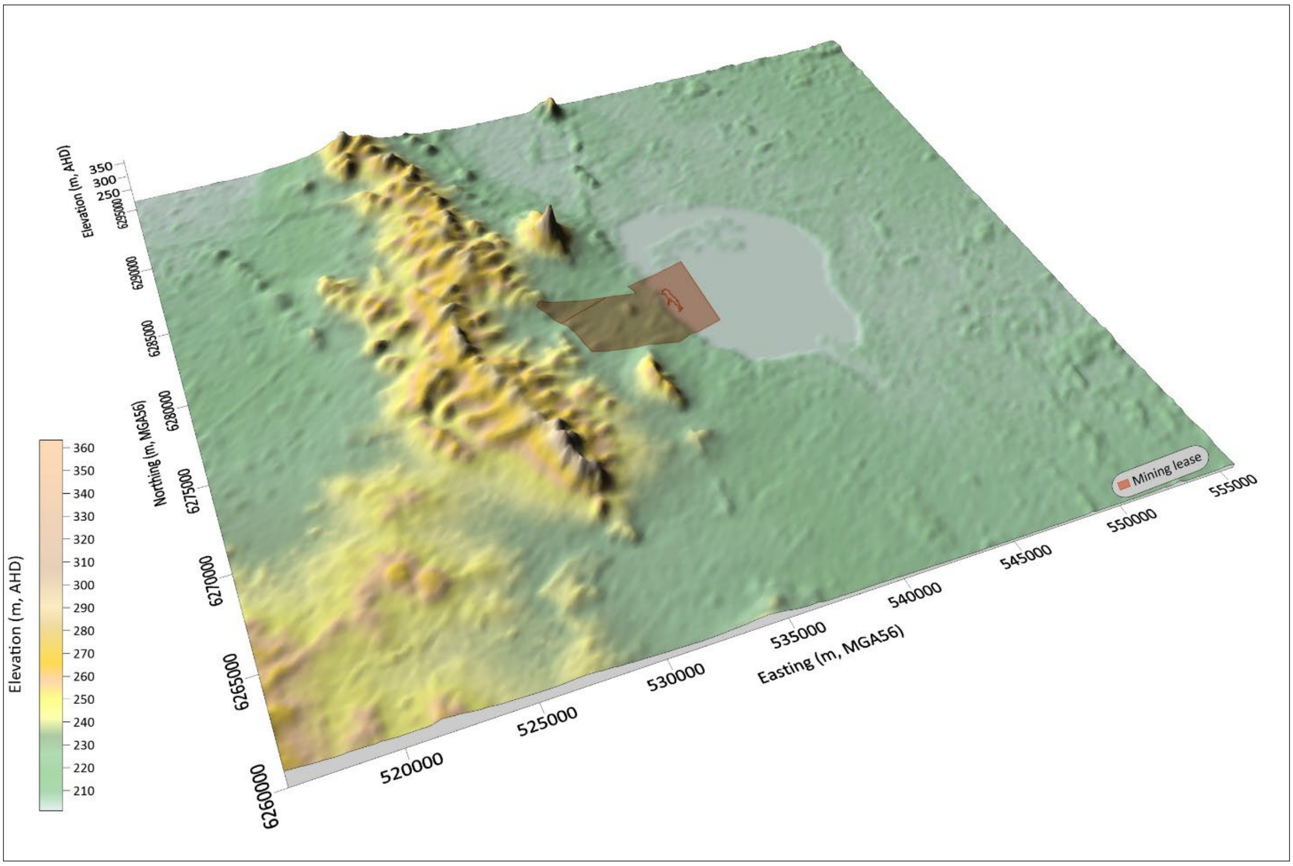

Figure 3.1 3-dimensional topography of the Project site and surrounding area

Source: NASA Shuttle Radar Topography Mission data. Vertical exaggeration of 4 applied to z-axis.

3.2 Assessment locations

The area surrounding the Project includes a number of privately-owned properties with the closest residence located approximately 1.2 km to the west of CGO. In order to comprehensively assess potential air quality impacts across the surrounding area, residences within a 15 km radius of the Project have been selected as discrete model prediction locations.

The 37 selected residences are referred to in this report as assessment locations. Assessment locations 1a to 1d and 42 are classified as mine-owned residences, while the remaining are classified as private residences. Details are provided in Table 3.1 and their locations are shown in Figure 3.2.

Table 3.1 Assessment locations

Assessment location ID	Type	Property name	Easting	Northing
1a	Residential	Coniston (Evolution-owned)	535153	6282548
1b	Residential	Lakeside (Evolution-owned)	536424	6283400
1c	Residential	Hillgrove (Evolution-owned)	534407	6272697
1d	Residential	Lake Cowal (Evolution-owned)	541794	6272704
4	Residential	Goodwood	547567	6281001
6	Residential	Boongarry	549989	6276946
15[1]	Residential	Laurel Park	532378	6283364
20	Residential	Bramboyne	530337	6282231
21[2]	Residential	Westella	531013	6278985
22a	Residential	Lakeview	528402	6277761
22b	Residential	Lakeview II	528249	6277583
22c[3]	Residential	Lakeview III	528976	6277626
22d	Residential	Thistleview	527918	6274662
24	Residential	Mangelsdorf	532297	6270665
25	Residential	Mangelsdorf II	531695	6269734
28	Residential	Bristowes	548681	6286710
30a	Residential	Wamboyne	530989	6288345
30b	Residential	Grinter	531171	6289740
31a	Residential	Koobah	549554	6273711
36a	Residential	The Glen	535625	6284898
36b	Residential	Wamboyne II	530297	6286030
38[1]	Residential	Gumbelah	545613	6276295
42[4]	Residential	Westlea (Evolution-owned)	532383	6274566
43a	Residential	Lake Cowal II	545105	6271379
43b	Residential	Billabong	547179	6268189
49a	Residential	Foxman Downs	531145	6271554
49b	Residential	Foxman Downs II	531386	6272221
56	Residential	Mattiske II	550605	6285032
57	Residential	Harmer	529760	6268071
61a	Residential	Bungabulla	545627	6275893
62	Residential	Cowal North	541979	6286026

Table 3.1 Assessment locations

Assessment location ID	Type	Property name	Easting	Northing
79	Residential	Ridley	526342	6286717
89	Residential	Morton	534740	6269452
90	Residential	Caloola	535441	6267131
100	Residential	Blampied	528226	6267940
122	Residential	Fitzgerald	531978	6288396
126	Residential	Noble	526050	6285038

Notes: 1. Evolution has a noise agreement in place with the owner(s) of this private property.
2. Subject to acquisition upon request in accordance with the development consent.
3. Subject to mitigation upon request in accordance with the development consent.
4. Property acquired by Evolution on 3 December 2018 in accordance with the land acquisition process defined in Condition 8.3 of the development consent.

Source: EMM (2023); Evolution (2023); DFSI (2017)

KEY

- Project area
- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Assessment location

- Private property
- Evolution owned property

Assessment locations

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure 3.2

EMM
creating opportunities

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA001_AssessmentLocations_20230405_03.mxd 5/04/2023

4 Pollutants and assessment criteria

4.1 Potential air pollutants

4.1.1 Overview

The operation of the CGO has the potential to generate emissions of various air pollutants. CGO emission sources will include a mixture of the following:

- fugitive dust/particulate matter from ore and waste extraction, handling and processing, movement of mobile plant and equipment, and wind erosion of exposed surfaces
- fugitive gaseous releases from the processing plant and the surface of active IWL
- combustion sources, such as exhaust emissions from site equipment
- emissions from underground ventilation portals.

Air pollutants emitted by 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})
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$)
- oxides of nitrogen (NO_x)[2], including nitrogen dioxide (NO_2)
- sulfur dioxide (SO_2)
- carbon monoxide (CO)
- volatile organic compounds (VOCs)
- hydrogen cyanide (HCN).

4.1.2 Emissions from the combustion of diesel fuel

The combustion of diesel in mining equipment results in combustion-related emissions, including particulate matter (largely in the $PM_{2.5}$ size fraction), NO_x, SO_2, CO, carbon dioxide (CO_2) and VOCs. To address diesel combustion emissions in this AQGHGA, focus has been given to emissions of particulate matter and NO_x.

Greenhouse gas emissions from diesel combustion are considered in Chapter 10.

[2] By convention, NOx = nitric oxide (NO) + NO_2.

4.1.3 Blast fume

Blast fume is the result of a less than optimal chemical reaction of ammonium nitrate explosives during the open cut blasting process, resulting in the release of nitric oxide and NO_2. Potential adverse impacts from blast fume can be effectively managed through good practice blast management.

CGO operates under an existing approved Blast Management Plan, which includes blast fume prevention measures, developed in accordance with the *Code of Good Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (Code of Practice) (Australian Explosives Industry and Safety Group Inc., 2011).

Particulate matter and NO_x emissions from blasting are included in the emission inventories presented in Chapter 7.

4.1.4 Hydrogen cyanide

Cyanide (CN) is used as a reagent in the processing plant, and can lead to small amounts of fugitive emissions of HCN through volatilisation from storage tanks and the IWL. CGO operates under an existing approved Cyanide Management Plan. The site uses a cyanide destruction process before discharge to the IWL, and undertakes twice daily cyanide monitoring. The Project will not change the rate of cyanide consumption at CGO, and therefore no change is anticipated to the management measures currently in place. No further assessment of HCN is presented in this report.

4.1.5 Odour

There are no significant sources of odour identified for the CGO. The processing plant may use small quantities of potassium amyl xanthate (PAX), which has a pungent odour. However, off-site odour impacts from its use do not currently occur (a review of the complaint register indicates that no odour complaints have been received from surrounding residences). There would be no increase in usage of PAX from the Project, and therefore no further assessment of odour is presented in this report.

4.2 Impact assessment criteria

This AQGHGA will focus on CGO emissions of particulate matter (TSP, PM_{10} and $PM_{2.5}$) and NO_X and the associated impact to the surrounding environment. Applicable impact assessment criteria for these air pollutants have been adopted from Section 7 of the Approved Methods for Modelling (NSW EPA 2022). The impact assessment criteria are designed to maintain ambient air quality for the adequate protection of human health and wellbeing. The relevant NSW EPA impact assessment criteria for particulate matter and NO_2 are presented in Table 4.1.

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 (NSW 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 can therefore lead to adverse human health impacts. The NSW 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}, $PM_{2.5}$, dust deposition and NO_2 as 'criteria pollutants'. The impact assessment criteria for criteria pollutants are applied at the nearest existing or likely future off-site sensitive receptors[3], and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction for the relevant averaging. Both the incremental (project only) and cumulative (project + background) impacts need to be presented, with the latter requiring consideration of the existing ambient background concentrations.

For dust deposition, the NSW 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 4.1 Impact assessment criteria for particulate matter

PM metric	Averaging period	Impact assessment criterion
TSP	Annual	90 µg/m^3
PM_{10}	24 hour	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hour	25 µg/m^3
	Annual	8 µg/m^3
Dust deposition	Annual	2 g/m^2/month (project increment only)
		4 g/m^2/month (cumulative)
NO_2	1 hour	164 µg/m^3
	Annual	31 µg/m^3

Notes: µg/m^3: micrograms per cubic meter; g/m^2/month: grams per square metre per month

4.3 Voluntary land acquisition and mitigation policy

In September 2018, NSW Department of Planning and Environment (DPE) released the Voluntary Land Acquisition and Mitigation Policy (VLAMP) for State Significant Mining, Petroleum and Extractive Industry Developments. The VLAMP describes the voluntary mitigation and land acquisition policy to address dust and noise impacts, and outlines mitigation and acquisition criteria for particulate matter. Under the VLAMP, if a development cannot comply with the relevant impact assessment criteria, or if the mitigation or acquisition criteria may be exceeded, the applicant should consider a negotiated agreement with the affected landowner or acquire the land. In doing so, the land is then no longer subject to the impact assessment, mitigation or acquisition criteria, although provisions do apply to the "use of the acquired land", primarily related to informing and protecting existing or prospective tenants.

In relation to dust, voluntary mitigation and acquisition rights apply when a development contributes to exceedances of the criteria set out in Table 4.2. The criteria for voluntary mitigation and acquisition are the same, except for the number of days the short-term impact assessment criteria for PM_{10} and $PM_{2.5}$ can be exceeded, which is zero for mitigation and five for acquisition.

[3] NSW 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.

Voluntary mitigation rights apply to any residence on privately-owned land or any workplace on privately-owned land where the consequences of the exceedance, in the opinion of the consent authority, are unreasonably deleterious to worker health or the carrying out of business. Voluntary acquisition rights also apply to any residence or any workplace on privately-owned land, but also apply when an exceedance occurs across more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

Table 4.2 VLAMP mitigation and acquisition criteria

Pollutant	Averaging period	Criterion	Basis	Allowable exceedances over life of development	Impact type
PM_{10}	24 hour	50 µg/m³	Project only	None for voluntary mitigation Five for voluntary acquisition	Human health
	Annual	25 µg/m³	Cumulative	NA	Human health
$PM_{2.5}$	24 hour	25 µg/m³	Project only	None for voluntary mitigation Five for voluntary acquisition	Human health
	Annual	8 µg/m³	Cumulative	NA	Human health
TSP	Annual	90 µg/m³	Cumulative	NA	Amenity
Deposited dust	Annual	2 g/m²/month	Project only	NA	Amenity
		4 g/m²/month	Cumulative	NA	

4.4 POEO (Clean Air) Regulation

The statutory framework for managing air emissions in NSW is provided in the *Protection of the Environment Operations Act*[4] *1997* (POEO Act) and the primary regulation for air quality made under the POEO Act is the Protection of the Environment Operations (Clean Air) Regulation 2010[5] (POEO Regulation). As a scheduled activity under the POEO Regulation, the Project will operate under an environment protection licence (EPL) and will comply with the associated requirements, including emission limits, monitoring and pollution reduction programs (PRPs).

[4] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N

[5] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N

5 Meteorology and climate

The prevailing dispersion meteorology experienced at CGO was comprehensively documented in Chapter 4 of the UG AQGHGA. The analysis was based on six years (2013 to 2018) of hourly measurements from the CGO meteorological station, installed near the southern boundary of ML 1535, and a review of long-term climatic trends based on data from the closest Bureau of Meteorology (BoM) climate station located at Wyalong Post Office (approximately 30 km south-west of CGO). The analysis from the UG AQGHGA is presented in Attachment A of this report.

The meteorological and climate data analysis presented in the UG AQGHGA concluded that the 2018 calendar year was representative of the CGO site for wind speed, wind direction and ambient temperature. Therefore, the 2018 calendar year dataset from the CGO meteorological station was considered appropriate for use in the dispersion modelling undertaken for the UG AQGHGA.

To supplement the work undertaken for the UG AQGHGA, meteorological monitoring data from the CGO meteorological monitoring station was collated for the period between 2019 and 2021 and analysed. Annual wind roses for the period between 2013 and 2021 are presented in Figure 5.1.

The generated wind roses for the additional three years of measurements from the CGO meteorological monitoring station show agreement with the period between 2013 and 2018 previously analysed for the UG AQGHGA. Specifically, the wind roses for the years between 2019 and 2021 show the same prevailing south-westerly airflow, similar average wind speed (between 3.1 m/s and 3.3 m/s) and similar frequency of calm wind conditions (between 1.7% and 2.1%) as shown in the wind roses for 2013 to 2018.

On the basis of the wind roses presented in Figure 5.1, it is considered that the 2018 calendar year remains representative of the CGO site relative to longer term trends. Consequently, the meteorological input dataset developed for use in the UG AQGHGA has been retained in the current assessment.

The meteorological data from the CGO site were processed by the AERMET meteorological processor for use in the dispersion modelling completed for this AQGHGA. A summary of the meteorological processing and outputs for the 2018 CGO meteorological dataset is provided in Attachment A.

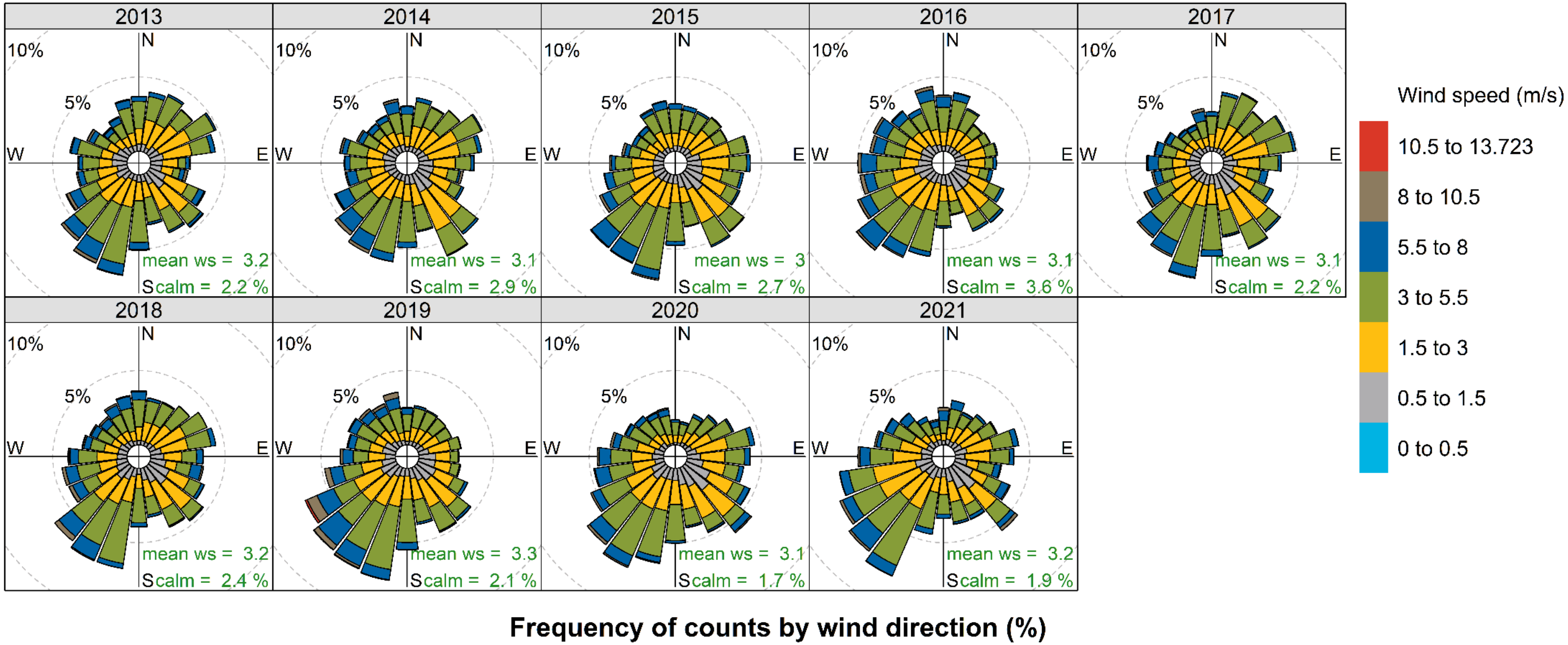

Figure 5.1 **Annual wind roses for CGO meteorological station – 2013 to 2021**

6 Background air quality

6.1 Particulate matter

Evolution maintains an air quality monitoring network at the CGO, consisting of the following components:

- 12 dust deposition gauges (DDGs)
- one high-volume air sampler (HVAS) (measuring TSP).

This monitoring program is described in the CGO Air Quality Management Plan (AQMP) (June 2022). As documented in Section 4.2.2 of the CGO AQMP, the TSP measurements by the HVAS are used to derive a PM_{10} concentration through the application of scaling factor of 40%.

Environmental monitoring data are published monthly, in accordance with the EPL, and summarised in the CGO Annual Review, in accordance with the development consent (DA 14/98).

In addition to the above air quality monitoring network, three Environmental Beta Attenuation Mass (E-BAM) continuous PM_{10} monitors were installed in October 2019 at Coniston (approximately 3 km north of the CGO northern boundary and near the HVAS location), at Lake Cowal Conservation Centre (approximately 3 km south of the CGO southern boundary), and at the CGO site office. The E-BAM units were installed for reactive management purposes, rather than compliance monitoring.

As identified in Chapter 5, the dispersion modelling completed in this AQGHGA adopted the same 2018 calendar year meteorological input dataset that was prepared for the UG AQGHGA. Consequently, the same background air quality data, contemporaneous with the meteorological input data, were applied in this AQGHGA to quantify cumulative impacts at surrounding assessment locations.

The UG AQGHG adopted the following resources in accounting for background air quality at CGO:

- continuous monitoring data from the DPE Bathurst air quality monitoring station (AQMS)[6] recorded during the 2018 calendar year for PM_{10} and $PM_{2.5}$
- annual average TSP concentrations and dust deposition levels from the CGO air quality monitoring network.

6.1.1 TSP, PM_{10} and $PM_{2.5}$

For short-term (24 hour average) cumulative assessment, there were days in the 2018 background datasets when the measured concentration was already above the impact assessment criteria due to regional scale influences (e.g. dust storm and vegetation burning). The assessment therefore focussed on the number of additional days above the impact assessment criteria. This approach is consistent with the guidance provided in Section 5.1.3 of the Approved Methods for Modelling for dealing with elevated background concentrations.

Summary statistics for the DPE Bathurst AQMS 2018 dataset are presented in Table 6.1, consistent with the UG AQGHGA.

[6] While this AQMS is located approximately 200 km east, it is the nearest suitable AQMS as Orange AQMS was only added recently (no data exists for 2018) and the Wagga Wagga AQMS is generally considered unsuitable for describing baseline air quality for other rural areas of NSW due to the influence of specific sources at this site.

Table 6.1 Summary statistics for PM_{10} and $PM_{2.5}$ concentrations (µg/m³) at Bathurst (2018)

Size fraction	Annual mean	Criterion	Max 24 hour average	Criterion	Days at or above the criterion	Highest 24 hour average concentration below the criterion
PM_{10}	18.8	25	274.1	50	8	49.7
$PM_{2.5}$	7.0	8	40.5	25	2	22.1

To demonstrate that the 2018 dataset remains relevant, the air quality monitoring data analysis presented in the UG AQGHGA has been updated to include more recent data from the CGO air quality monitoring network and the DPE Bathurst AQMS.

The annual average TSP (and derived PM_{10}) concentrations recorded at the CGO HVAS, and the annual average PM_{10} concentrations recorded by the CGO Coniston E-BAM and DPE Bathurst AQMS between 2010 and 2021 are presented in Table 6.2. It is noted that for the CGO Coniston E-BAM, monitoring commenced monitoring in October 2019 (23% data completeness for 2019) and featured extensive missing data from October 2021 onwards (76% data completeness for 2021).

Table 6.2 Annual mean TSP and PM_{10} concentrations (µg/m³) at Bathurst and the CGO HVAS and Coniston E-BAM

Year	TSP concentrations (µg/m³)	PM_{10} concentrations (µg/m³)		
	CGO HVAS	CGO HVAS	CGO Coniston	DPE Bathurst
2010	38.8	15.5	-	9.4
2011	28.6	11.4	-	11.0
2012	35.0	14.0	-	13.4
2013	44.2	17.7	-	15.1
2014	45.3	18.1	-	14.6
2015	43.0	17.2	-	13.4
2016	32.3	12.9	-	13.3
2017	27.5	11.0	-	14.1
2018	64.2	**25.7**	-	18.8
2019	76.0	**30.4**	**-**	**59.8**
2020	44.0	17.6	21.6	17.0
2021	30.8	12.3	11.4	11.4

The data show general agreement in annual average PM_{10} concentrations between the two CGO monitoring locations and the DPE Bathurst AQMS for each year. The 2019 period was notably higher at the CGO HVAS and DPE Bathurst monitoring locations (incomplete year of data at CGO Coniston), which was due to the influence of emissions from drought and Black Summer bushfire-related events across NSW.

Concurrent 24 hour average PM_{10} concentrations at the CGO HVAS and DPE Bathurst AQMS recorded between 2010 and 2021 are illustrated in Figure 6.1. The concurrent continuous PM_{10} measurements from the CGO Coniston monitoring station and DPE Bathurst AQMS for the period following the NSW Black Summer bushfire events (between February 2020 and October 2021) are illustrated in Figure 6.2.

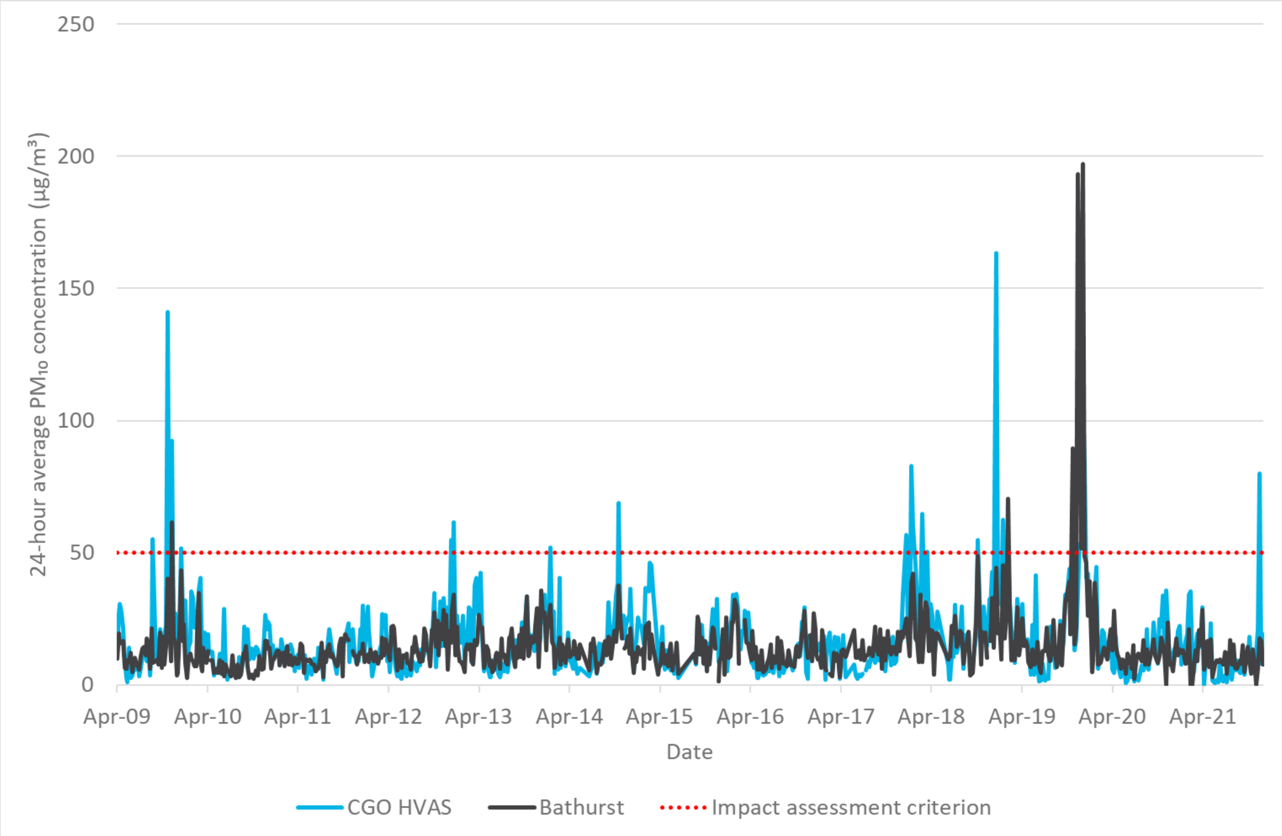

Figure 6.1 Periods of concurrent 24-hr average PM_{10} concentration – Bathurst and CGO HVAS

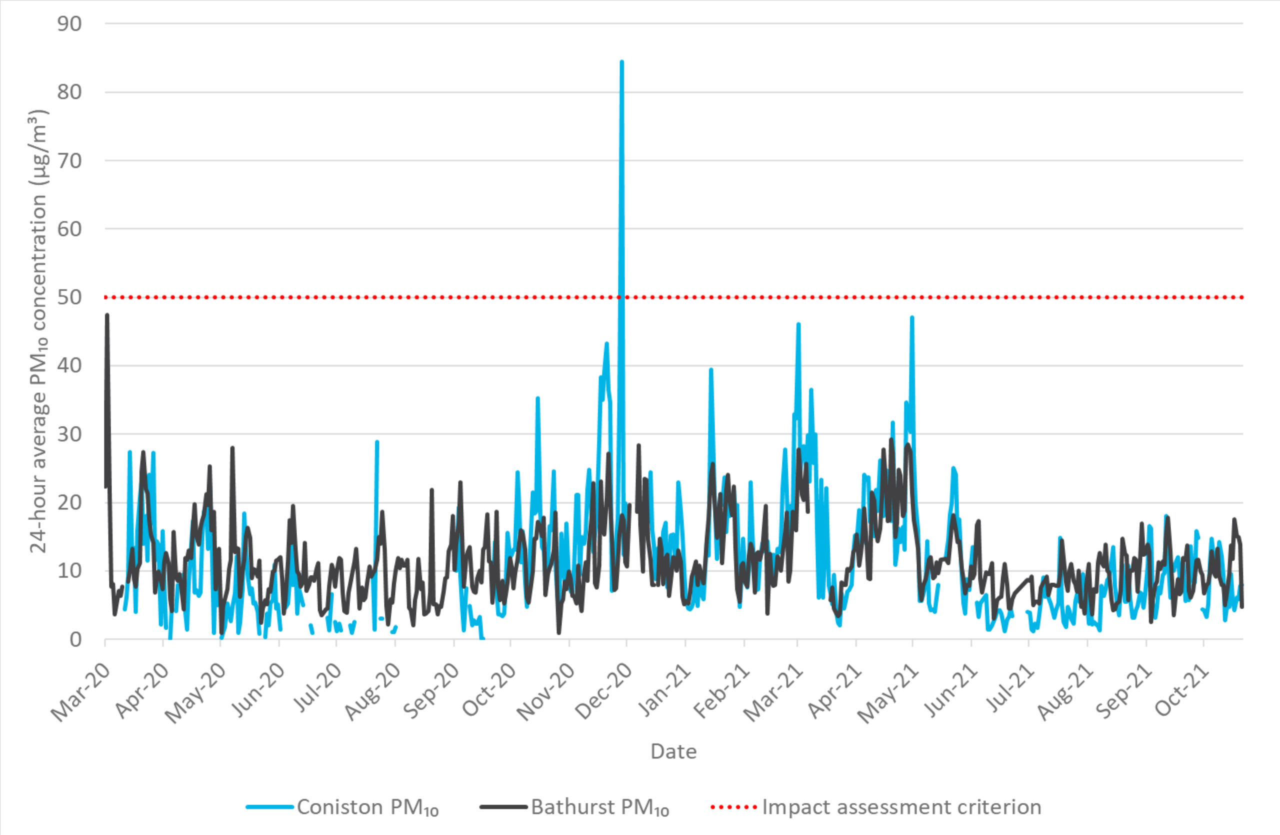

Figure 6.2 Periods of concurrent 24 hr average PM_{10} concentration – for Bathurst and CGO Coniston

These graphs highlight that, in general, the daily varying PM_{10} concentrations recorded at CGO (HVAS and E-BAM) and Bathurst follow a similar trend.

The Pearson's correlation coefficient I[7] value was calculated for the concurrent DPE Bathurst AQMS and CGO monitoring datasets. The calculations returned *r* values of 0.56 for the relationship between the DPE Bathurst AQMS and the CGO HVAS and 0.57 for the relationship between the DPE Bathurst AQMS and the CGO Coniston E-BAM, indicating a moderate to strong linear agreement between concurrent PM_{10} measurements recorded at CGO and Bathurst.

While the DPE Bathurst AQMS is spatially distant from the CGO, it is considered that the outcomes of this analysis support the continued use of the 2018 DPE Bathurst AQMS PM_{10} and $PM_{2.5}$ data to represent background air quality at CGO in this AQGHGA, consistent with the UG AQGHGA. It is reiterated that the use of the 2018 DPE Bathurst AQMS dataset as background was accepted for the UG AQGHGA by NSW EPA.

6.1.2 Dust deposition

The annual average dust deposition levels for 2012 to 2021 from the CGO dust deposition monitoring locations beyond the mining lease boundary are presented in Figure 6.3. The analysis shows that dust deposition levels greater than that impact assessment criterion (4 g/m²/month) occur in most years, but not necessarily at the same locations.

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

Across all sites and years, the annual average dust deposition levels ranged from 1.0 g/m^2/month to 9.0 g/m^2/month (average of 3.7 g/m^2/month). During 2018, annual average dust deposition levels range from 1.7 g/m^2/month to 6.5 g/m^2/month (average of 4.1 g/m^2/month) across all sites.

Consistent with the analysis presented in the UG AQGHGA, the recorded dust deposition levels fluctuate from year to year and between monitoring locations. The increase in dust deposition levels associated with the drought and Black Summer bushfires is evident in the 2018 and 2019 data.

For consistency with the UGAQGHGA, the average dust deposition rate across all sites between 2012 and 2018 (average of 3.4 g/m^2/month) has been retained as background dust deposition.

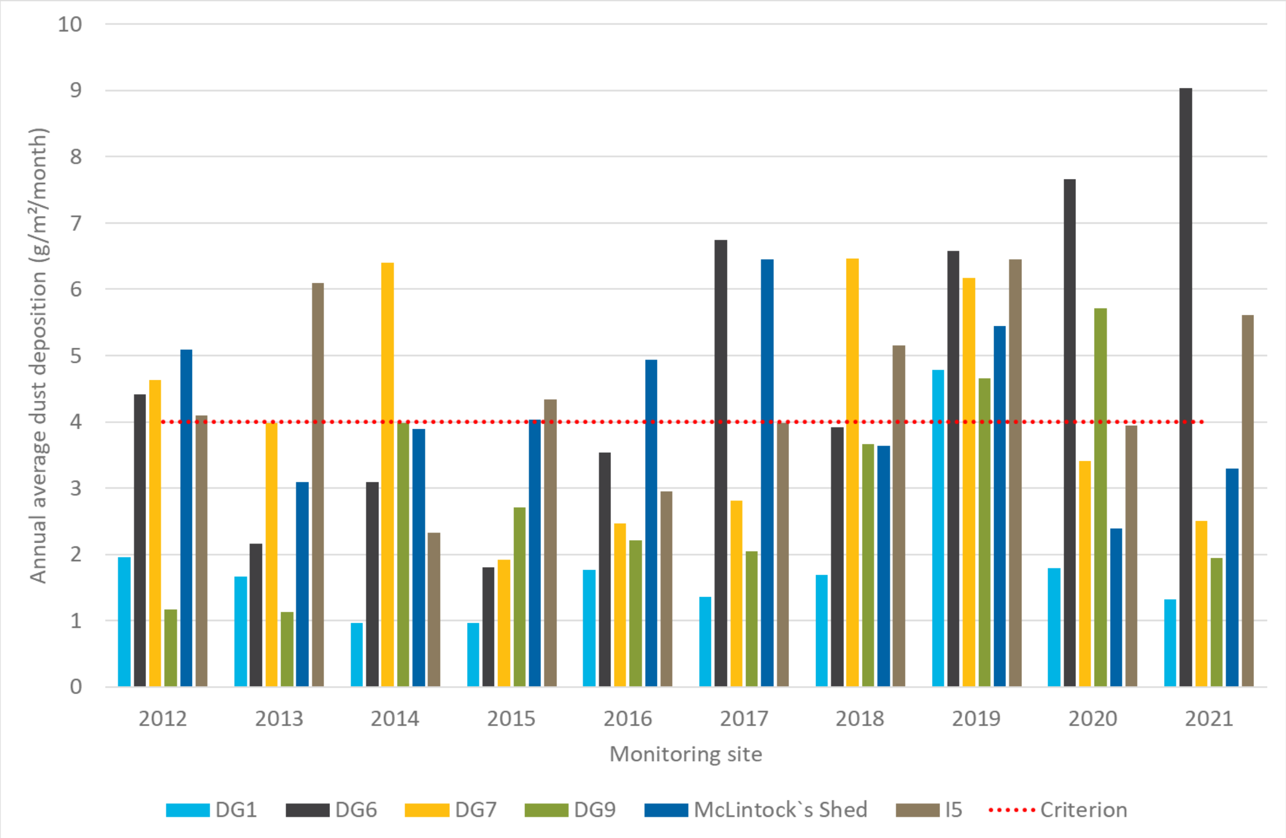

Figure 6.3 Annual average dust deposition for sites representative of residences – 2012 to 2021

6.2 Nitrogen dioxide and ozone

In addition to emissions of particulate matter, this AQGHGA quantified NO_x emissions associated with diesel combustion and blasting. To convert predicted concentrations of NO_x to NO_2, the ozone limiting method (OLM) prescribed in Section 8.1.2 of the NSW EPA Approved Methods for Modelling (EPA 2022) has been applied. While further detail relating to this approach is presented in Section 8.2, the OLM requires background concentrations of NO_2 and ozone (O_3).

No monitoring of NO_2 or O_3 is conducted in the vicinity of the CGO, and there is limited publicly available ambient monitoring data for NO_2 and O_3 in regional NSW. For the 2018 calendar year across regional NSW, only the DPE Gunnedah AQMS recorded hourly-varying concentrations of NO_2 and O_3. While spatially distant from the CGO area (approximately 400 km north-east of the CGO), in the absence of any other regional monitoring data, the hourly varying NO_2 and O_3 concentrations recorded at the DPE Gunnedah AQMS in 2018 were adopted as the most appropriate background dataset for a rural setting. Gaps in the 2018 Gunnedah AQMS data were supplemented by data recorded by the three Lower Hunter DPE stations (Beresfield, Wallsend and Newcastle).

The hourly time series of the 2018 DPE Gunnedah AQMS NO_2 and O_3 concentration data is illustrated in Figure 6.4.

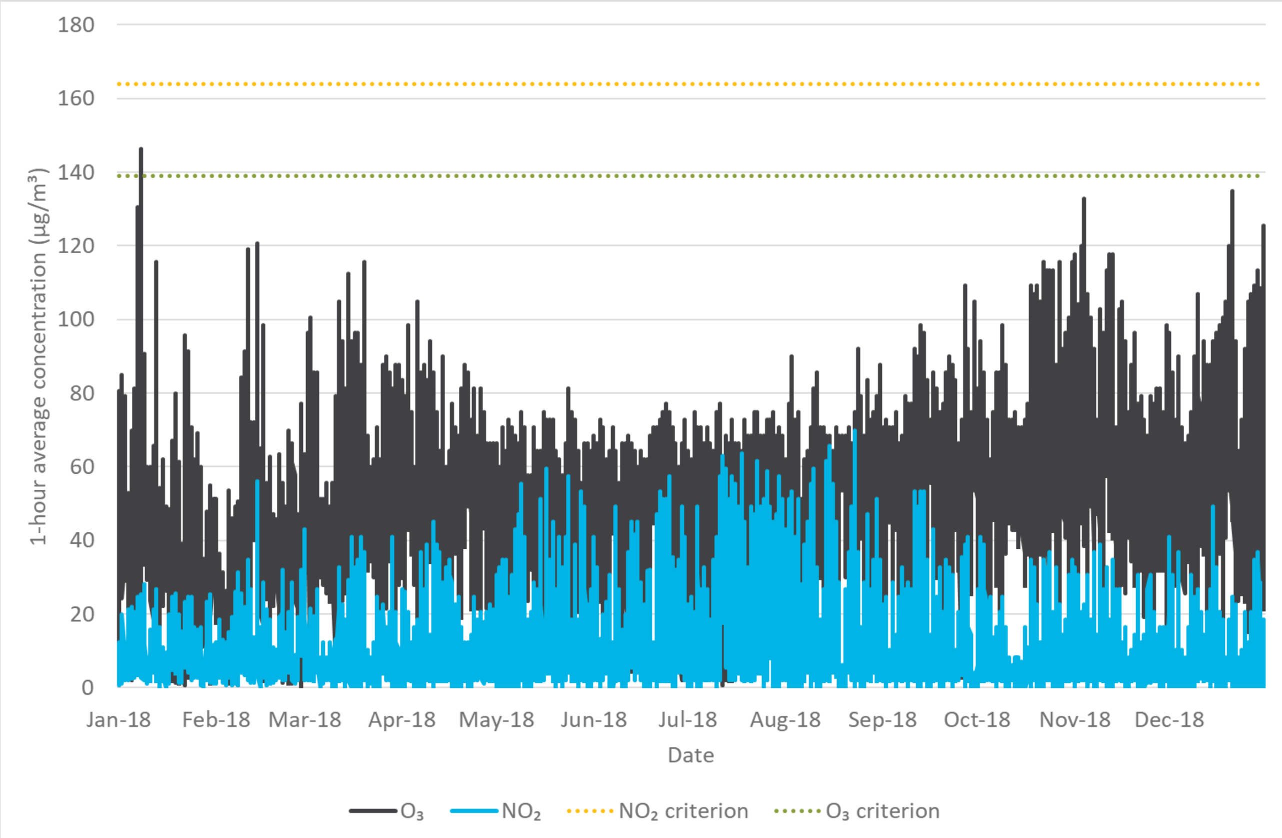

Figure 6.4 1 hour average NO_2 and O_3 concentrations – DPE Gunnedah AQMS 2018

6.3 Summary

In summary, the following background air pollutant concentrations and dust deposition levels, consistent with the UG AQGHGA where relevant, are adopted for cumulative assessment in this report:

- 24 hour PM_{10} concentration – daily varying, based on data recorded during 2018 by the DPE Bathurst AQMS
- annual average PM_{10} concentration – 18.8 µg/m^3
- 24-hour $PM_{2.5}$ concentration – daily varying, based on data recorded during 2018 by the DPE Bathurst air quality monitoring station (AQMS)
- annual average $PM_{2.5}$ concentration – 7.0 µg/m^3
- annual average TSP concentration – 64.2 µg/m^3
- annual average dust deposition – 3.4 g/m^2/month
- 1 hour NO_2 – hourly varying, based on data recorded during 2018 by the DPE Gunnedah AQMS
- annual average NO_2 – 10.4 µg/m^3.

7 Emissions inventory

7.1 Emission scenarios

The key drivers for particulate matter emission generation are annual material extraction rates (i.e. waste rock and run of mine (ROM) ore) and the total annual haul truck kilometres travelled. In order to determine the key future years to quantify emissions from the Project, the future mine schedule was provided to EMM by Evolution and interrogated based on the amount of material extracted by location, the amount of material unloaded by destination, the distance per haul truck run, and the number of haul truck movements per year.

Two graphs were generated from this analysis:

- Figure 7.1, showing the total material extracted by year and location, and the corresponding total annual haul distance (expressed as vehicle kilometres travelled, or VKT)

- Figure 7.2, showing the relationship between annual material extracted and the calculated annual haul distances.

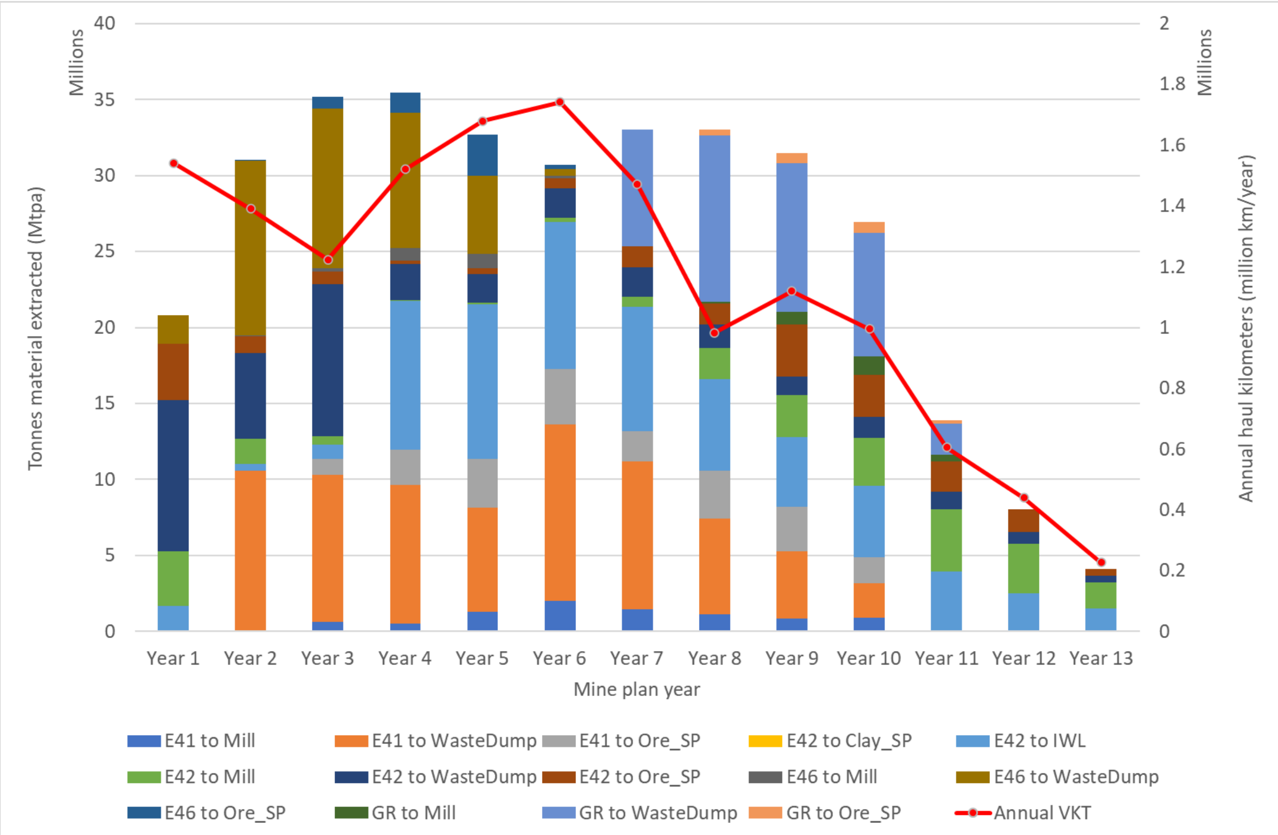

Figure 7.1 Total annual material extracted (waste + ore) by load point and destination and annual haul kilometres by mine schedule year

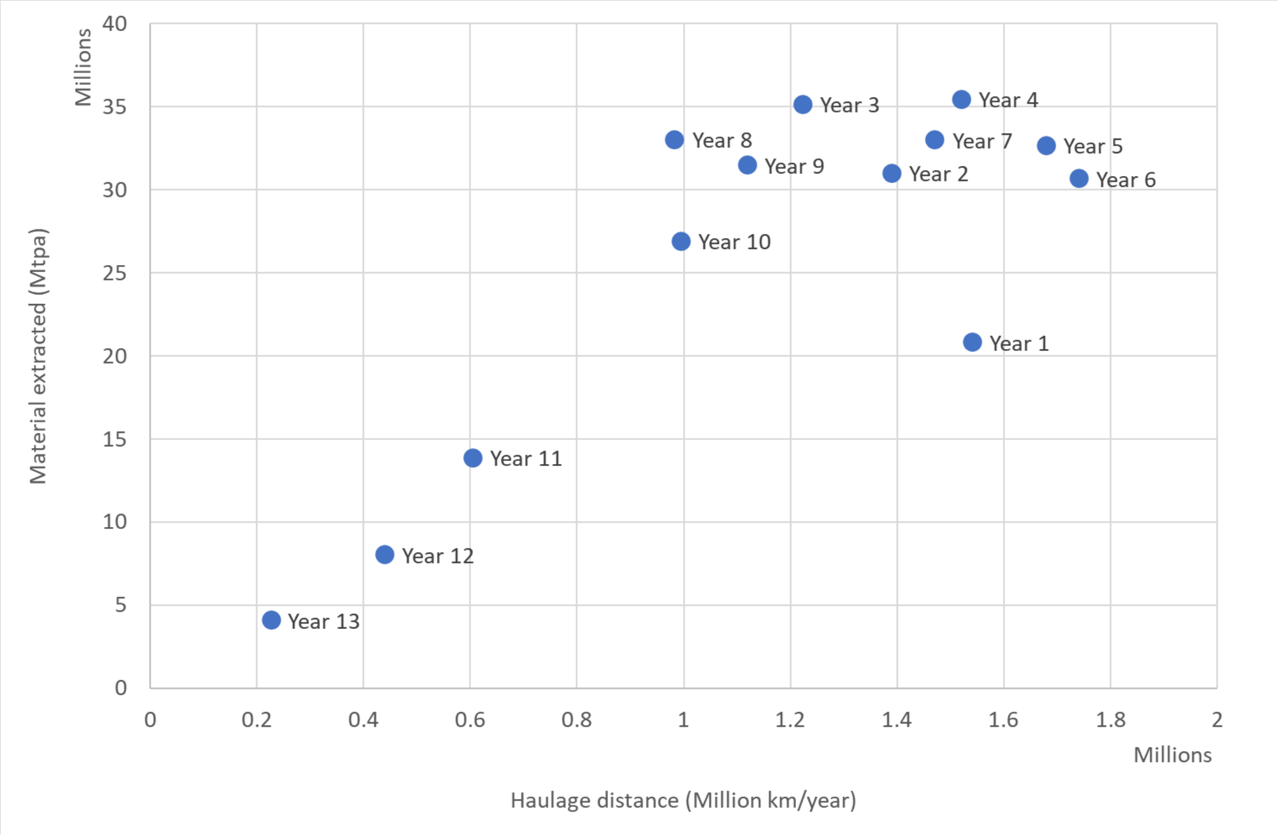

Figure 7.2 Relationship between total material extracted and annual haulage distance by mine schedule year

From these figures, the following key points were identified:

- Year 4 represents the peak year for total material extraction across CGO and near peak operations in the E46 pit
- Year 6 represents the peak year for total annual haulage distance across CGO, the peak of E41 pit operations and the peak north-west IWL construction activities.

These two scenarios are therefore considered to be the peak operational scenarios for the Project for particulate matter generation. In addition to these two years, the following additional scenarios are also selected:

- Year 1, characterising the peak of LPB construction activities and the peak of operations from the E42 pit
- Year 9, representing a later development year and the peak of operations for the GR pit.

Therefore, the following mine schedule years have been selected for quantification of air pollutant emissions:

- Year 1
- Year 4
- Year 6
- Year 9.

On the basis that these four mine schedule year cover the highest phases of construction and operational intensity across the various areas of the CGO Project Area, it is considered that these four scenarios will provide an indication of likely highest annual air pollutant emissions from the Project. Consequently, if model predictions for these four scenarios achieve compliance with applicable criteria, then it can be inferred that all years of the Project will comply.

The mine schedule animation accompanying the future mine schedule was reviewed for each of the selected years. For the purpose of quantifying emissions and the configuration of dispersion models, the projected alignment of material haulage routes and location of material loading and unloading points were identified. While there is monthly spatial variation in activities within each mine year, the location of haulage and mining activities was simplified to the dominant areas shown over the relevant 12 month period.

7.2 Sources of emissions

For this AQGHGA, to account for cumulative air quality impacts at surrounding assessment locations, emissions from Project-related sources and other approved activities at CGO (e.g. underground operations) have been included in each modelling scenario. It is noted that the UG AQGHGA concluded that emissions and impacts from underground operations were minor relative to surface operations.

Sources of atmospheric emissions at the CGO accounted for in the selected four future scenarios representative of the Project include the following:

- clearing, loading and transportation of topsoil and subsoil material
- drill and blasting activities in various open pits
- loading of blasted waste rock and ore material to haul trucks in various open pits
- transport of waste rock to WREs and infrastructure construction areas (i.e. LPB and IWL)
- WRE management by dozers
- transport of ore material from pits to the ROM piles and primary hopper area
- processing plant, featuring material crushing, screening and grinding circuit and associated conveyor belt transfers points
- wind erosion associated with WREs, dried IWL surfaces, ore material stockpiles and other exposed surfaces
- diesel fuel combustion by on-site plant and equipment.

7.3 Fugitive particulate matter emissions

Fugitive dust sources associated with the Project were quantified through the application of NPI emission estimation techniques and USEPA AP-42 emission factor equations. The same emission factors adopted in the UG AQGHG were applied in the current assessment wherever possible.

Particulate matter emissions were quantified for the three size fractions identified in Chapter 4, with the TSP fraction also used to provide an indication of dust deposition rates. 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 USEPA AP-42).

The USEPA AP-42 emission factors developed for mining emission inventories do not separate PM emissions from mechanical processes (i.e. crustal material) and diesel exhaust (combustion). Consistent with previous assessments completed for CGO (e.g. UG AQGHGA), the emissions of particulate matter are assumed to include the contribution from diesel combustion in mining equipment. However, the emissions controls applied are often only relevant to the crustal fraction of total PM, for example the watering of haul roads does not control the diesel component of the emissions (US EPA 1998).

The estimated diesel emissions for hauling are subtracted from the uncontrolled haul road emissions to derive the wheel-generated component of emissions for each haul road. The control for watering is then applied to the wheel-generated component only, and the diesel emissions are then added back to derive the final emission estimate from haul trucks.

7.3.1 Particulate matter emission controls

As documented in Section 7.1 of the CGO AQMP (June 2022), a range of particulate matter emission controls are currently implemented at CGO. Source-specific mitigation measures, consistent with the CGO AQMP Table 7 and Table 8, are documented in Table 7.1.

Table 7.1 Existing air quality management practices (CGO AQMP Table 7 and Table 8)

Emission source	Management measure
Haul roads	• All roads and trafficked areas will be watered and/or treated with an alternative dust suppressant (using water trucks or other methods) and regularly maintained (using graders) to minimise the generation of dust. • Routes will be clearly marked. • Obsolete roads will be ripped and re-vegetated
Minor roads	• Development of minor roads will be limited and the locations of these will be clearly defined and within approved surface disturbance areas. • Regularly used minor roads will be watered and/or treated with an alternative dust suppressant (using water trucks or other methods) and regularly maintained. • Obsolete minor roads will be ripped and re-vegetated. • Minimise construction of new roads and use existing tracks.
Materials handling	• Prevention of truck overloading to reduce spillage during ore loading/unloading and hauling. • A water spray dust suppression system will be used at the primary crusher bin during truck dumping of raw ore. • Freefall height during ore/waste stockpiling will be limited.
Soil stripping	• Soil stripping will be limited to areas required for mining operations.
Drilling	• Dust aprons will be lowered during drilling for collection of fine dust. • Water injection or dust suppression sprays will be used when high levels of dust are being generated
Blasting	• Fine material collected during drilling will not be used for blast stemming. • Adequate stemming will be used at all times. • Blasting will only occur following an assessment of weather conditions by the responsible person in the environmental management team to ensure that wind speed and direction will not result in excess dust emissions from the site towards adjacent residences (refer to the Blasting Management Plan for further information).

Table 7.1 Existing air quality management practices (CGO AQMP Table 7 and Table 8)

Emission source	Management measure
Equipment maintenance	• Emissions from mobile equipment exhausts will be minimised by the implementation of a maintenance programme to service equipment in accordance with the equipment manufacturer specifications
General areas disturbed by mining	• Only the minimum area necessary for mining will be disturbed. • Exposed areas will be reshaped, topsoiled and revegetated as soon as practicable in accordance with Development Consent Condition 2.4(b), to minimise the generation of wind erosion dust.
WRE areas	• Exposed active work areas on waste emplacement surfaces will be watered to suppress dust where practicable. • Rehabilitation (i.e. reshaping, topsoil placement and revegetation) of waste emplacement areas will be conducted progressively, as soon as practicable following completion of landform, in accordance with Development Consent Condition 2.4(b).
Tailings storage facilities/IWL	• During non-operational periods, dust suppression measures will be undertaken to minimise dust emissions from dry exposed areas on the surface of the tailings storage facilities.
Soil stockpiles	• Long-term soil stockpiles will be revegetated with a cover crop.
Material handling and ore stockpiles	• Prevention of truck overloading to reduce spillage during ore loading/unloading and hauling. • The coarse ore stockpile features a water spray at the loadout conveyor. • The surface of all stockpiles will be sufficiently treated to minimise dust emissions. • Such treatment may include application of a dust suppressant, regular dust suppression watering or establishment of vegetation on longer term stockpiles (e.g. the low grade ore stockpile).

Taking the measures listed in Table 7.1 and the information provided by Evolution, appropriate particulate matter emission reduction factors have been selected for incorporation into the emissions inventory calculations for this AQGHGA (see Section 7.3.2). Table 7.2 presents the particulate matter emission control measures and the corresponding emission reduction factor applied to the emissions inventory calculations.

It is noted that progressive rehabilitation of exposed surfaces (e.g. LPB, IWL, completed WREs etc.) would occur throughout the life of the CGO, which would reduce the potential for wind erosion emissions. However, this AQGHGA has not applied any rehabilitation controls to any of the future particulate matter emission scenarios prepared for the Project.

Table 7.2 Particulate matter emission control measures

Emission sources	Control measures	Emission reduction factors (%)[1]
Material haulage using watering/suppressants	Water/suppressant application Travel speed reduction **Combined emission reduction**	80 44 **88**
Drilling	Dust aprons	63
Dozer and grader operations	Watering of travel routes	50
Processing mill	Water sprays Underground/enclosure **Combined emission reduction**	50 70 **85 (primary and recycle crushers only)**

[1] All control reduction factors adopted from *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone, 2011). Where multiple controls are in place (e.g. haulage routes), the multiplicative control factor has been applied as per NPI (2012).

7.3.2 Annual emissions

A summary of annual site particulate matter emissions by particle size fraction and source type is presented in Table 7.3 (Year 1, Table 7.4 (Year 4), Table 7.5 (Year 6) and Table 7.6 (Year 9). Particulate matter control measures, as documented in Section 7.3.1, are accounted for in these emission totals. Further details regarding emission estimation factors and assumptions are provided in Attachment B.

Total annual emissions by scenario are illustrated in Figure 7.3. For reference, the total annual emissions presented in Table 6.1 of the UG AQGHGA are also included in Figure 7.3.

It is noted that existing (approved) operations adopted in the UG AQGHGA were based on the emissions scenario presented in the 2018 modification (Mod 14), which corresponds to a nominal mining year of 2020 (PEL 2018) and a simplified spatial representation of CGO operations (e.g. single locations for waste/ore material loading and unloading, haul truck movements, etc).

The particulate matter emission inventories prepared for the future mine years in this AQGHGA are based on the latest staging plans for the CGO, including the operation of multiple open cut pits and WRE areas per year. To account for this additional detail, refinements in emissions inventory methodology and structure were therefore necessary to quantify emissions for the Project. Consequently, the emissions inventory totals illustrated in Figure 7.3 for the UG AQGHGA and the four future mine years are not directly comparable and merely presented for reference only.

Further, the emissions inventory for underground mining operations from the UG AQGHGA was adjusted for each of the four future mine year scenarios based on the corresponding projected underground mining activity rates (i.e. waste and ore extraction rates).

The following points are noted from the emissions inventory tables (Table 7.3 to Table 7.6) and Figure 7.3:

- Year 6 represents the highest potential emissions scenario of the four quantified years
- Year 9 represents the lowest potential emissions scenario of the four quantified years
- the difference between the minimum and maximum annual emission totals ranges between 9% for TSP, 14% for PM_{10} and 12% for $PM_{2.5}$
- the annual emissions assessed in the UG AQGHGA are within the range of the four future mine scenarios, noting the differences in methodology referenced in the previous paragraph.

Table 7.3 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 1

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E41 – topsoil removal/emplacement	-	-	-
E42 – topsoil removal/emplacement	57.41	14.45	7.73
E46 – topsoil removal/emplacement	5.07	1.28	0.68
GR – topsoil removal/emplacement	-	-	-
E41 – drilling	-	-	-
E42 – drilling	5.09	2.65	0.26
E46 – drilling	0.45	0.23	0.02
GR – drilling	-	-	-
E41 – blasting	-	-	-
E42 – blasting	8.29	4.31	0.25
E46 – blasting	0.71	0.37	0.02
GR – blasting	-	-	-
E41 – excavator in pit on ore/waste	-	-	-
E42 – excavator in pit on ore/waste	43.73	20.68	3.13
E46 – excavator in pit on ore/waste	3.87	1.83	0.28
GR – excavator in pit on ore/waste	-	-	-
E41 – dozer in pit operations	-	-	-
E42 – dozer in pit operations	150.01	29.44	15.75
E46 – dozer in pit operations	13.26	2.60	1.39
GR – dozer in pit operations	-	-	-
North WRE – waste unloading	4.22	2.00	0.30
Central WRE – waste unloading	0.77	0.37	0.06
South WRE – waste unloading	17.37	8.22	1.24
IWL – waste unloading	1.42	0.67	0.10
LBP – waste unloading	12.34	5.84	0.88
North WRE – dozer operations	7.24	1.42	0.76
Central WRE – dozer operations	1.33	0.26	0.14
South WRE – dozer operations	29.79	5.85	3.13
IWL – dozer operations	2.43	0.48	0.26
LBP – dozer operations	21.16	4.15	2.22

Table 7.3 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 1

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E41 – waste/ore haulage in pit	-	-	-
E42 – waste/ore haulage in pit	860.63	221.14	22.11
E46 – waste/ore haulage in pit	- (N.B. accounted for in waste haulage below)	- (N.B. accounted for in waste haulage below)	- (N.B. accounted for in waste haulage below)
GR – waste/ore haulage in pit	-	-	-
E41 – waste to southern WRE	-	-	-
E41 – ore haulage pit to mill/ROM pile	-	-	-
E41 – ore haulage pile to mill	-	-	-
E42 – waste haulage to central WRE	3.54	0.91	0.09
E42 – waste haulage to northern WRE	-	-	-
E42 – waste haulage to southern WRE	244.54	62.83	6.28
E42 – waste haulage to IWL	32.47	8.34	0.83
E42 – waste haulage to LPB	181.77	46.71	4.67
E42 – ore haulage pit to mill/ROM pile	18.51	4.76	0.48
E42 – ore haulage pile to mill	4.70	1.21	0.12
E46 – waste to northern WRE	29.04	7.46	0.75
E46 – ore haulage pit to mill/ROM pile	-	-	-
E46 – ore haulage pile to mill	-	-	-
GR – waste to northern WRE	-	-	-
GR – ore haulage pit to mill/ROM pile	-	-	-
GR – ore haulage pile to mill	-	-	-
E41 – ore pile loading	-	-	-
E42 – ore pile loading	4.78	2.26	0.34
E46 – ore pile loading	-	-	-
GR – ore pile loading	-	-	-
Unloading ore to mill	8.13	3.85	0.58
Mill – primary crusher	237.95	23.79	4.41
Mill – loading to crushed ore stockpile	8.13	3.85	0.58
Mill – recycle crusher	23.79	2.38	0.44
Mill – loading to recycle stockpile	0.81	0.38	0.06
Grading roads	70.64	22.34	2.19

Table 7.3 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 1

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wind erosion – plant stockpiles and exposed areas	725.81	362.91	54.44
Wind erosion – tailings storage dams	52.36	26.18	3.93
Diesel combustion – haulage	48.73	48.73	44.67
Additional blasting for UG development	1.43	0.74	0.04
Removal of material (underground)	25.52	5.01	2.68
Waste and ore – hauling (underground)	71.18	18.29	1.83
Total	**3,040.44**	**981.17**	**190.14**

Table 7.4 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 4

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E41 – topsoil removal/WRE	12.64	3.18	1.70
E42 – topsoil removal/WRE	15.03	3.78	2.02
E46 – topsoil removal/WRE	11.71	2.95	1.58
GR – topsoil removal/WRE	-	-	-
E41 – drilling	3.88	2.02	0.20
E42 – drilling	4.62	2.40	0.24
E46 – drilling	3.60	1.87	0.19
GR – drilling	-	-	-
E41 – blasting	6.31	3.28	0.19
E42 – blasting	7.51	3.91	0.23
E46 – blasting	5.81	3.02	0.17
GR – blasting	-	-	-
E41 – excavator in pit on ore/waste	24.52	11.60	1.76
E42 – excavator in pit on ore/waste	29.16	13.79	2.09
E46 – excavator in pit on ore/waste	22.72	10.74	1.63
GR – excavator in pit on ore/waste	-	-	-
E41 – dozer in pit operations	48.65	9.55	5.11
E42 – dozer in pit operations	57.86	11.36	6.08

Table 7.4 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 4

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E46 – dozer in pit operations	45.07	8.85	4.73
GR – dozer in pit operations	-	-	-
North WRE – waste unloading	25.80	12.20	1.85
Central WRE – waste unloading	-	-	-
South WRE – waste unloading	19.58	9.26	1.40
IWL – waste unloading	22.97	10.86	1.64
LBP – waste unloading	-	-	-
North WRE – dozer operations	25.59	5.02	2.69
Central WRE – dozer operations	-	-	-
South WRE – dozer operations	19.42	3.81	2.04
IWL – dozer operations	22.78	4.47	2.39
LBP – dozer operations	-	-	-
E41 – waste/ore haulage in pit	108.16	27.79	2.78
E42 – waste/ore haulage in pit	237.51	61.03	6.10
E46 – waste/ore haulage in pit	107.92	27.73	2.77
GR – waste/ore haulage in pit	-	-	-
E41 – waste to southern WRE	147.41	37.88	3.79
E41 – ore haulage pit to mill/ROM pile	21.02	5.40	0.54
E41 – ore haulage pile to mill	0.96	0.25	0.02
E42 – waste haulage to central WRE	-	-	-
E42 – waste haulage to northern WRE	21.95	5.64	0.56
E42 – waste haulage to southern WRE	-	-	-
E42 – waste haulage to IWL	308.31	79.22	7.92
E42 – waste haulage to LPB	-	-	-
E42 – ore haulage pit to mill/ROM pile	1.29	0.33	0.03
E42 – ore haulage pile to mill	40.52	10.41	1.04
E46 – waste to northern WRE	37.51	9.64	0.96
E46 – ore haulage pit to mill/ROM pile	14.17	3.64	0.36
E46 – ore haulage pile to mill	3.06	0.79	0.08
GR – waste to northern WRE	-	-	-

Table 7.4 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 4

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
GR – ore haulage pit to mill/ROM pile	-	-	-
GR – ore haulage pile to mill	-	-	-
E41 – ore pile loading	0.49	0.23	0.04
E42 – ore pile loading	8.84	4.18	0.63
E46 – ore pile loading	1.56	0.74	0.11
GR – ore pile loading	-	-	-
Unloading ore to mill	9.16	4.33	0.66
Mill – primary crusher	267.97	26.80	4.96
Mill – loading to crushed ore stockpile	5.49	2.60	0.39
Mill – recycle crusher	26.80	2.68	0.50
Mill – loading to recycle stockpile	0.92	0.43	0.07
Grading roads	105.96	33.51	3.28
Wind erosion – plant stockpiles and exposed areas	875.05	437.52	65.63
Wind erosion – tailings storage dams	52.36	26.18	3.93
Diesel combustion – haulage	51.92	51.92	47.59
Additional blasting for UG development	1.43	0.74	0.04
Removal of material (underground)	25.52	5.01	2.68
Waste and ore – hauling (underground)	65.04	16.71	1.67
Total	**2,983.49**	**1,021.25**	**199.07**

Table 7.5 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 6

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E41 – topsoil removal/WRE	10.36	2.61	1.40
E42 – topsoil removal/WRE	8.80	2.21	1.18
E46 – topsoil removal/WRE	0.53	0.13	0.07
GR – topsoil removal/WRE	-	-	-
E41 – drilling	6.80	3.54	0.35
E42 – drilling	5.77	3.00	0.30

Table 7.5 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 6

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E46 – drilling	0.35	0.18	0.02
GR – drilling	-	-	-
E41 – blasting	11.06	5.75	0.33
E42 – blasting	9.36	4.87	0.28
E46 – blasting	0.57	0.29	0.02
GR – blasting	-	-	-
E41 – excavator in pit on ore/waste	35.39	16.74	2.54
E42 – excavator in pit on ore/waste	30.05	14.21	2.15
E46 – excavator in pit on ore/waste	1.83	0.86	0.13
GR – excavator in pit on ore/waste	-	-	-
E41 – dozer in pit operations	83.39	16.37	8.76
E42 – dozer in pit operations	70.78	13.89	7.43
E46 – dozer in pit operations	4.31	0.85	0.45
GR – dozer in pit operations	-	-	-
North WRE – waste unloading	6.13	2.90	0.44
Central WRE – waste unloading	-	-	-
South WRE – waste unloading	25.23	11.93	1.81
IWL – waste unloading	23.26	11.00	1.67
LBP – waste unloading	-	-	-
North WRE – dozer operations	7.22	1.42	0.76
Central WRE – dozer operations	-	-	-
South WRE – dozer operations	29.72	5.83	3.12
IWL – dozer operations	27.40	5.38	2.88
LBP – dozer operations	-	-	-
E41 – waste/ore haulage in pit	295.72	75.99	7.60
E42 – waste/ore haulage in pit	271.11	69.66	6.97
E46 – waste/ore haulage in pit	10.37	2.67	0.27
GR – waste/ore haulage in pit	-	-	-
E41 – waste to southern WRE	82.61	21.23	2.12
E41 – ore haulage pit to mill/ROM pile	35.67	9.17	0.92

Table 7.5 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 6

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E41 – ore haulage pile to mill	8.35	2.15	0.21
E42 – waste haulage to central WRE	-	-	-
E42 – waste haulage to northern WRE	38.96	10.01	1.00
E42 – waste haulage to southern WRE	-	-	-
E42 – waste haulage to IWL	426.42	109.57	10.96
E42 – waste haulage to LPB	-	-	-
E42 – ore haulage pit to mill/ROM pile	7.28	1.87	0.19
E42 – ore haulage pile to mill	4.38	1.13	0.11
E46 – waste to northern WRE	4.07	1.05	0.10
E46 – ore haulage pit to mill/ROM pile	3.19	0.82	0.08
E46 – ore haulage pile to mill	5.75	1.48	0.15
GR – waste to northern WRE	-	-	-
GR – ore haulage pit to mill/ROM pile	-	-	-
GR – ore haulage pile to mill	-	-	-
E41 – ore pile loading	4.25	2.01	0.30
E42 – ore pile loading	1.34	0.63	0.10
E46 – ore pile loading	2.93	1.38	0.21
GR – ore pile loading	-	-	-
Unloading ore to mill	9.13	4.32	0.65
Mill – primary crusher	267.20	26.72	4.95
Mill – loading to crushed ore stockpile	5.48	2.59	0.39
Mill – recycle crusher	26.72	2.67	0.49
Mill – loading to recycle stockpile	0.91	0.43	0.07
Grading roads	105.96	33.51	3.28
Wind erosion – plant stockpiles and exposed areas	977.30	488.65	73.30
Wind erosion – tailings storage dams	111.85	55.93	8.39
Diesel combustion – haulage	57.86	57.86	53.04
Additional blasting for UG development	1.43	0.74	0.04
Removal of material (underground)	25.52	5.01	2.68
Waste and ore – hauling (underground)	62.52	16.06	1.61

Table 7.5 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 6

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Total	**3,252.60**	**1,129.27**	**216.26**

Table 7.6 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 9

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
E41 – topsoil removal/WRE	-	-	-
E42 – topsoil removal/WRE	-	-	-
E46 – topsoil removal/WRE	-	-	-
GR – topsoil removal/WRE	-	-	-
E41 – drilling	2.88	1.50	0.15
E42 – drilling	4.89	2.54	0.25
E46 – drilling	-	-	-
GR – drilling	3.97	2.07	0.21
E41 – blasting	4.68	2.43	0.14
E42 – blasting	7.94	4.13	0.24
E46 – blasting	-	-	-
GR – blasting	6.45	3.35	0.19
E41 – excavator in pit on ore/waste	16.81	7.95	1.20
E42 – excavator in pit on ore/waste	28.48	13.47	2.04
E46 – excavator in pit on ore/waste	-	-	-
GR – excavator in pit on ore/waste	23.16	10.95	1.66
E41 – dozer in pit operations	43.32	8.50	4.55
E42 – dozer in pit operations	73.41	14.41	7.71
E46 – dozer in pit operations	-	-	-
GR – dozer in pit operations	59.67	11.71	6.27
North WRE – waste unloading	33.84	16.01	2.42
Central WRE – waste unloading	-	-	-
South WRE – waste unloading	9.13	4.32	0.65
IWL – waste unloading	-	-	-

Table 7.6 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 9

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
LBP – waste unloading	-	-	-
North WRE – dozer operations	43.60	8.56	4.58
Central WRE – dozer operations	-	-	-
South WRE – dozer operations	11.77	2.31	1.24
IWL – dozer operations	-	-	-
LBP – dozer operations	-	-	-
E41 – waste/ore haulage in pit	88.07	22.63	2.26
E42 – waste/ore haulage in pit	382.38	98.25	9.83
E46 – waste/ore haulage in pit	-	-	-
GR – waste/ore haulage in pit	83.40	21.43	2.14
E41 – waste to southern WRE	53.84	13.83	1.38
E41 – ore haulage pit to mill/ROM pile	35.19	9.04	0.90
E41 – ore haulage pile to mill	3.59	0.92	0.09
E42 – waste haulage to central WRE	-	-	-
E42 – waste haulage to northern WRE	103.41	26.57	2.66
E42 – waste haulage to southern WRE	-	-	-
E42 – waste haulage to IWL	-	-	-
E42 – waste haulage to LPB	-	-	-
E42 – ore haulage pit to mill/ROM pile	37.16	9.55	0.95
E42 – ore haulage pile to mill	12.95	3.33	0.33
E46 – waste to northern WRE	-	-	-
E46 – ore haulage pit to mill/ROM pile	-	-	-
E46 – ore haulage pile to mill	-	-	-
GR – waste to northern WRE	98.77	25.38	2.54
GR – ore haulage pit to mill/ROM pile	8.54	2.19	0.22
GR – ore haulage pile to mill	1.66	0.43	0.04
E41 – ore pile loading	1.83	0.86	0.13
E42 – ore pile loading	3.96	1.87	0.28
E46 – ore pile loading	2.93	1.38	0.21
GR – ore pile loading	0.85	0.40	0.06

Table 7.6 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – Year 9

Emissions source	Calculated annual emissions (tonnes/annum) by source		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Unloading ore to mill	9.13	4.32	0.65
Mill – primary crusher	267.20	26.72	4.95
Mill – loading to crushed ore stockpile	5.48	2.59	0.39
Mill – recycle crusher	26.72	2.67	0.49
Mill – loading to recycle stockpile	0.91	0.43	0.07
Grading roads	70.64	22.34	2.19
Wind erosion – plant stockpiles and exposed areas	1,029.22	514.61	77.19
Wind erosion – tailings storage dams	111.85	55.93	8.39
Diesel combustion – haulage	60.89	60.89	55.82
Additional blasting for UG development	1.43	0.74	0.04
Removal of material (underground)	25.52	5.01	2.68
Waste and ore – hauling (underground)	56.39	14.49	1.45
Total	**2,957.93**	**1,063.05**	**211.85**

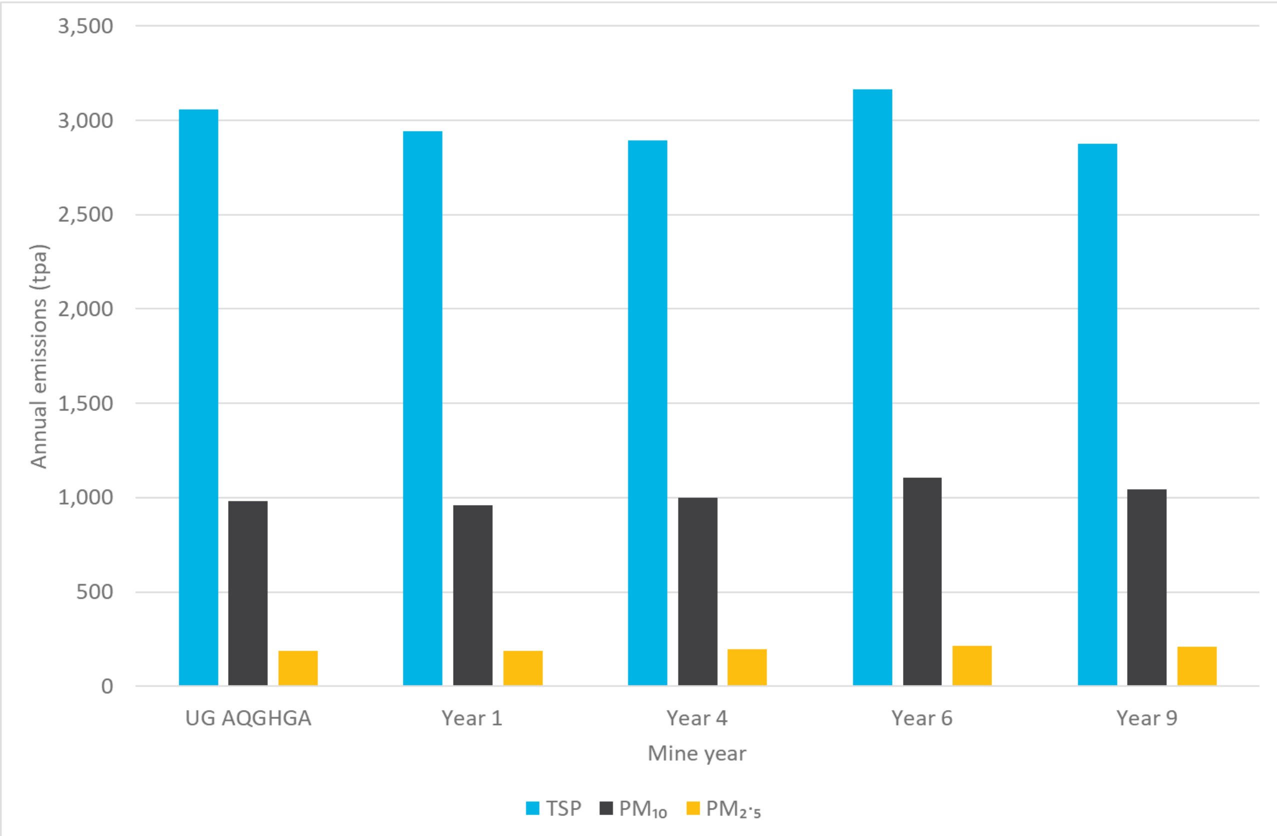

Figure 7.3 Comparison of annual TSP, PM_{10} and $PM_{2.5}$ emissions – future CGO scenarios and UG AQGHGA

7.3.3 Source significance

The significance of primary source categories to annual particulate matter emissions, relative to mine year and particle size fraction, was reviewed. The relative contribution to total annual emissions is illustrated in Figure 7.4, Figure 7.5 and Figure 7.6 for TSP, PM_{10} and $PM_{2.5}$ respectively.

For annual emissions of TSP and PM_{10}, the most significant contributing emission sources are the movement of haul trucks across unpaved road surfaces and wind erosion of exposed surfaces. As the emissions scenarios progress from Year 1 to Year 9, the relative contribution of emissions from unpaved roads decreases while the contribution from wind erosion increases. This is largely associated with a decrease in point to point haulage distances linked to the completion of construction-related movements (e.g. IWL and LPB construction) and the increasing area of exposed surfaces (e.g. IWL, open cut pits and WREs). It is reiterated that no allowance is made in the emission inventory for the progressive rehabilitation of exposed surfaces and therefore presented emission totals should be viewed as conservative.

For $PM_{2.5}$ emissions, wind erosion emissions remain the key contributing source of annual emissions across the four future scenarios, while diesel combustion emissions overtake unpaved haul road emissions as the second most significant contributing emission source.

For processing mill emissions, all processes from the ball mill onwards are a wet process and therefore generate no particulate matter emissions. It is noted with regards to the mill components (e.g. crushers, screens, etc) that the emission factors adopted account for all associated processes, including conveying to and transfer from the component.

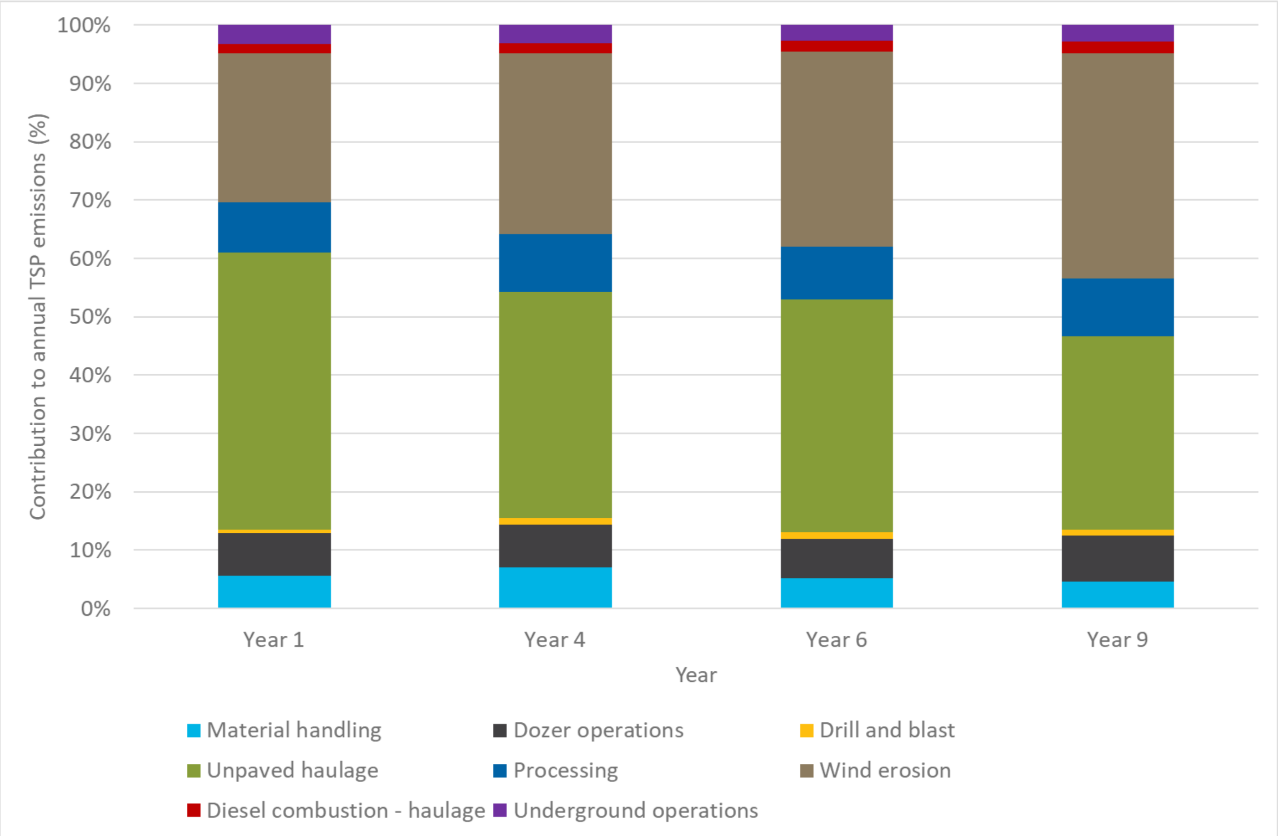

Figure 7.4 Contribution to annual TSP emissions by source type and future CGO scenario

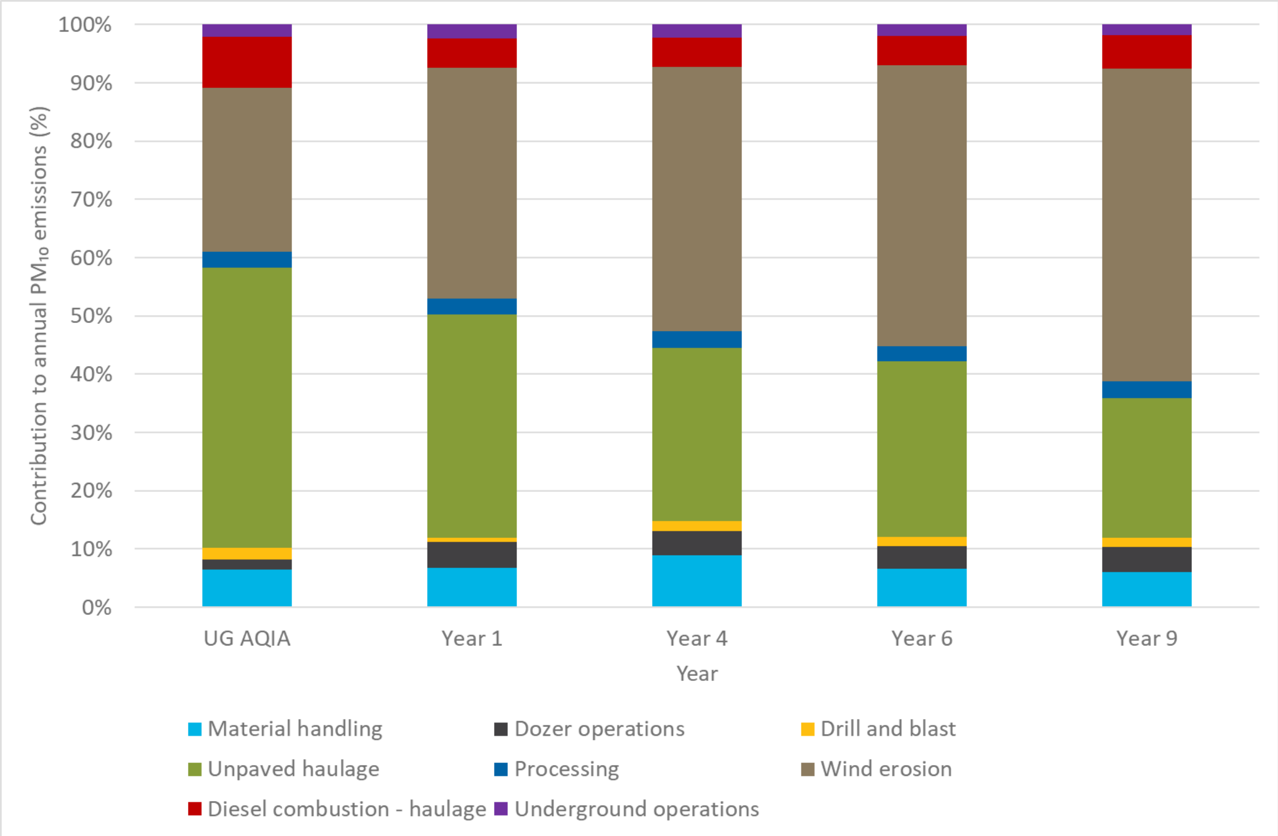

Figure 7.5 Contribution to annual PM_{10} emissions by source type and future CGO scenario

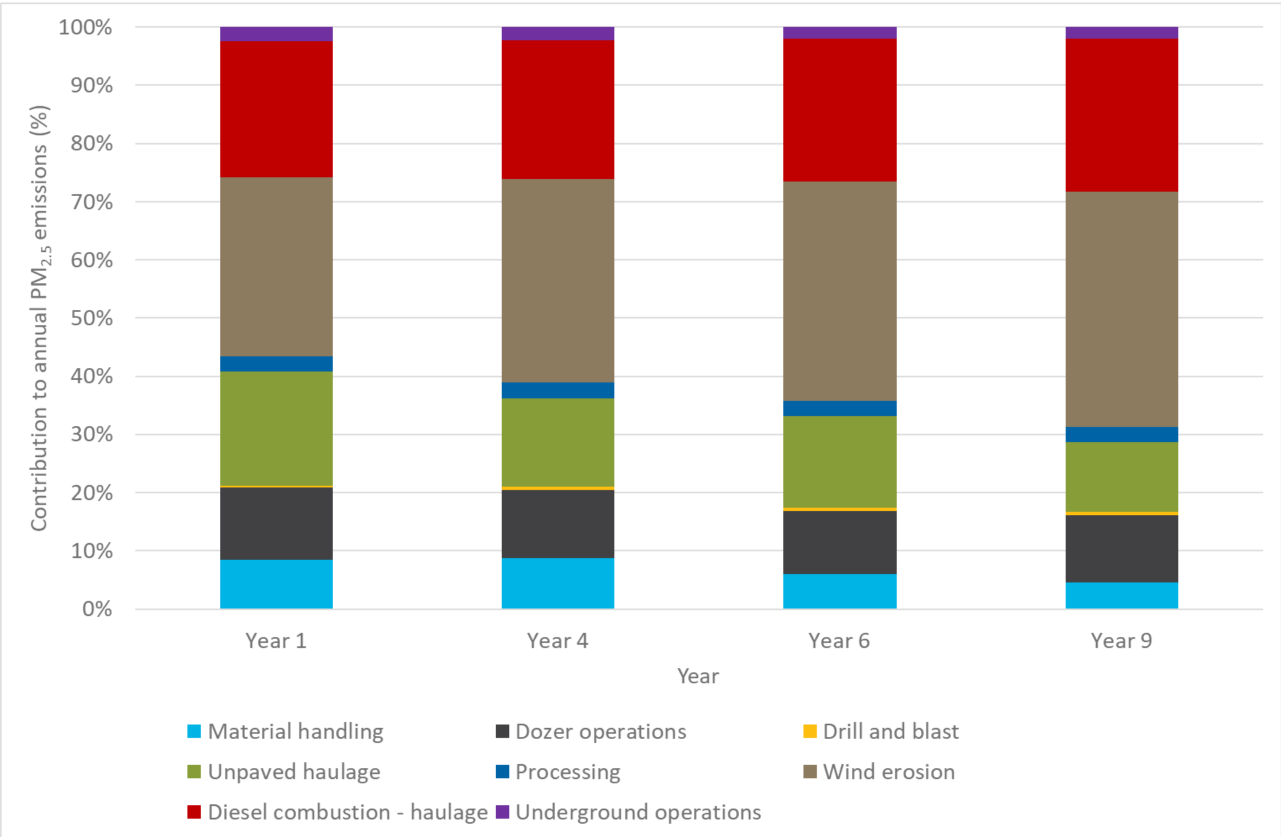

Figure 7.6 Contribution to annual $PM_{2.5}$ emissions by source type and future CGO scenario

7.4 Combustion source emissions

In addition to particulate matter emissions (addressed in Section 7.3), CGO operations will generate combustion emissions from diesel-fuelled equipment exhaust and blasting operations. This AQGHGA focuses on emissions of NO_x and associated predicted concentrations of NO_2 in addressing combustion-related pollutants from CGO.

7.4.1 Diesel combustion emissions

Annual diesel consumption totals were provided by Evolution for all future operating years of the CGO. In order to estimate worst case diesel combustion emissions, the highest projected year of diesel consumption was selected from the future schedule, equating to Year 5 (29,315,397 L diesel). Year 5 was not a modelling scenario assessed in the particulate matter emissions modelling, therefore the Year 6 model configuration was used to represent diesel combustion NO_X emission release points.

Emission factors were adopted from Table 35 (diesel industrial vehicle (miscellaneous)) of National Pollution Inventory (NPI) *Emission Estimation Technique Manual for Combustion Engines* (NPI 2008).

7.4.2 Blasting emissions

In addition to diesel combustion emissions, the use of explosives during blasting operations within open cut pit areas of CGO has the potential to generate emissions of gaseous pollutants. Emissions of blasting related to NO_x were estimated for the maximum projected explosives use from the future schedule, equating to Year 5 (6,495,538 kg explosives). Further details on blasting emissions are presented in Attachment B.

7.4.3 Combustion emission totals

Maximum year annual NO_x emissions from diesel combustion and blasting operations are presented in Table 7.7.

Table 7.7 Annual NO_X emissions from diesel combustion and blasting operations – maximum year

Fuel type	Maximum annual emissions (tonnes/annum)
Diesel combustion	1,693.7
Blasting	34.4

8 Dispersion modelling

8.1 Dispersion model selection and configuration

The atmospheric dispersion modelling completed for this assessment used the AERMOD dispersion model (version v22112). AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

In addition to the 37 individual residential assessment locations (documented in Section 3.2), air pollutant concentrations were predicted over a total 27 km by 25 km domain featuring the following nested grids:

- a 7 km by 5 km domain with a 250 m cell resolution
- a 17 km by 15 km domain with a 500 m cell resolution
- a 27 km by 25 km domain with a 1,000 m cell resolution.

Model predictions for the nested grid were used to generate concentration isopleth plots (Attachment C).

Each modelling scenario featured the corresponding mine development terrain elevations, including the depth of open-cut pits and the height of WREs. The influence on emission dispersion by these mine-related terrain features (e.g. retention of particles from pit depth) were therefore accounted for in the modelling.

Specific activities (hauling, dozers, excavators, wind erosion etc) were represented by a series of volume sources and area sources which were located according to the mine plan for each scenario. The configured model source locations for each future mine scenario are provided in Attachment B.

Simulations were undertaken for the 12 month period of 2018 using the AERMET-generated file based largely on the on-site meteorological monitoring dataset as input (see Chapter 5 for a description of input meteorology).

8.2 NO_x to NO_2 conversion

NO_X emissions from 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, and 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 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, a highly conservative approach.
- 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.
- 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 OLM has been applied to convert model-predicted ground level concentrations 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 NO_2 and O_3 concentrations recorded at the DPE Gunnedah AQMS during 2018 (see 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 µg/m^3

$[NO_x]_{PRED}$ = The AERMOD prediction of ground level NO_X concentrations in µg/m^3

MIN = The minimum of the two quantities within the braces

$[O_3]_{BKGD}$ = The background ambient O_3 concentration – hourly varying DPE Gunnedah AQMS 2018 dataset in µg/m^3

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

$[NO_2]_{BKGD}$ = The background ambient NO_2 concentration – hourly varying DPE Gunnedah AQMS 2018 dataset in µg/m^3.

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 ground level concentrations calculated using the OLM approach are considered conservative.

8.3 Incremental (CGO-only) results

8.3.1 Particulate matter results

Predicted incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates at each of the selected assessment locations from proposed future mining operations at CGO are presented in Table 8.1 for Year 1, Table 8.2 for Year 4, Table 8.3 for Year 6 and Table 8.4 for Year 9.

Additionally, a visual comparison of the predicted concentrations and deposition rates by private assessment location and scenario is presented in Figure 8.1 (annual TSP), Figure 8.2 (24 hour PM_{10}), Figure 8.3 (annual PM_{10}), Figure 8.4 (24 hour $PM_{2.5}$), Figure 8.5 (annual $PM_{2.5}$) and Figure 8.6 (annual dust deposition). For reference, these figures also show the equivalent prediction from the UG AQGHGA.

Table 8.1 Incremental (CGO-only) concentration and deposition results –Year 1

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
1a	2.2	17.9	2.3	3.8	0.5	0.1
1b	1.7	12.3	1.7	2.6	0.4	0.1
1c	0.9	6.7	0.9	1.4	0.2	0.1
1d	0.7	8.1	1.0	1.6	0.2	0.1
4	0.5	6.2	0.7	1.3	0.2	<0.1
6	0.3	4.2	0.5	0.9	0.1	<0.1

Table 8.1 Incremental (CGO-only) concentration and deposition results –Year 1

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
15	1.3	11.0	1.3	2.2	0.3	0.1
20	0.8	6.1	0.8	1.2	0.2	<0.1
21	1.2	10.1	1.3	2.0	0.3	0.1
22a	0.6	5.1	0.6	1.0	0.1	<0.1
22b	0.6	5.0	0.6	1.0	0.1	<0.1
22c	0.7	6.1	0.7	1.2	0.1	0.1
22d	0.5	3.4	0.5	0.7	0.1	<0.1
24	0.5	4.8	0.5	1.0	0.1	<0.1
25	0.4	3.8	0.4	0.7	0.1	<0.1
28	0.4	4.6	0.6	0.9	0.1	<0.1
30a	0.5	5.5	0.6	1.1	0.1	<0.1
30b	0.4	5.7	0.5	1.2	0.1	<0.1
31a	0.3	3.8	0.4	0.8	0.1	<0.1
36a	1.0	9.5	1.1	1.9	0.2	<0.1
36b	0.6	5.6	0.7	1.1	0.1	<0.1
38[1]	0.6	6.8	0.9	1.4	0.2	<0.1
42[4]	1.0	9.5	1.0	2.0	0.2	0.1
43a	0.3	4.1	0.5	0.8	0.1	<0.1
43b	0.2	2.1	0.3	0.4	0.1	<0.1
49a	0.5	4.3	0.4	0.9	0.1	<0.1
49b	0.5	4.4	0.5	0.9	0.1	<0.1
56	0.3	3.6	0.5	0.7	0.1	<0.1
57	0.3	2.7	0.3	0.5	0.1	<0.1
61a	0.6	6.5	0.8	1.4	0.2	<0.1
62	1.0	8.2	1.1	1.7	0.2	0.1
79	0.4	4.3	0.5	0.9	0.1	<0.1
89	0.5	6.1	0.6	1.2	0.1	<0.1
90	0.4	6.4	0.5	1.3	0.1	<0.1
100	0.3	3.5	0.3	0.7	0.1	<0.1

Table 8.1 Incremental (CGO-only) concentration and deposition results –Year 1

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
122	0.5	7.1	0.6	1.5	0.1	<0.1
126	0.4	4.1	0.5	0.8	0.1	<0.1

Notes: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background) concentrations and are provided for comparison purposes only.

Table 8.2 Incremental (CGO-only) concentration and deposition results – Year 4

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
1a	2.7	21.3	2.9	4.6	0.6	0.1
1b	2.0	12.2	2.1	2.6	0.4	0.1
1c	1.1	8.1	1.4	1.9	0.3	0.1
1d	0.8	9.8	1.2	2.1	0.3	0.1
4	0.6	7.0	0.9	1.6	0.2	<0.1
6	0.4	5.2	0.6	1.1	0.1	<0.1
15	1.7	15.7	1.9	3.1	0.4	0.1
20	1.4	10.3	1.5	1.9	0.3	0.1
21	1.9	14.2	2.2	2.8	0.4	0.1
22a	0.8	8.6	1.0	1.6	0.2	0.1
22b	0.8	8.1	0.9	1.5	0.2	0.1
22c	1.0	8.6	1.2	1.8	0.2	0.1
22d	0.6	4.7	0.7	1.0	0.1	<0.1
24	0.6	5.1	0.7	1.2	0.2	<0.1
25	0.5	4.2	0.6	1.0	0.1	<0.1
28	0.5	6.3	0.7	1.4	0.1	<0.1
30a	0.6	8.2	0.7	1.7	0.2	<0.1
30b	0.5	7.7	0.6	1.6	0.1	<0.1
31a	0.3	4.2	0.5	0.9	0.1	<0.1
36a	1.2	10.3	1.4	2.2	0.3	0.1

Table 8.2 Incremental (CGO-only) concentration and deposition results – Year 4

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
36b	0.8	9.9	1.0	2.0	0.2	<0.1
38[1]	0.7	8.5	1.1	1.8	0.2	<0.1
42[4]	1.3	10.8	1.6	2.4	0.3	0.1
43a	0.4	5.0	0.7	1.1	0.1	<0.1
43b	0.2	2.8	0.4	0.6	0.1	<0.1
49a	0.6	4.6	0.6	1.0	0.1	<0.1
49b	0.7	5.4	0.8	1.2	0.2	<0.1
56	0.4	4.0	0.6	0.9	0.1	<0.1
57	0.3	3.1	0.4	0.7	0.1	<0.1
61a	0.7	8.5	1.0	1.8	0.2	<0.1
62	1.2	8.0	1.3	1.9	0.3	0.1
79	0.6	5.2	0.7	1.1	0.1	<0.1
89	0.6	7.2	0.8	1.6	0.2	<0.1
90	0.5	7.6	0.7	1.6	0.1	<0.1
100	0.3	3.2	0.4	0.7	0.1	<0.1
122	0.6	9.0	0.8	1.9	0.2	<0.1
126	0.5	5.3	0.7	1.1	0.1	<0.1

Notes: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background) concentrations and are provided for comparison purposes only.

Table 8.3 Incremental (CGO-only) concentration and deposition results – Year 6

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
1a	3.2	22.5	3.4	4.9	0.7	0.1
1b	2.3	13.4	2.5	2.9	0.5	0.1
1c	1.2	7.4	1.4	1.6	0.3	0.1
1d	0.8	9.9	1.3	2.1	0.3	0.1
4	0.6	6.6	0.9	1.3	0.2	<0.1

Table 8.3 Incremental (CGO-only) concentration and deposition results – Year 6

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
6	0.4	5.1	0.7	1.1	0.1	<0.1
15	2.0	20.6	2.3	4.5	0.5	0.1
20	1.8	14.7	1.9	3.2	0.4	0.1
21	2.2	16.2	2.7	3.6	0.6	0.1
22a	0.9	8.7	1.1	1.9	0.2	0.1
22b	0.9	8.0	1.0	1.8	0.2	0.1
22c	1.0	9.7	1.3	2.1	0.3	0.1
22d	0.7	4.7	0.7	1.0	0.2	<0.1
24	0.6	5.1	0.8	1.1	0.2	<0.1
25	0.5	4.1	0.6	0.9	0.1	<0.1
28	0.5	4.5	0.7	1.0	0.1	<0.1
30a	0.6	9.6	0.8	2.1	0.2	<0.1
30b	0.5	8.5	0.7	1.9	0.1	<0.1
31a	0.3	4.5	0.5	1.0	0.1	<0.1
36a	1.4	11.4	1.7	2.5	0.4	0.1
36b	0.9	12.0	1.1	2.6	0.2	<0.1
38[1]	0.7	9.1	1.1	2.0	0.2	<0.1
42[4]	1.3	10.0	1.7	2.2	0.4	0.1
43a	0.4	5.4	0.7	1.1	0.1	<0.1
43b	0.2	3.3	0.4	0.6	0.1	<0.1
49a	0.6	4.7	0.7	1.0	0.1	<0.1
49b	0.7	5.7	0.8	1.2	0.2	<0.1
56	0.4	4.5	0.6	1.0	0.1	<0.1
57	0.3	2.9	0.4	0.6	0.1	<0.1
61a	0.7	8.9	1.1	1.9	0.2	<0.1
62	1.2	7.4	1.3	1.6	0.3	0.1
79	0.6	6.4	0.8	1.4	0.2	<0.1
89	0.6	7.2	0.9	1.5	0.2	<0.1
90	0.5	7.7	0.7	1.6	0.2	<0.1

Table 8.3 Incremental (CGO-only) concentration and deposition results – Year 6

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
100	0.3	3.4	0.4	0.7	0.1	<0.1
122	0.7	9.8	0.8	2.1	0.2	<0.1
126	0.6	5.8	0.8	1.3	0.2	<0.1

Notes: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background) concentrations and are provided for comparison purposes only.

Table 8.4 Incremental (CGO-only) concentration and deposition results – Year 9

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
1a	2.3	17.9	2.3	3.8	0.5	0.1
1b	1.7	12.3	1.7	2.6	0.4	0.1
1c	0.8	6.7	0.9	1.4	0.2	0.1
1d	0.7	8.1	1.0	1.6	0.2	0.1
4	0.5	6.2	0.7	1.3	0.2	<0.1
6	0.3	4.2	0.5	0.9	0.1	<0.1
15	1.3	11.0	1.3	2.2	0.3	<0.1
20	0.8	6.1	0.8	1.2	0.2	<0.1
21	1.2	10.1	1.3	2.0	0.3	0.1
22a	0.6	5.1	0.6	1.0	0.1	<0.1
22b	0.6	5.0	0.6	1.0	0.1	<0.1
22c	0.7	6.1	0.7	1.2	0.1	0.1
22d	0.5	3.4	0.5	0.7	0.1	<0.1
24	0.4	4.8	0.5	1.0	0.1	<0.1
25	0.4	3.8	0.4	0.7	0.1	<0.1
28	0.4	4.6	0.6	0.9	0.1	<0.1
30a	0.5	5.5	0.6	1.1	0.1	<0.1
30b	0.4	5.7	0.5	1.2	0.1	<0.1
31a	0.3	3.8	0.4	0.8	0.1	<0.1

Table 8.4 Incremental (CGO-only) concentration and deposition results – Year 9

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
36a	1.0	9.5	1.1	1.9	0.2	<0.1
36b	0.6	5.6	0.7	1.1	0.1	<0.1
38[1]	0.6	6.8	0.9	1.4	0.2	<0.1
42[4]	0.9	9.5	1.0	2.0	0.2	0.1
43a	0.3	4.1	0.5	0.8	0.1	<0.1
43b	0.2	2.1	0.3	0.4	0.1	<0.1
49a	0.4	4.3	0.4	0.9	0.1	<0.1
49b	0.5	4.4	0.5	0.9	0.1	<0.1
56	0.3	3.6	0.5	0.7	0.1	<0.1
57	0.3	2.7	0.3	0.5	0.1	<0.1
61a	0.5	6.5	0.8	1.4	0.2	<0.1
62	1.0	8.2	1.1	1.7	0.2	0.1
79	0.4	4.3	0.5	0.9	0.1	<0.1
89	0.5	6.1	0.6	1.2	0.1	<0.1
90	0.4	6.4	0.5	1.3	0.1	<0.1
100	0.2	3.5	0.3	0.7	0.1	<0.1
122	0.5	7.1	0.6	1.5	0.1	<0.1
126	0.4	4.1	0.5	0.8	0.1	<0.1

Notes: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background) concentrations and are provided for comparison purposes only.

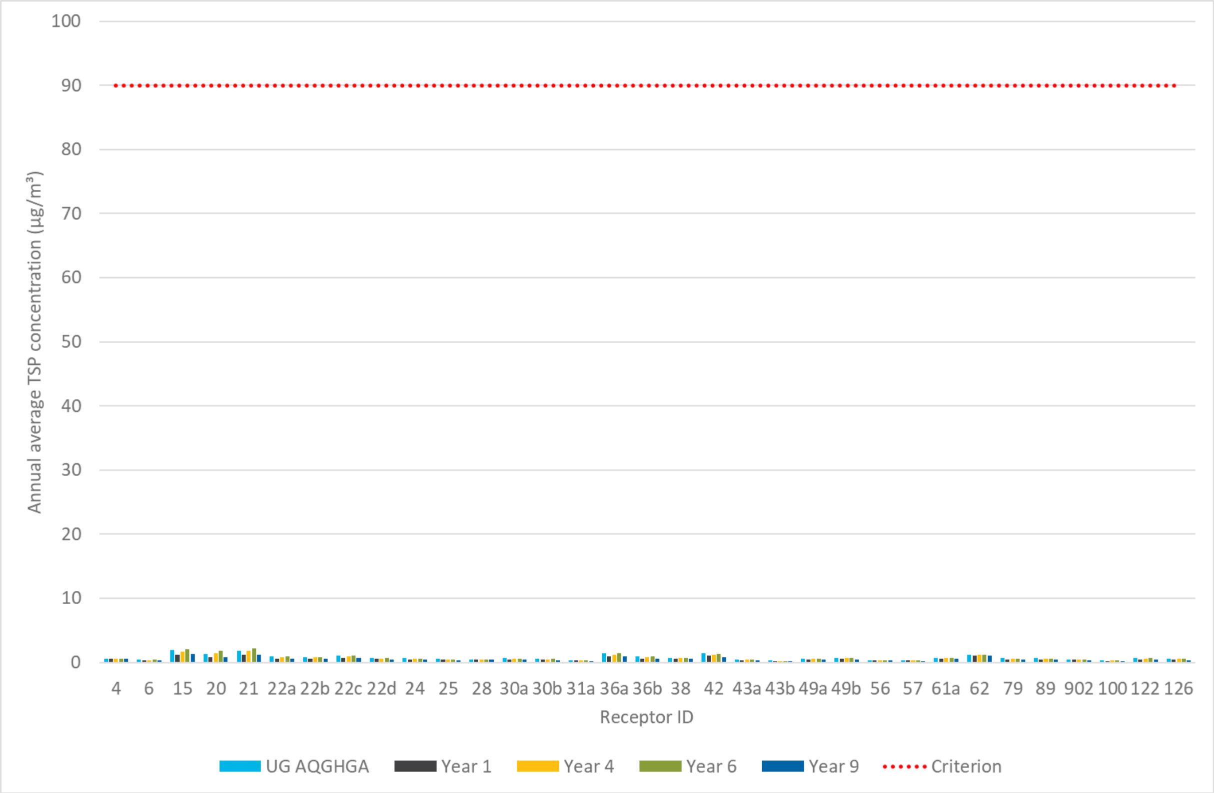

Figure 8.1 Predicted incremental annual average TSP concentrations – CGO mine years and UG AQGHGA

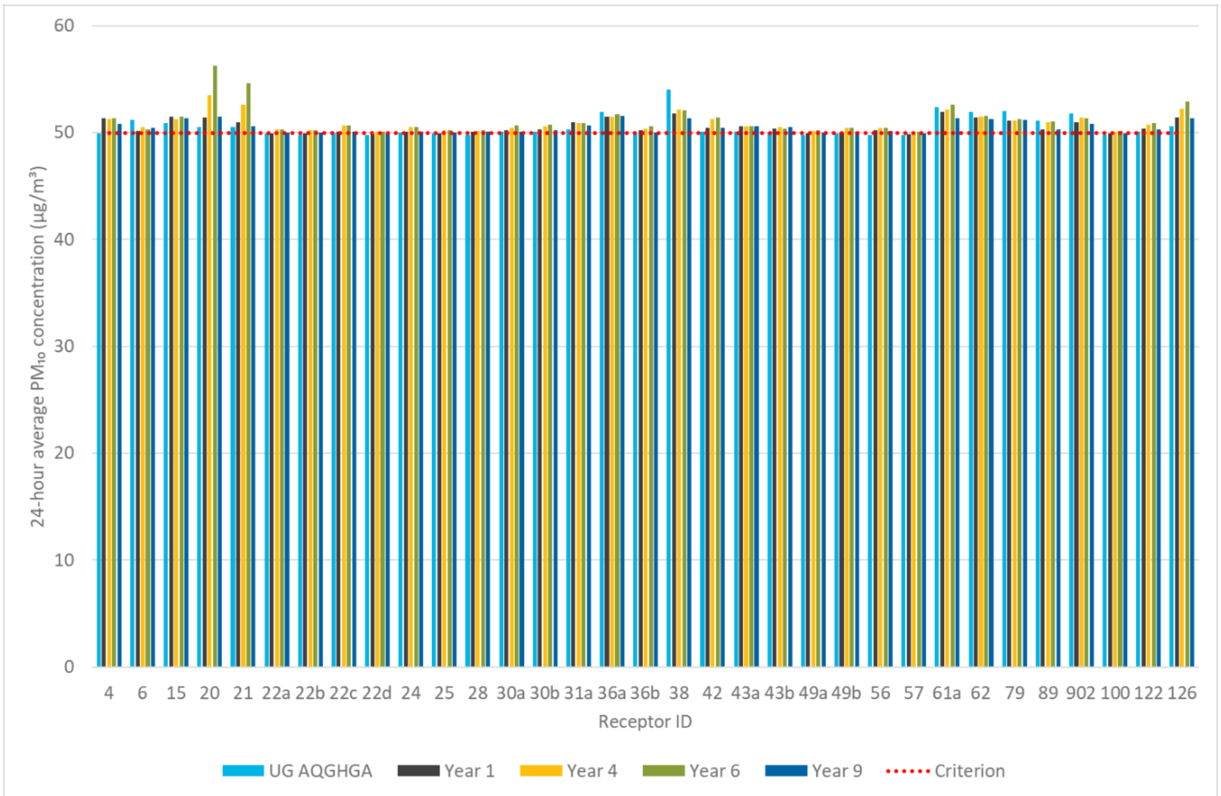

Figure 8.2 Maximum predicted incremental 24-hour average PM_{10} concentrations – CGO mine years and UG AQGHGA

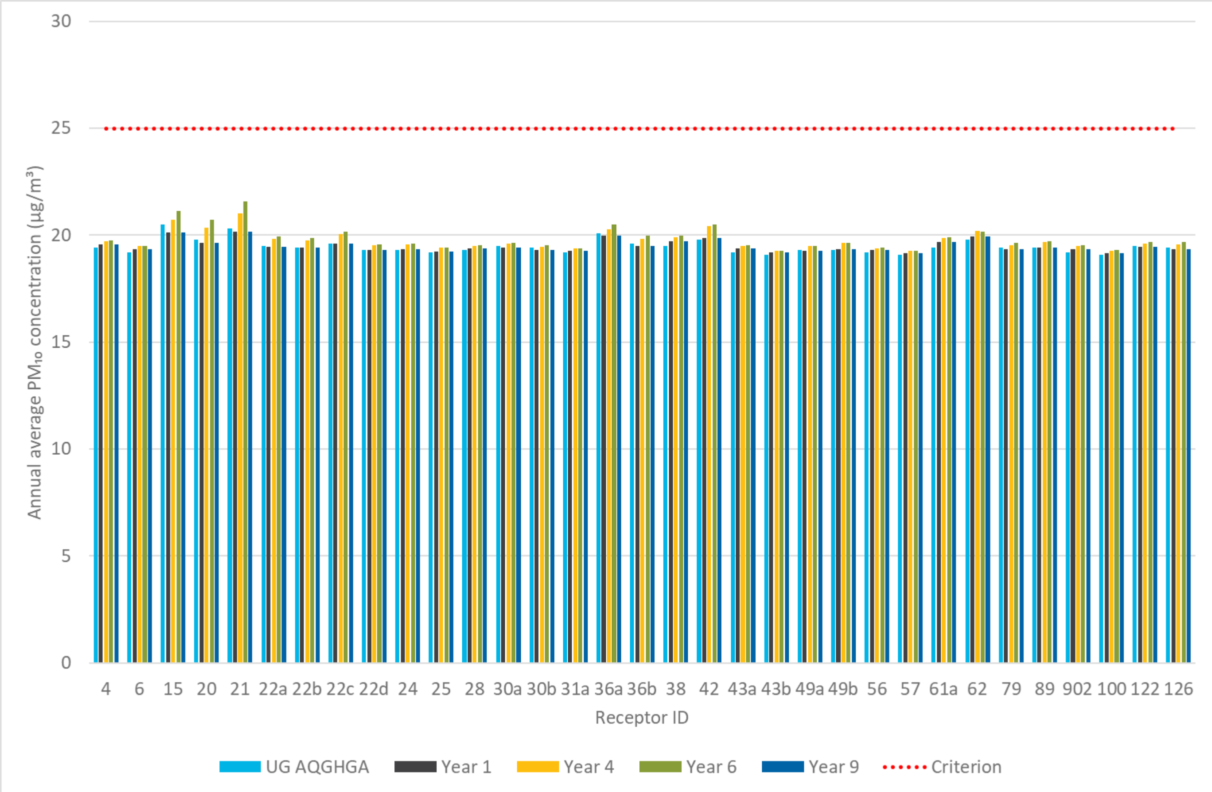

Figure 8.3 Predicted incremental annual average PM_{10} concentrations – CGO mine years and UG AQGHGA

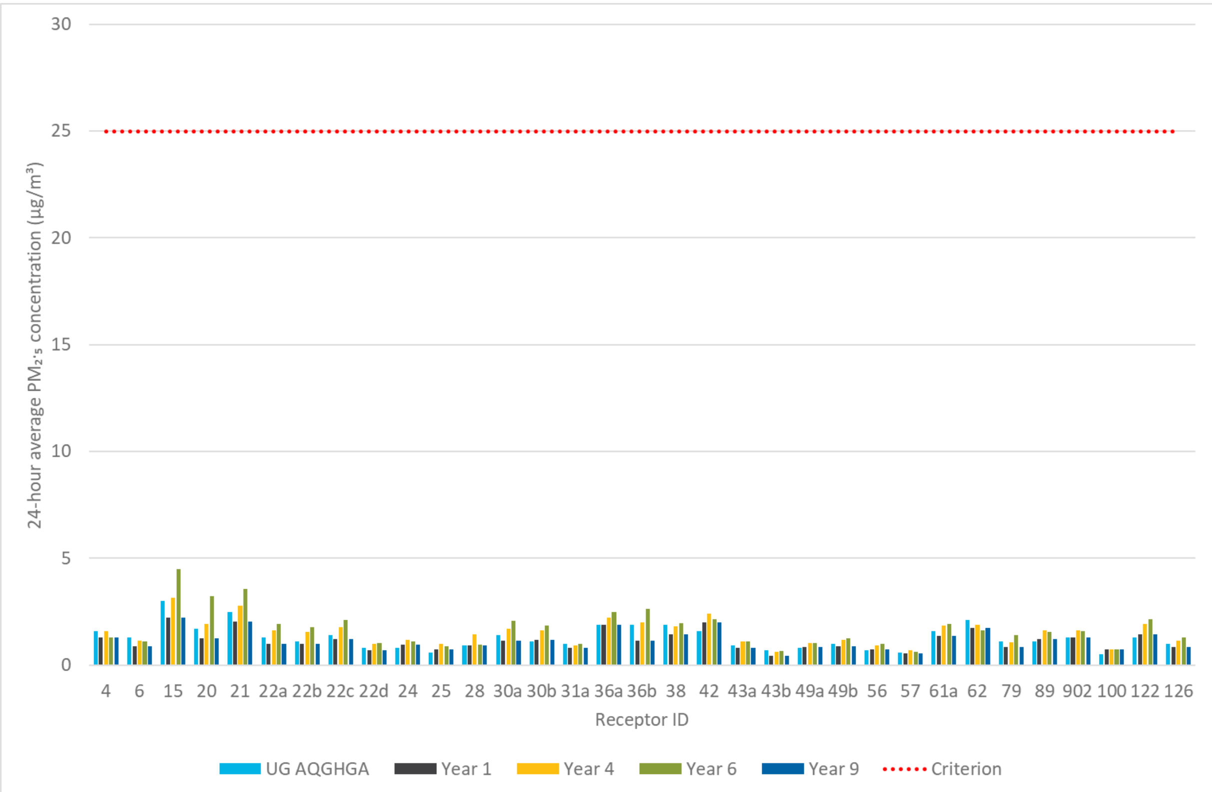

Figure 8.4 Maximum predicted incremental 24-hour average $PM_{2.5}$ concentrations – CGO mine years and UG AQGHGA

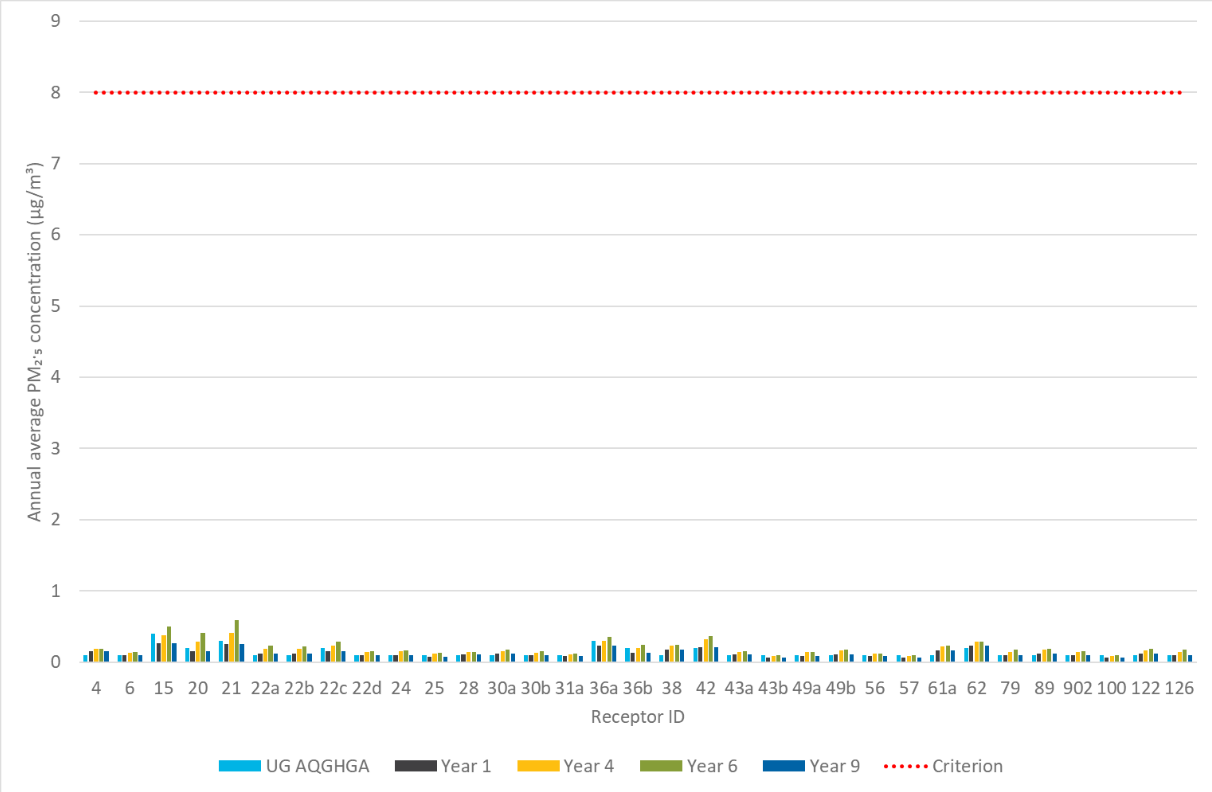

Figure 8.5 Predicted incremental annual average $PM_{2.5}$ concentrations – CGO mine years and UG AQGHGA

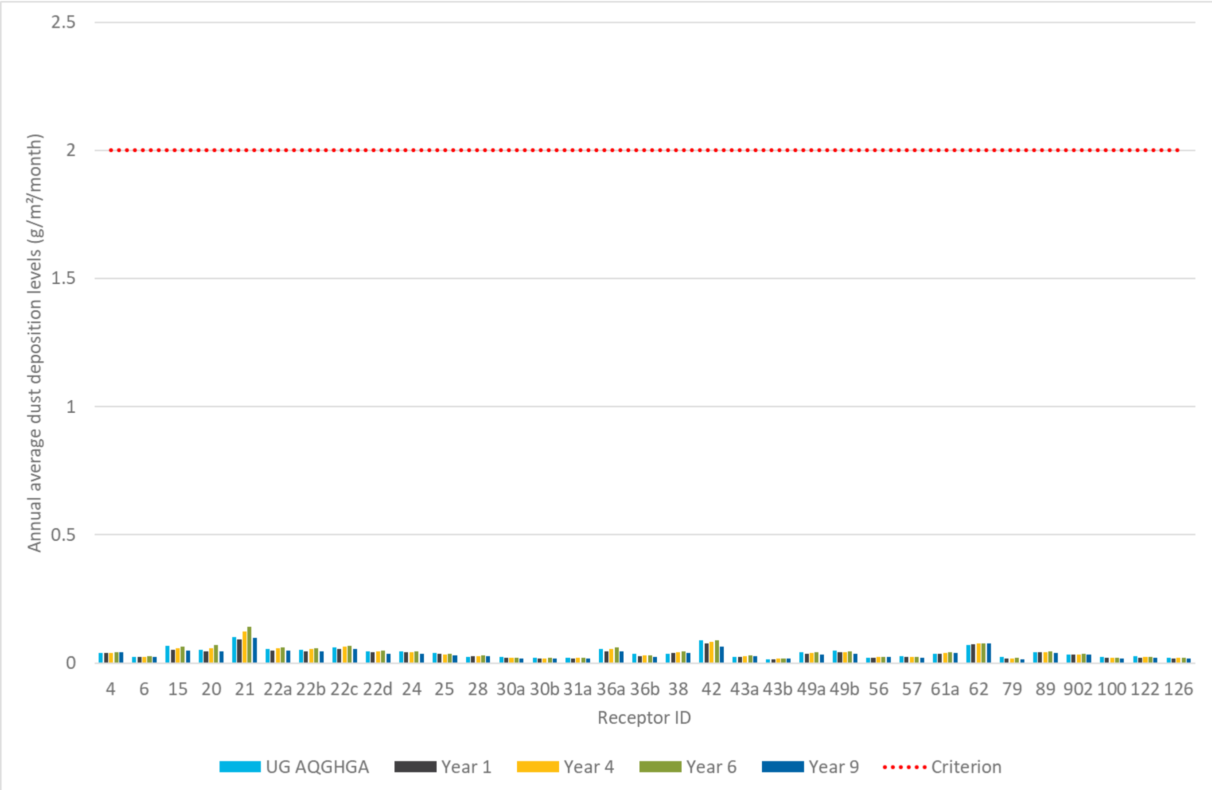

Figure 8.6 Predicted incremental annual average dust deposition levels concentrations – CGO mine years and UG AQGHGA

The predicted incremental concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criterion at all assessment locations for all future modelling scenarios. However, aside from dust deposition, the assessment criteria listed are applicable to cumulative concentrations. Analysis of cumulative impact compliance is presented in Section 8.4.

The four graphs of predicted incremental concentrations and deposition rates show the following points:

- At each assessment location, the model predicted concentrations for Year 1 and Year 9 scenarios are lower than the predictions from the Year 4 and Year 6 scenarios, which is consistent with the variation in calculated annual emissions (Figure 7.3).
- The model predictions are typically highest for the Year 6 scenario across all assessment locations, in particular at the closest assessment locations to the north-west IWL construction area (i.e. 15, 20, 21, 22a-c, and 36b).
- Relative to the equivalent predictions from the UG AQGHGA, the model predicted concentrations for the Year 1 and Year 9 scenarios are generally lower, while the predictions from the Year 4 and Year 6 scenarios are generally higher.

Isopleth plots, illustrating spatial variations in project-related incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates are provided in Attachment C. Isopleth plots of the maximum 24 hour average concentrations presented in Attachment C do not represent the dispersion pattern on any individual day, but rather illustrate the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions contained within the 2018 modelling period.

8.3.2 Nitrogen dioxide

The maximum predicted incremental 1 hour and annual average NO_2 concentrations from diesel combustion and blasting-related NO_x emissions based on the maximum year of the Project (Year 5) are presented in Table 8.5. The NO_2 concentrations were derived from predicted NO_x concentrations using the OLM method, as detailed in Section 8.2.

Table 8.5 Incremental (CGO-only) NO_2 concentrations – maximum year scenario

Assessment location ID	Predicted incremental NO_2 concentrations (µg/m³)	
	1 hour	Annual
Criterion	**164**	**31**
1a	103.0	8.9
1b	103.3	6.8
1c	97.3	3.9
1d	96.1	3.3
4	81.7	2.5
6	85.8	1.9
15	107.7	5.9
20	110.2	4.0
21	100.4	6.7

Table 8.5 Incremental (CGO-only) NO_2 concentrations – maximum year scenario

Assessment location ID	Predicted incremental NO_2 concentrations (µg/m³)	
	1 hour	Annual
Criterion	**164**	**31**
22a	87.1	2.9
22b	87.0	2.7
22c	89.1	3.5
22d	78.1	2.1
24	95.3	2.2
25	89.6	1.7
28	68.2	1.9
30a	87.5	2.3
30b	89.6	2.0
31a	78.7	1.6
36a	93.6	4.6
36b	102.0	3.0
38[1]	89.9	3.1
42[4]	90.8	4.7
43a	86.8	1.9
43b	75.5	1.2
49a	86.8	1.9
49b	87.5	2.4
56	74.2	1.6
57	88.6	1.3
61a	88.1	3.0
62	88.3	3.6
79	101.7	2.3
89	93.6	2.3
90	87.0	1.9
100	87.6	1.3
122	89.7	2.4
126	90.3	2.2

From the results presented in Table 8.5, the maximum 1 hour average and annual average NO_2 concentrations are below the applicable NSW EPA impact assessment criterion at all assessment locations. However, the assessment criteria listed are applicable to cumulative concentrations. Analysis of cumulative impact compliance is presented in Section 8.4.

An analysis of cumulative NO_2 impacts is presented in Section 8.4.4.

8.4 Cumulative (CGO + background) results

8.4.1 Cumulative assessment approach

For each of the four modelling scenarios and for all pollutants, cumulative concentrations have been quantified by combining the model-predicted incremental concentrations from the CGO future mine scenarios with the adopted background concentrations (Chapter 6).

Cumulative 24 hour average concentrations of PM_{10} and $PM_{2.5}$ are quantified in the following ways:

- Using a 'paired-in-time' approach, combining the daily-varying model predictions at each assessment location with the corresponding background concentration from the adopted 2018 DPE Bathurst AQMS dataset (e.g. model prediction on 1 January 2018 paired with background concentration on 1 January 2018).

- Where cumulative exceedance is predicted from the paired-in-time approach, a frequency analysis of days above the impact assessment criterion, whereby multiple years of background data (from CGO HVAS and Bathurst) are combined with each daily model prediction at each assessment location to derive a probability of days above the impact assessment criterion occurring.

As detailed in Table 6.1, there are eight existing exceedances of the 24 hour average PM_{10} criterion and two existing exceedances of the 24 hour average $PM_{2.5}$ criterion in the DPE Bathurst AQMS background data. For cumulative impact assessment purposes, these are classed as existing exceedances.

Section 5.1.3 of the Approved Methods for Modelling states that in the event of existing ambient air pollutant concentrations in exceedance of applicable impact assessment criteria, the assessment must:

> …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.

Cumulative annual average concentrations (TSP, PM_{10} and $PM_{2.5}$) and dust deposition rates are quantified by combining the predicted annual average concentration or deposition rate with the corresponding background value (Section 6.3).

Cumulative NO_2 concentrations are quantified through the paired in time approach, combining the hourly-varying model predictions at each assessment location with the corresponding background concentration from the adopted 2018 DPE Gunnedah AQMS dataset.

8.4.2 Particulate matter

Predicted cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations associated with the Project are presented in Table 8.6 for Year 1, Table 8.7 for Year 4, Table 8.8 for Year 6 and Table 8.9 for Year 9.

Consistent with the approach listed in Section 8.4.1, to assess whether any additional exceedances of the applicable criteria will occur as a result of operational emissions from the Project, the 9th highest 24 hour cumulative PM_{10} and 3rd highest cumulative $PM_{2.5}$ concentrations at each assessment location are reported in Table 8.6 to Table 8.8. 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.

Additionally, a visual comparison of the predicted concentrations and deposition rates by private assessment location and scenario is presented in Figure 8.7 (annual TSP), Figure 8.8 (24 hour PM_{10}), Figure 8.9 (annual PM_{10}), Figure 8.10 (24 hour $PM_{2.5}$), Figure 8.11 (annual $PM_{2.5}$) and Figure 8.12 (annual dust deposition). For reference, these figures also show the equivalent cumulative prediction from the UG AQGHGA.

Table 8.6 Cumulative (CGO plus background) concentration and deposition results – Year 1

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
1a	66.4	**52.4**	21.1	22.4	7.5	3.5
1b	65.9	**52.1**	20.6	22.5	7.3	3.5
1c	65.1	**50.6**	19.7	22.6	7.2	3.5
1d	64.9	**53.8**	19.8	22.3	7.2	3.4
4	64.7	**51.4**	19.6	22.2	7.1	3.4
6	64.5	**50.2**	19.3	22.2	7.1	3.4
15	65.5	**51.5**	20.1	22.5	7.3	3.4
20	65.0	**51.4**	19.6	23.3	7.2	3.4
21	65.4	**50.9**	20.1	22.9	7.3	3.5
22a	64.8	49.9	19.5	22.5	7.1	3.4
22b	64.8	49.9	19.4	22.4	7.1	3.4
22c	64.9	**50.0**	19.6	22.6	7.1	3.4
22d	64.7	49.9	19.3	22.8	7.1	3.4
24	64.7	**50.0**	19.3	22.2	7.1	3.4
25	64.6	49.9	19.2	22.2	7.1	3.4
28	64.6	**50.1**	19.4	22.2	7.1	3.4
30a	64.7	**50.2**	19.4	22.1	7.1	3.4
30b	64.6	**50.3**	19.3	22.1	7.1	3.4
31a	64.5	**51.0**	19.3	22.2	7.1	3.4
36a	65.2	**51.5**	20.0	22.2	7.2	3.4
36b	64.8	**50.2**	19.5	22.2	7.1	3.4
38[1]	64.8	**51.8**	19.7	22.3	7.2	3.4

Table 8.6 Cumulative (CGO plus background) concentration and deposition results – Year 1

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
42[4]	65.2	**50.4**	19.9	22.6	7.2	3.4
43a	64.5	**50.6**	19.4	22.2	7.1	3.4
43b	64.4	**50.4**	19.2	22.2	7.1	3.4
49a	64.7	49.9	19.3	22.2	7.1	3.4
49b	64.7	**50.0**	19.3	22.2	7.1	3.4
56	64.5	**50.2**	19.3	22.2	7.1	3.4
57	64.5	49.9	19.1	22.2	7.1	3.4
61a	64.8	**51.9**	19.7	22.3	7.2	3.4
62	65.2	**51.4**	20.0	22.4	7.2	3.4
79	64.6	**51.1**	19.3	22.4	7.1	3.4
89	64.7	**50.3**	19.4	23.3	7.1	3.4
90	64.6	**51.0**	19.3	22.8	7.1	3.4
100	64.5	49.9	19.2	22.2	7.1	3.4
122	64.7	**50.4**	19.4	22.2	7.1	3.4
126	64.6	**51.4**	19.3	22.9	7.1	3.4

Notes: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background) concentrations and are provided for comparison purposes only.

Table 8.7 Cumulative (CGO plus background) concentration and deposition results – Year 4

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
1a	66.9	**53.1**	21.7	22.5	7.6	3.5
1b	66.2	**52.1**	21.0	22.5	7.4	3.5
1c	65.3	**51.6**	20.2	22.8	7.3	3.5
1d	65.0	**55.5**	20.1	22.4	7.3	3.4
4	64.8	**51.2**	19.7	22.3	7.2	3.4
6	64.6	**50.6**	19.5	22.2	7.1	3.4

Table 8.7 Cumulative (CGO plus background) concentration and deposition results – Year 4

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
15	65.9	**51.3**	20.7	22.4	7.4	3.4
20	65.6	**53.5**	20.3	23.7	7.3	3.4
21	66.1	**52.6**	21.0	23.4	7.4	3.5
22a	65.0	**50.3**	19.8	22.6	7.2	3.4
22b	65.0	**50.2**	19.8	22.6	7.2	3.4
22c	65.2	**50.6**	20.0	22.9	7.2	3.4
22d	64.8	**50.1**	19.5	23.0	7.1	3.4
24	64.8	**50.5**	19.6	22.3	7.1	3.4
25	64.7	**50.2**	19.4	22.4	7.1	3.4
28	64.7	**50.2**	19.5	22.3	7.1	3.4
30a	64.8	**50.4**	19.6	22.2	7.2	3.4
30b	64.7	**50.6**	19.5	22.2	7.1	3.4
31a	64.5	**50.9**	19.4	22.2	7.1	3.4
36a	65.4	**51.5**	20.3	22.3	7.3	3.4
36b	65.0	**50.4**	19.8	22.2	7.2	3.4
38[1]	64.9	**52.1**	19.9	22.3	7.2	3.4
42[4]	65.5	**51.3**	20.4	23.0	7.3	3.5
43a	64.6	**50.6**	19.5	22.3	7.1	3.4
43b	64.4	**50.5**	19.3	22.2	7.1	3.4
49a	64.8	**50.2**	19.5	22.3	7.1	3.4
49b	64.9	**50.4**	19.6	22.4	7.2	3.4
56	64.6	**50.4**	19.4	22.2	7.1	3.4
57	64.5	**50.1**	19.3	22.2	7.1	3.4
61a	64.9	**52.2**	19.9	22.3	7.2	3.4
62	65.4	**51.5**	20.2	22.8	7.3	3.4
79	64.8	**51.1**	19.5	22.4	7.1	3.4
89	64.8	**51.0**	19.7	23.7	7.2	3.4
90	64.7	**51.4**	19.5	22.9	7.1	3.4

Table 8.7 Cumulative (CGO plus background) concentration and deposition results – Year 4

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
100	64.5	**50.1**	19.3	22.2	7.1	3.4
122	64.8	**50.8**	19.6	22.2	7.2	3.4
126	64.7	**52.3**	19.6	23.1	7.1	3.4

Note: Due to the occurrence of eight existing exceedances of the 24 hour average PM_{10} criterion and two existing exceedances of the 24-hour average $PM_{2.5}$ criterion in the DPE Bathurst AQMS background dataset, the 9th highest 24-hour cumulative PM_{10} and 3rd highest cumulative $PM_{2.5}$ concentrations at each assessment location are presented. Exceedances of criteria are marked by bold.

Table 8.8 Cumulative (CGO plus background) concentration and deposition results – Year 6

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
1a	67.4	**53.9**	22.2	22.8	7.7	3.5
1b	66.5	**52.3**	21.3	22.8	7.5	3.5
1c	65.4	**51.8**	20.3	22.9	7.3	3.5
1d	65.0	**55.8**	20.1	22.4	7.3	3.4
4	64.8	**51.3**	19.7	22.3	7.2	3.4
6	64.6	**50.3**	19.5	22.2	7.1	3.4
15	66.2	**51.5**	21.1	22.5	7.5	3.4
20	66.0	**56.2**	20.7	24.5	7.4	3.4
21	66.4	**54.6**	21.6	24.2	7.6	3.5
22a	65.1	**50.3**	19.9	23.0	7.2	3.4
22b	65.1	**50.2**	19.9	22.9	7.2	3.4
22c	65.2	**50.7**	20.2	23.1	7.3	3.4
22d	64.9	**50.1**	19.6	22.8	7.1	3.4
24	64.8	**50.5**	19.6	22.6	7.2	3.4
25	64.7	**50.3**	19.4	22.6	7.1	3.4
28	64.7	**50.2**	19.5	22.2	7.1	3.4
30a	64.8	**50.7**	19.7	22.2	7.2	3.4

Table 8.8 Cumulative (CGO plus background) concentration and deposition results – Year 6

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
30b	64.7	**50.7**	19.5	22.2	7.1	3.4
31a	64.5	**50.9**	19.4	22.2	7.1	3.4
36a	65.6	**51.7**	20.5	22.4	7.4	3.4
36b	65.1	**50.6**	20.0	22.2	7.2	3.4
38[1]	64.9	**52.1**	20.0	22.3	7.2	3.4
42[4]	65.5	**51.4**	20.5	23.6	7.4	3.5
43a	64.6	**50.6**	19.5	22.3	7.1	3.4
43b	64.4	**50.4**	19.3	22.2	7.1	3.4
49a	64.8	**50.2**	19.5	22.6	7.1	3.4
49b	64.9	**50.4**	19.7	22.6	7.2	3.4
56	64.6	**50.4**	19.4	22.2	7.1	3.4
57	64.5	**50.1**	19.3	22.4	7.1	3.4
61a	64.9	**52.6**	19.9	22.3	7.2	3.4
62	65.4	**51.6**	20.2	22.6	7.3	3.4
79	64.8	**51.2**	19.6	22.3	7.2	3.4
89	64.8	**51.0**	19.7	23.4	7.2	3.4
90	64.7	**51.3**	19.5	22.9	7.1	3.4
100	64.5	**50.1**	19.3	22.2	7.1	3.4
122	64.9	**50.9**	19.7	22.3	7.2	3.4
126	64.8	**52.9**	19.7	23.1	7.2	3.4

Note: Due to the occurrence of eight existing exceedances of the 24-hour average PM_{10} criterion and two existing exceedances of the 24-hour average $PM_{2.5}$ criterion in the DPE Bathurst AQMS background dataset, the 9th highest 24-hour cumulative PM_{10} and 3rd highest cumulative $PM_{2.5}$ concentrations at each assessment location are presented. Exceedances of criteria are marked by bold.

Table 8.9 Cumulative (CGO plus background) concentration and deposition results – Year 9

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
1a	66.5	**52.0**	21.1	22.4	7.5	3.5
1b	65.9	**51.8**	20.6	22.6	7.3	3.5
1c	65.0	**50.4**	19.7	22.6	7.2	3.4
1d	64.9	**55.8**	19.8	22.4	7.2	3.4
4	64.7	**50.8**	19.6	22.2	7.1	3.4
6	64.5	**50.5**	19.3	22.2	7.1	3.4
15	65.5	**51.3**	20.1	22.4	7.3	3.4
20	65.0	**51.5**	19.6	23.6	7.2	3.4
21	65.4	**50.6**	20.1	22.9	7.3	3.5
22a	64.8	**50.0**	19.5	22.5	7.1	3.4
22b	64.8	**50.0**	19.4	22.5	7.1	3.4
22c	64.9	**50.1**	19.6	22.6	7.1	3.4
22d	64.7	49.9	19.3	22.7	7.1	3.4
24	64.6	**50.1**	19.3	22.3	7.1	3.4
25	64.6	**50.0**	19.2	22.2	7.1	3.4
28	64.6	**50.1**	19.4	22.2	7.1	3.4
30a	64.7	**50.1**	19.4	22.2	7.1	3.4
30b	64.6	**50.2**	19.3	22.2	7.1	3.4
31a	64.5	**50.7**	19.3	22.2	7.1	3.4
36a	65.2	**51.5**	20.0	22.3	7.2	3.4
36b	64.8	**50.0**	19.5	22.2	7.1	3.4
38[1]	64.8	**51.3**	19.7	22.3	7.2	3.4
42[4]	65.1	**50.4**	19.9	22.6	7.2	3.4
43a	64.5	**50.6**	19.4	22.2	7.1	3.4
43b	64.4	**50.5**	19.2	22.2	7.1	3.4
49a	64.6	**50.0**	19.3	22.2	7.1	3.4
49b	64.7	**50.1**	19.3	22.2	7.1	3.4
56	64.5	**50.2**	19.3	22.2	7.1	3.4

Table 8.9 Cumulative (CGO plus background) concentration and deposition results – Year 9

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour (9th highest)	Annual	24-hour (3rd highest)	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
57	64.5	49.9	19.1	22.2	7.1	3.4
61a	64.7	**51.3**	19.7	22.3	7.2	3.4
62	65.2	**51.3**	20.0	22.7	7.2	3.4
79	64.6	**51.2**	19.3	22.5	7.1	3.4
89	64.7	**50.3**	19.4	23.6	7.1	3.4
90	64.6	**50.8**	19.3	22.8	7.1	3.4
100	64.4	49.9	19.2	22.2	7.1	3.4
122	64.7	**50.3**	19.4	22.2	7.1	3.4
126	64.6	**51.4**	19.3	23.3	7.1	3.4

Note: Due to the occurrence of eight existing exceedances of the 24-hour average PM_{10} criterion and two existing exceedances of the 24-hour average $PM_{2.5}$ criterion in the DPE Bathurst AQMS background dataset, the 9th highest 24-hour cumulative PM_{10} and 3rd highest cumulative $PM_{2.5}$ concentrations at each assessment location are presented. Exceedances of criteria are marked by bold.

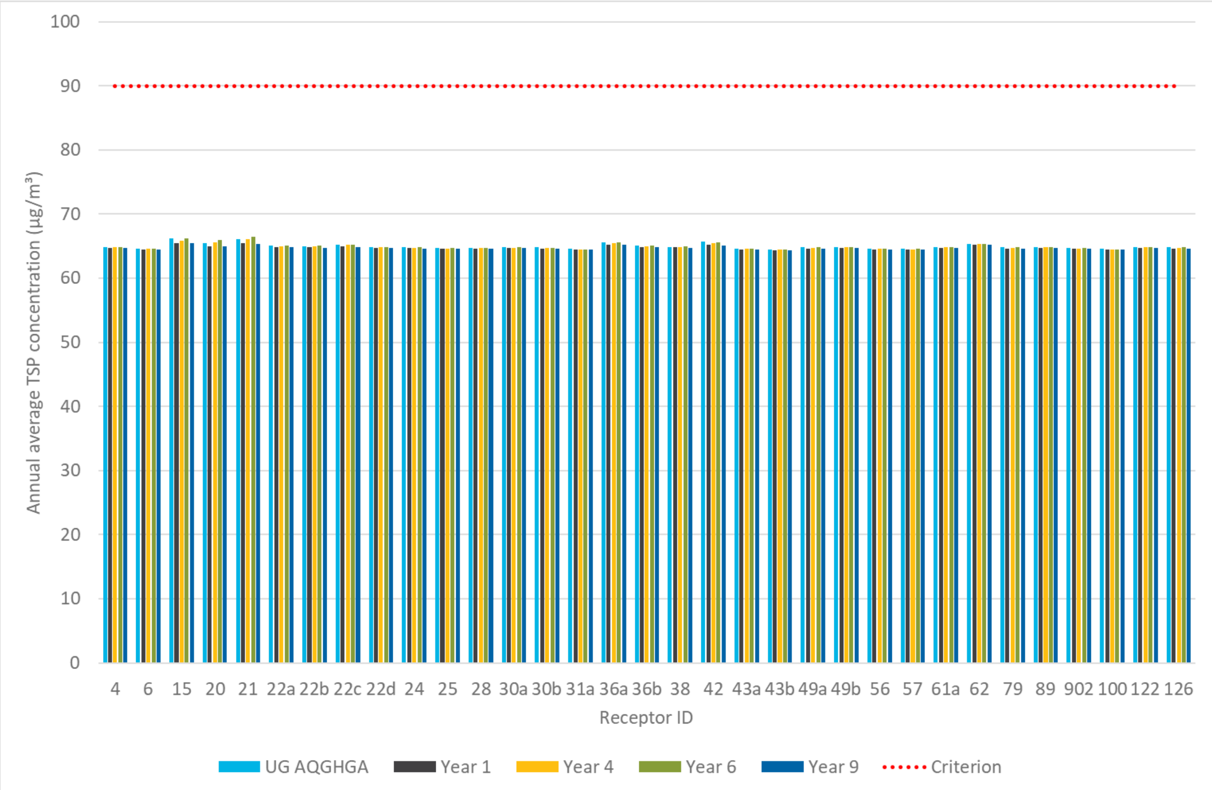

Figure 8.7 Predicted cumulative annual average TSP concentrations – CGO mine years and UG AQGHGA

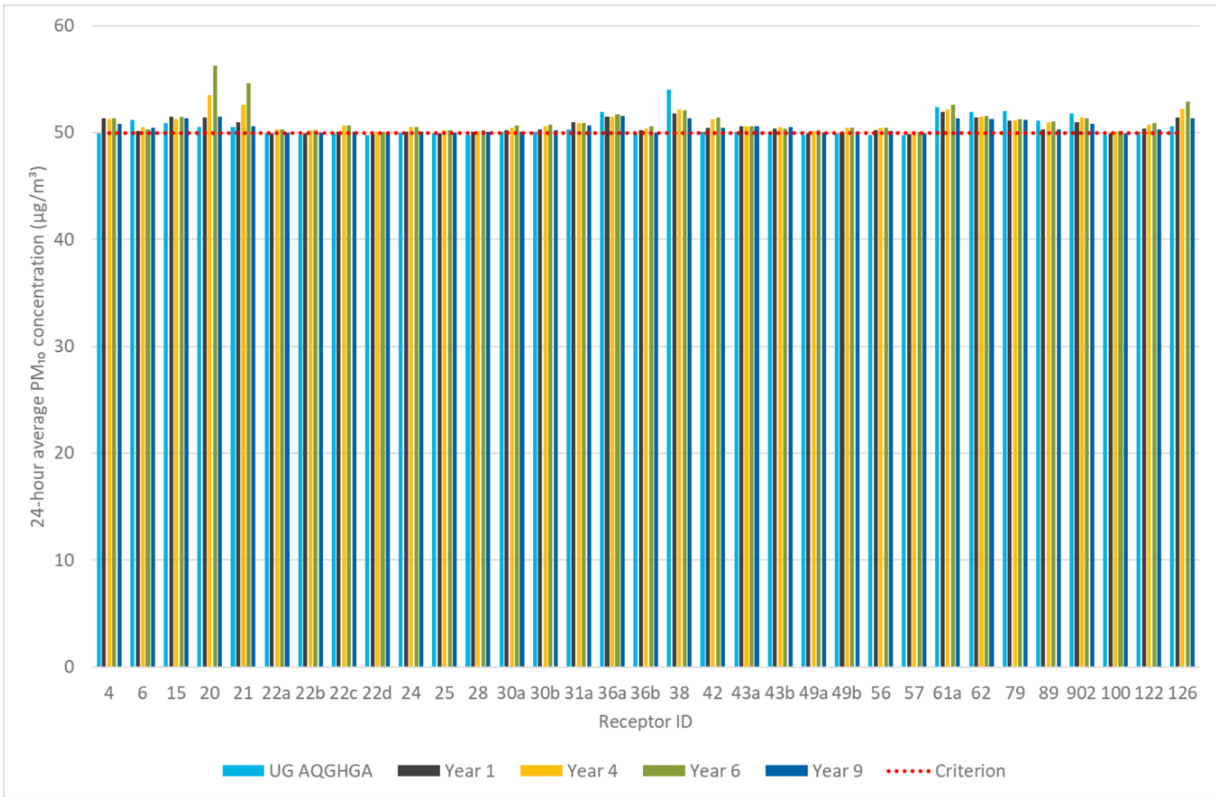

Figure 8.8 **Predicted 9th highest cumulative 24-hour average PM_{10} concentrations – CGO mine years and UG AQGHGA**

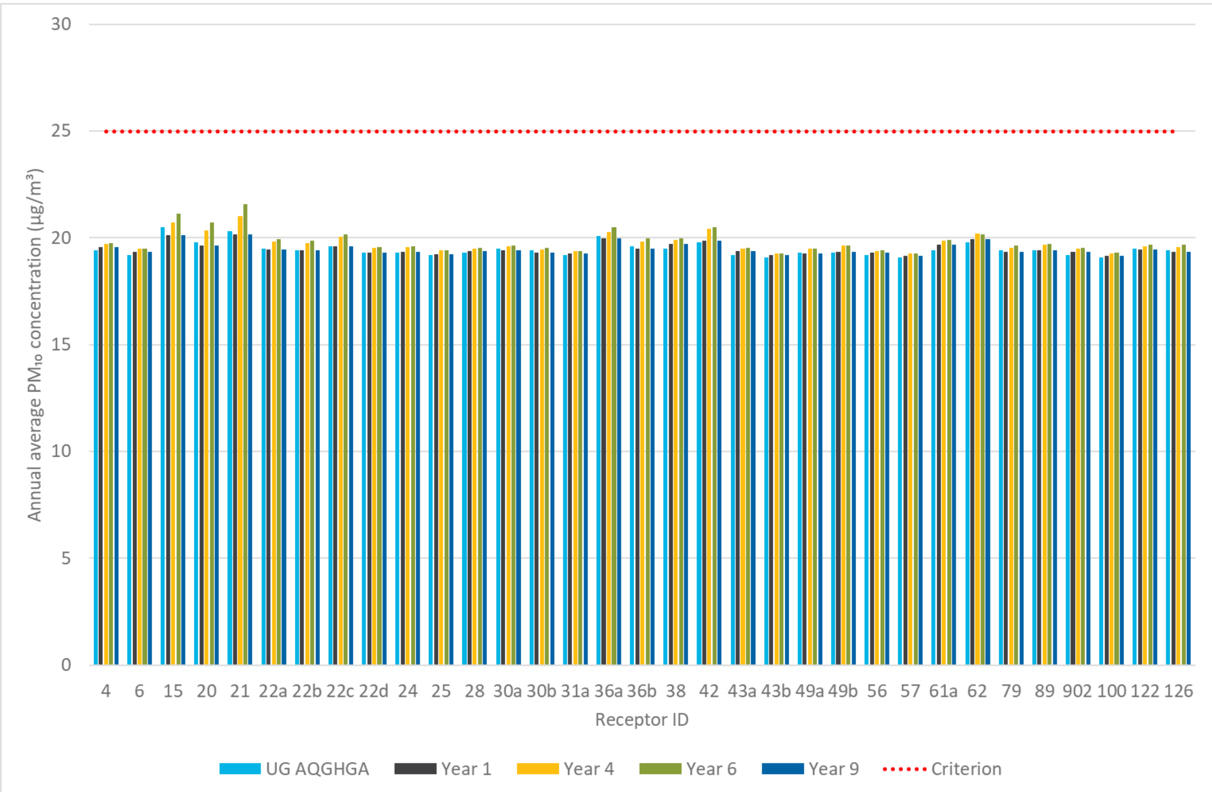

Figure 8.9 **Predicted cumulative annual average PM_{10} concentrations – CGO mine years and UG AQGHGA**

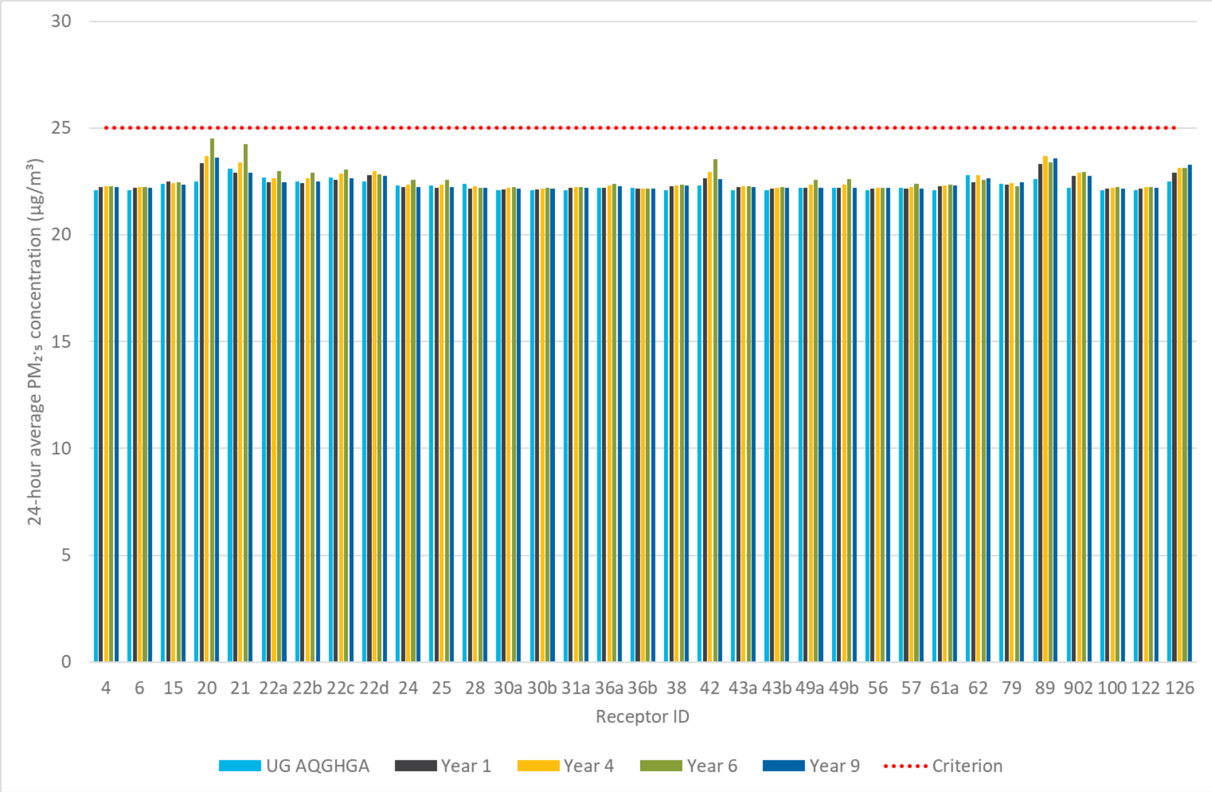

Figure 8.10 Predicted 3rd highest cumulative 24-hour average $PM_{2.5}$ concentrations – CGO mine years and UG AQGHGA

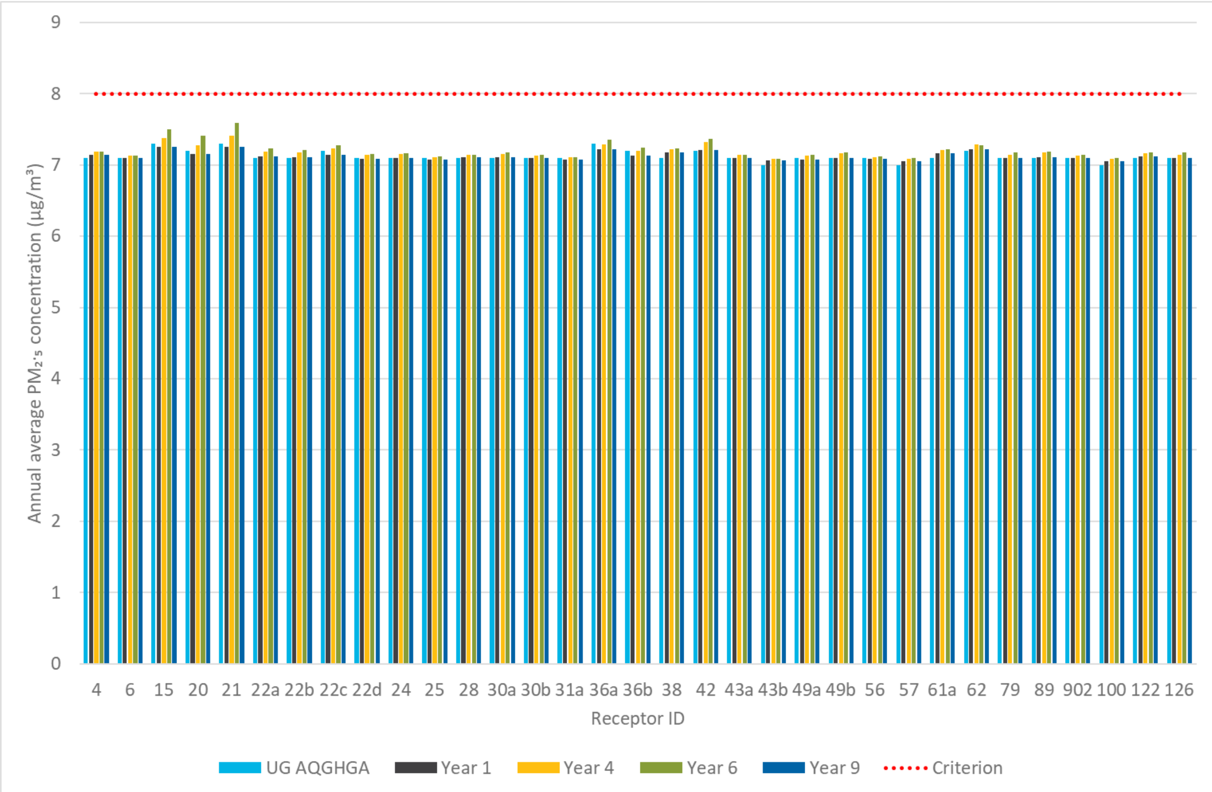

Figure 8.11 Predicted cumulative annual average $PM_{2.5}$ concentrations – CGO mine years and UG AQGHGA

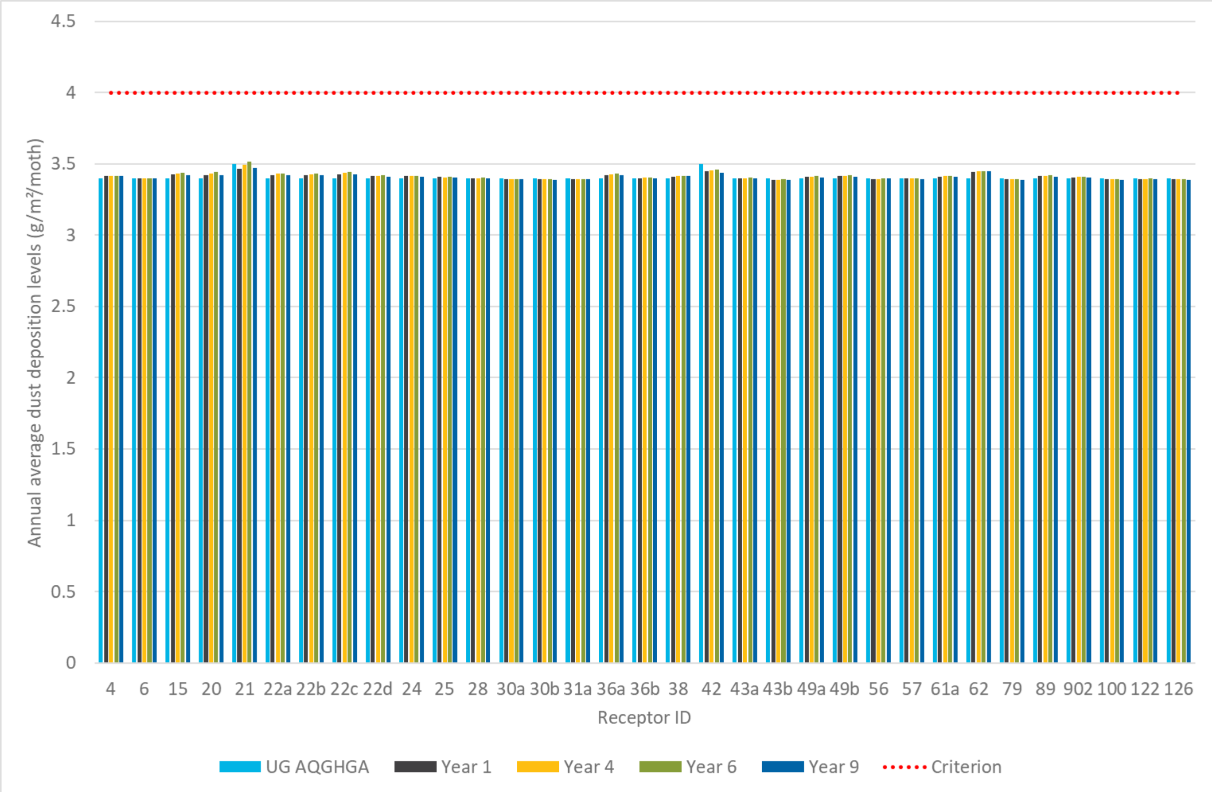

Figure 8.12 Predicted cumulative annual average dust deposition levels concentrations – CGO mine years and UG AQGHGA

For all modelling scenarios, the predicted cumulative concentrations for all pollutants and averaging periods comply with the applicable NSW EPA assessment criterion at all assessment locations with the exception of 24 hour PM_{10} concentrations.

Across the four modelling scenarios, the 9th highest cumulative 24 hour average PM_{10} concentration is greater than 50 µg/m³ at the majority of assessment locations. However, it is reiterated that the 9th highest background 24 hour average PM_{10} concentration from the adopted 2018 Bathurst AQMS data is 49.7 µg/m³ (i.e. 99.4% of the criterion of 50 µg/m³) and therefore dominates the predicted 9th highest cumulative 24 hour average PM_{10} concentration.

The number of additional cumulative exceedance days (i.e. additional to the existing eight days in the 2018 Bathurst AQMS PM_{10} background data) calculated by the NSW EPA contemporaneous approach is presented in Figure 8.13, comparing assessment locations and model scenarios. For reference, the number of predicted additional cumulative exceedance days from the UG AQGHGA by assessment location is also included in Figure 8.13.

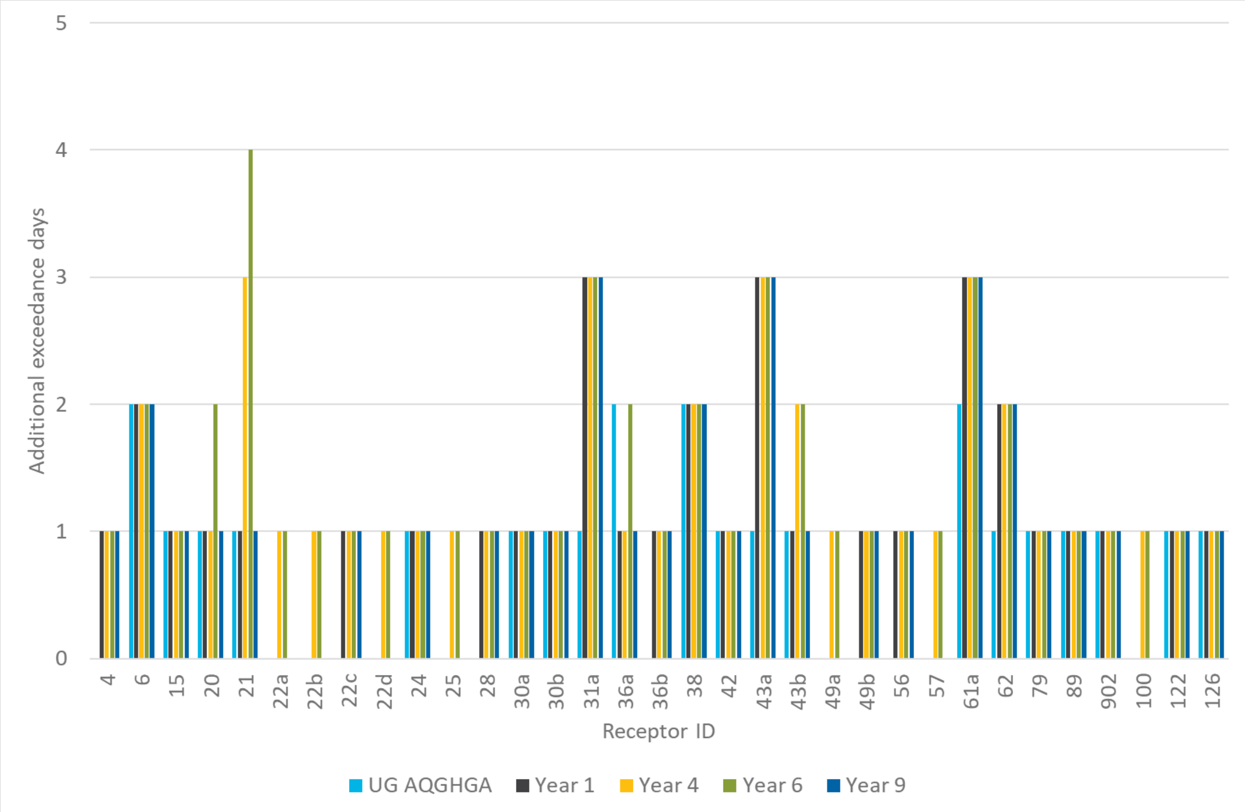

Figure 8.13 Number of additional days greater than 50 µg/m³ relative to background – 24-hour average PM_{10} – four Project scenarios and UG AQGHGA

From Figure 8.13, the following points are noted relevant to the paired in time analysis approach for cumulative 24 hour average PM_{10} concentrations:

- all assessment locations are predicted to have one additional exceedance in at least one of the four modelled scenarios (i.e. associated with the background concentration of 49.7 µg/m³, or 99% of the NSW EPA criterion of 50 µg/m³)
- several assessment locations are predicted to experience between two (assessment locations 6, 20, 36a, 38, 43b and 62) and three (assessment locations 31a, 43a and 61a) additional exceedance days
- the Project is predicted to result in up to four additional exceedance days at assessment location 21 (Year 6).

Relative to the equivalent UG AQGHGA predictions, the Project returns:

- up to three additional exceedance days at assessment location 21
- up to two additional exceedance days at assessment locations 31a and 43a
- between no additional days and one additional exceedance at the remainder of assessment locations.

To illustrate the daily-varying contribution to cumulative 24 hour average PM_{10} concentration by model prediction and background, cumulative timeseries plots have been generated for Year 6 Project operations at assessment locations 21 (Figure 8.14), 31a (Figure 8.15), 43a (Figure 8.16) and 61a (Figure 8.17).

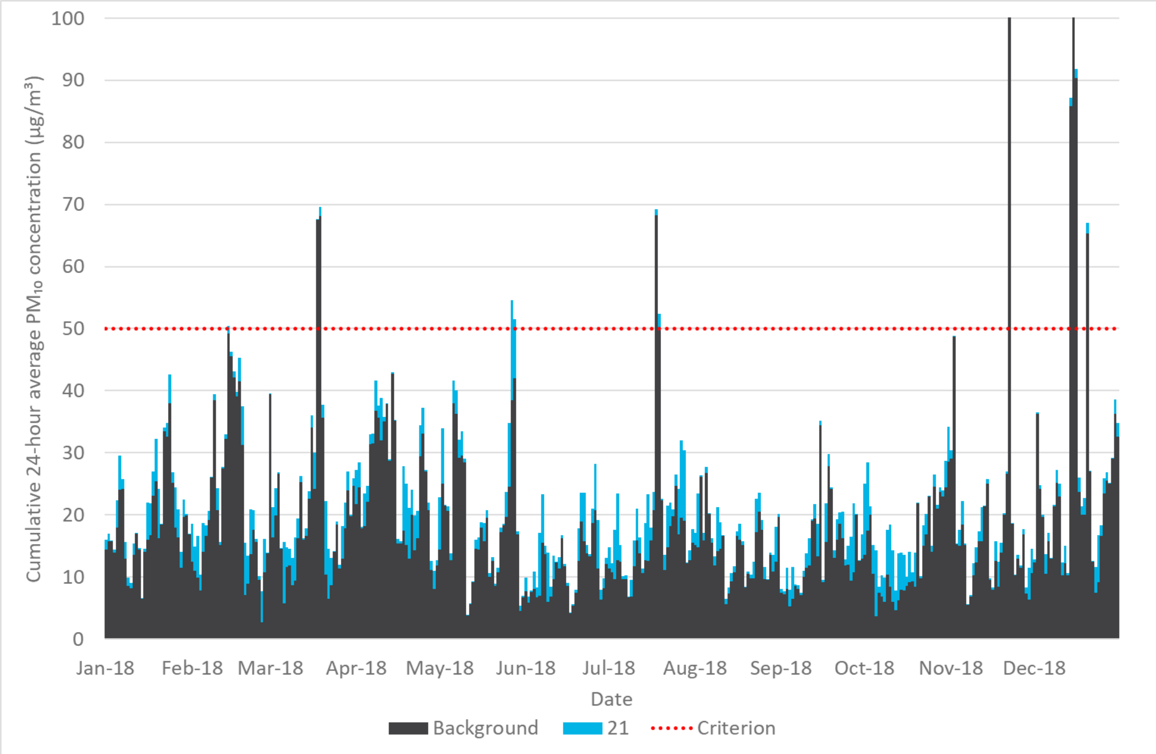

Figure 8.14 Timeseries of cumulative 24 hour average PM_{10} concentrations – Year 6 Project operations and background – assessment location 21

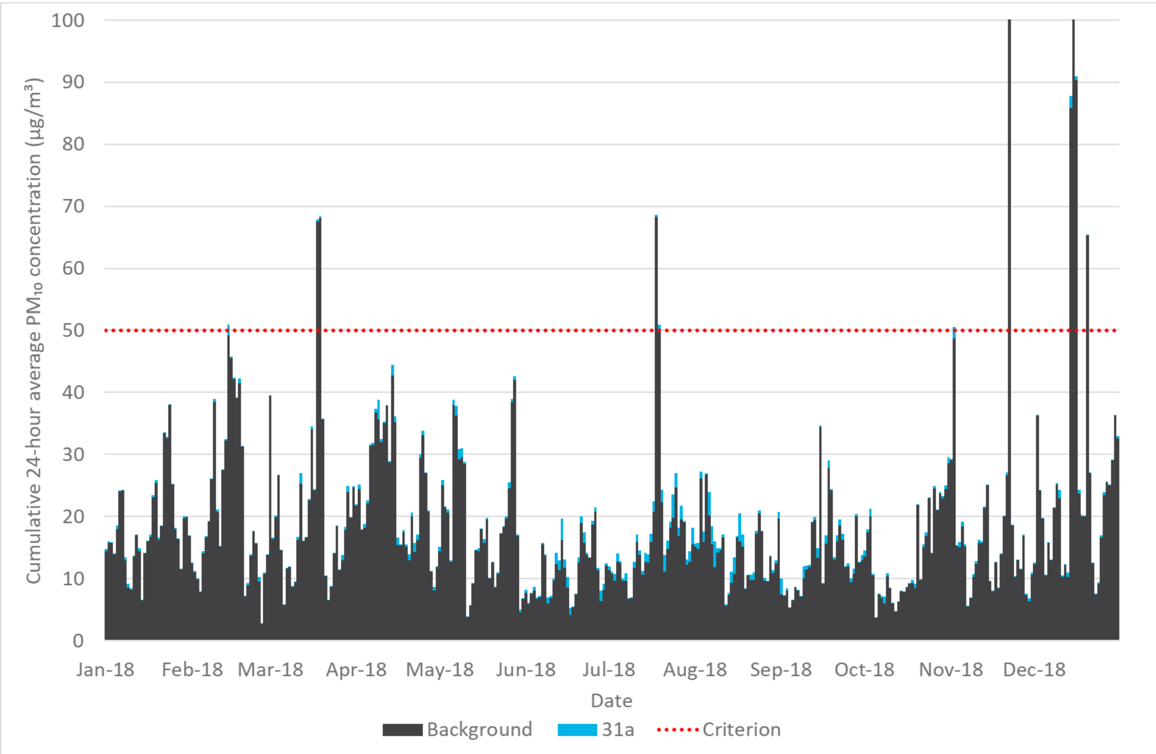

Figure 8.15 Timeseries of cumulative 24 hour average PM_{10} concentrations – Year 6 Project operations and background – assessment location 31a

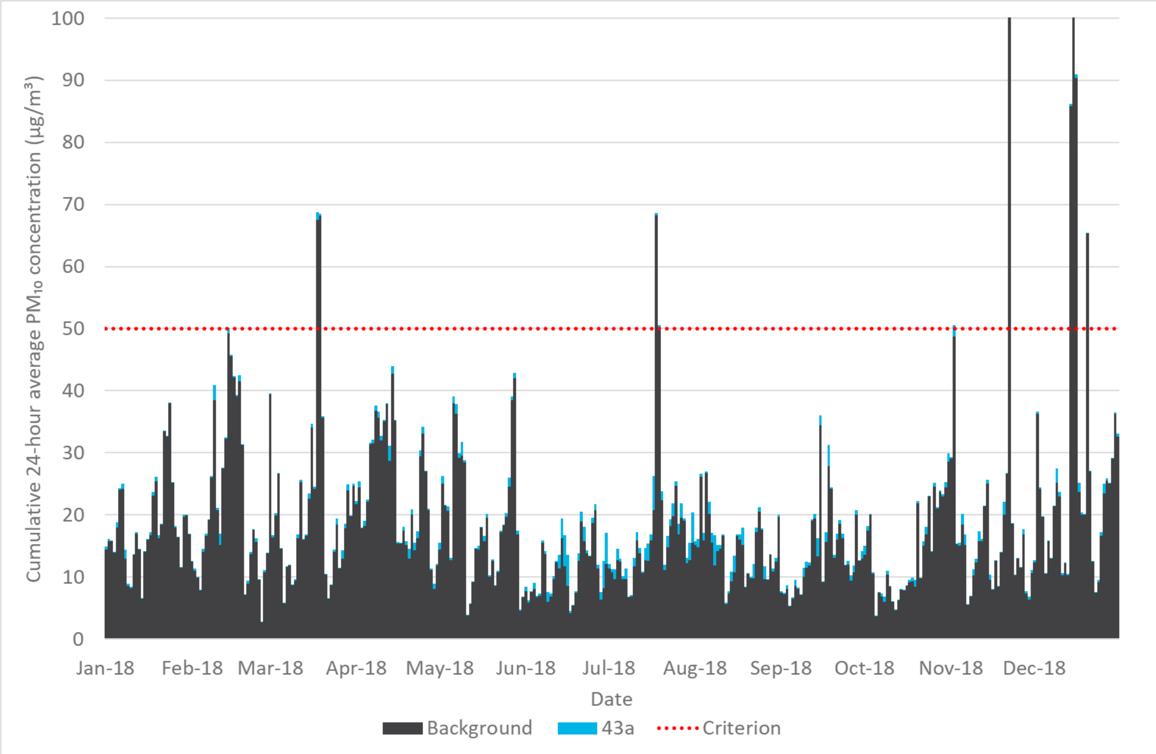

Figure 8.16 Timeseries of cumulative 24 hour average PM_{10} concentrations – Year 6 Project operations and background – assessment location 43a

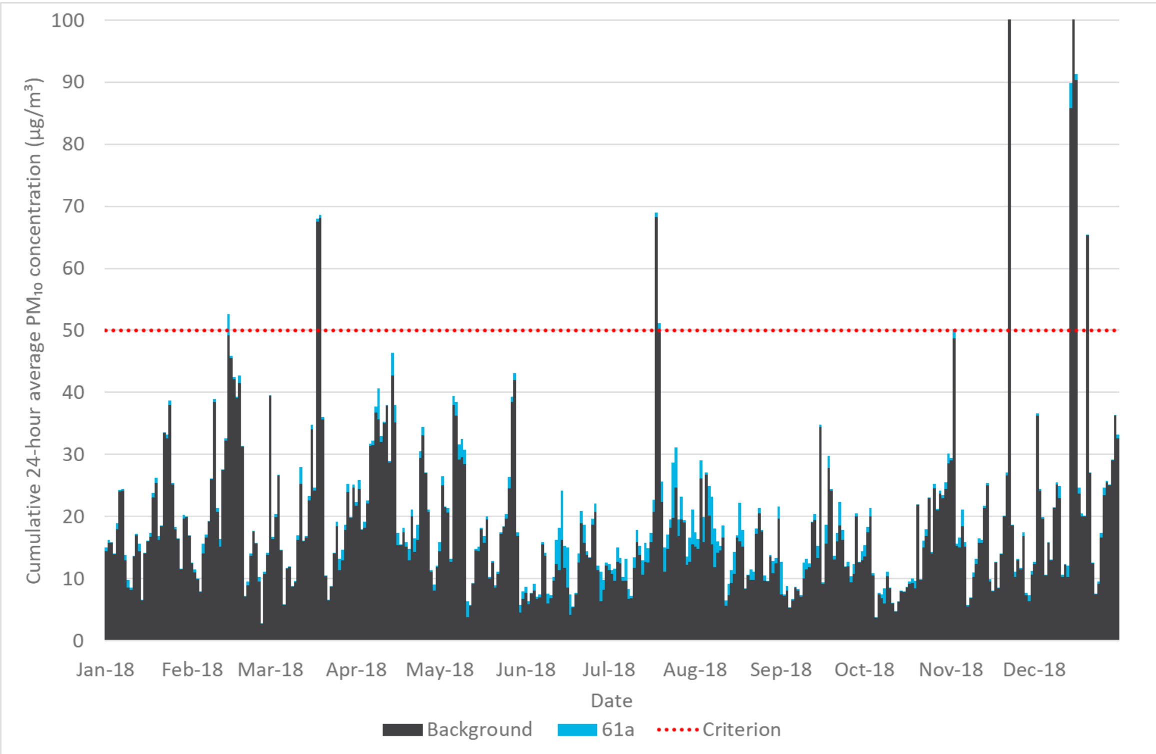

Figure 8.17 Timeseries of cumulative 24 hour average PM_{10} concentrations – Year 6 Project operations and background – assessment location 61a

These four graphs show that at each assessment location, the additional cumulative exceedances occur when the corresponding background concentration is greater than 40 µg/m³. These charts also illustrate that on any given day, the background concentration is higher than the predicted increment from the modelled Year 6 scenario.

Additional frequency analysis of cumulative exceedances for the assessment locations with greater than one additional exceedance day predicted from the paired in time approach is presented in Section 8.4.3.

There are no assessment locations (mine-owned or private) where the cumulative annual average concentration and deposition levels exceed the relevant impact assessment criterion.

8.4.3 Cumulative 24 hour average PM_{10} – additional probability analysis

Further cumulative analysis for 24 hour PM_{10} is presented in Figure 8.18, for the assessment locations with more than one additional exceedance day predicted from the paired in time approach (Section 8.4.2). This analysis relates to assessment locations 6, 15, 20, 21, 31a, 36a, 38, 43a, 43b, 61a and 62.

Consistent with the approach implemented in the UG AQGHGA, an extended background dataset comprising of 10 years of CGO HVAS data and 10 years of data from the DPE Bathurst AQMP (2009 to 2018 inclusive) has been collated (comprising of 4,108 data points).

From this collated long-term background dataset, the frequency of days greater than the 24 hour average PM_{10} criterion of 50 µg/m³ per year was calculated to be 0.998%, or 3.64 days per year.

A cumulative frequency analysis has been undertaken at the eleven selected assessment locations. This analysis was completed by pairing all predicted 24 hour average PM_{10} concentrations at each assessment location (i.e. 365 predictions for the 2018 modelling year) with all recorded background concentrations (as stated, 4,108 data points). Therefore, for each assessment location and modelling scenario, there are 1,499,420 combinations of background and model-predicted impacts for 24 hour PM_{10}.

For each assessment location and modelling scenario, the frequency of cumulative days greater than the 24 hour average PM_{10} criterion of 50 µg/m³ per year was then calculated from the combined model prediction and background dataset (1,499,420 combinations per assessment location and model scenario).

For each modelling scenario and assessment location, the likelihood of additional cumulative 24 hour average PM_{10} concentrations days above 50 µg/m³ is then calculated by subtracting the exceedance days from the long-term background dataset (i.e. 3.64 days per year) from the calculated frequency of cumulative days greater than 50 µg/m³. The calculated additional exceedance days from this approach is presented in Figure 8.18.

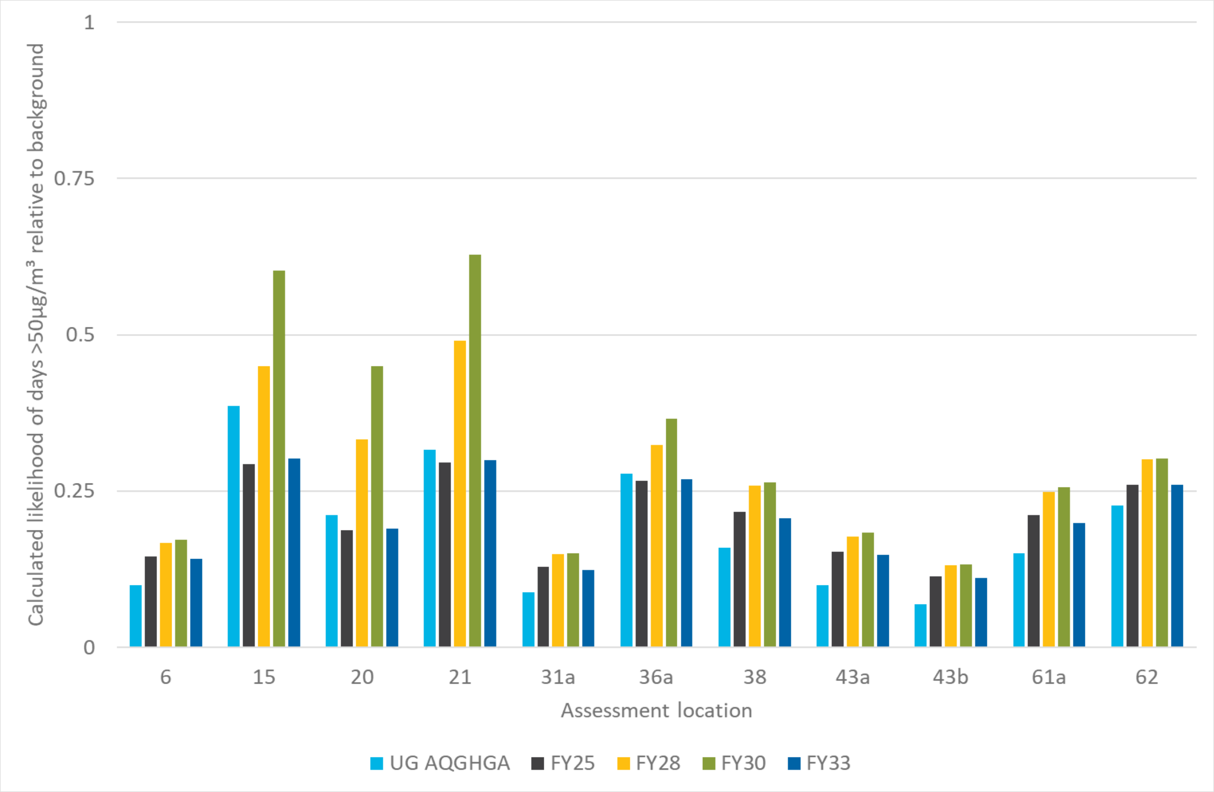

Figure 8.18 Calculated likelihood of additional days greater than 50 µg/m³ – 24 hour average PM_{10} – four Project scenarios and UG AQGHGA results

The results of the additional cumulative frequency analysis undertaken, presented in Figure 8.18, show that when long-term background records are considered, the likelihood of additional days above 50 µg/m³ is less than one additional day for each assessment location across all modelling scenarios.

It is noted that the quantified likelihood of less than one additional exceedance day is consistent with the results returned for the UG AQGHGA results (i.e. existing approved operations plus underground operations). Consequently, the Project does not increase the likelihood of additional cumulative 24 hour average PM_{10} exceedances occurring relative to existing approved operations.

8.4.4 Nitrogen dioxide

The maximum predicted cumulative 1 hour and annual average NO_2 concentrations from diesel combustion and blasting-related NO_x emissions based on the maximum year of the Project (Year 5) are presented in Table 8.10. The cumulative NO_2 concentrations at each assessment location were derived through the paired-in-time approach combining model predictions with the corresponding NO_2 concentration from the 2018 DPE Gunnedah AQMS background dataset.

Table 8.10 Predicted cumulative (CGO plus background) NO_2 concentrations – maximum year scenario

Assessment location ID	Predicted cumulative NO_2 concentrations (µg/m³)	
	1-hour	Annual
Criterion	**164**	**31**
1a	140.4	18.4
1b	136.3	16.3

Table 8.10 Predicted cumulative (CGO plus background) NO_2 concentrations – maximum year scenario

Assessment location ID	Predicted cumulative NO_2 concentrations (µg/m³)	
	1-hour	Annual
Criterion	**164**	**31**
1c	127.4	13.3
1d	134.1	12.7
4	112.1	11.9
6	108.3	11.3
15	145.8	15.3
20	139.6	13.4
21	130.7	16.2
22a	129.0	12.4
22b	126.5	12.2
22c	130.2	13.0
22d	117.6	11.5
24	125.4	11.7
25	119.7	11.1
28	110.3	11.3
30a	127.3	11.8
30b	127.8	11.4
31a	123.1	11.0
36a	131.5	14.0
36b	140.9	12.5
38[1]	126.2	12.5
42[4]	125.4	14.1
43a	115.0	11.3
43b	100.2	10.7
49a	121.5	11.4
49b	115.7	11.8
56	100.6	11.0
57	118.6	10.7
61a	126.7	12.4
62	125.6	13.1

Table 8.10 Predicted cumulative (CGO plus background) NO_2 concentrations – maximum year scenario

Assessment location ID	Predicted cumulative NO_2 concentrations (µg/m³)	
	1-hour	Annual
Criterion	**164**	**31**
79	122.0	11.7
89	129.3	11.8
90	106.8	11.3
100	117.6	10.8
122	129.5	11.9
126	122.5	11.7

From the results presented in Table 8.10, the maximum cumulative 1 hour average and annual average NO_2 concentrations are below the applicable NSW EPA impact assessment criterion at all assessment locations.

8.5 Voluntary land acquisition criteria

The results presented in Section 8.3 and Section 8.4 demonstrate compliance with the relevant VLAMP criteria for both mitigation and acquisition presented in Section 4.3. As stated, VLAMP criteria also apply if the development contributes to an exceedance on more than 25% of privately-owned land upon which a dwelling could be built under existing planning controls.

Analysis of the contour plots presented in Attachment C indicates that project-only 24 hour PM_{10} and $PM_{2.5}$ concentrations will not exceed 50 µg/m³ or 25 µg/m³ across more than 25% of any privately-owned land during any of the four modelled scenarios.

To assess against voluntary land acquisition criteria for cumulative annual average PM_{10}, $PM_{2.5}$, TSP or dust deposition, the relevant fixed background value from Section 6.3 was added to the incremental contour plots presented in Attachment C. This analysis highlighted that no exceedance of relevant VLAMP criteria across more than 25% of any privately-owned land would occur for the modelled scenarios.

9 Mitigation and monitoring

9.1 Emissions mitigation and management

CGO operates under an AQMP developed for approved operations at the site. The particulate matter emission mitigation measures currently implemented at CGO, as documented in the AQMP, are summarised in Section 7.3.1. Consistent with the existing CGO AQMP, these measures would continue to be implemented throughout the life of the Project.

Methods incorporated into the CGO AQMP for the management of diesel consumption include the following:

- regular maintenance of plant and equipment to minimise fuel consumption
- efficient mine planning (e.g. minimising rehandling and haulage of materials) to minimise fuel consumption
- consideration of energy efficiency in the plant equipment selection phase.

9.2 Air quality monitoring

As discussed in Section 6.1, Evolution maintains an air quality monitoring network at CGO, consisting of the following components:

- one meteorological monitoring station
- 12 DDGs
- one HVAS (TSP/inferred PM_{10}).

Data from this network is used for ongoing compliance monitoring and reporting purposes against Consent Condition criteria. The monitoring would continue through the life of the Project, consistent with the CGO AQMP.

The three E-BAM continuous PM_{10} monitors (Coniston, Lake Cowal Conservation Centre and CGO site office) are not currently used for compliance monitoring purposes. These continuous monitoring sites will provide upwind and downwind measurements of PM_{10} and will allow Evolution to better monitor and manage dust emissions from CGO operations. Data from these locations is presented in Section 6.1.

10 GHG assessment

10.1 Introduction

The estimation of GHG emissions for the Project was based on the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) National Greenhouse Accounts Factors (NGAF) workbook (DCCEEW 2022). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the National Greenhouse and Energy Reporting Act 2007 (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect'. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and are a result of the organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities, but are physically produced by the activities of another organisation (DCCEEW 2022).

Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, such as the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (Bhatia et al 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations.

Examples of Scope 1, 2 and 3 emissions are provided in Figure 10.1.

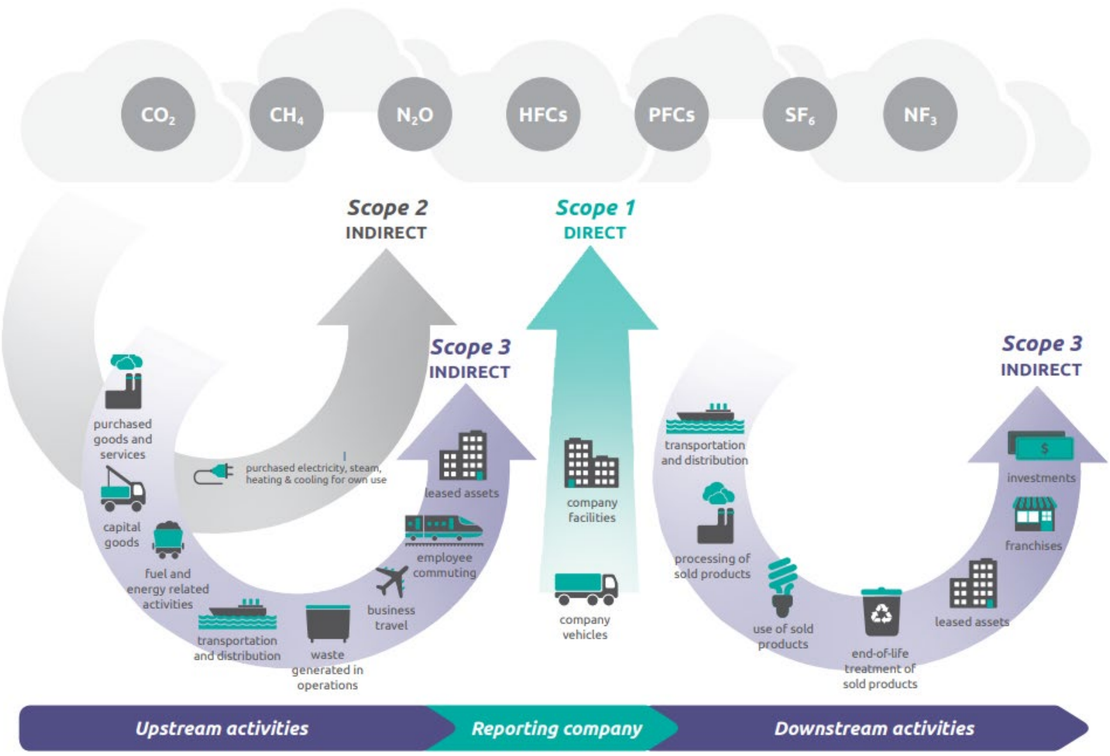

Figure 10.1 Overview of GHG emission scopes (WRI & WBCSD 2013)

In this assessment, GHG emissions are presented as carbon dioxide equivalents (CO_2-e) and include emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), calculated based on the applicable global warming potentials (GWPs).

10.2 Emission sources

The GHG emission sources included in this assessment are listed in Table 10.1, representing the most significant sources associated with the Project. Emissions of GHGs have been quantified for the Project on an annual basis, based on energy data and explosives usage provided by Evolution.

GHG emissions from the Project are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and Scope 1, 2 and 3 emission factors for diesel, liquified petroleum gas (LPG), explosives and electricity use in NSW.

Table 10.1 Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel, LPG) by onsite plant and equipment.	Indirect emissions associated with the consumption of purchased electricity.	Indirect upstream emissions from the extraction, production and transport of diesel used for onsite plant and equipment.
Direct emissions associated with explosives use.		Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.

10.3 Activity data

Estimates of annual diesel consumption, electricity consumption and explosive usage associated with the Project have been provided by Evolution. Annual LPG consumption by the mill furnace was based on the actual reported LPG consumption rate and ore processed by the mill for FY22 (a rate of 0.21 L LPG/t ore processed), combined with the annual projected mill processing rate for the Project. A summary of estimated annual energy consumption is presented in Table 10.2.

Table 10.2 Project annual energy consumption

Year	Projected diesel consumption (kL)	Projected LPG consumption (kL)	Projected explosives usage (t)	Projected electricity consumption (kWh)
Year 1	32,040.3	1,656.2	2,222.5	226,048,310.6
Year 2	30,444.7	1,694.7	972.7	231,303,168.1
Year 3	33,421.9	1,859.9	2,713.9	253,840,417.3
Year 4	36,122.9	1,865.2	4,745.3	254,572,264.0
Year 5	37,637.0	1,859.9	6,495.5	253,840,363.3
Year 6	37,138.8	1,859.9	5,353.5	253,840,296.6
Year 7	33,834.3	1,859.9	4,114.6	253,840,396.2
Year 8	31,624.2	1,865.2	3,772.7	254,572,249.2
Year 9	34,700.0	1,859.9	4,629.1	253,840,347.9

Table 10.2 Project annual energy consumption

Year	Projected diesel consumption (kL)	Projected LPG consumption (kL)	Projected explosives usage (t)	Projected electricity consumption (kWh)
Year 10	30,108.0	1,859.9	4,542.9	253,840,376.7
Year 11	21,488.2	1,859.9	2,908.9	253,840,370.6
Year 12	16,831.1	1,865.2	1,700.8	254,572,238.8
Year 13	11,939.1	1,859.9	847.3	253,840,426.0
Year 14	2,884.4	1,859.9	-	253,840,437.0
Year 15	2,875.5	1,859.9	-	253,840,437.0
Year 16	2,842.0	1,865.2	-	254,572,288.5
Year 17	2,633.5	1,714.2	-	233,954,173.9
Year 18	870.6	97.5	-	13,312,525.1

10.4 Emission estimates

The following emission factors have been used to estimate GHG emissions from the project:

- diesel consumption on-site (Scope 1, Scope 3) – diesel oil factors from Table 6 of the NGAF workbook (2022)
- LPG consumption on-site (Scope 1, Scope 3) – LPG factors from Table 6 of the NGAF workbook (2022)
- electricity consumption (Scope 2) – NSW Scope 2 emission factor from Table 1 of the NGAF workbook (2022)
- explosives use (Scope 1) – emission factor from the NGAF workbook (2008).

The estimated annual GHG emissions for each emission source are presented in Table 10.3. The breakdown of annual GHG emissions by scope is illustrated in Figure 10.2.

Table 10.3 Annual GHG emission totals – Project life

Project year	Annual GHG emissions (t CO_2-e/year) by scope						
	Scope 1			Scope 2	Scope 3		
	Diesel	Explosives	LPG	Electricity consumption	Diesel	LPG	Electricity consumption
Year 1	86,820	371	2,579	165,015	21,396	860	13,563
Year 2	82,497	162	2,639	168,851	20,330	880	13,878
Year 3	90,564	453	2,897	185,304	22,318	966	15,230
Year 4	97,883	792	2,905	185,838	24,122	968	15,274
Year 5	101,986	1,085	2,897	185,303	25,133	966	15,230

Table 10.3 Annual GHG emission totals – Project life

Project year	Annual GHG emissions (t CO_2-e/year) by scope						
	Scope 1			Scope 2	Scope 3		
	Diesel	Explosives	LPG	Electricity consumption	Diesel	LPG	Electricity consumption
Year 6	100,636	894	2,897	185,303	24,801	966	15,230
Year 7	91,681	687	2,897	185,303	22,594	966	15,230
Year 8	85,693	630	2,905	185,838	21,118	968	15,274
Year 9	94,027	773	2,897	185,303	23,172	966	15,230
Year 10	81,584	759	2,897	185,303	20,106	966	15,230
Year 11	58,227	486	2,897	185,303	14,349	966	15,230
Year 12	45,607	284	2,905	185,838	11,239	968	15,274
Year 13	32,352	141	2,897	185,304	7,973	966	15,230
Year 14	7,816	-	2,897	185,304	1,926	966	15,230
Year 15	7,792	-	2,897	185,304	1,920	966	15,230
Year 16	7,701	-	2,905	185,838	1,898	968	15,274
Year 17	7,136	-	2,670	170,787	1,759	890	14,037
Year 18	2,359	-	152	9,718	581	51	799

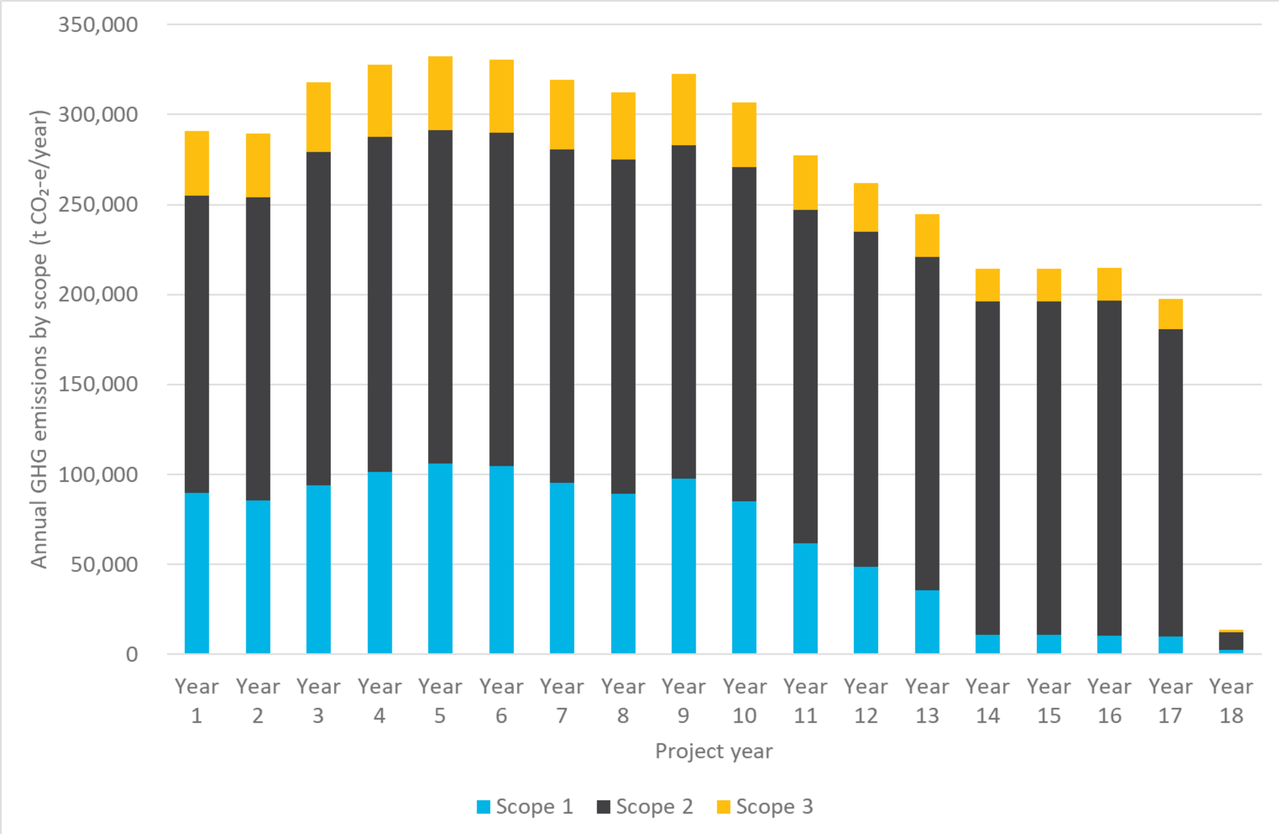

Figure 10.2 Annual GHG emissions by scope – Project life

Annual GHG emissions from the Project are projected to peak between Year 3 and Year 9 before decreasing year on year as open pit operations are completed.

The average annual and maximum annual totals for Scope 1 only, Scope 2 only and Scope 1 plus Scope 2 GHG emissions for the Project are presented in Table 10.4, along with the equivalent actual GHG emissions generated by CGO during FY22[8].

Table 10.4 Annual GHG emission totals – Project average, Project maximum and FY22 actual

Emissions total	Annual GHG emissions (t CO_2-e/year)		
	Scope 1	Scope 2	Scope 1 + Scope 2
Project average	63,250	172,820	236,070
Project maximum	105,967	185,838	291,271
FY22 actual	101,375	199,329	300,704

[8] https://evolutionmining.com.au/wp-content/uploads/2022/10/Evolution-Annual-Report-2022.pdf

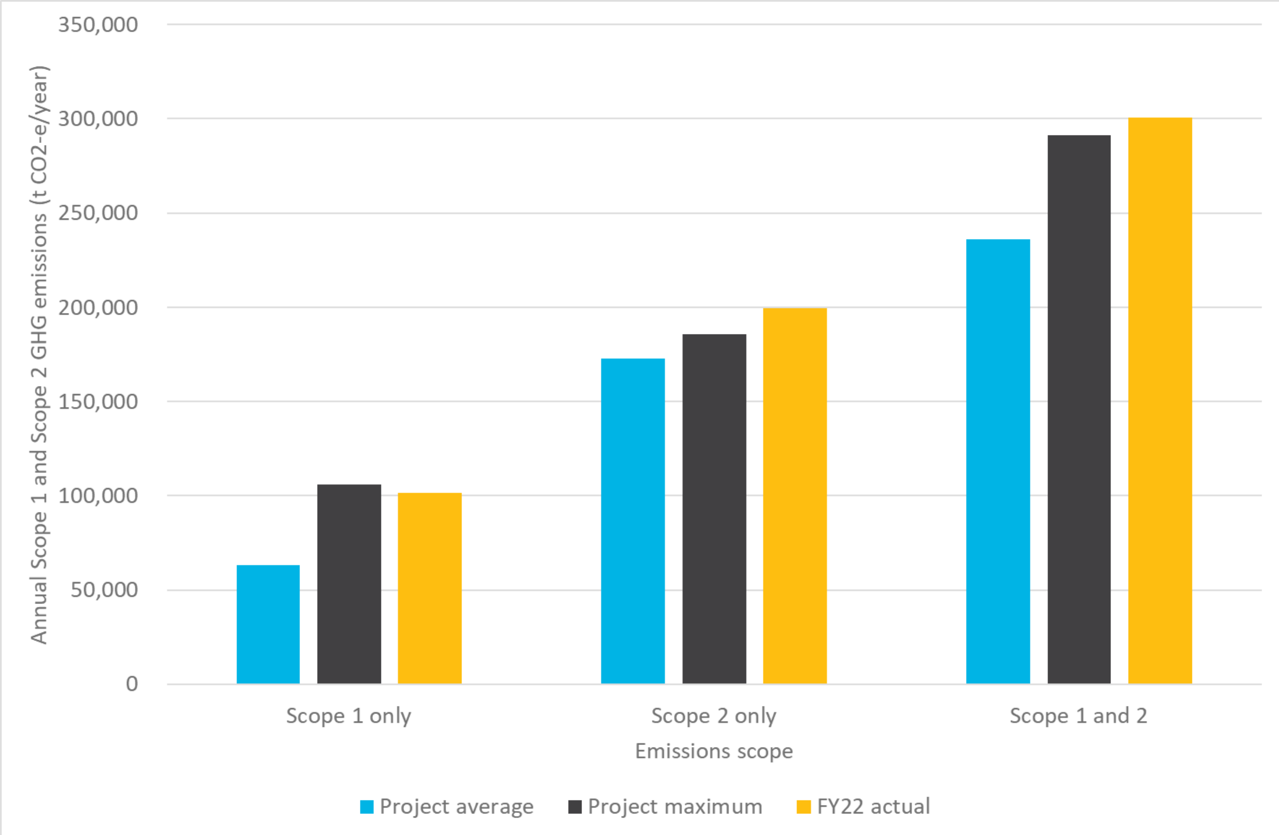

Figure 10.3 Annual Scope 1 and Scope 2 GHG emissions – Project average, Project maximum and FY22 actual

It can be seen that for the peak year of Project GHG emissions, the calculated total Scope 1 and Scope 2 is slightly lower than the most recent operational year at CGO. Therefore, the Project is not anticipated to increase annual GHG emissions relative to existing approved operations.

The contribution to annual Scope 1 and Scope 2 GHG emissions by source type over the life of the Project is illustrated in Figure 10.3.

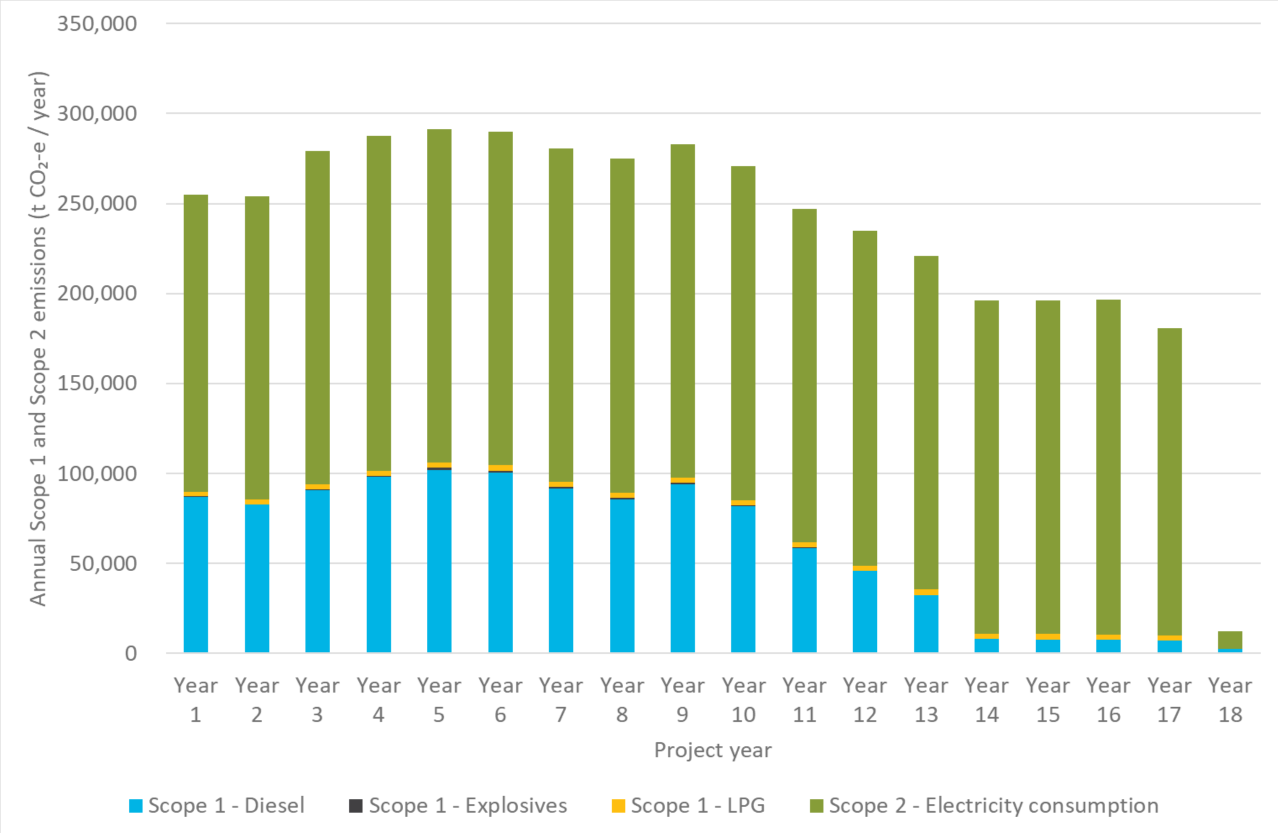

Figure 10.4 Contribution to annual Scope 1 and Scope 2 GHG emissions by source – Project life

Figure 10.3 highlights that the consumption of purchased electricity and diesel use are by far the most significant contributors to annual Scope 1 and Scope 2 GHG emissions from the Project.

The significance of Project GHG emissions relative to state and national GHG emissions is made by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2020[9]) for NSW (132,408 kt CO_2-e) and Australia (497,166 kt CO_2-e).

Relative to 2020 emission inventory totals, annual Scope 1 and Scope 2 GHG emissions generated by the Project represent approximately 0.17% of NSW total emissions and 0.044% of national total emissions on an annual average basis; and approximately 0.22% of NSW total emissions and 0.059% of national total emissions when compared to the maximum Project year. The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion to its contribution to global GHG emissions.

The calculated annual Scope 1 and 2 emissions from the Project are greater than the NGER Scheme facility reporting threshold of 25,000 tonnes per annum CO_2-e. Consequently, Evolution Mining will continue to measure energy consumption, and calculate and report Scope 1 and 2 GHG emissions in accordance with the requirements of the NGER Act.

9 https://greenhouseaccounts.climatechange.gov.au

10.5 GHG emissions management

As highlighted in Section 10.4, GHG emissions from the Project are primarily associated with on-site energy consumption, specifically diesel combustion and consumption of purchased electricity. The proposed mining development is a continuation of existing open pit mining operations featuring conventional drill, blast and haul techniques, which is largely dependent on the use of diesel-powered equipment.

Evolution has made a public commitment to achieve Net Zero emissions by 2050 based on its asset portfolio. This commitment includes an interim goal of 30% reduction in emissions by 2030 based on the company-wide FY20 baseline. On the basis of the results presented in Section 10.4, electricity and diesel consumption are the two primary areas for focus from Evolution to achieve the proposed interim emissions reduction goal.

As part of this commitment, Evolution has already commenced activities to identify emissions reduction opportunities including:

- taking a group wide approach to achieving Net Zero by implementing a Project Initiative labelled "*Net Zero Future BBP Project*", the purpose of which is to align the business on a common understanding and outcome of progress against Evolution's Net Zero commitment
- completing an energy audit of Evolution assets (including CGO) to understand each site's energy profile and identify opportunities to improve energy efficiency
- developing group wide and site based emissions reduction roadmaps to provide a pathway for achieving the interim and long-term Net Zero goals
- leveraging off technology initiatives by identifying mature technology innovations that will contribute towards the group's transition to Net Zero.

From a site perspective, CGO also operates under an AQMP developed for approved operations at the site. The AQMP includes GHG management measures implemented at the CGO. These include:

- regular maintenance of plant and equipment to minimise fuel consumption
- efficient mine planning (e.g. minimising rehandling and haulage of materials) to minimise fuel consumption
- consideration of energy efficiency in the plant equipment selection phase.

Finally, noting the extensive activities currently being undertaken by Evolution to reduce emissions across all sites, the following actions will be implemented at CGO to ensure these are achieved:

- review progress against the emissions reduction roadmap every three years
- monitor external factors such as the NSW Government Net Zero Plan and its influence on site emissions
- review and update the technology roadmap to identify current or future technologies that may be mature enough to implement
- update the AQMP to include feasible actions identified in the emission reduction roadmap and technology.

11 Conclusion

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

Emissions from the Project were quantified for four future operational scenarios:

- Year 1
- Year 4
- Year 6
- Year 9.

Emissions from all existing and approved activities (e.g. underground operations) were included to predict cumulative air quality impacts in the surrounding environment. The following points are noted from review of the developed emissions inventories for the Project:

- Year 6 represents the highest potential emissions scenario of the four quantified years
- Year 9 represents the lowest potential emissions scenario of the four quantified years
- the difference between the minimum and maximum annual emission totals ranges between 9% for TSP, 14% for PM_{10} and 12% for $PM_{2.5}$
- relative to the total annual PM_{10} emissions assessed in the UG AQGHGA (i.e. existing approved operations), the total annual PM_{10} emissions quantified for the four Project scenarios are between 3% lower and 11% higher than existing approved operations.

Atmospheric dispersion modelling was undertaken using the US-EPA regulatory model, AERMOD. Hourly meteorological observations from 2018, collected primarily by the onsite meteorological station, were used as inputs into the dispersion modelling process. The background air quality, emissions inventory methodology and dispersion modelling approach are consistent with the UG AQGHGA wherever possible to provide consistency between the two assessments.

The results of the modelling show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) and NO_2 are below the applicable impact assessment criteria at all assessment locations. The modelling results show the following key points:

- at each assessment location, the model predicted concentrations for Year 1 and Year 9 scenarios are lower than the predictions from the Year 4 and Year 6 scenarios, which is consistent with the variation in calculated annual emissions
- the model predictions are typically highest for the Year 6 scenario across all assessment locations, in particular at the closest assessment locations to the north-west IWL construction area (i.e. 15, 20, 21, 22a–c, and 36b)
- relative to the equivalent predictions from the UG AQGHGA, the model predicted concentrations for the Year 1 and Year 9 scenarios are generally lower, while the predictions from the Year 4 and Year 6 scenarios are generally higher.

When background concentrations are added, the cumulative annual average concentrations for all pollutants were predicted to be below the relevant impact assessment criteria. Further, the maximum predicted cumulative 24 hour $PM_{2.5}$ concentrations and 1 hour NO_2 concentrations were below the impact assessment criterion at all assessment locations. However, the predicted cumulative 24 hour average PM_{10} is greater than the impact assessment criterion (50 µg/m³) at a number of private assessment locations across the four modelled scenarios. The following points are noted relevant to the paired in time analysis approach for cumulative 24 hour average PM_{10} concentrations from the Project:

- all assessment locations are predicted to have one additional exceedance in at least one of the four modelled scenarios (i.e. associated with the background concentration of 49.7 µg/m³, or 99% of the NSW EPA criterion of 50 µg/m³)
- assessment locations 6, 20, 36a, 38, 43b and 62 are predicted to experience up to two additional exceedance days in Year 6
- assessment locations 31a, 43a and 61aare predicted to experience up to three additional exceedance days in Year 6
- the Project is predicted to result in up to four additional exceedance days at assessment location 21 (Year 6).

Relative to the equivalent UG AQGHGA predictions, the Project returns:

- up to three additional exceedance days at assessment location 21
- up to two additional exceedance days at assessment locations 31a and 43a
- between no additional days and one additional exceedance at the remainder of assessment locations.

Analysis of the predicted additional exceedance days illustrated that all coincided a background concentration greater than 40 µg/m³.

Additional cumulative analysis was undertaken to determine the likelihood of additional exceedances when a longer-term background dataset is paired with model predictions.

This additional cumulative frequency analysis showed that the likelihood of additional days above 50 µg/m³ is less than one additional day for each assessment location across all modelling scenarios.

It is noted that the quantified likelihood of less than one additional exceedance day is consistent with the results returned for the UG AQGHGA results (i.e. existing approved operations plus underground operations). Consequently, the Project does not increase the likelihood of additional cumulative 24 hour average PM_{10} exceedances occurring relative to existing approved operations.

There are no private residences or land area where the 24-hour or annual average VLAMP criteria are triggered for any of the assessed scenarios.

A GHG assessment was also undertaken for the Project. The GHG assessment showed the following:

- emissions from the consumption of purchased electricity and diesel fuel are the dominant sources of GHG emissions from all years of the Project
- annual GHG emissions from the Project are projected to peak between Year 3 and Year 9 before decreasing year on year as open cut pit operations are completed

- on the basis that the calculated peak year Scope 1 and Scope 2 GHG emissions from the Project (291,271 t CO_2-e/year) are lower than the most recent operational year (FY22) at CGO (300,704 t CO_2-e/year), the Project is not anticipated to increase annual GHG emissions relative to existing approved operations.

Relative to 2020 emission inventory totals, annual Scope 1 and Scope 2 GHG emissions generated by the Project represent approximately 0.17% of NSW total emissions and 0.044% of national total emissions on an annual average basis; and approximately 0.22% of NSW total emissions and 0.059% of national total emissions when compared to the maximum Project year.

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Glossary

Abbreviation	Definition
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AHD	Australian height datum
Approved Methods for Modelling	*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
AQGHGA	air quality and greenhouse gas assessment
AQMS	air quality monitoring station
AWS	automatic weather station
BoM	Bureau of Meteorology
CGO	Cowal Gold Operations
CH_4	methane
CO	carbon monoxide
CO_2-e	carbon dioxide equivalent
DDG	dust deposition gauge
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPE	Department of Planning and Environment
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environment Protection Authority
EPL	environment protection licence
Evolution	Evolution Mining (Cowal) Pty Limited
GHG	greenhouse gas
HCN	hydrogen cyanide
HVAS	High volume air sampler
IWL	integrated waste landform
kW	kilowatt
kWh	kilowatt hour
LPB	lake protection bund
ML	Mining Lease
Mtpa	million tonnes per annum
NEPC	National Environment Protection Council
NGAF	National Greenhouse Accounts Factors
N_2O	nitrous oxide

Abbreviation	Definition
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPI	National Pollution Inventory
NSW	New South Wales
O_3	ozone
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)	Protection of the Environment Operations (Clean Air) Regulation Clean Air Regulation 2010
Project	Open Pit Continuation Project
SEARs	Secretary's Environmental Assessment Requirements
SO_2	sulphur dioxide
SSD	State Significant Development
TAPM	The Air Pollution Model
TSF	Tailings storage facility
TSP	total suspended particulate matter
UG AQGHGA	Underground Development air quality and greenhouse gas assessment
US-EPA	United States Environmental Protection Agency
VKT	Vehicle kilometre travelled
VLAMP	Voluntary Land Acquisition and Mitigation Policy
VOCs	volatile organic compounds
WRE	waste rock emplacement

Appendix A

Meteorological modelling and processing

EMM
creating opportunities

A.1 UG AQGHGA meteorological analysis (EMM 2020)

A.1.1 Overview

A description of the prevailing meteorology for the local area is based on the CGO meteorological station, installed near the southern boundary of ML 1535. Further analysis of long-term climatic trends is made based on data from the closest Bureau of Meteorology (BoM) monitoring sites at Wyalong Post Office, located approximately 30 km south-west of the site. The location of the CGO meteorological station is shown in Figure A.1.

A.1.2 Prevailing winds

Six years of hourly data from the CGO meteorological station were reviewed and annual wind roses for the period 2013 to 2018 are presented in Figure A.2. The analysis shows consistency in wind direction, average wind speed and percentage occurrence of calm winds (less than or equal to 0.5 m/s). Winds are recorded from all directions for all years, with a slightly higher frequency of occurrence from the south-west.

The high degree of consistency in winds across all years indicates that each calendar year would be suitable for modelling. The period of January to December 2018 was selected for modelling.

The recorded wind speed and direction profile is comparable across all years with winds present from all directions. A dominant south-easterly wind is seen in all years. Average wind speeds and percentage of calms are consistent for each year with wind speeds ranging from 3.0 m/s to 3.2 m/s and calms ranging from 2.2 m/s and 3.6 m/s.

A.1.3 Ambient temperature

The inter-annual variation in temperature for Lake Cowal is presented as a box and whisker plot in Figure A.3 (individual years) and Figure A.4 (all years grouped in one plot). The plots show that the monthly median temperature (lines) and the monthly quantile ranges (5/95 and 25/75). The plots demonstrate that temperatures measured across the modelled year (2018) are consistent and therefore representative when compared with the most recent six-year period of measurements.

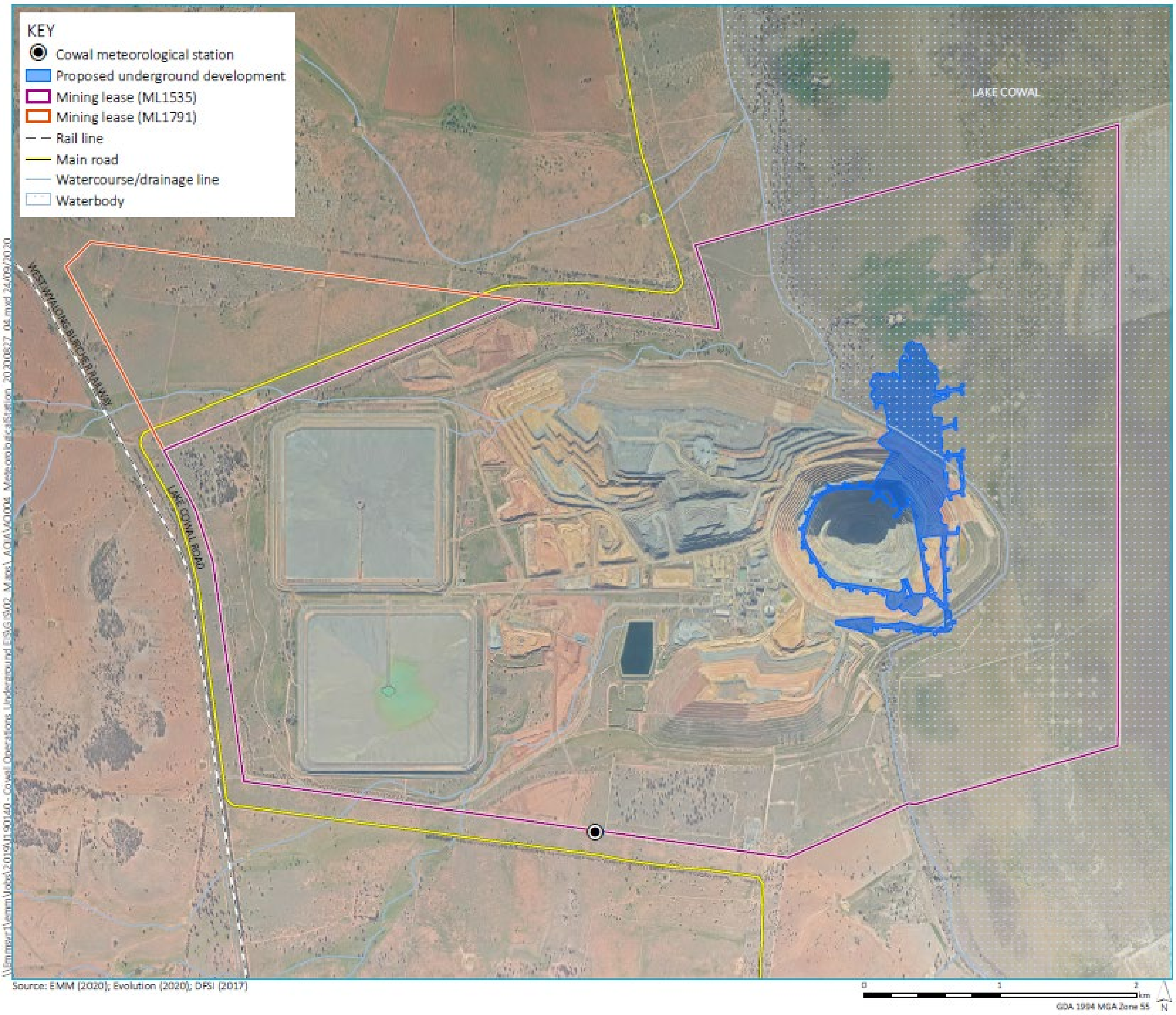


Figure A.1 CGO meteorological monitoring site

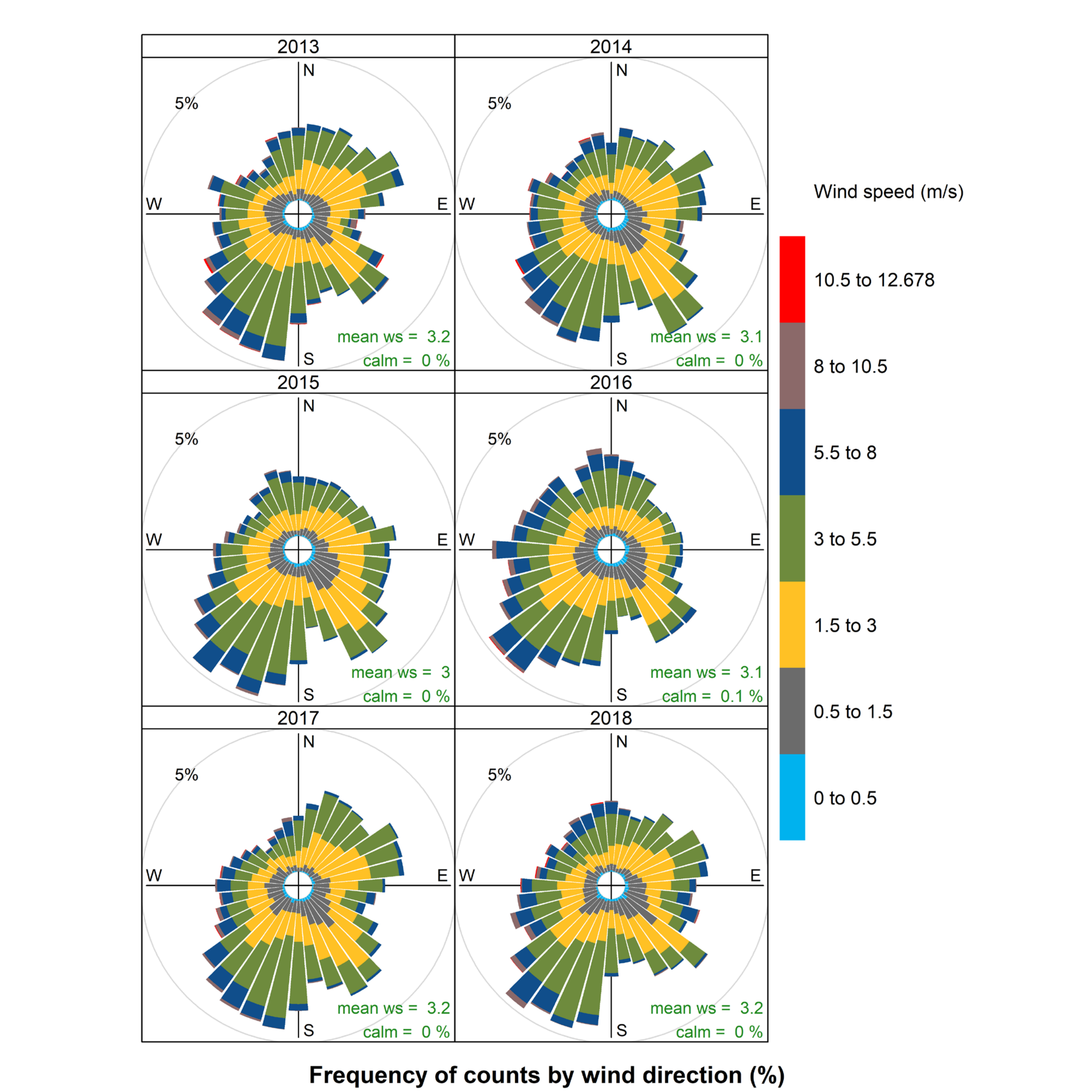


Figure A.2 Annual wind roses for CGO meteorological station – 2013-2018

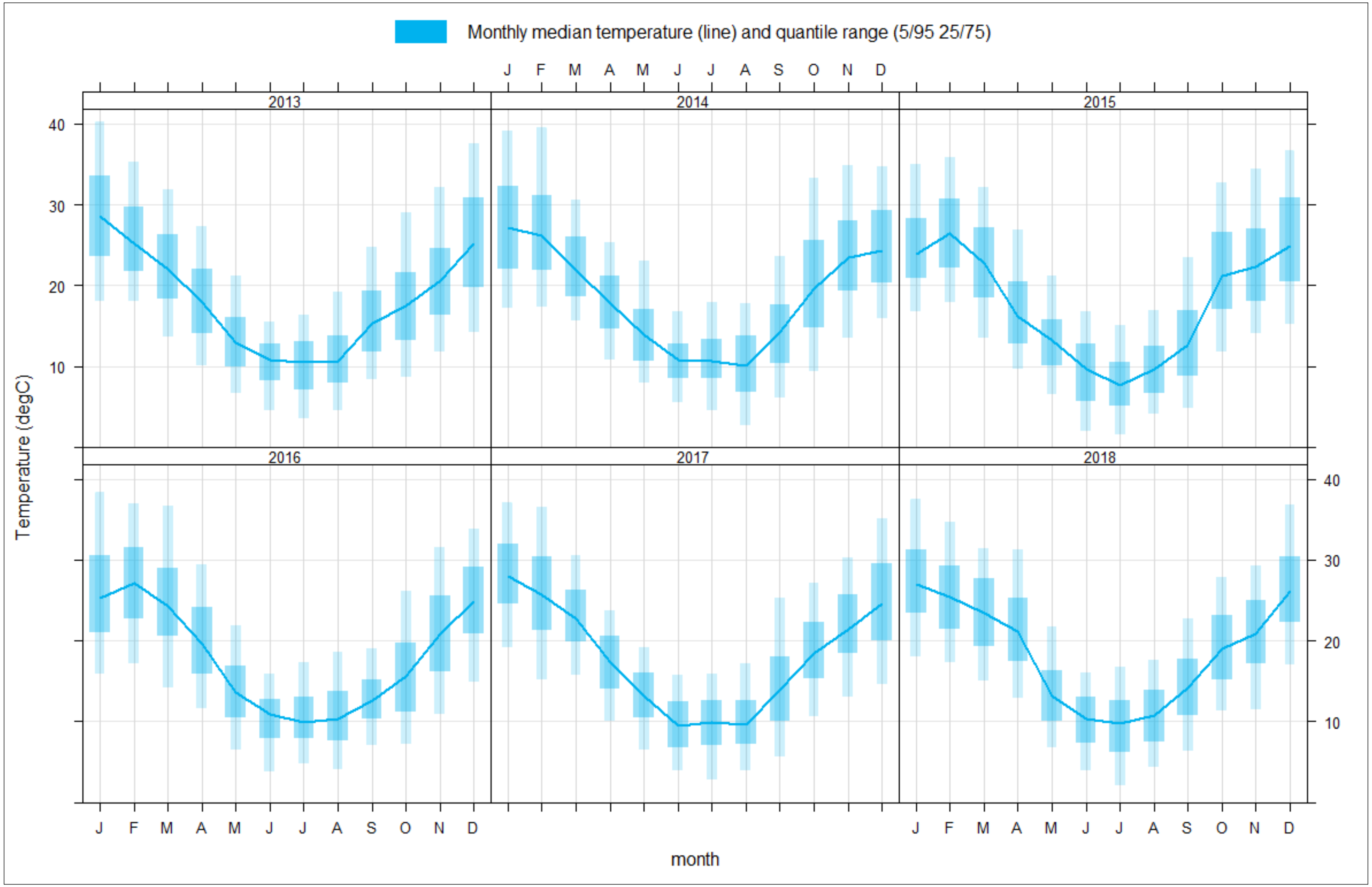


Figure A.3 Box and whisker plot of temperature for CGO meteorological station – 2013-2018

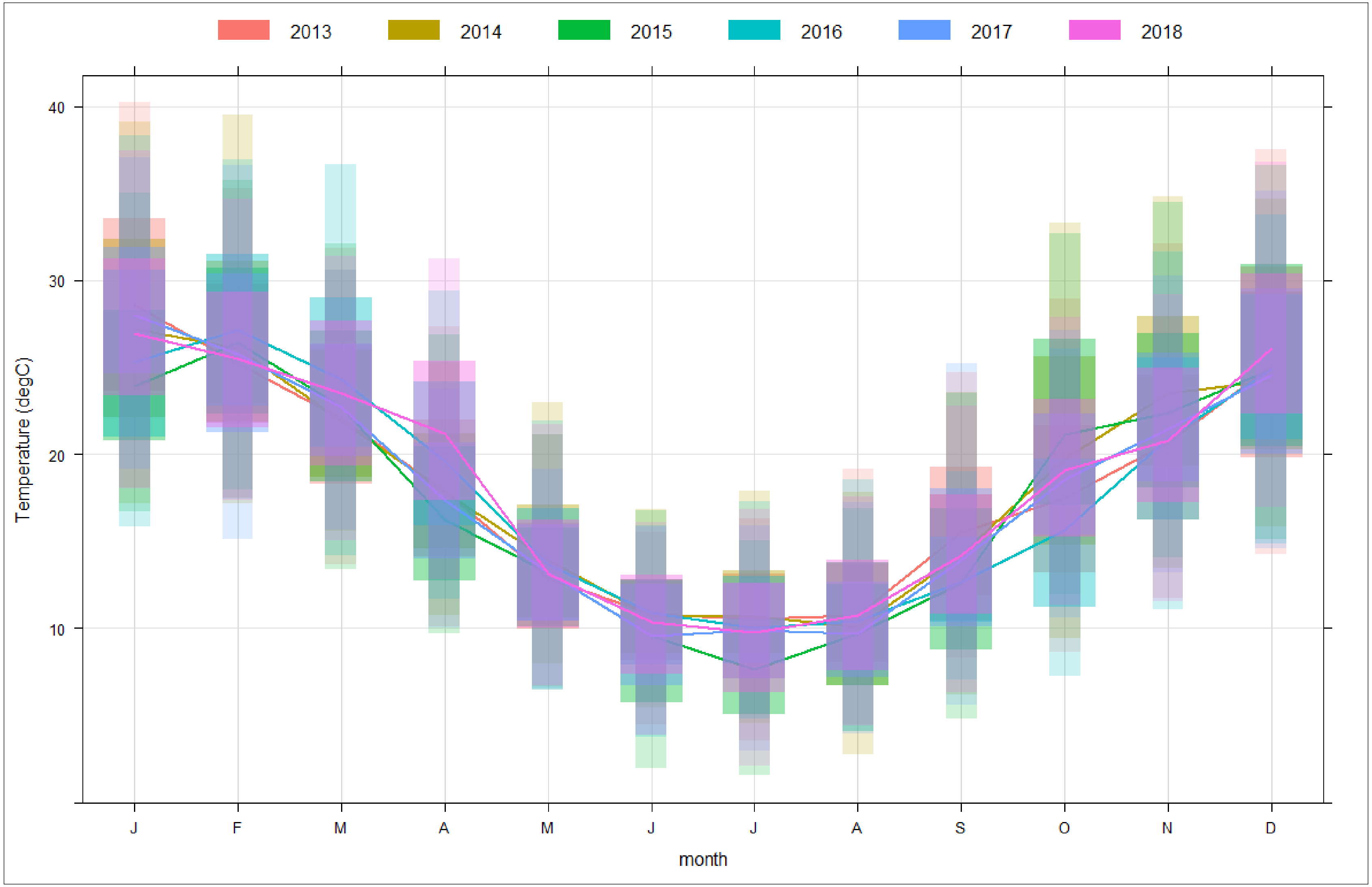


Figure A.4 Box and whisker plot of temperature for CGO meteorological station – 2013-2018 (grouped)

A.1.4 Rainfall

Figure A.5 compares the long term monthly mean rainfall at West Wyalong with the monthly rainfall for 2018 (at West Wyalong and from the CGO meteorological station).

Based on historical data recorded at West Wyalong, rainfall for the region is considered low, with a long-term annual rainfall of 479 mm. Analysis of the CGO data for the period 2013–2018 shows that the average annual rainfall over the last six years (535 mm) is similar to the long-term average for West Wyalong. The annual rainfall for the modelling period 2018 is the lowest for the past six years (246 mm). It is noted that 2018 was dominated by very dry conditions and was the driest year in NSW since 2002[10].

To provide a conservative (upper bound) estimate of the PM concentrations, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report. Furthermore, the emission inventories developed for this study have not applied a natural mitigation factor[11] for rainfall and are therefore more conservative (higher) than if rainfall was incorporated.

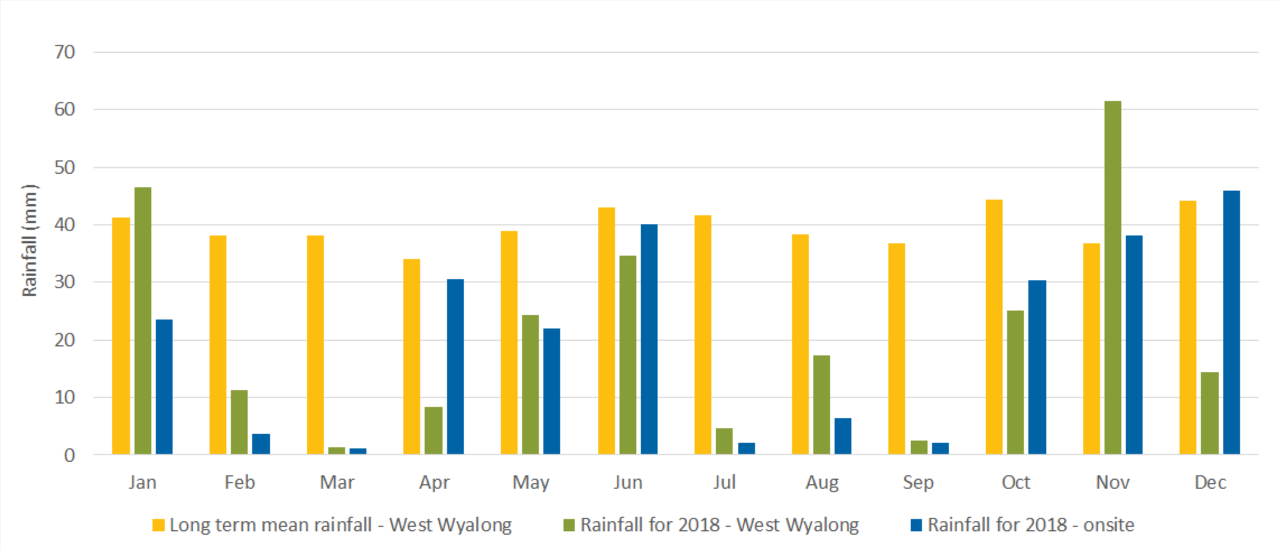


Figure A.5 Monthly rainfall for West Wyalong and the onsite station

A.1.5 Selection of a representative year

While 2018 was the most recent and complete year of monitoring data from the on-site meteorological station, in order to determine the most representative year of data for modelling an analysis of inter-annual trends was conducted. Inter-annual wind roses for 2014 to 2018 were shown in Figure A.2. Seasonal and diurnal wind roses are presented in Figure A.6 below. The diurnal distribution of wind speed (Figure A.7), wind direction (Figure A.8), temperature (Figure A.9) and relative humidity (Figure A.10) recorded between 2014 and 2018 are also analysed.

[10] http://www.bom.gov.au/climate/current/annual/nsw/summary.shtml

[11] The US EPA AP-42 emission factor documentation for unsealed roads (Chapter 13.2.2) describes a 'natural mitigation' factor, which can be applied for rainfall and other precipitation, based on the assumption that annual emissions are inversely proportional to the number of days with measurable rain, defined as the number of days with greater than 0.25 mm recorded.

The following points are noted from these figures:

- The recorded wind speed and direction profile is comparable across all years with winds present from all directions. A dominant south-easterly wind is seen in all year.
- Average wind speeds and percentage of calms are consistent for each year with wind speeds ranging from 3.0 m/s to 3.2 m/s and calms ranging from 2.2 m/s and 3.6 m/s.
- Afternoon to night-time air temperatures (midday to midnight) were typically higher during 2018 relative to the previous four years of data. This is indicative of the drought conditions experienced in 2018.
- Relative humidity was typically lowest during 2018 also considered to be a reflection of drought conditions.

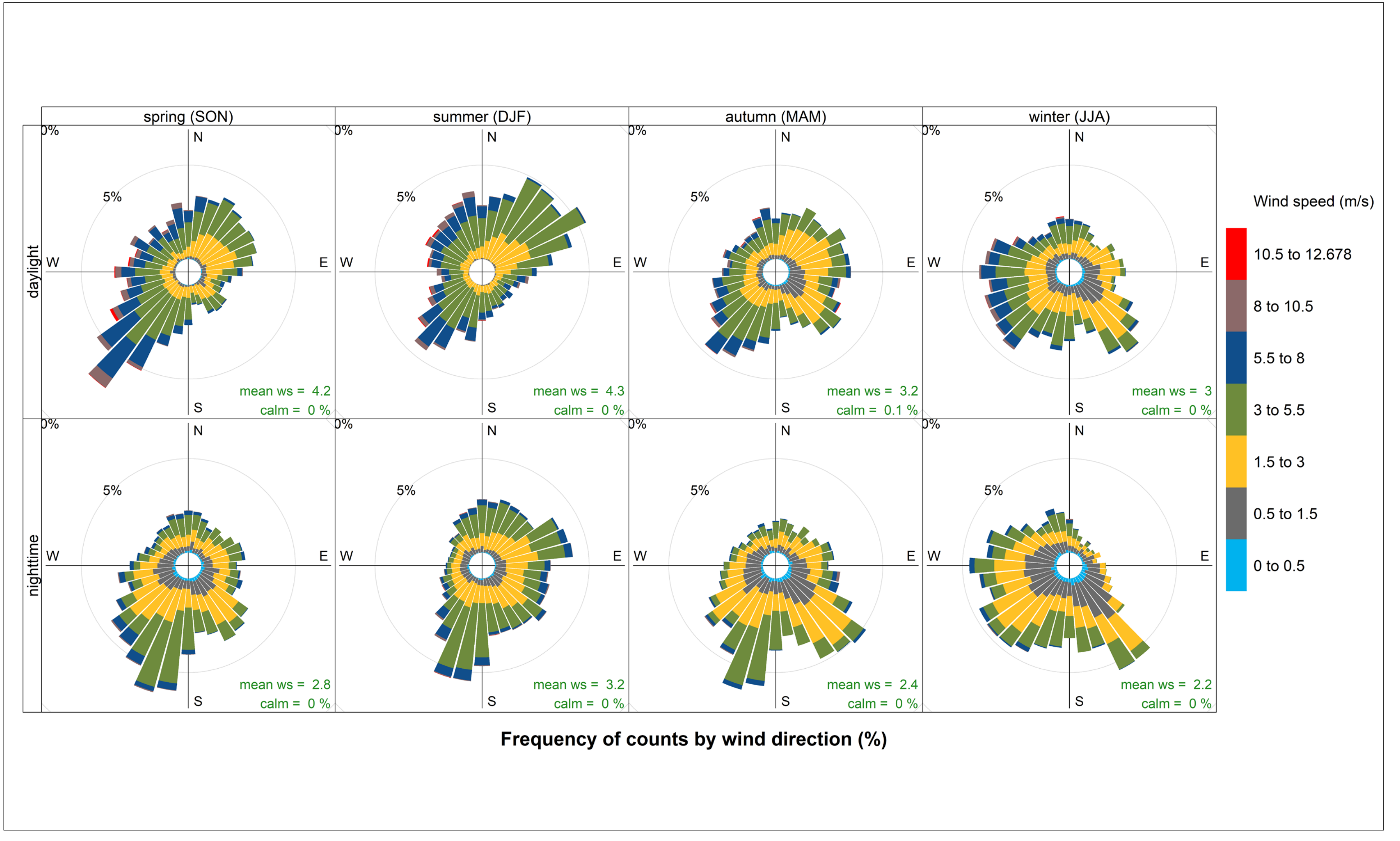


Figure A.6 Seasonal and diurnal wind roses – CGO meteorological station – 2014 to 2018

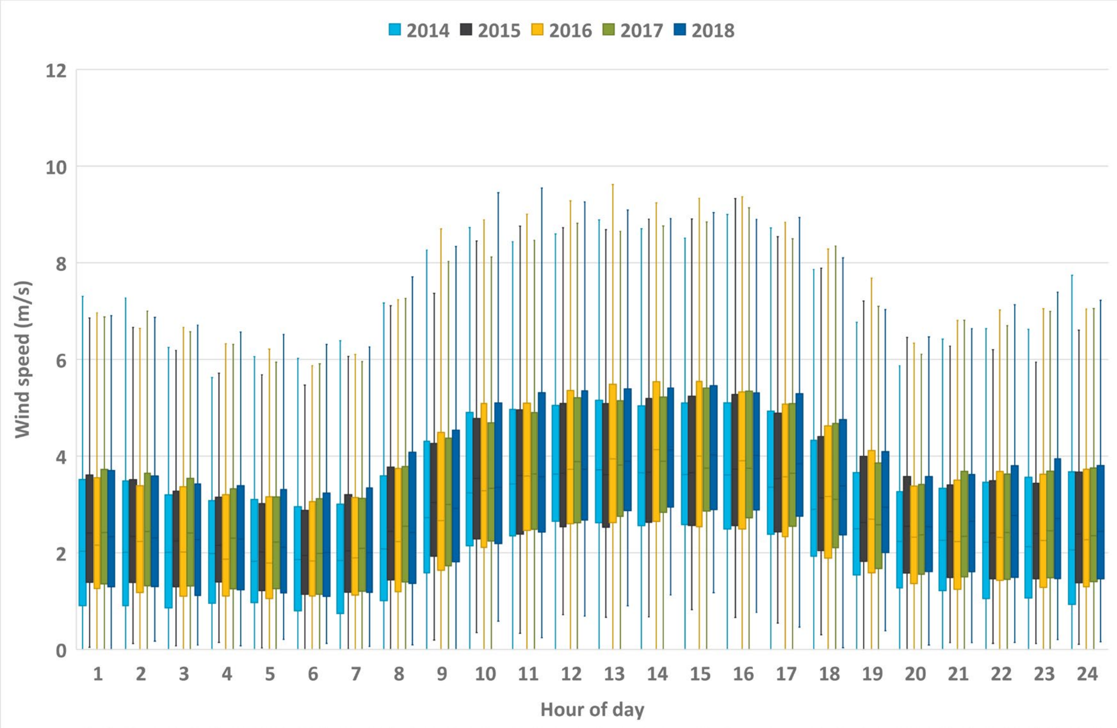


Figure A.7 Inter-annual variability in diurnal wind speed – on-site meteorological station – 2014 to 2018

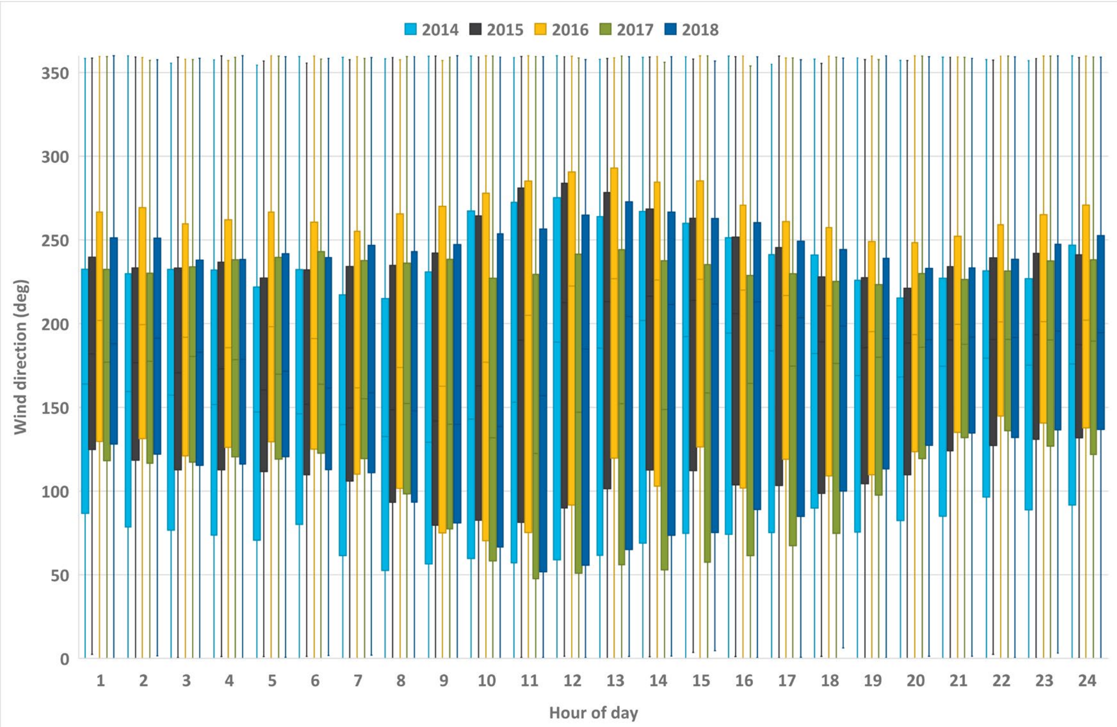


Figure A.8 Inter-annual variability in diurnal wind direction – on-site meteorological station – 2014 to 2018

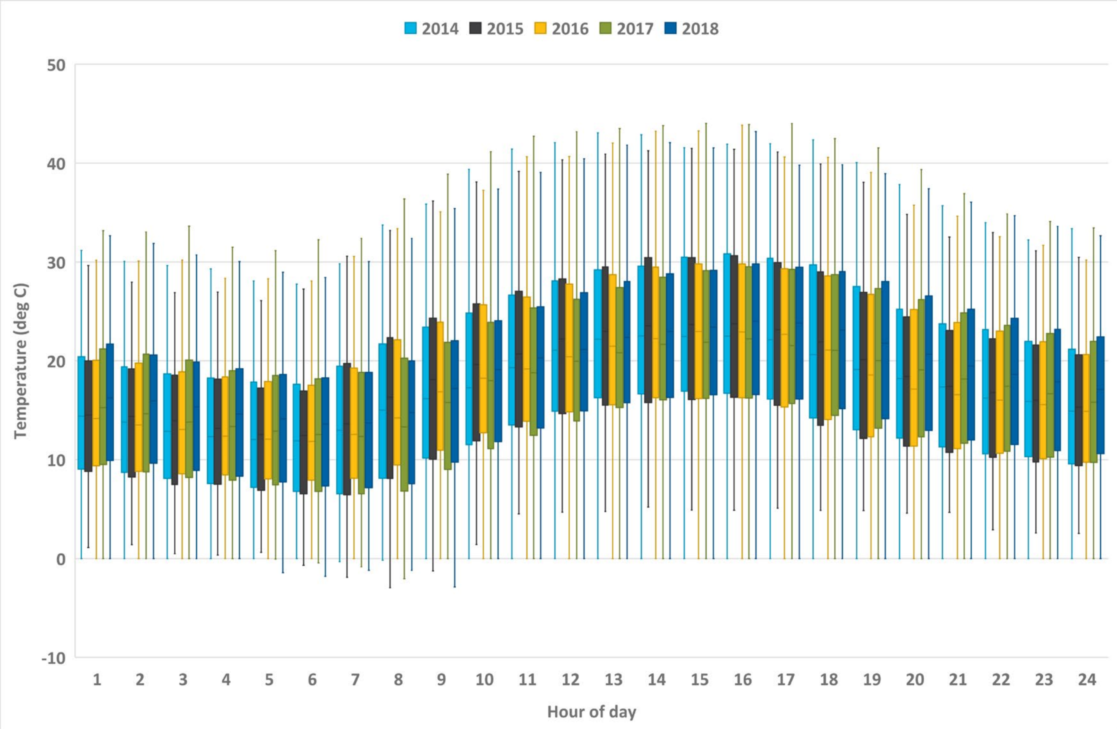


Figure A.9 **Inter-annual variability in diurnal air temperature – on-site meteorological station – 2014 to 2018**

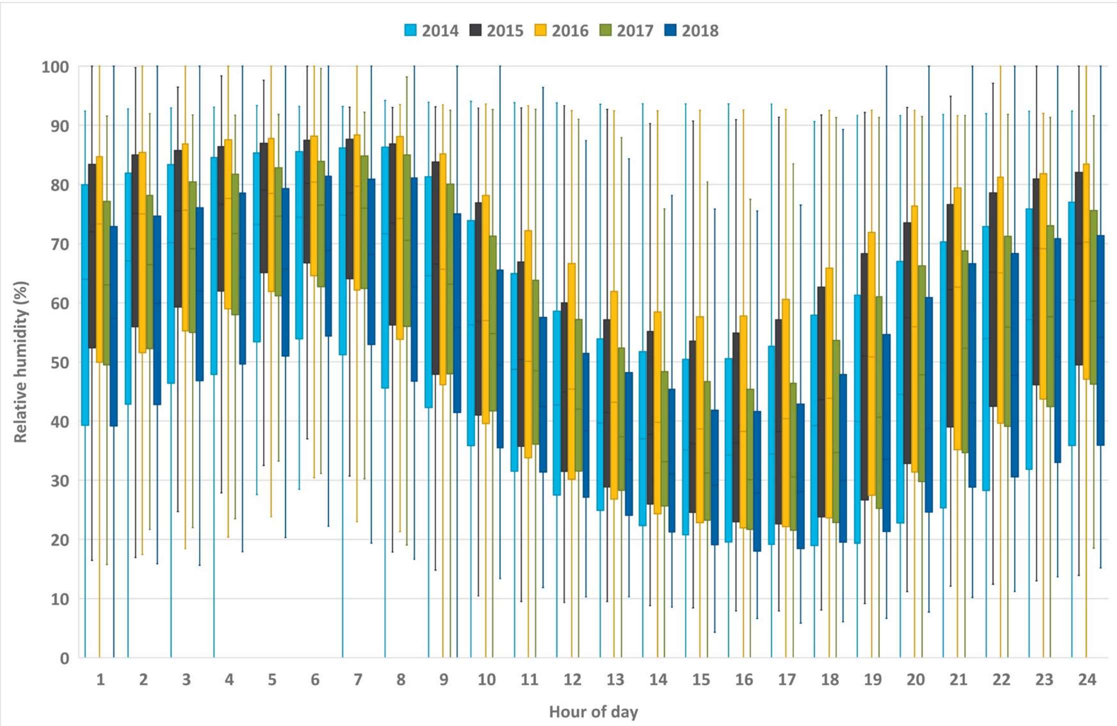


Figure A.10 **Inter-annual variability in diurnal relative humidity – on-site meteorological station – 2014 to 2018**

A.2 Meteorological modelling

Atmospheric dispersion modelling for this assessment has been completed using the AMS[12]/USEPA[13] regulatory model (AERMOD) (model version v22112). The meteorological inputs for AERMOD were generated using the AERMET meteorological processor using local surface observations and upper air profiles generated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) TAPM meteorological modelling module.

Hourly average meteorological data from the CGO meteorological station was used as observations in the TAPM and AERMET modelling.

A.3 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 mixing height and vertical wind/temperature profile.

TAPM was configured and run in accordance with the Section 4.5 of the Approved Methods for Modelling 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 and 1 km. Each grid domain features 25 x 25 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.

A.4 AERMET meteorological processing

The meteorological inputs for AERMOD were generated using the AERMET meteorological processor. The following sections provide an overview of meteorological processing completed for this assessment.

A.4.1 Surface characteristics

Prior to processing meteorological data, the surface characteristics of the area surrounding the adopted monitoring station require parameterisation. The following surface parameters are required by AERMET:

- surface roughness length
- albedo
- Bowen ratio.

[12] AMS - American Meteorological Society

[13] USEPA - United States Environmental Protection Agency

As detailed by USEPA (2013), the surface roughness length is related to the height of obstacles to the wind flow (e.g. vegetation, built environment) and is, in principle, the height at which the mean horizontal wind speed is zero based on a logarithmic profile. The surface roughness length influences the surface shear stress and is an important factor in determining the magnitude of mechanical turbulence and the stability of the boundary layer. The albedo is the fraction of total incident solar radiation reflected by the surface back to space without absorption. The daytime Bowen ratio, an indicator of surface moisture, is the ratio of sensible heat flux to latent heat flux and is used for determining planetary boundary layer parameters for convective conditions driven by the surface sensible heat flux.

The land cover of the 10 km by 10 km area surrounding the Project was mapped (see Figure A.11). Using the AERSURFACE tool and following the associated guidance of USEPA (2013), surface roughness was determined for 12 (30 degree) sectors grouped by similar land use types within a 1 km radius around the on-site meteorological station, while the Bowen ratio and albedo were determined for the total area. Monthly-varying values for surface roughness, Bowen ratio and albedo were allocated to each sector based on the values prescribed by USEPA (2013).

It is noted that Lake Cowal was assigned a land use type of 'Scrubland' (not open water) and the mine site was assigned a land use type 'Bare rock/Sand/Clay".

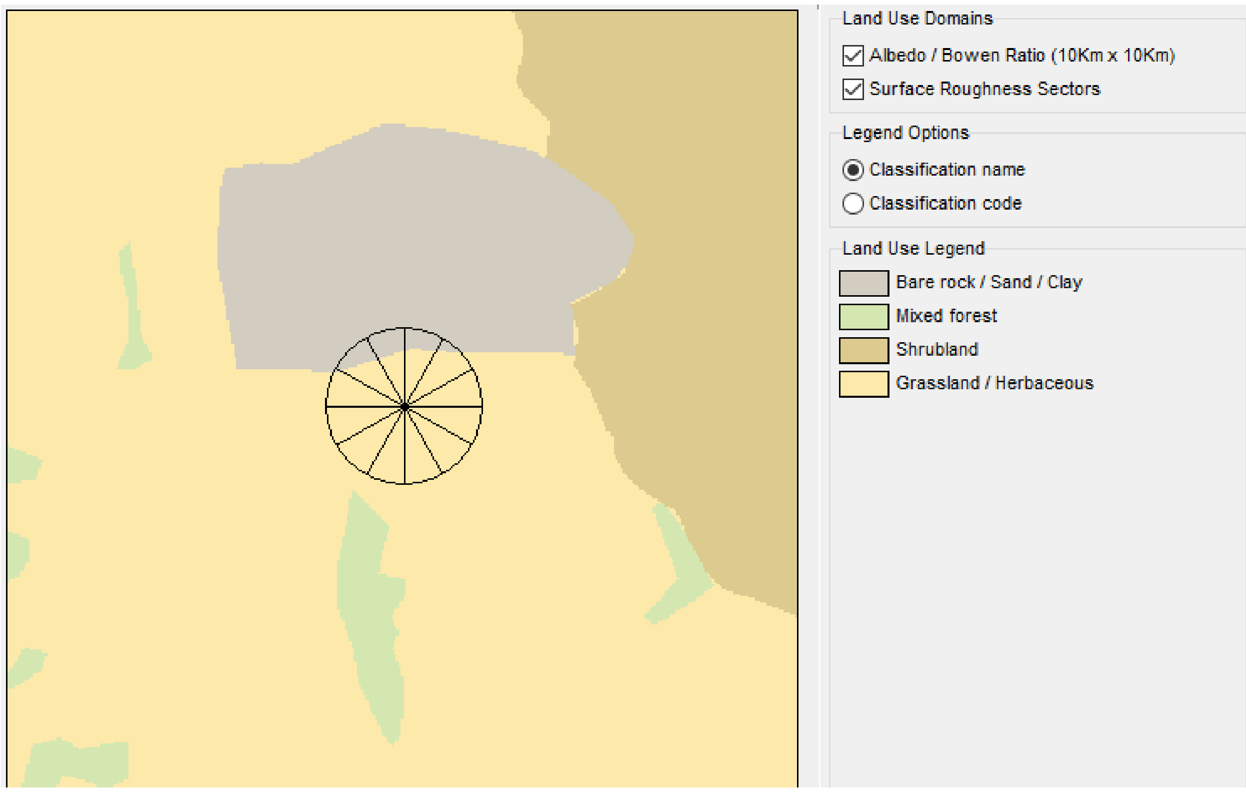


Figure A.11 Land use map for AERSURFACE processing – on-site meteorological station

Note: Marked in figure are the 1 km radius for surface roughness (12 sectors defined) and 10 km x 10 km for albedo/bowen ratio (total image shown)

A.4.2 Meteorological inputs

Monitoring data from the on-site meteorological station at CGO were combined with TAPM meteorological modelling outputs for input to AERMET. The following parameters were input as on-site data to AERMET:

- wind speed and direction – on-site
- sigma-theta (standard deviation of wind direction) - on-site
- temperature (heights of 2 m and 10 m) - on-site
- relative humidity - on-site
- station level pressure – on-site
- cloud cover – BoM Parkes Airport
- solar insolation - on-site
- mixing depth – TAPM at on-site station.

The period of meteorological data input to AERMET was 1 January 2018 to 31 December 2018.

A.4.3 Upper air profile

Due to the absence of necessary local upper air meteorological measurements, the hourly profile file generated by TAPM at the on-site meteorological station location was adopted. Using the temperature difference between levels, the TAPM-generated vertical temperature profile for each hour was adjusted relative to the hourly surface (10 m) temperature observations from the on-site station.

A.4.4 Atmospheric stability and mixing depth

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 (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10% of the mixing height). 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 A.12 illustrates the overall diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET based on observations collected at the on-site meteorological station in 2018. 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. This profile indicates that the potential for effective atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

Mixing depth refers to the height of the atmosphere above ground level within which the dispersion of air pollution can be dispersed. The mixing depth 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 depths and greater potential for the atmospheric dispersion of pollutants.

Hourly-varying atmospheric boundary layer depths were generated by AERMET, the meteorological processor for the AERMOD dispersion model. The variation in AERMET-calculated boundary layer depth by hour of the day is illustrated in Figure A.13. Greater boundary layer depths occur during the daytime hours, peaking in the mid to late afternoon.

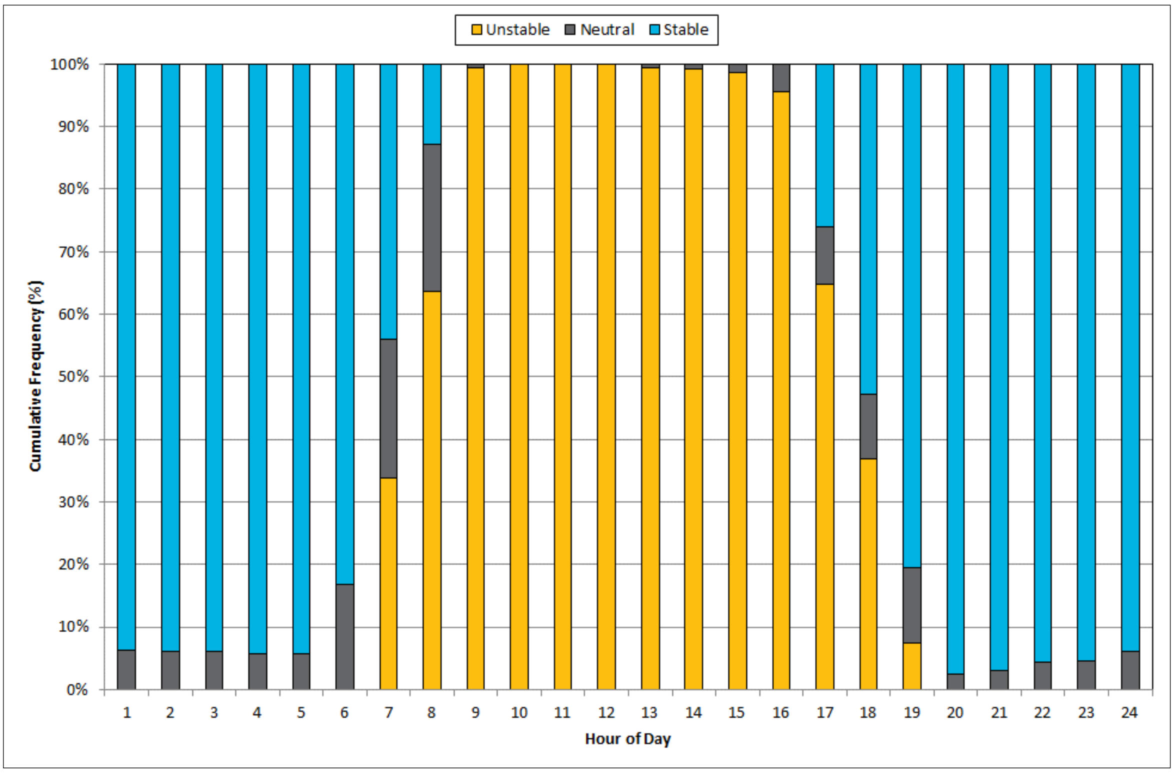


Figure A.12 Diurnal variations in AERMET-generated atmospheric stability

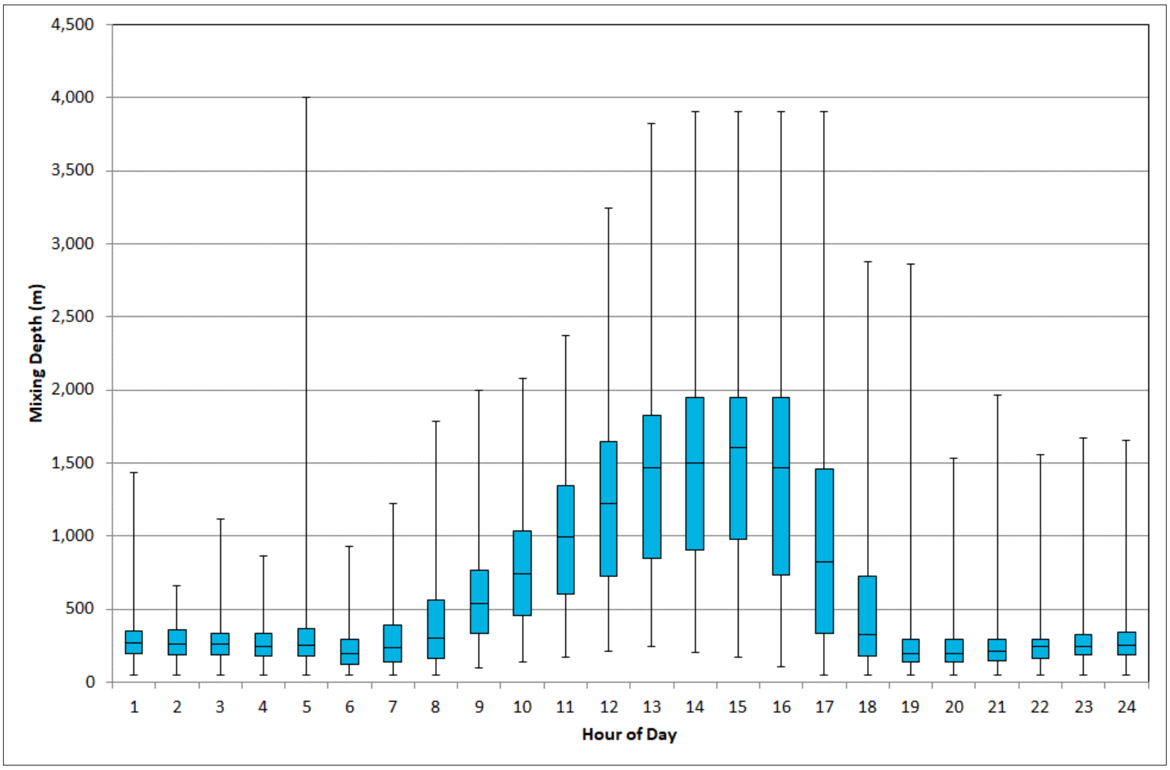


Figure A.13 Diurnal variation in AERMET generated mixing heights

Appendix B
Emissions inventory

creating opportunities

B.1 Fugitive dust emissions

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

- US-EPA AP-42 Chapter 11.9 – Western surface coal mining (US-EPA 1998)
- US-EPA AP-42 Chapter 11.24 – Metallic minerals processing (US-EPA 1982)
- US-EPA AP-42 Chapter 13.2.4 – Aggregate handling and storage piles (US-EPA 2006a)
- US-EPA AP-42 Chapter 13.2.4 – Industrial wind erosion (US-EPA 2006b).

B.2 Sources of particulate matter emissions

Sources of atmospheric emissions at the CGO accounted for in the selected four future scenarios representative of the Project include the following:

- clearing, loading and transportation of topsoil material
- drill and blasting activities in various open cut pits
- loading of blasted waste rock and ore material to haul trucks in various open cut pits
- transport of waste rock to WREs and infrastructure construction areas (i.e. LPB and IWL)
- WRE management by dozers
- transport of ore material from pits to the ROM piles and primary hopper area
- processing plant, featuring material crushing, screening and grinding circuit and associated conveyor belt transfers points
- wind erosion associated with WREs, dried IWL surfaces, ore material stockpiles and other exposed surfaces
- diesel fuel combustion by on-site plant and equipment.

B.3 Project-related input data used for particulate matter emission estimates

The material property inputs used in the emission estimates are summarised in Table B.1.

Table B.1 Material property inputs for emission estimation

Material properties	Value	Source of information
Unpaved road silt content (%)	5	PEL 2018
Waste moisture (%)	2	PEL 2018
Ore moisture (%)	2	PEL 2018

B.4 Emissions inventory activity data

The activity data by emissions source and scenario adopted in the emissions inventory is presented in Table B.2.

Table B.2 Emissions inventory activity data

Source	Year 1	Year 4	Year 6	Year 9	Units
E41 – topsoil removal/emplacement	0.00	435,706.64	357,291.80	0.00	t/y
E42 – topsoil removal/emplacement	1,979,649.02	518,248.38	303,299.48	0.00	t/y
E46 – topsoil removal/emplacement	174,967.04	403,688.69	18,430.89	0.00	t/y
GR – topsoil removal/emplacement	0.00	0.00	0.00	0.00	t/y
E41 – drilling	0	17793	31160	13211	Holes/year
E42 – drilling	23327	21164	26451	22384	Holes/year
E46 – drilling	2062	16486	1607	0	Holes/year
GR – drilling	0	0	0	18198	Holes/year
E41 – blasting	0	89	156	66	Blasts/year
E42 – blasting	117	106	132	112	Blasts/year
E46 – blasting	10	82	8	0	Blasts/year
GR – blasting	0	0	0	91	Blasts/year
E41 – excavator in pit on ore/waste	0.00	11,958,166.89	17,263,370.54	8,199,505.34	t/y
E42 – excavator in pit on ore/waste	21,330,237.15	14,223,562.52	14,654,607.97	13,893,113.74	t/y
E46 – excavator in pit on ore/waste	1,885,227.36	11,079,419.75	890,530.58	0.00	t/y
GR – excavator in pit on ore/waste	0.00	0.00	0.00	11,294,810.06	t/y
E41 – dozer in pit operations	0	6678	11447	5947	hr/year
E42 – dozer in pit operations	20593	7943	9717	10077	hr/year
E46 – dozer in pit operations	1820	6187	591	0	hr/year
GR – dozer in pit operations	0	0	0	8192	hr/year
North WRE – waste unloading	2,060,194.40	12,582,989.47	2,989,982.15	16,506,377.12	t/y

Table B.2 Emissions inventory activity data

Source	Year 1	Year 4	Year 6	Year 9	Units
Central WRE – waste unloading	376,708.86	0.00	0.00	0.00	t/y
South WRE – waste unloading	8,471,470.61	9,547,542.65	12,306,632.50	4,455,448.16	t/y
IWL – waste unloading	690,947.37	11,201,743.13	11,343,118.25	0.00	t/y
LBP – waste unloading	6,017,244.81	0.00	0.00	0.00	t/y
North WRE – dozer operations	1989	7026	1983	11972	hr/year
Central WRE – dozer operations	364	0	0	0	hr/year
South WRE – dozer operations	8179	5331	8161	3232	hr/year
IWL – dozer operations	667	6255	7522	0	hr/year
LBP – dozer operations	5809	0	0	0	hr/year
E41 – waste/ore haulage in pit	0.00	176,087.82	481,438.86	143,379.33	VKT/year
E42 – waste/ore haulage in pit	1,401,140.70	386,670.45	441,380.88	622,532.97	VKT/year
E46 – waste/ore haulage in pit	0.00	175,697.83	16,887.81	0.00	VKT/year
GR – waste/ore haulage in pit	0.00	0.00	0.00	135,784.60	VKT/year
E41 – waste to southern WRE	0.00	239,992.88	134,498.72	87,648.16	VKT/year
E41 – ore haulage pit to mill/ROM pile	0.00	34,218.19	58,076.83	57,286.12	VKT/year
E41 – ore haulage pile to mill	0.00	1,566.66	13,596.21	5,847.37	VKT/year
E42 – waste haulage to central dump	5,763.85	0.00	0.00	0.00	VKT/year
E42 – waste haulage to northern WRE	0.00	35,728.75	63,427.22	168,353.55	VKT/year
E42 – waste haulage to southern WRE	398,112.83	0.00	0.00	0.00	VKT/year
E42 – waste haulage to IWL	52,859.36	501,936.03	694,223.63	0.00	VKT/year
E42 – waste haulage to LPB	295,930.07	0.00	0.00	0.00	VKT/year
E42 – ore haulage pit to mill/ROM pile	30,134.05	2,099.90	11,844.79	60,500.83	VKT/year

Table B.2 Emissions inventory activity data

Source	Year 1	Year 4	Year 6	Year 9	Units
E42 – ore haulage pile to mill	7,648.78	65,962.76	7,129.31	21,089.03	VKT/year
E46 – waste to northern WRE	47,283.15	61,074.15	6,630.45	0.00	VKT/year
E46 – ore haulage pit to mill/ROM pile	0.00	23,064.11	5,197.59	0.00	VKT/year
E46 – ore haulage pile to mill	0.00	4,979.70	9,362.88	0.00	VKT/year
GR – waste to northern WRE	0.00	0.00	0.00	160,800.55	VKT/year
GR – ore haulage pit to mill/ROM pile	0.00	0.00	0.00	13,895.71	VKT/year
GR – ore haulage pile to mill	0.00	0.00	0.00	2,708.65	VKT/year
E41 – ore pile loading to trucks	0.00	238,915.15	2,073,422.11	891,724.13	tpa
E42 – ore pile loading to trucks	2,332,877.93	4,311,137.42	652,331.47	1,929,646.17	tpa
E46 – ore pile loading to trucks	0.00	759,404.82	1,427,838.45	1,427,838.45	tpa
GR – ore pile loading to trucks	0.00	0.00	0.00	413,069.03	tpa
Unloading ore to mill	7,931,519.67	8,932,360.14	8,906,677.07	8,906,678.87	tpa
Mill – primary crusher	7,931,519.67	8,932,360.14	8,906,677.07	8,906,678.87	tpa
Mill – loading to crushed ore stockpile	7,931,519.67	8,932,360.14	8,906,677.07	8,906,678.87	tpa
Mill – recycle crusher	793,151.97	893,236.01	890,667.71	890,667.89	tpa
Mill – loading to recycle stockpile	793,151.97	893,236.01	890,667.71	890,667.89	tpa
Graders on roads	131,400.00	197,100.00	197,100.00	131,400.00	VKT/year
Wind erosion – plant stockpiles and exposed areas	853.90	1,029.47	1,149.77	1,210.85	ha
Wind erosion – tailings storage dams	61.61	61.61	131.59	131.59	ha

B.5 Haulage calculations

The material haulage assumptions applied in the emissions inventory is presented in Table B.3.

Table B.3 Material haulage assumptions

Source	Year 1	Year 4	Year 6	Year 9	Units
Haul distance					
E41 – waste/ore haulage in pit	0	1.3	2.5	1.6	km
E42 – waste/ore haulage in pit	5.5	2.4	2.7	4.1	km
E46 – waste/ore haulage in pit	0	1.4	1.7	0	km
GR – waste/ore haulage in pit	0	0	0	1.1	km
E41 – waste to southern WRE	0	2.3	1	1.8	km
E41 – ore haulage pit to mill/ROM pile	0	1.1	1	1.4	km
E41 – ore haulage pile to mill	0	0.6	0.6	0.6	km
E42 – waste to central WRE	1.4	0	0	0	km
E42 – waste to northern WRE	0	1	2.3	2.3	km
E42 – waste to southern WRE	4.3	0	0	0	km
E42 – waste to IWL	7	4.1	5.6	0	km
E42 – waste to LPB	4.5	0	0	0	km
E42 – ore haulage pit to mill/ROM pile	0.7	0.8	1.4	1.4	km
E42 – ore haulage pile to mill	0.3	1.4	1	1	km
E46 – waste to northern WRE	2.1	0.6	1.3	0	km
E46 – ore haulage pit to mill/ROM pile	0	1.6	1.7	0	km
E46 – ore haulage pile to mill	0	0.6	0.6	0	km
GR – waste to northern WRE	0	0	0	1.5	km
GR – ore haulage pit to mill/ROM pile	0	0	0	1.9	km
GR – ore haulage pile to mill	0	0	0	0.6	km

Table B.3 Material haulage assumptions

Source	Year 1	Year 4	Year 6	Year 9	Units
Material per year					
E41 – waste/ore haulage in pit	0.00	12,393,873.54	17,620,662.34	8,199,505.34	tpa
E42 – waste/ore haulage in pit	23,309,886.17	14,741,810.91	14,957,907.45	13,893,113.74	tpa
E46 – waste/ore haulage in pit	2,060,194.40	11,483,108.45	908,961.47	0.00	tpa
GR – waste/ore haulage in pit	0.00	0.00	0.00	11,294,810.06	tpa
E41 – waste to southern WRE	0.00	9,547,542.65	12,306,632.50	4,455,448.16	tpa
E41 – ore haulage pit to mill/ROM pile	0.00	2,846,330.89	5,314,029.84	3,744,057.17	tpa
E41 – ore haulage pile to mill	0.00	238,915.15	2,073,422.11	891,724.13	tpa
E42 – waste to central WRE	376,708.86	0.00	0.00	0.00	tpa
E42 – waste to northern WRE	0.00	3,269,180.87	2,523,300.15	6,697,543.50	tpa
E42 – waste to southern WRE	8,471,470.61	0.00	0.00	0.00	tpa
E42 – waste to IWL	690,947.37	11,201,743.13	11,343,118.25	0.00	tpa
E42 – waste to LPB	6,017,244.81	0.00	0.00	0.00	tpa
E42 – ore haulage pit to mill/ROM pile	3,938,950.64	240,176.36	774,141.50	3,954,161.33	tpa
E42 – ore haulage pile to mill	2,332,877.93	4,311,137.42	652,331.47	1,929,646.17	tpa
E46 – waste to northern WRE	2,060,194.40	9,313,808.60	466,682.01	0.00	tpa
E46 – ore haulage pit to mill/ROM pile	0.00	1,318,978.64	279,752.81	0.00	tpa
E46 – ore haulage pile to mill	0.00	759,404.82	1,427,838.45	1,427,838.45	tpa
GR – waste to northern WRE	0.00	0.00	0.00	9,808,833.62	tpa
GR – ore haulage pit to mill/ROM pile	0.00	0.00	0.00	669,187.90	tpa
GR – ore haulage pile to mill	0.00	0.00	0.00	413,069.03	tpa

Table B.3 Material haulage assumptions

Source	Year 1	Year 4	Year 6	Year 9	Units
Trips per year					
E41 – waste/ore haulage in pit	0.00	67,726.08	96,287.77	44,806.04	trips per year
E42 – waste/ore haulage in pit	127,376.43	80,556.34	81,737.20	75,918.65	trips per year
E46 – waste/ore haulage in pit	11,257.89	62,749.23	4,967.00	0.00	trips per year
GR – waste/ore haulage in pit	0.00	0.00	0.00	61,720.27	trips per year
E41 – waste to southern WRE	0.00	52,172.36	67,249.36	24,346.71	trips per year
E41 – ore haulage pit to mill/ROM pile	0.00	15,553.72	29,038.41	20,459.33	trips per year
E41 – ore haulage pile to mill	0.00	1,305.55	11,330.18	4,872.81	trips per year
E42 – waste to central WRE	2,058.52	0.00	0.00	0.00	trips per year
E42 – waste to northern WRE	0.00	17,864.38	13,788.53	36,598.60	trips per year
E42 – waste to southern WRE	46,292.19	0.00	0.00	0.00	trips per year
E42 – waste to IWL	3,775.67	61,211.71	61,984.25	0.00	trips per year
E42 – waste to LPB	32,881.12	0.00	0.00	0.00	trips per year
E42 – ore haulage pit to mill/ROM pile	21,524.32	1,312.44	4,230.28	21,607.44	trips per year
E42 – ore haulage pile to mill	12,747.97	23,558.13	3,564.65	10,544.51	trips per year
E46 – waste to northern WRE	11,257.89	50,895.13	2,550.17	0.00	trips per year
E46 – ore haulage pit to mill/ROM pile	0.00	7,207.53	1,528.70	0.00	trips per year
E46 – ore haulage pile to mill	0.00	4,149.75	7,802.40	7,802.40	trips per year
GR – waste to northern WRE	0.00	0.00	0.00	53,600.18	trips per year
GR – ore haulage pit to mill/ROM pile	0.00	0.00	0.00	3,656.76	trips per year
GR – ore haulage pile to mill	0.00	0.00	0.00	2,257.21	trips per year

B.6 Emissions inventory tables

Emissions inventories of TSP, PM_{10} and $PM_{2.5}$ developed for each of the four emission scenarios is presented in Table B.4, Table B.5, Table B.6 and Table B.7 for Year 1, Year 4, Year 6 and Year 9 respectively.

Table B.4 Year 1 emissions inventory

Source name	Source Type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Parameter 5	Unit	Reduction factor	Emission control	Emission factor source
E41 - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E42 - topsoil removal/emplacement	Material handling	57,409.82	14,451.44	7,730.58	1,979,649	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E46 - topsoil removal/emplacement	Material handling	5,074.04	1,277.26	683.25	174,967	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
GR - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E41 - drilling	Drill and blast	0.00	0.00	0.00	0	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E42 - drilling	Drill and blast	5,092.28	2,647.99	264.80	23,327	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E46 - drilling	Drill and blast	450.13	234.07	23.41	2,062	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
GR - drilling	Drill and blast	0.00	0.00	0.00	0	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E41 - blasting	Drill and blast	0.00	0.00	0.00	0	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E42 - blasting	Drill and blast	8,293.83	4,312.79	248.82	117	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E46 - blasting	Drill and blast	708.87	368.61	21.27	10	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
GR - blasting	Drill and blast	0.00	0.00	0.00	0	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E41 - excavator in pit on ore/waste	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - excavator in pit on ore/waste	Material handling	43,732.90	20,684.48	3,132.22	21,330,237	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - excavator in pit on ore/waste	Material handling	3,865.24	1,828.15	276.83	1,885,227	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - excavator in pit on ore/waste	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E41 - dozer in pit operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E42 - dozer in pit operations	Dozer operations	150,009.23	29,444.65	15,750.97	20,593	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E46 - dozer in pit operations	Dozer operations	13,257.75	2,602.30	1,392.06	1,820	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
GR - dozer in pit operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
North WRE - waste unloading	Material handling	4,223.97	1,997.82	302.53	2,060,194	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Central WRE - waste unloading	Material handling	772.36	365.30	55.32	376,709	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
South WRE - waste unloading	Material handling	17,368.86	8,215.00	1,243.99	8,471,471	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
IWL - waste unloading	Material handling	1,416.63	670.03	101.46	690,947	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
LBP - waste unloading	Material handling	12,337.02	5,835.08	883.60	6,017,245	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
North WRE - dozer operations	Dozer operations	7,244.41	1,421.97	760.66	1,989	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Central WRE - dozer operations	Dozer operations	1,325.77	260.23	139.21	364	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
South WRE - dozer operations	Dozer operations	29,789.87	5,847.32	3,127.94	8,179	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
IWL - dozer operations	Dozer operations	2,429.37	476.85	255.08	667	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
LBP - dozer operations	Dozer operations	21,157.76	4,152.96	2,221.57	5,809	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
E41 - waste/ore haulage in pit	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste/ore haulage in pit	Unpaved haulage	860,630.65	221,141.24	22,114.12	1,401,141	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	5.5	Return haul distance (km)	127,376	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste/ore haulage in pit	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	11,258	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste/ore haulage in pit	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - waste to southern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pit to mill/ROM pile	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pile to mill	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to central WRE	Unpaved haulage	3,540.36	909.71	90.97	5,764	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.4	Return haul distance (km)	2,059	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to northern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to southern WRE	Unpaved haulage	244,535.11	62,833.92	6,283.39	398,113	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	4.3	Return haul distance (km)	46,292	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to IWL	Unpaved haulage	32,468.11	8,342.76	834.28	52,859	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	7.0	Return haul distance (km)	3,776	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to LPB	Unpaved haulage	181,770.82	46,706.48	4,670.65	295,930	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	4.5	Return haul distance (km)	32,881	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pit to mill/ROM pile	Unpaved haulage	18,509.41	4,756.04	475.60	30,134	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.7	Return haul distance (km)	21,524	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pile to mill	Unpaved haulage	4,698.15	1,207.20	120.72	7,649	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.3	Return haul distance (km)	12,748	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste to northern WRE	Unpaved haulage	29,043.00	7,462.67	746.27	47,283	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.1	Return haul distance (km)	11,258	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pit to mill/ROM pile	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pile to mill	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste to northern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pit to mill/ROM pile	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pile to mill	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore pile loading to trucks	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - ore pile loading to trucks	Material handling	4,783.05	2,262.25	342.57	2,332,676	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - ore pile loading to trucks	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - ore pile loading to trucks	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Unloading ore to mill	Material handling	8,130.91	3,845.70	582.35	7,931,520	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Mill - primary crusher	Processing	237,945.59	23,794.56	4,406.40	7,931,520	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to crushed ore stockpile	Material handling	8,130.91	3,845.70	582.35	7,931,520	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Mill - recycle crusher	Processing	23,794.56	2,379.46	440.64	793,152	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to recycle stockpile	Material handling	813.09	384.57	58.23	793,152	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Graders on roads	Unpaved haulage	70,638.96	22,338.00	2,189.81	131,400	km/year	1.0752	0.3400	0.0333	kg/VKT	10	travel speed (km/hr)									0.5	Watering	USEPA AP-42 11.9.2 - Grading
Wind erosion - plant stockpiles and exposed areas	Wind erosion	725,814.76	362,907.38	54,436.11	854	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - tailings storage dams	Wind erosion	52,364.25	26,182.13	3,927.32	62	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Diesel combustion - haulage	Diesel combustion	48,728.65	48,728.65	44,667.93	13,535,737	l/year	0.0036	0.0036	0.0033	kg/L													NPI EET for Combustion engines v3, June 2008
Additional blasting for UG development	Underground operations	1,430.00	743.60	42.90	52	Blasts/year	27.5000	14.3000	0.8250	kg/blast	2500.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
Removal of material (underground)	Underground operations	25,524.81	5,010.15	2,680.10	7,008	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Waste and ore - hauling (underground)	Underground operations	71,180.12	18,289.91	1,828.99	76,374	VKT/year	3.3285	0.8553	0.0855	kg/VKT	5.0	Road silt content (%)	2.0	Return haul distance (km)	38,187	Loads/year	75	Average weight (t)	63	Load in truck (t)	0.72	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads

Table B.5 Year 4 emissions inventory

Source name	Source Type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Parameter 5	Unit	Reduction factor	Emission control	Emission factor source
E41 - topsoil removal/emplacement	Material handling	12,635.49	3,180.66	1,701.44	435,707	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E42 - topsoil removal/emplacement	Material handling	15,029.20	3,783.21	2,023.77	518,248	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E46 - topsoil removal/emplacement	Material handling	11,706.97	2,946.93	1,576.41	403,689	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
GR - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E41 - drilling	Drill and blast	3,884.21	2,019.79	201.98	17,793	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E42 - drilling	Drill and blast	4,620.10	2,402.45	240.25	21,164	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E46 - drilling	Drill and blast	3,598.89	1,871.42	187.14	16,486	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
GR - drilling	Drill and blast	0.00	0.00	0.00	0	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E41 - blasting	Drill and blast	6,308.98	3,280.67	189.27	89	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E42 - blasting	Drill and blast	7,514.07	3,907.32	225.42	106	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E46 - blasting	Drill and blast	5,812.77	3,022.64	174.38	82	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
GR - blasting	Drill and blast	0.00	0.00	0.00	0	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E41 - excavator in pit on ore/waste	Material handling	24,517.56	11,596.14	1,755.99	11,958,167	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - excavator in pit on ore/waste	Material handling	29,162.25	13,792.96	2,088.65	14,223,563	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - excavator in pit on ore/waste	Material handling	22,715.88	10,744.00	1,626.95	11,079,420	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - excavator in pit on ore/waste	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E41 - dozer in pit operations	Dozer operations	48,645.74	9,548.46	5,107.80	6,678	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E42 - dozer in pit operations	Dozer operations	57,860.60	11,357.20	6,075.36	7,943	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E46 - dozer in pit operations	Dozer operations	45,069.06	8,846.41	4,732.25	6,187	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
GR - dozer in pit operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
North WRE - waste unloading	Material handling	25,798.62	12,202.05	1,847.74	12,582,989	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Central WRE - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
South WRE - waste unloading	Material handling	19,575.11	9,258.50	1,402.00	9,547,543	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
IWL - waste unloading	Material handling	22,966.68	10,862.62	1,644.91	11,201,743	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
LBP - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
North WRE - dozer operations	Dozer operations	25,590.37	5,023.02	2,686.99	7,026	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Central WRE - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
South WRE - dozer operations	Dozer operations	19,416.77	3,811.23	2,038.76	5,331	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
IWL - dozer operations	Dozer operations	22,782.20	4,471.82	2,392.13	6,255	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
LBP - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
E41 - waste/ore haulage in pit	Unpaved haulage	108,159.43	27,791.84	2,779.18	176,088	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.3	Return haul distance (km)	67,726	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste/ore haulage in pit	Unpaved haulage	237,506.80	61,027.98	6,102.80	386,670	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.4	Return haul distance (km)	80,556	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste/ore haulage in pit	Unpaved haulage	107,919.88	27,730.29	2,773.03	175,698	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.4	Return haul distance (km)	62,749	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste/ore haulage in pit	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - waste to southern WRE	Unpaved haulage	147,412.19	37,877.94	3,787.79	239,993	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.3	Return haul distance (km)	52,172	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pit to mill/ROM pile	Unpaved haulage	21,018.03	5,400.64	540.06	34,218	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.1	Return haul distance (km)	15,554	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pile to mill	Unpaved haulage	962.30	247.26	24.73	1,567	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	1,306	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to central WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to northern WRE	Unpaved haulage	21,945.88	5,639.05	563.90	35,729	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.0	Return haul distance (km)	17,864	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to southern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to IWL	Unpaved haulage	308,307.03	79,220.28	7,922.03	501,936	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	4.1	Return haul distance (km)	61,212	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to LPB	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pit to mill/ROM pile	Unpaved haulage	1,289.84	331.43	33.14	2,100	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.8	Return haul distance (km)	1,312	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pile to mill	Unpaved haulage	40,516.68	10,410.86	1,041.09	65,963	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.4	Return haul distance (km)	23,558	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste to northern WRE	Unpaved haulage	37,513.93	9,639.30	963.93	61,074	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	50,895	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pit to mill/ROM pile	Unpaved haulage	14,166.80	3,640.19	364.02	23,064	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.6	Return haul distance (km)	7,208	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pile to mill	Unpaved haulage	3,058.71	785.94	78.59	4,980	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	4,150	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste to northern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pit to mill/ROM pile	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pile to mill	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore pile loading to trucks	Material handling	489.84	231.68	35.08	238,915	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - ore pile loading to trucks	Material handling	8,839.03	4,180.62	633.07	4,311,137	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - ore pile loading to trucks	Material handling	1,556.99	736.41	111.51	759,405	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - ore pile loading to trucks	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Unloading ore to mill	Material handling	9,156.91	4,330.97	655.83	8,932,360	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Mill - primary crusher	Processing	267,970.80	26,797.08	4,962.42	8,932,360	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to crushed ore stockpile	Material handling	5,494.14	2,598.58	393.50	8,932,360	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.7	Cover	USEPA AP-42 13.2.4 - Materials handling equation
Mill - recycle crusher	Processing	26,797.08	2,679.71	496.24	893,236	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to recycle stockpile	Material handling	915.69	433.10	65.58	893,236	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Graders on roads	Unpaved haulage	105,958.44	33,507.00	3,284.71	197,100	km/year	1.0752	0.3400	0.0333	kg/VKT	10	travel speed (km/hr)									0.5	Watering	USEPA AP-42 11.9.2 - Grading
Wind erosion - plant stockpiles and exposed areas	Wind erosion	875,047.06	437,523.53	65,628.53	1,029	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - tailings storage dams	Wind erosion	52,364.25	26,182.13	3,927.32	62	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Diesel combustion - haulage	Diesel combustion	51,915.67	51,915.67	47,589.36	14,421,019	l/year	0.0036	0.0036	0.0033	kg/L													NPI EET for Combustion engines v3, June 2008
Additional blasting for U/G development	Underground operations	1,430.00	743.60	42.90	52	Blasts/year	27.5000	14.3000	0.8250	kg/blast	2500.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
Removal of material (underground)	Underground operations	25,524.81	5,010.15	2,680.10	7,008	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Waste and ore - hauling (underground)	Underground operations	65,035.38	16,711.01	1,671.10	69,781	VKT/year	3.3285	0.8553	0.0855	kg/VKT	5.0	Road silt content (%)	2.0	Return haul distance (km)	34,891	Loads/year	75	Average weight (t)	63	Load in truck (t)	0.72	Watering or suppressants, travel speed 40km/hr	USEPA AP-42 13.2.2 - Unpaved roads

Table B.6 Year 6 emissions inventory

Source name	Source Type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Parameter 5	Unit	Reduction factor	Emission control	Emission factor source
E41 - topsoil removal/emplacement	Material handling	10,361.46	2,608.23	1,395.23	357,292	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E42 - topsoil removal/emplacement	Material handling	8,795.68	2,214.09	1,184.39	303,299	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E46 - topsoil removal/emplacement	Material handling	534.50	134.55	71.97	18,431	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
GR - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E41 - drilling	Drill and blast	6,802.23	3,537.16	353.72	31,160	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E42 - drilling	Drill and blast	5,774.25	3,002.61	300.26	26,451	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E46 - drilling	Drill and blast	350.81	182.42	18.24	1,607	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
GR - drilling	Drill and blast	0.00	0.00	0.00	0	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E41 - blasting	Drill and blast	11,058.45	5,750.39	331.75	156	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E42 - blasting	Drill and blast	9,357.15	4,865.72	280.71	132	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E46 - blasting	Drill and blast	567.10	294.89	17.01	8	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
GR - blasting	Drill and blast	0.00	0.00	0.00	0	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E41 - excavator in pit on ore/waste	Material handling	35,394.70	16,740.74	2,535.03	17,263,371	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - excavator in pit on ore/waste	Material handling	30,046.01	14,210.95	2,151.94	14,654,608	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - excavator in pit on ore/waste	Material handling	1,825.83	863.57	130.77	890,531	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - excavator in pit on ore/waste	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E41 - dozer in pit operations	Dozer operations	83,385.40	16,367.35	8,755.47	11,447	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E42 - dozer in pit operations	Dozer operations	70,783.26	13,893.73	7,432.24	9,717	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E46 - dozer in pit operations	Dozer operations	4,305.13	845.03	452.04	591	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
GR - dozer in pit operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
North WRE - waste unloading	Material handling	6,130.29	2,899.46	439.06	2,989,982	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Central WRE - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
South WRE - waste unloading	Material handling	25,232.01	11,934.06	1,807.16	12,306,632	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
IWL - waste unloading	Material handling	23,256.54	10,999.71	1,665.67	11,343,118	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
LBP - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
North WRE - dozer operations	Dozer operations	7,222.56	1,417.68	758.37	1,983	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Central WRE - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
South WRE - dozer operations	Dozer operations	29,724.31	5,834.45	3,121.05	8,161	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
IWL - dozer operations	Dozer operations	27,396.92	5,377.62	2,876.68	7,522	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
LBP - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
E41 - waste/ore haulage in pit	Unpaved haulage	295,716.94	75,985.22	7,598.52	481,439	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.5	Return haul distance (km)	96,288	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste/ore haulage in pit	Unpaved haulage	271,111.90	69,662.89	6,966.29	441,381	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.7	Return haul distance (km)	81,737	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste/ore haulage in pit	Unpaved haulage	10,373.10	2,665.39	266.54	16,888	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.7	Return haul distance (km)	4,967	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste/ore haulage in pit	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - waste to southern WRE	Unpaved haulage	82,613.91	21,227.86	2,122.79	134,499	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.0	Return haul distance (km)	67,249	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pit to mill/ROM pile	Unpaved haulage	35,672.86	9,166.23	916.62	58,077	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.0	Return haul distance (km)	29,038	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pile to mill	Unpaved haulage	8,351.28	2,145.88	214.59	13,596	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	11,330	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to central WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to northern WRE	Unpaved haulage	38,959.26	10,010.68	1,001.07	63,427	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.3	Return haul distance (km)	13,789	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to southern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to IWL	Unpaved haulage	426,416.94	109,568.92	10,956.89	694,224	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	5.6	Return haul distance (km)	61,984	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to LPB	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pit to mill/ROM pile	Unpaved haulage	7,275.49	1,869.46	186.95	11,845	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.4	Return haul distance (km)	4,230	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pile to mill	Unpaved haulage	4,379.07	1,125.21	112.52	7,129	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.0	Return haul distance (km)	3,565	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste to northern WRE	Unpaved haulage	4,072.66	1,046.48	104.65	6,630	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.3	Return haul distance (km)	2,550	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pit to mill/ROM pile	Unpaved haulage	3,192.55	820.33	82.03	5,198	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.7	Return haul distance (km)	1,529	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pile to mill	Unpaved haulage	5,751.01	1,477.74	147.77	9,363	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	7,802	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste to northern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pit to mill/ROM pile	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pile to mill	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore pile loading to trucks	Material handling	4,251.09	2,010.65	304.47	2,073,422	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - ore pile loading to trucks	Material handling	1,337.46	632.58	95.79	652,331	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - ore pile loading to trucks	Material handling	2,927.46	1,384.61	209.67	1,427,838	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - ore pile loading to trucks	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Unloading ore to mill	Material handling	9,130.58	4,318.52	653.95	8,906,677	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Mill - primary crusher	Processing	267,200.31	26,720.03	4,948.15	8,906,677	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to crushed ore stockpile	Material handling	5,478.35	2,591.11	392.37	8,906,677	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.7	Cover	USEPA AP-42 13.2.4 - Materials handling equation
Mill - recycle crusher	Processing	26,720.03	2,672.00	494.82	890,668	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to recycle stockpile	Material handling	913.06	431.85	65.39	890,668	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Graders on roads	Unpaved haulage	105,958.44	33,507.00	3,284.71	197,100	km/year	1.0752	0.3400	0.0333	kg/VKT	10	travel speed (km/hr)									0.5	Watering	USEPA AP-42 11.9.2 - Grading
Wind erosion - plant stockpiles and exposed areas	Wind erosion	977,300.40	488,650.20	73,297.53	1,150	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - tailings storage dams	Wind erosion	111,854.16	55,927.08	8,389.06	132	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Diesel combustion - haulage	Diesel combustion	57,864.58	57,864.58	53,042.53	16,073,495	l/year	0.0036	0.0036	0.0033	kg/L													NPI EET for Combustion engines v3, June 2008
Additional blasting for UG development	Underground operations	1,430.00	743.60	42.90	52	Blasts/year	27.5000	14.3000	0.8250	kg/blast	2500.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
Removal of material (underground)	Underground operations	25,524.81	5,010.15	2,680.10	7,008	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Waste and ore - hauling (underground)	Underground operations	62,515.75	16,063.58	1,606.36	67,078	VKT/year	3.3285	0.8553	0.0855	kg/VKT	5.0	Road silt content (%)	2.0	Return haul distance (km)	33,539	Loads/year	75	Average weight (t)	63	Load in truck (t)	0.72	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads

Table B.7 Year 9 emissions inventory

Source name	Source Type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Parameter 5	Unit	Reduction factor	Emission control	Emission factor source
E41 - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E42 - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E46 - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
GR - topsoil removal/emplacement	Material handling	0.00	0.00	0.00	0	t/y	0.0290	0.0073	0.0039	kg/t													USEPA AP-42 11.9.2 - Topsoil removal by scraper
E41 - drilling	Drill and blast	2,883.96	1,499.66	149.97	13,211	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E42 - drilling	Drill and blast	4,886.43	2,540.94	254.09	22,384	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E46 - drilling	Drill and blast	0.00	0.00	0.00	0	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
GR - drilling	Drill and blast	3,972.62	2,065.76	206.58	18,198	Holes/year	0.5900	0.3068	0.0307	kg/hole											0.63	Dust aprons (Katestone 2011)	USEPA AP-42 11.9.2 - Drilling
E41 - blasting	Drill and blast	4,678.57	2,432.86	140.36	66	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E42 - blasting	Drill and blast	7,939.40	4,128.49	238.18	112	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E46 - blasting	Drill and blast	0.00	0.00	0.00	0	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
GR - blasting	Drill and blast	6,450.76	3,354.40	193.52	91	Blasts/year	70.8875	36.8615	2.1266	kg/blast	4700.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
E41 - excavator in pit on ore/waste	Material handling	16,811.26	7,951.27	1,204.05	8,199,505	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - excavator in pit on ore/waste	Material handling	28,484.74	13,472.51	2,040.12	13,893,114	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - excavator in pit on ore/waste	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - excavator in pit on ore/waste	Material handling	23,157.49	10,952.87	1,658.58	11,294,810	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E41 - dozer in pit operations	Dozer operations	43,320.78	8,503.25	4,548.68	5,947	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E42 - dozer in pit operations	Dozer operations	73,405.67	14,408.48	7,707.60	10,077	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
E46 - dozer in pit operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
GR - dozer in pit operations	Dozer operations	59,674.43	11,713.23	6,265.82	8,192	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)									USEPA AP-42 11.9.2 - Dozer on other material
North WRE - waste unloading	Material handling	33,842.65	16,006.66	2,423.87	16,506,377	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Central WRE - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
South WRE - waste unloading	Material handling	9,134.90	4,320.56	654.26	4,455,448	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
IWL - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
LBP - waste unloading	Material handling	0.00	0.00	0.00	0	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
North WRE - dozer operations	Dozer operations	43,604.88	8,559.01	4,578.51	11,972	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Central WRE - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
South WRE - dozer operations	Dozer operations	11,771.71	2,310.62	1,236.03	3,232	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
IWL - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
LBP - dozer operations	Dozer operations	0.00	0.00	0.00	0	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
E41 - waste/ore haulage in pit	Unpaved haulage	88,068.70	22,629.48	2,262.95	143,379	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.6	Return haul distance (km)	44,806	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste/ore haulage in pit	Unpaved haulage	382,381.98	98,254.02	9,825.40	622,533	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	4.1	Return haul distance (km)	75,919	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste/ore haulage in pit	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste/ore haulage in pit	Unpaved haulage	83,403.75	21,430.81	2,143.08	135,785	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.1	Return haul distance (km)	61,720	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - waste to southern WRE	Unpaved haulage	53,836.63	13,833.46	1,383.35	87,648	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.8	Return haul distance (km)	24,347	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pit to mill/ROM pile	Unpaved haulage	35,187.18	9,041.44	904.14	57,286	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.4	Return haul distance (km)	20,459	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore haulage pile to mill	Unpaved haulage	3,591.66	922.89	92.29	5,847	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	4,873	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to central WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to northern WRE	Unpaved haulage	103,408.76	26,571.15	2,657.11	168,354	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	2.3	Return haul distance (km)	36,599	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to southern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to IWL	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - waste haulage to LPB	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pit to mill/ROM pile	Unpaved haulage	37,161.77	9,548.81	954.88	60,501	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.4	Return haul distance (km)	21,607	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E42 - ore haulage pile to mill	Unpaved haulage	12,953.63	3,328.47	332.85	21,089	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.0	Return haul distance (km)	10,545	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - waste to northern WRE	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pit to mill/ROM pile	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	0	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E46 - ore haulage pile to mill	Unpaved haulage	0.00	0.00	0.00	0	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.0	Return haul distance (km)	7,802	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - waste to northern WRE	Unpaved haulage	98,769.44	25,379.06	2,537.91	160,801	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.5	Return haul distance (km)	53,600	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pit to mill/ROM pile	Unpaved haulage	8,535.24	2,193.15	219.32	13,896	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	1.9	Return haul distance (km)	3,657	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
GR - ore haulage pile to mill	Unpaved haulage	1,663.75	427.50	42.75	2,709	VKT/year	5.4842	1.4092	0.1409	kg/VKT	5.0	Road silt content (%)	0.6	Return haul distance (km)	2,257	Loads/year	228	Average weight (t)	183	Load in truck (t)	0.888	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads
E41 - ore pile loading to trucks	Material handling	1,828.28	864.73	130.94	891,724	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E42 - ore pile loading to trucks	Material handling	3,956.31	1,871.23	283.36	1,929,646	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
E46 - ore pile loading to trucks	Material handling	2,927.46	1,384.61	209.67	1,427,838	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
GR - ore pile loading to trucks	Material handling	846.91	400.56	60.66	413,069	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)									USEPA AP-42 13.2.4 - Materials handling equation
Unloading ore to mill	Material handling	9,130.58	4,318.52	653.95	8,906,679	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Mill - primary crusher	Processing	267,200.37	26,720.04	4,948.15	8,906,679	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to crushed ore stockpile	Material handling	5,478.35	2,591.11	392.37	8,906,679	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.7	Cover	USEPA AP-42 13.2.4 - Materials handling equation
Mill - recycle crusher	Processing	26,720.04	2,672.00	494.82	890,668	t/y	0.2000	0.0200	0.0037	kg/t											0.85	Watering + enclosure	USEPA AP-42 11.24-1 - low moisture content primary crushing
Mill - loading to recycle stockpile	Material handling	913.06	431.85	65.39	890,668	t/y	0.0021	0.0010	0.00015	kg/t	3.36	Average wind speed (m/s)	2.0	Moisture content (%)							0.5	Watering	USEPA AP-42 13.2.4 - Materials handling equation
Graders on roads	Unpaved haulage	70,638.96	22,330.00	2,189.81	131,400	km/year	1.0752	0.3400	0.0333	kg/VKT	10	travel speed (km/hr)									0.5	Watering	USEPA AP-42 11.9.2 - Grading
Wind erosion - plant stockpiles and exposed areas	Wind erosion	1,029,220.29	514,610.15	77,191.52	1,211	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - tailings storage dams	Wind erosion	111,854.16	55,927.08	8,389.06	132	ha	850.0	425.0000	63.7500	kg/ha/year													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Diesel combustion - haulage	Diesel combustion	60,891.27	60,891.27	55,816.99	16,914,240	l/year	0.0036	0.0036	0.0033	kg/L													NPI EET for Combustion engines v3, June 2008
Additional blasting for UG development	Underground operations	1,430.00	743.60	42.90	52	Blasts/year	27.5000	14.3000	0.8250	kg/blast	2500.0	Area of blast m2											USEPA AP-42 11.9.2 - Blasting
Removal of material (underground)	Underground operations	25,524.81	5,010.15	2,680.10	7,008	hr/year	7.2845	1.4298	0.7649	kg/hr	2.0	Moisture content (%)	5.0	Silt content (%)							0.5	Watering	USEPA AP-42 11.9.2 - Dozer on other material
Waste and ore - hauling (underground)	Underground operations	56,390.87	14,489.78	1,448.98	60,506	VKT/year	3.3285	0.8553	0.0855	kg/VKT	5.0	Road silt content (%)	2.0	Return haul distance (km)	30,253	Loads/year	75	Average weight (t)	63	Load in truck (t)	0.72	Watering or suppressants, travel	USEPA AP-42 13.2.2 - Unpaved roads

B.7 Gaseous pollutant blasting emissions

The use of explosives such as ammonium nitrate for blasting at open cut mining operations releases primarily CO_2, water and nitrogen. Air pollutants released from blasts include a range of gases such as CO, nitric oxide (NO), hydrocarbons (HC) and lesser amounts of NO_2 and SO_2. The extent of the latter depends on the sulphur content of the fuel oil used. Particulates are also produced by blasts, but due to the large quantities of particulate generated in the shattering of rock and earth in the explosion, the quantity of particulates from the explosive charge cannot be distinguished.

NO_2 is a direct product of the detonation process. It is also produced post-detonation by secondary oxidation of NO to NO_2 as the cloud mixes with air. NO_2 has a greater potential to impact on human health, compared to NO, in the event that exposure occurs. While NO and CO are not visible, NO_2 appears as a yellow to reddish-brown gas.

Emission factors for explosives detonation for Australian blast practices has been assessed by Attalla *et al.* (2007). Maximum and average emission rates derived by Attalla *et al.* (2007) for ammonium nitrate fuel oil (ANFO) explosives use are listed within Table B.8.

Table B.8 Blasting emission factors derived by Attalla et al. (2007)

	Emission factors (kg pollutant per t of explosives)				
	CO	**NO**	**NO_2**	**NO_x**	**SO_2**
Maximum	97.2	5.0	0.32	5.3	2.4
Average	19.2	0.9	0.06	0.9	0.4

In order to estimate likely maximum blasting emissions from the Project, the following assumptions were made:

- 296 blasts per year
- 6,495,538 kg explosives per year
- a maximum NO_x emission rate of 5.3 kg/t from Table B.8 was adopted.

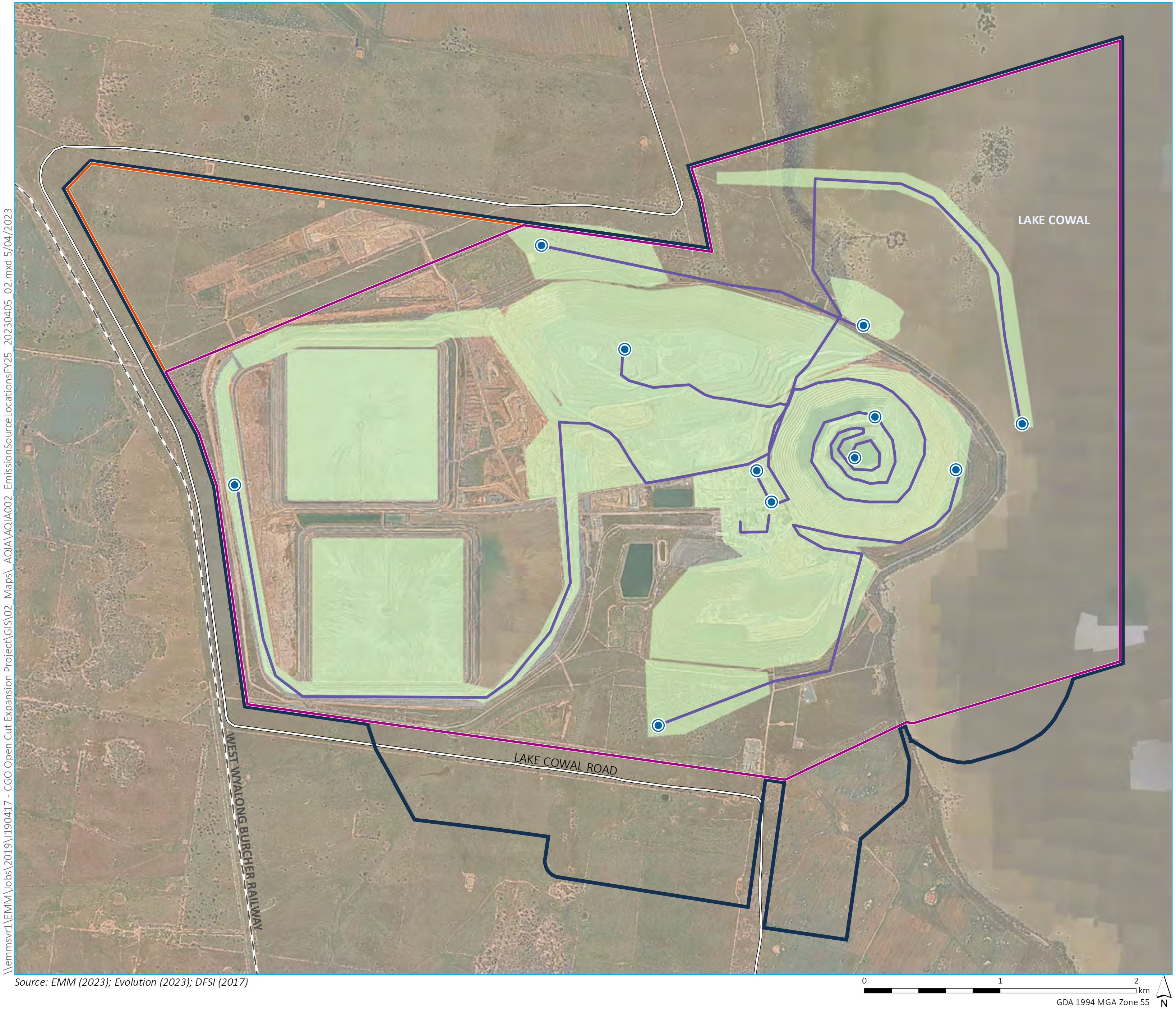
Emissions of blasting were assumed to occur from each active open cut pit for the relevant mine scenario at noon on each day of the modelling period.

B.8 Model emission source locations

The spatial allocation of emission sources for each scenario is presented in Figure B.1 to Figure B.4.

CGO emission sources are represented by a series of volume, line volume and area sources, as follows:

- material handling (unloading, loading) and dozer operations are modelled as a series of volume sources at the expected works location, with source dimensions configured to the size of the equipment (5.25 m for excavators, 3 m for dozers)
- material haulage routes and processing mill emission s are modelled as line volume sources (haulage source dimensions configured using truck dimensions (6.1 m high) and USEPA haul truck parameterisation guidance, mill dimensions set to 10 m high)
- wind erosion sources are represented by area sources (0 m release height).



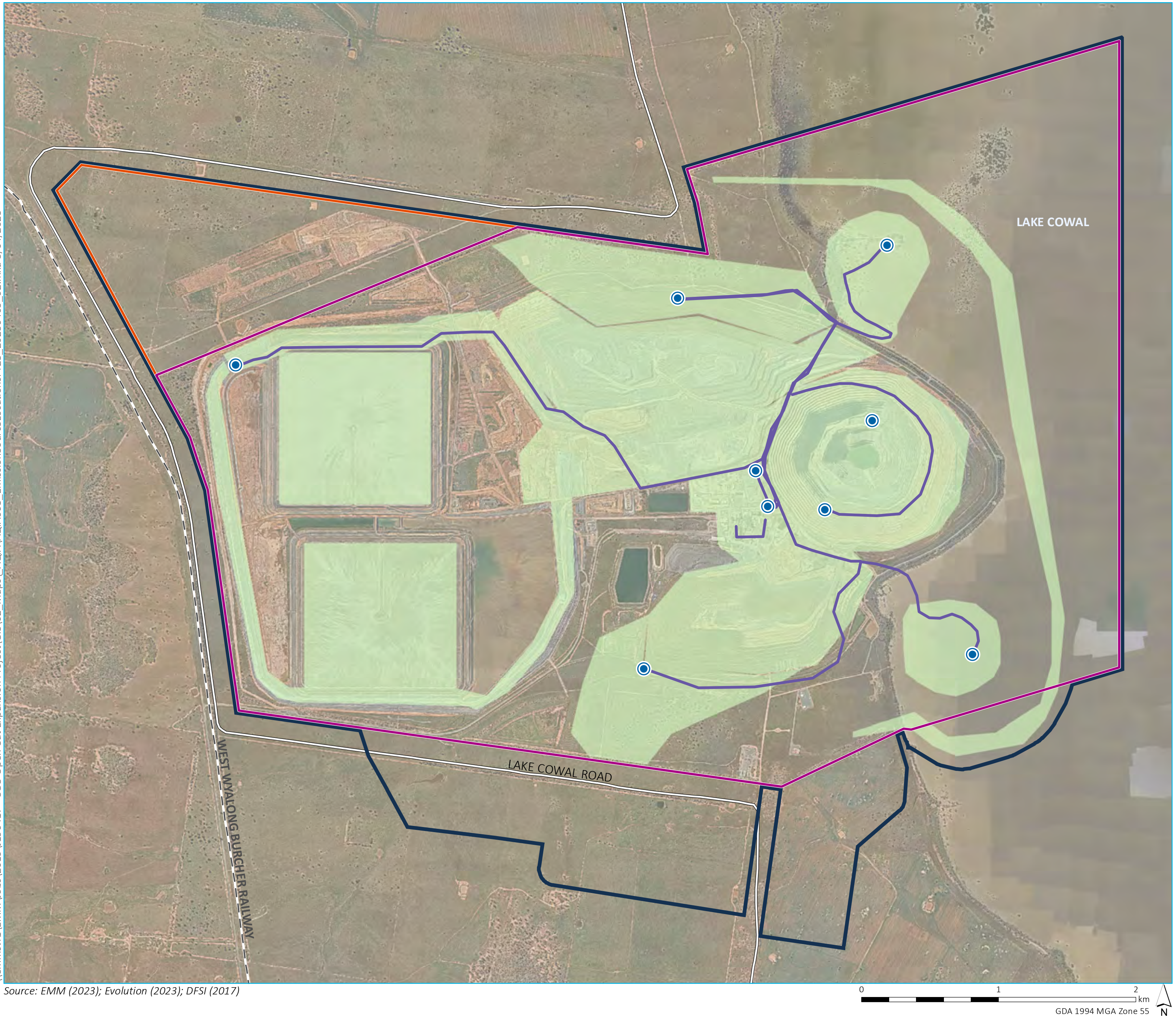
\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA002_EmissionSourceLocationsFY25_20230405_02.mxd 5/04/2023

Source: EMM (2023); Evolution (2023); DFSI (2017)

Emission source locations - FY25

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure B.1

EMM creating opportunities



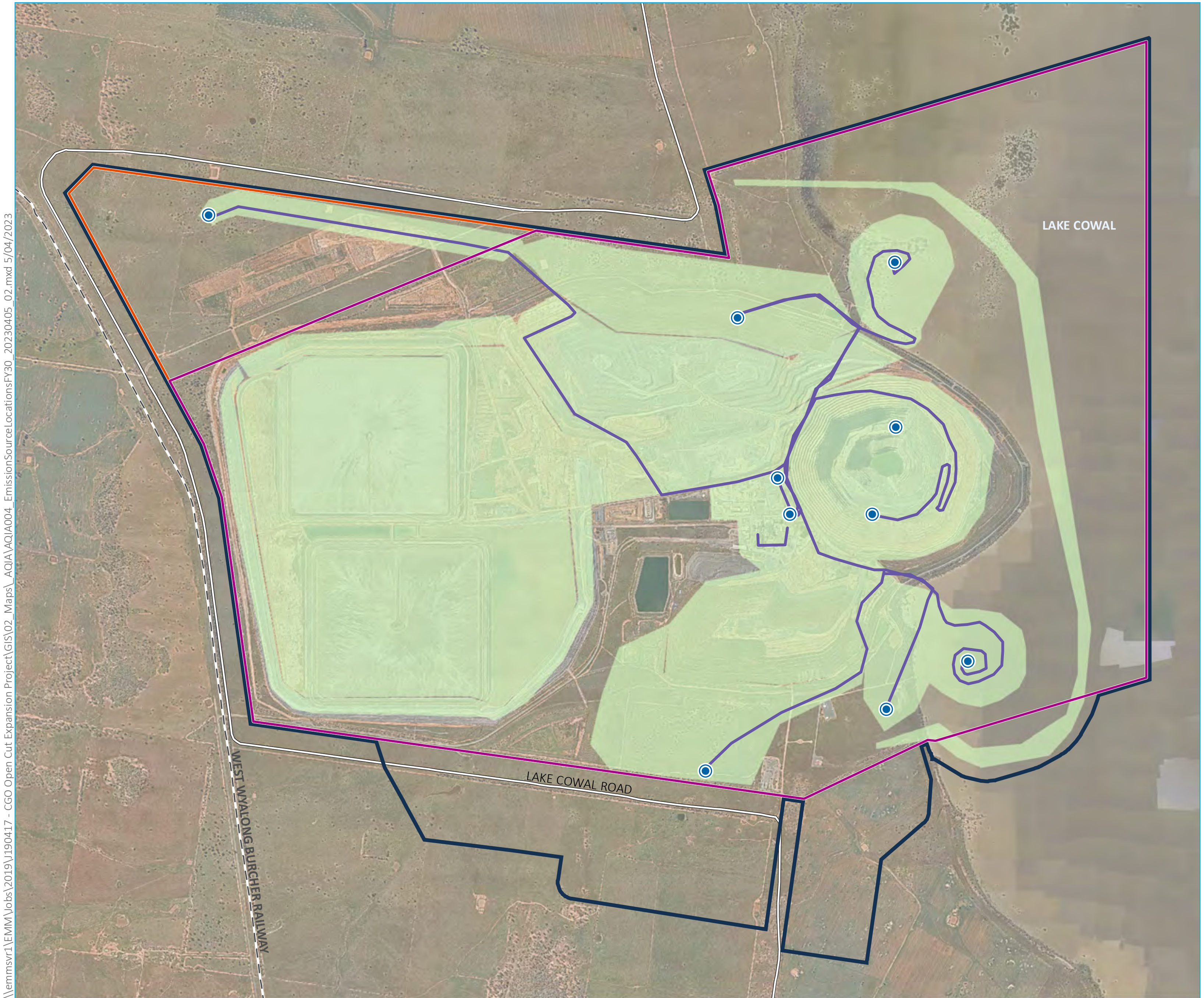
Source: EMM (2023); Evolution (2023); DFSI (2017)

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA003_EmissionSourceLocationsFY28_20230405_02.mxd 5/04/2023

Emission source locations - FY28

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure B.2

EMM creating opportunities



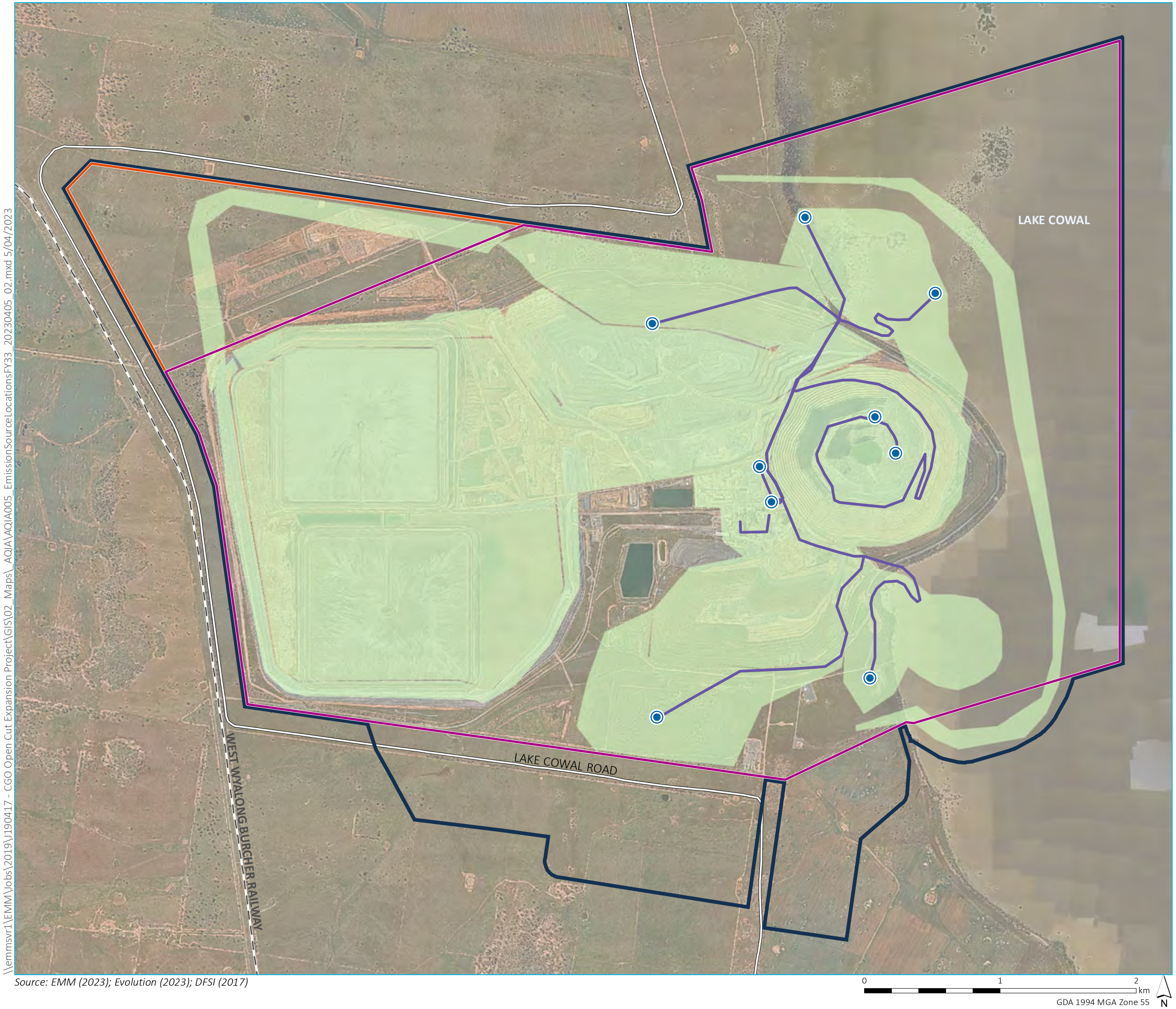
Source: EMM (2023); Evolution (2023); DFSI (2017)

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA004_EmissionSourceLocationsFY30_20230405_02.mxd 5/04/2023

Emission source locations - FY30

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure B.3

EMM
creating opportunities



Source: EMM (2023); Evolution (2023); DFSI (2017)

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA005_EmissionSourceLocationsFY33_20230405_02.mxd 5/04/2023

Emission source locations - FY33

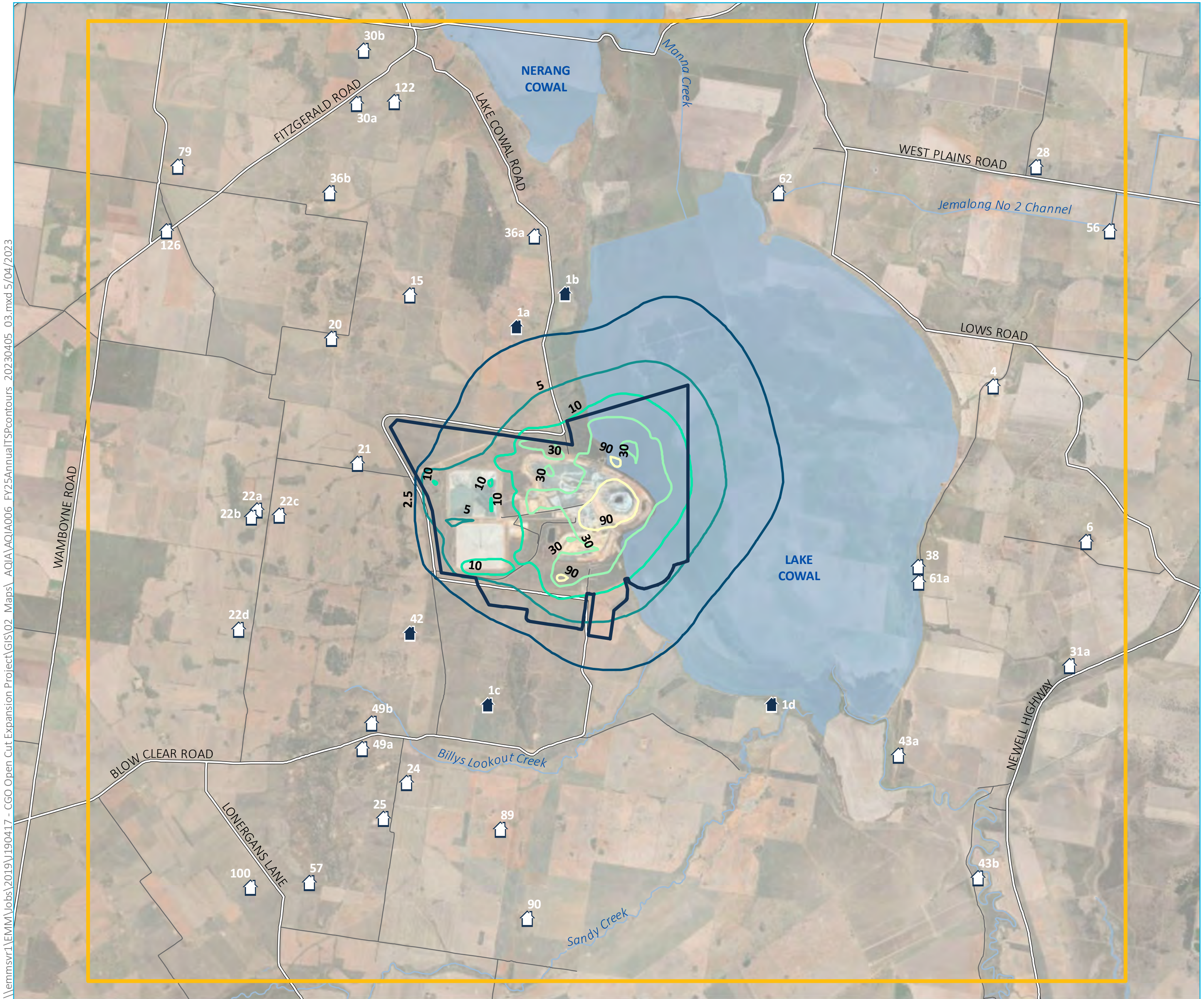
Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure B.4

EMM creating opportunities

Appendix C

Predicted Project increment isopleth plots

creating opportunities

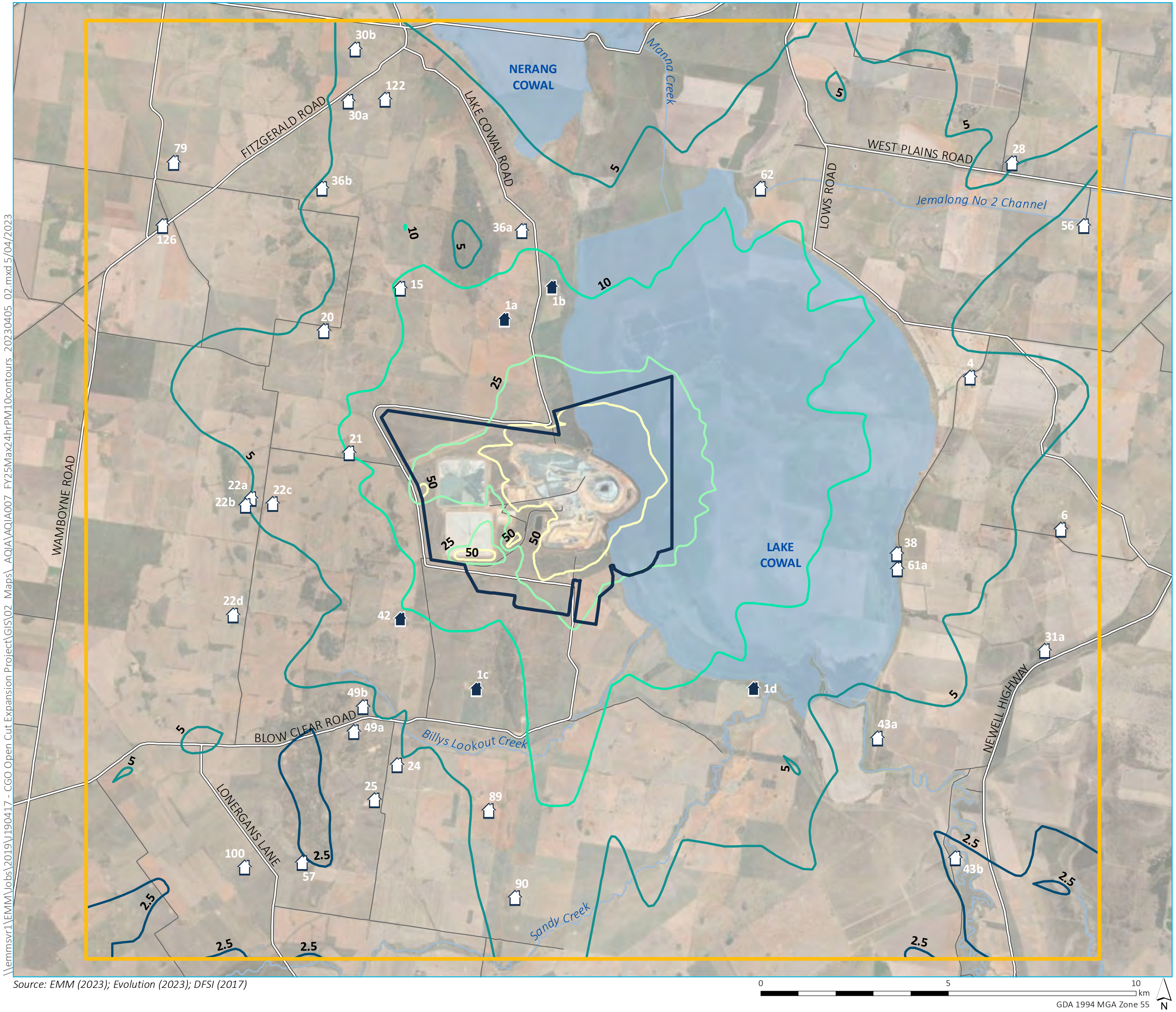


Source: EMM (2023); Evolution (2023); DFSI (2017)

Predicted annual average TSP concentrations (µg/m³) - FY25 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.1

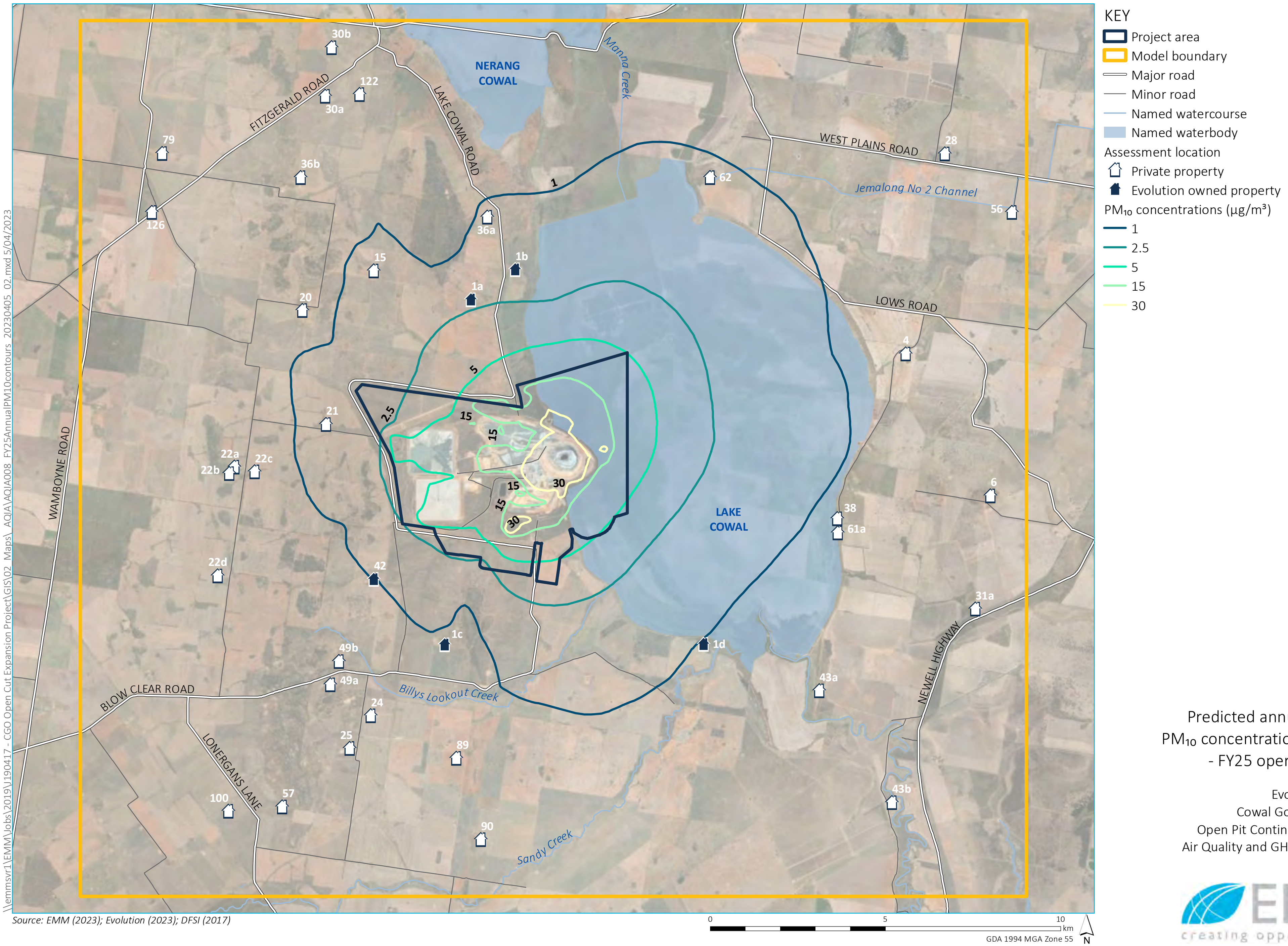
EMM creating opportunities



Maximum predicted 24-hour average PM_{10} concentrations (µg/m³) - FY25 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.2

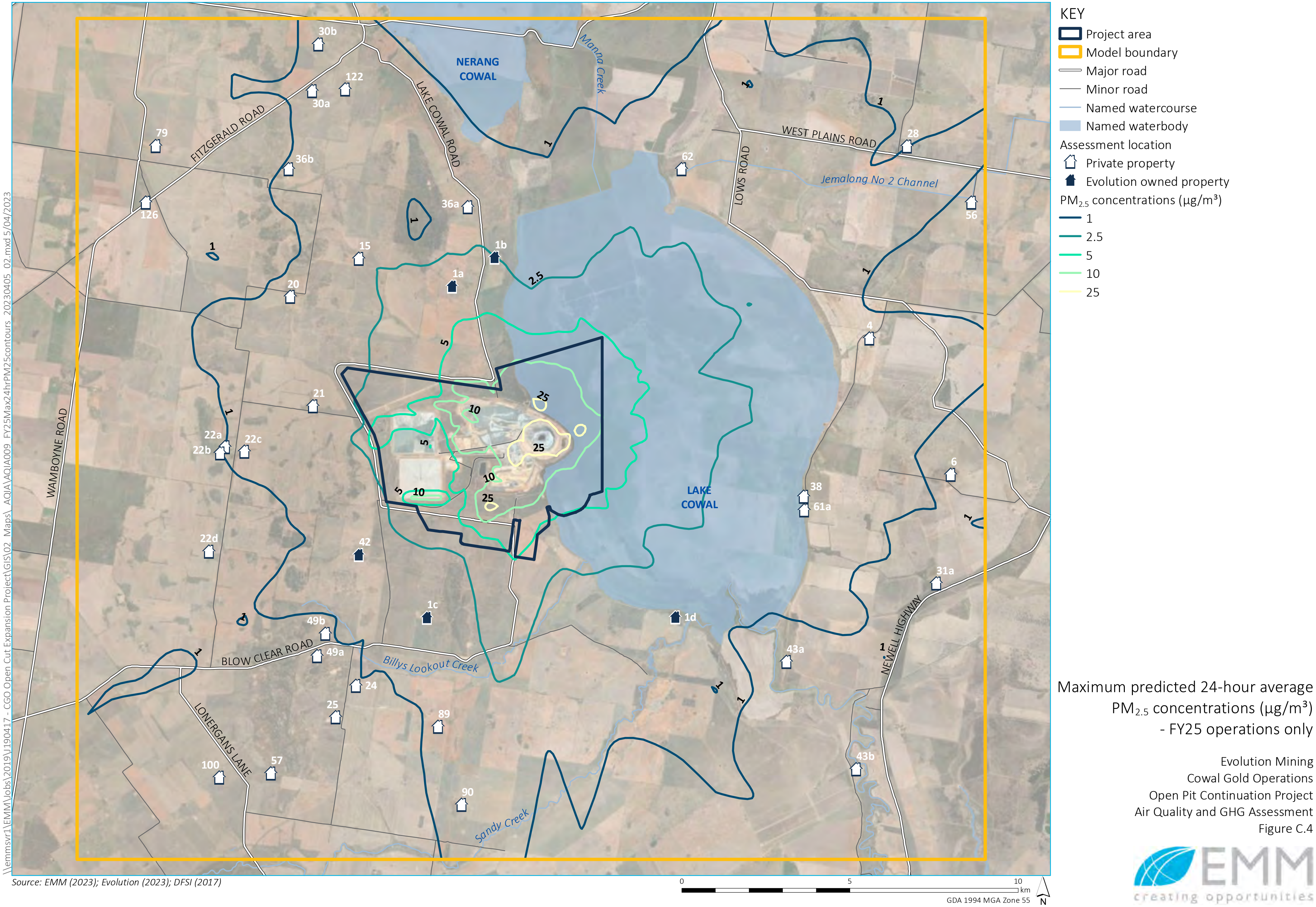
EMM creating opportunities



Predicted annual average PM_{10} concentrations (µg/m³) - FY25 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.3

EMM
creating opportunities



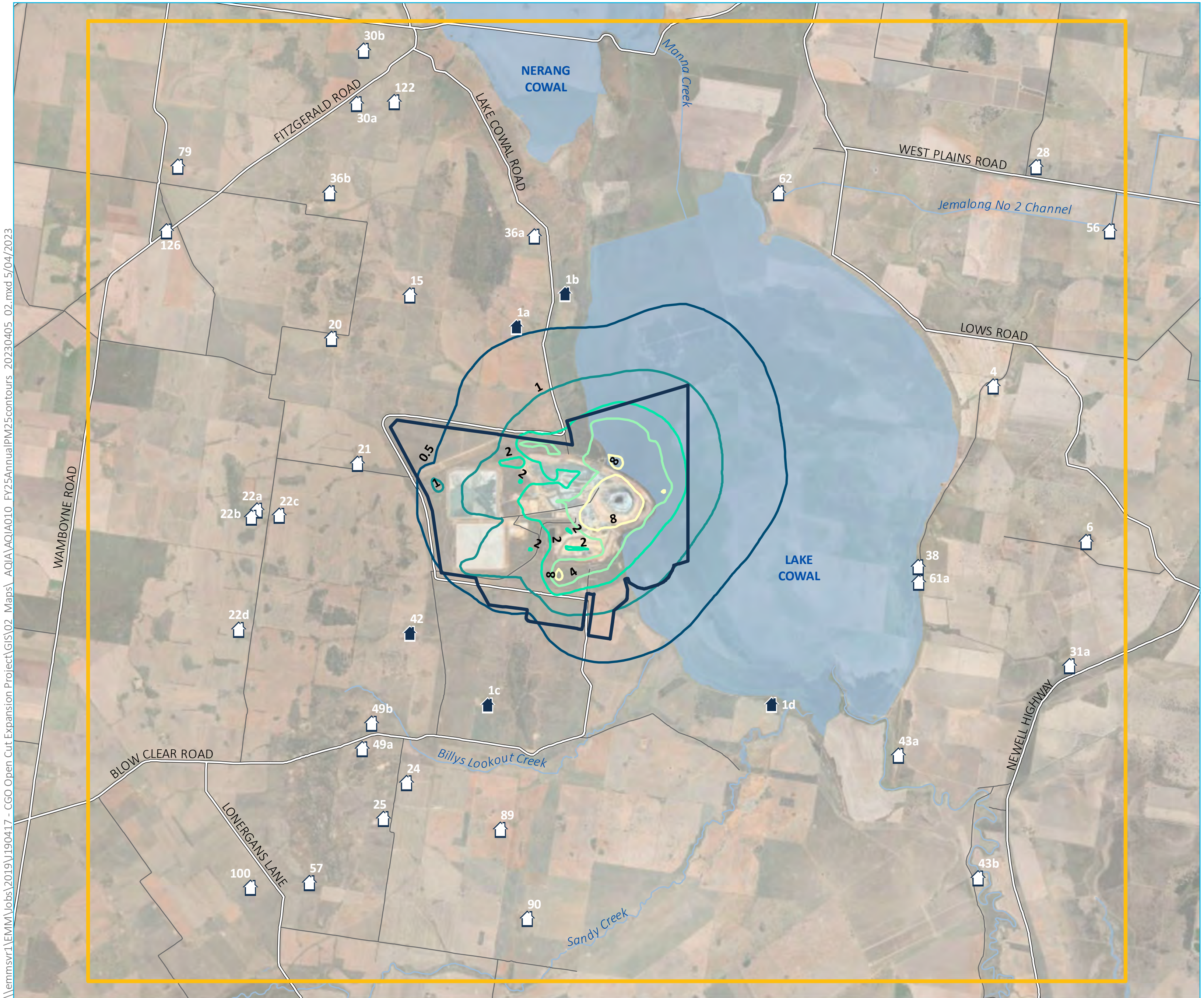
Source: EMM (2023); Evolution (2023); DFSI (2017)

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA009_FY25Max24hrPM25contours_20230405_02.mxd 5/04/2023

Maximum predicted 24-hour average $PM_{2.5}$ concentrations (µg/m³) - FY25 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.4

EMM creating opportunities



KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

- Private property
- Evolution owned property

$PM_{2.5}$ concentrations (µg/m³)

- 0.5
- 1
- 2
- 4
- 8

Source: EMM (2023); Evolution (2023); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

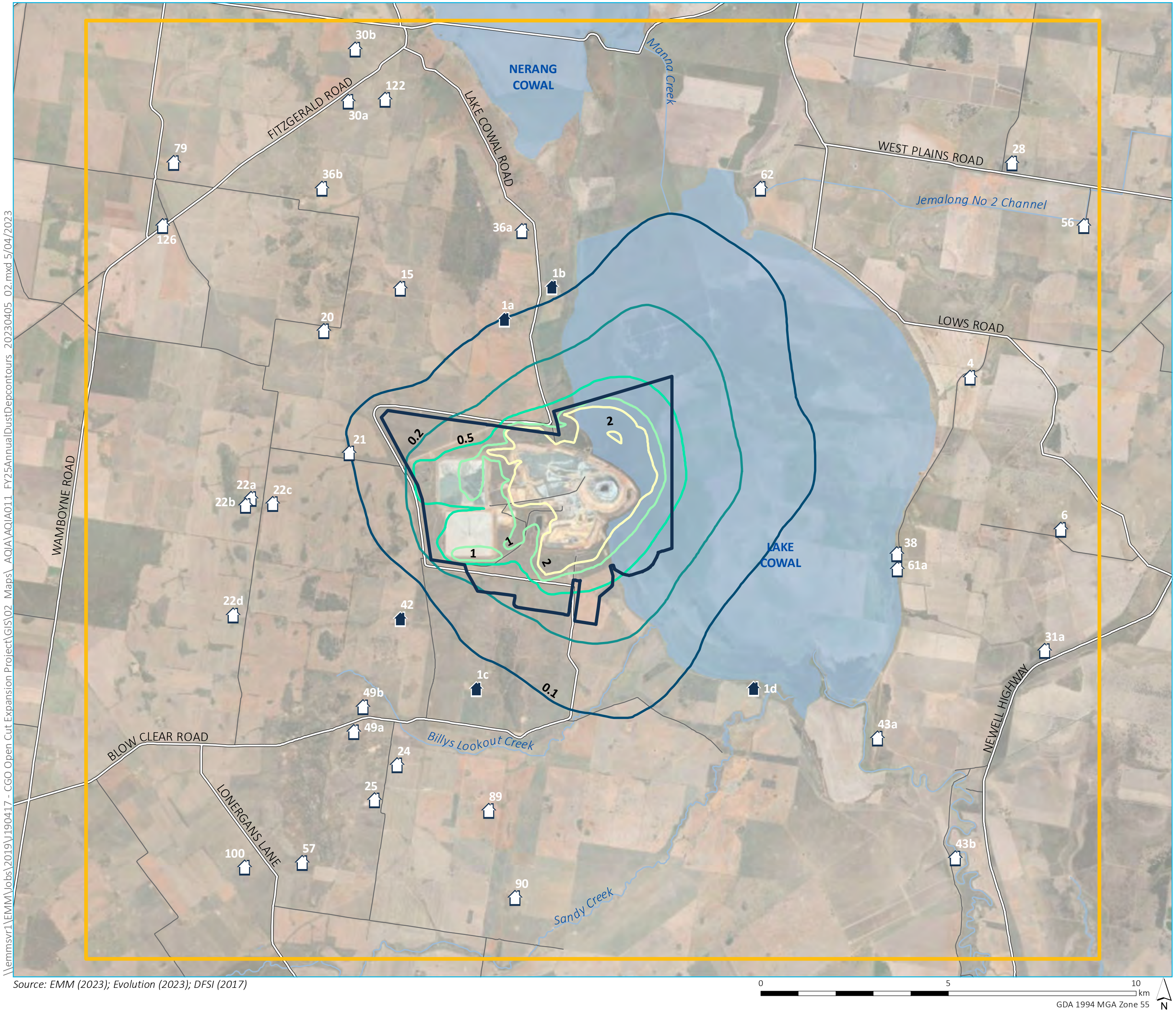
N

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA010_FY25AnnualPM25contours_20230405_02.mxd 5/04/2023

Predicted annual average $PM_{2.5}$ concentrations (µg/m³) - FY25 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.5

EMM creating opportunities



Source: EMM (2023); Evolution (2023); DFSI (2017)

KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

- Private property
- Evolution owned property

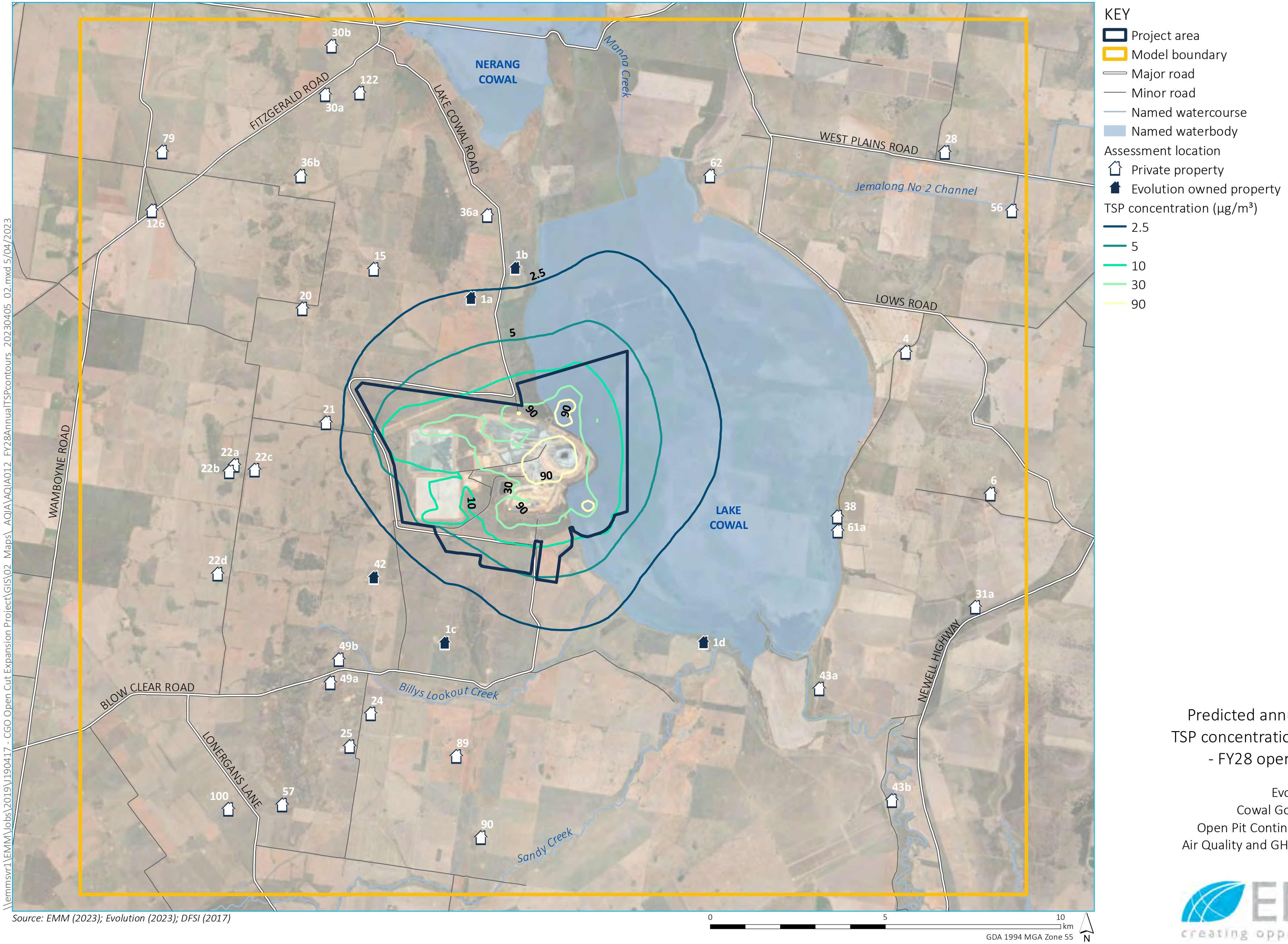
Dust deposition (g/m²/month)

- 0.1
- 0.2
- 0.5
- 1
- 2

Predicted annual average dust deposition levels (g/m²/month) - FY25 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.6

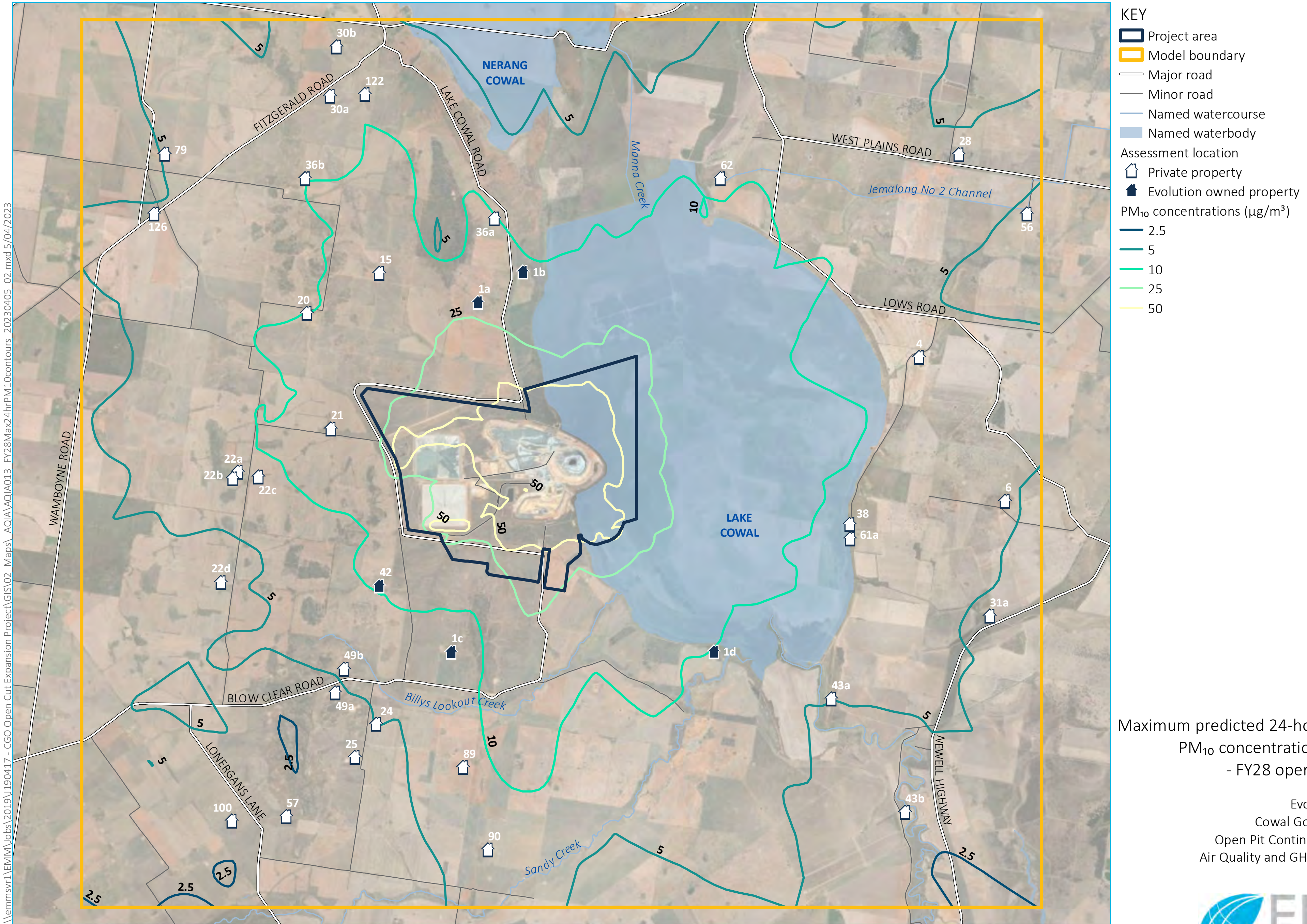
EMM creating opportunities



Predicted annual average TSP concentrations (µg/m³) - FY28 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.7

EMM
creating opportunities

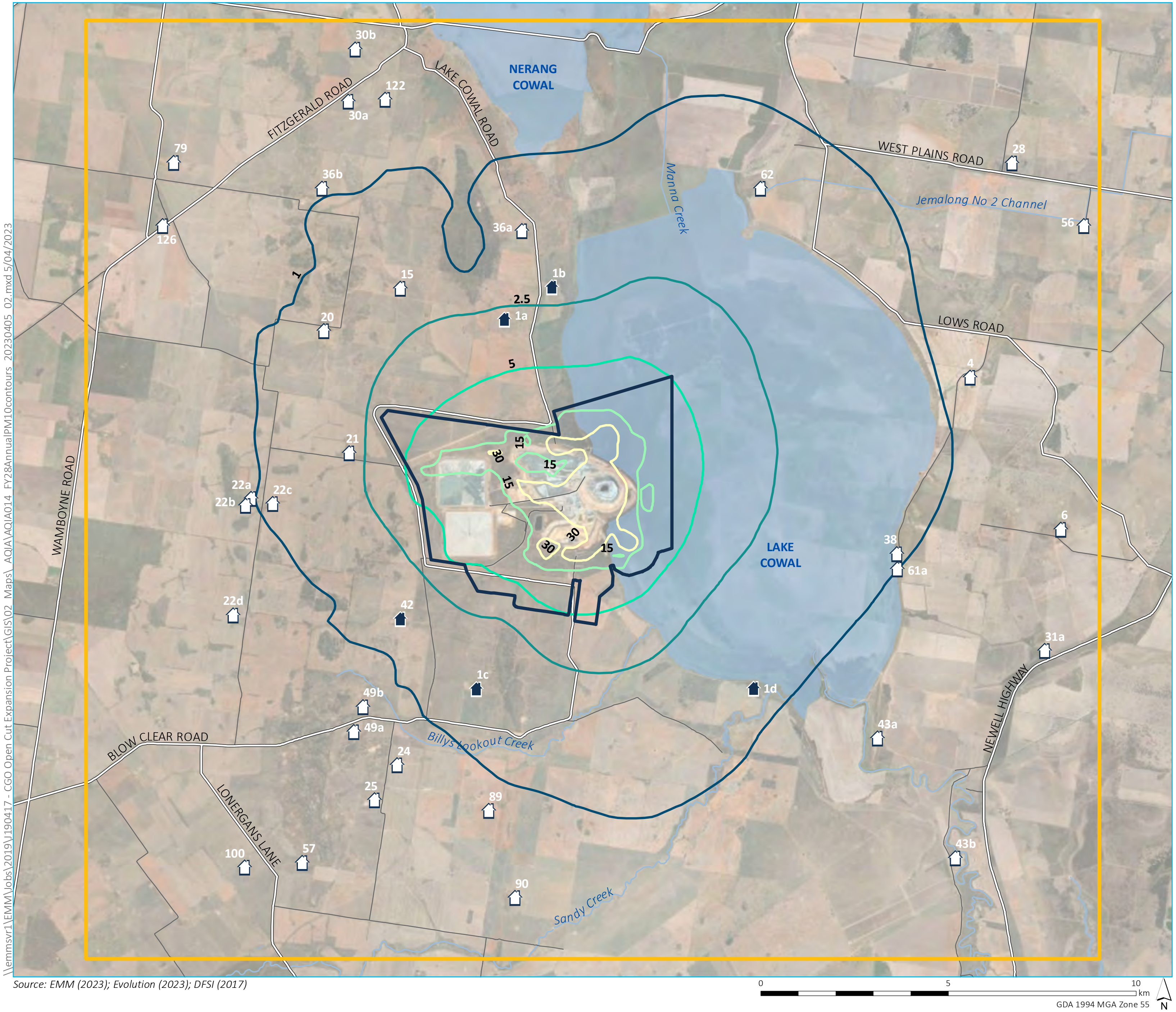


Source: EMM (2023); Evolution (2023); DFSI (2017)

Maximum predicted 24-hour average PM_{10} concentrations (µg/m³) - FY28 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.8

EMM creating opportunities



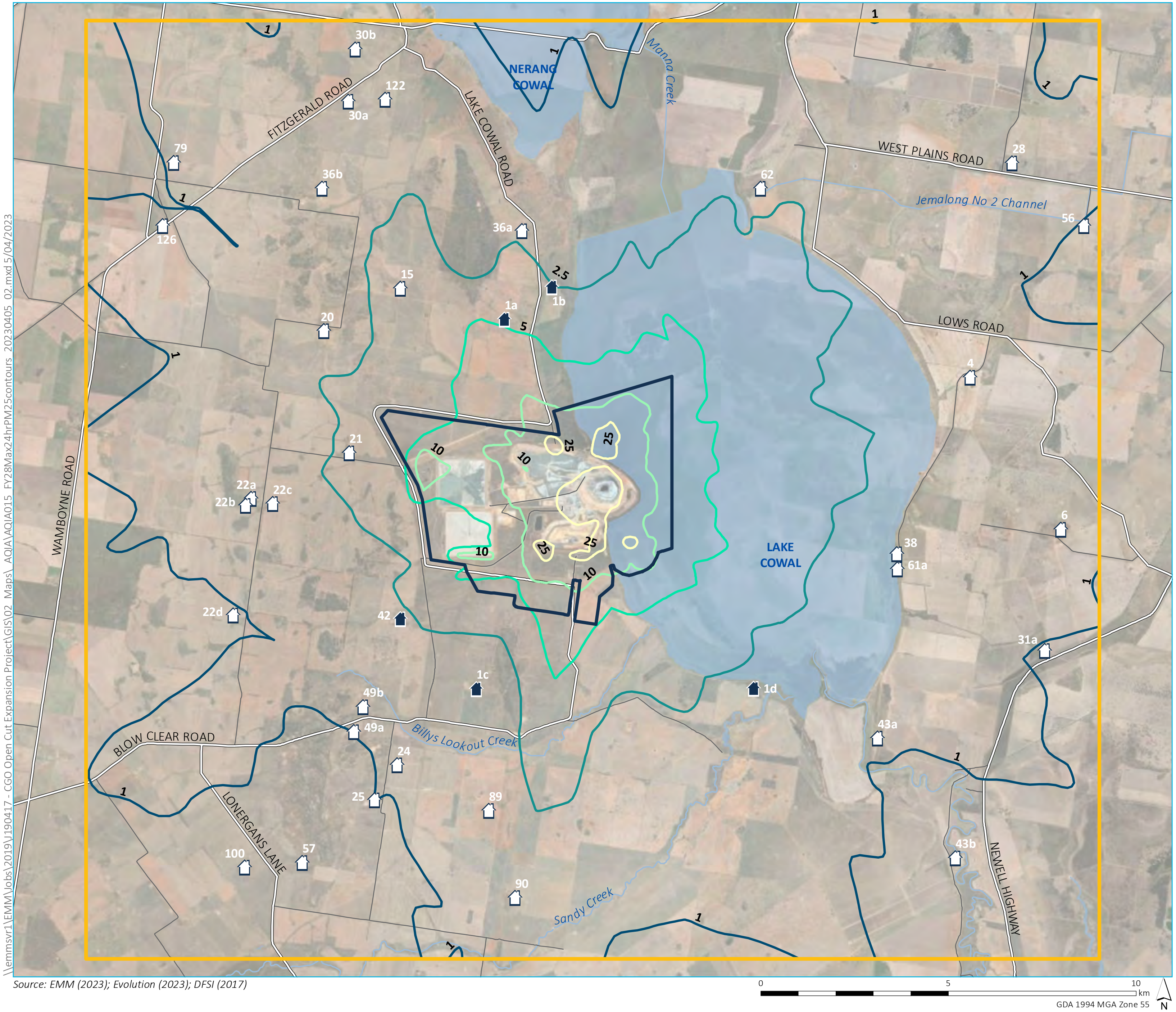
Source: EMM (2023); Evolution (2023); DFSI (2017)

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQ\AQ014_FY28AnnualPM10contours_20230405_02.mxd 5/04/2023

Predicted annual average PM_{10} concentrations (µg/m³) - FY28 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.9

EMM creating opportunities



Source: EMM (2023); Evolution (2023); DFSI (2017)

KEY
- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location
- Private property
- Evolution owned property

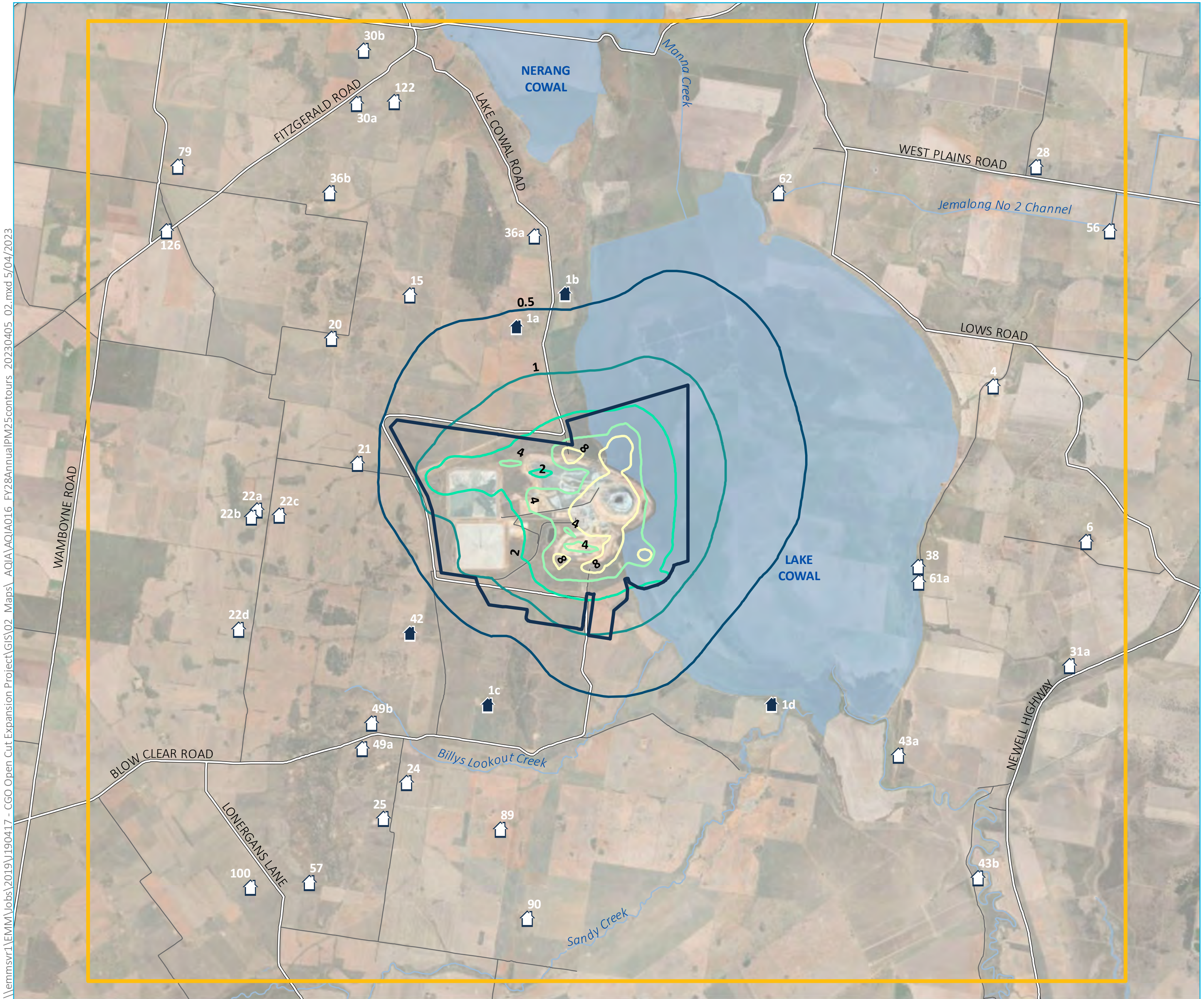
$PM_{2.5}$ concentrations (µg/m³)
- 1
- 2.5
- 5
- 10
- 25

Maximum predicted 24-hour average $PM_{2.5}$ concentrations (µg/m³) - FY28 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.10

EMM
creating opportunities

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps\AQIA\AQIA015_FY28Max24hrPM25contours_20230405_02.mxd 5/04/2023

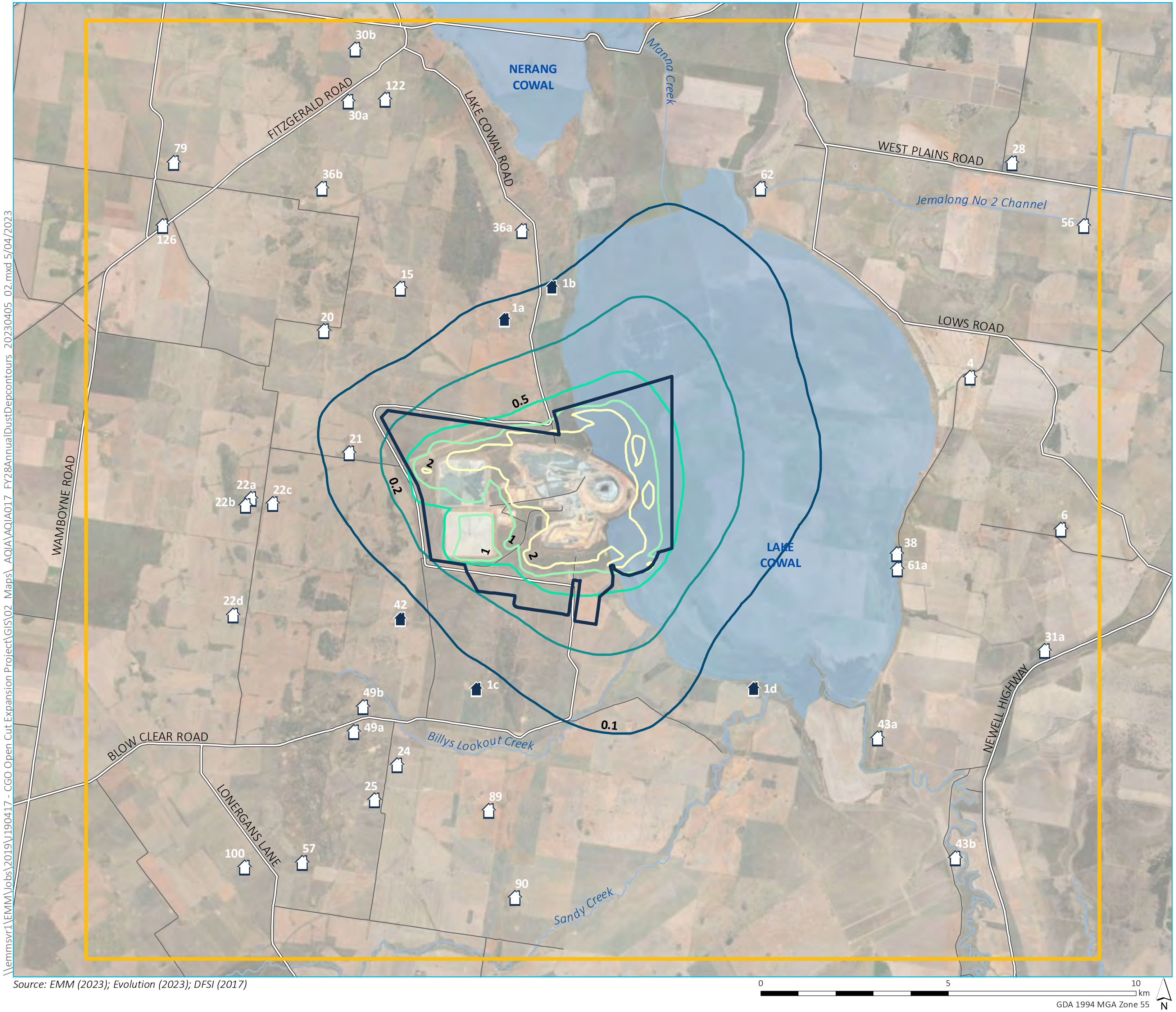


Source: EMM (2023); Evolution (2023); DFSI (2017)

Predicted annual average $PM_{2.5}$ concentrations (µg/m³) - FY28 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.11

EMM creating opportunities



KEY
- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

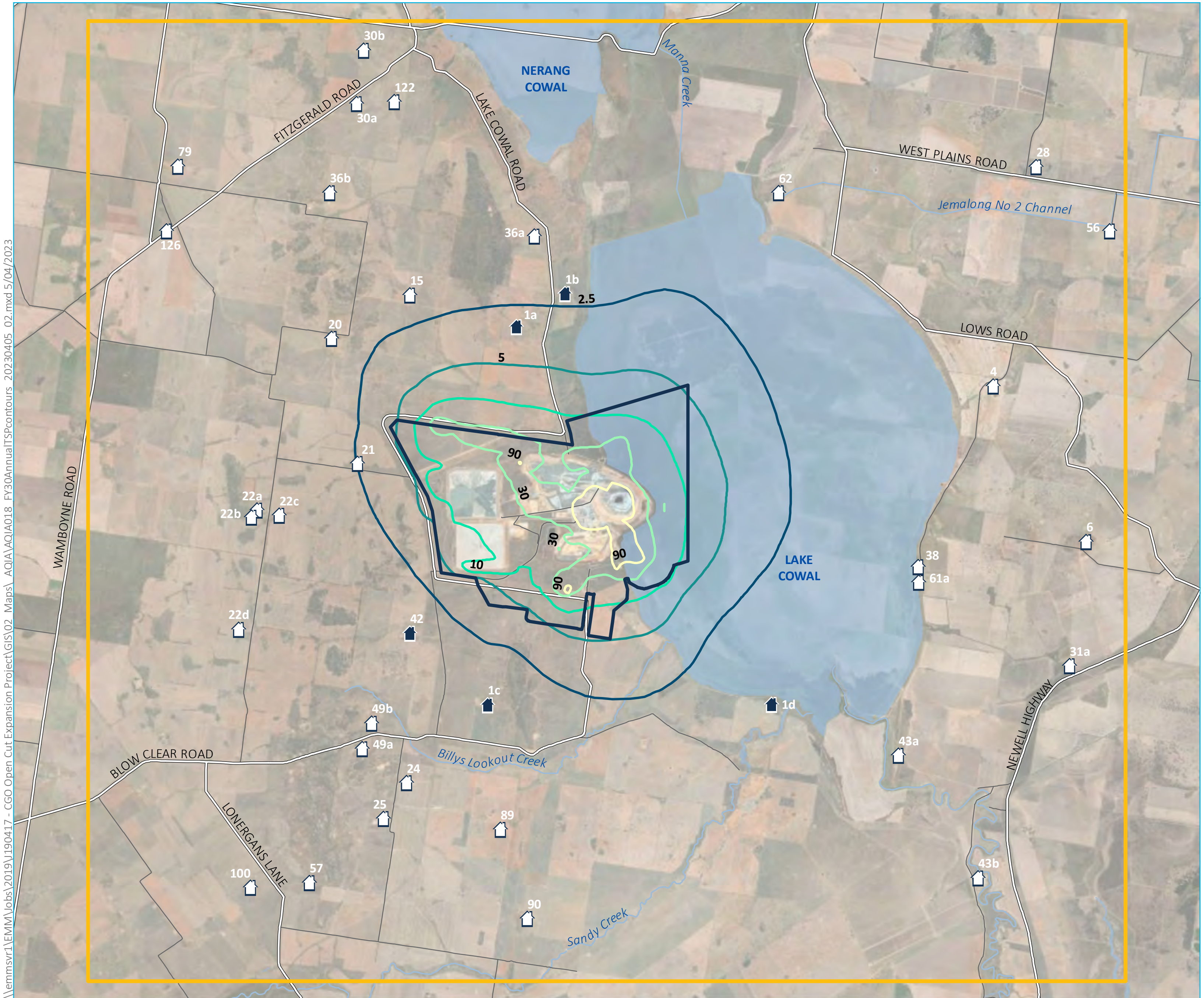
Assessment location
- Private property
- Evolution owned property

Dust deposition (g/m²/month)
- 0.1
- 0.2
- 0.5
- 1
- 2

Predicted annual average dust deposition levels (g/m²/month) - FY28 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.12

Source: EMM (2023); Evolution (2023); DFSI (2017)



\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA018_FY30AnnualTSPcontours_20230405_02.mxd 5/04/2023

KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

- Private property
- Evolution owned property

TSP concentration (µg/m³)

- 2.5
- 5
- 10
- 30
- 90

Predicted annual average TSP concentrations (µg/m³) - FY30 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.13

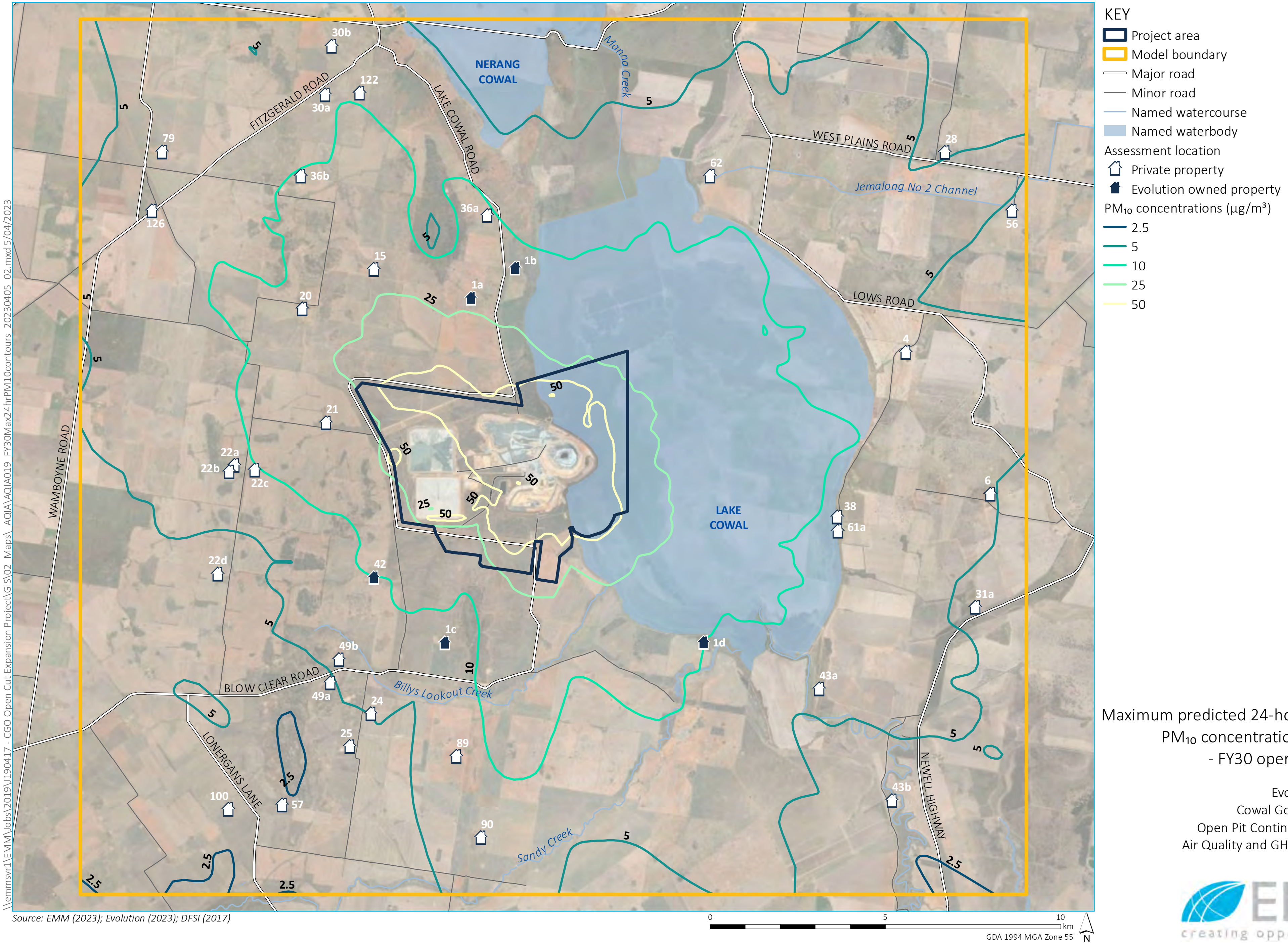
Source: EMM (2023); Evolution (2023); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

EMM creating opportunities



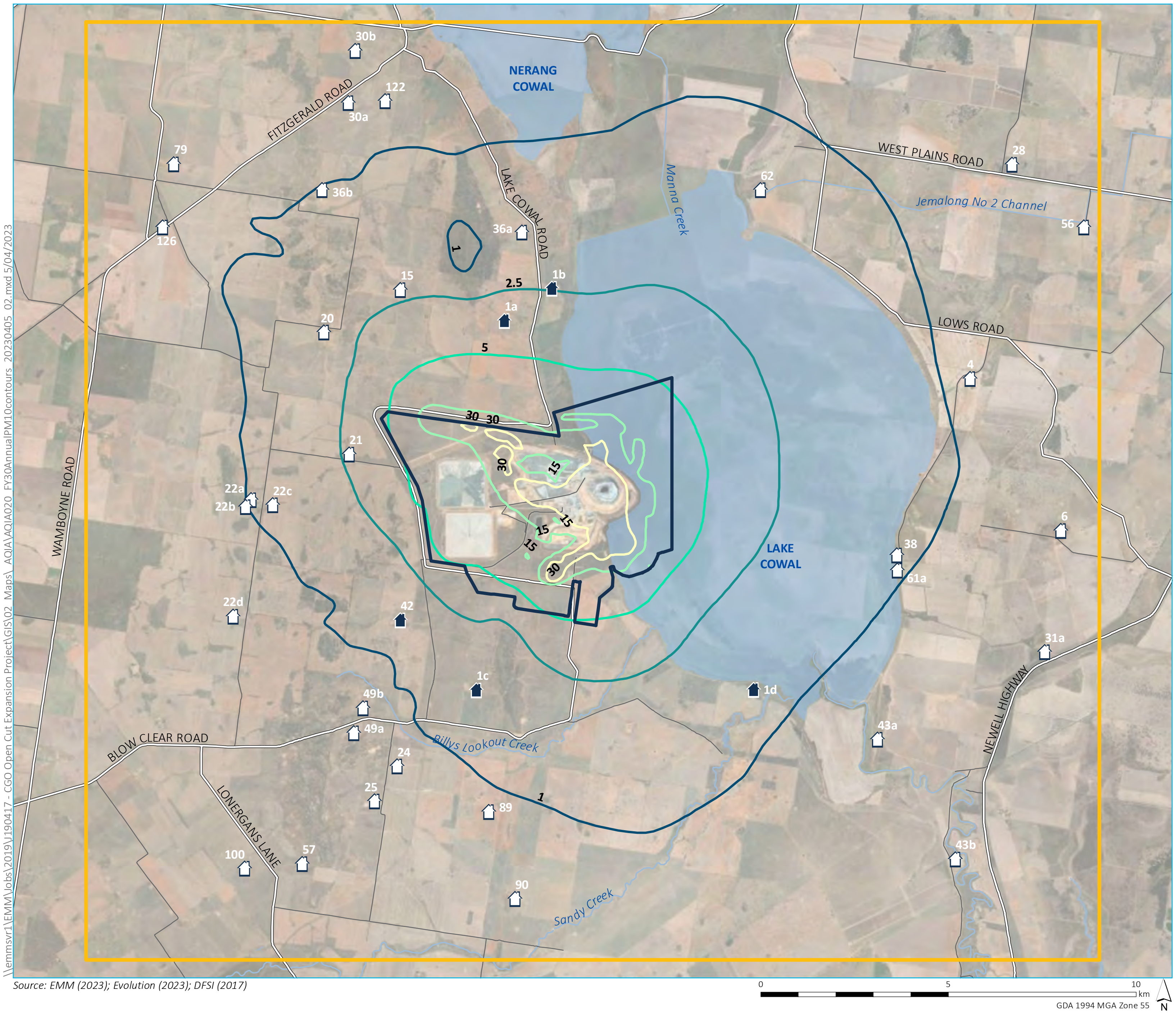
Source: EMM (2023); Evolution (2023); DFSI (2017)

Maximum predicted 24-hour average PM_{10} concentrations (µg/m³) - FY30 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.14

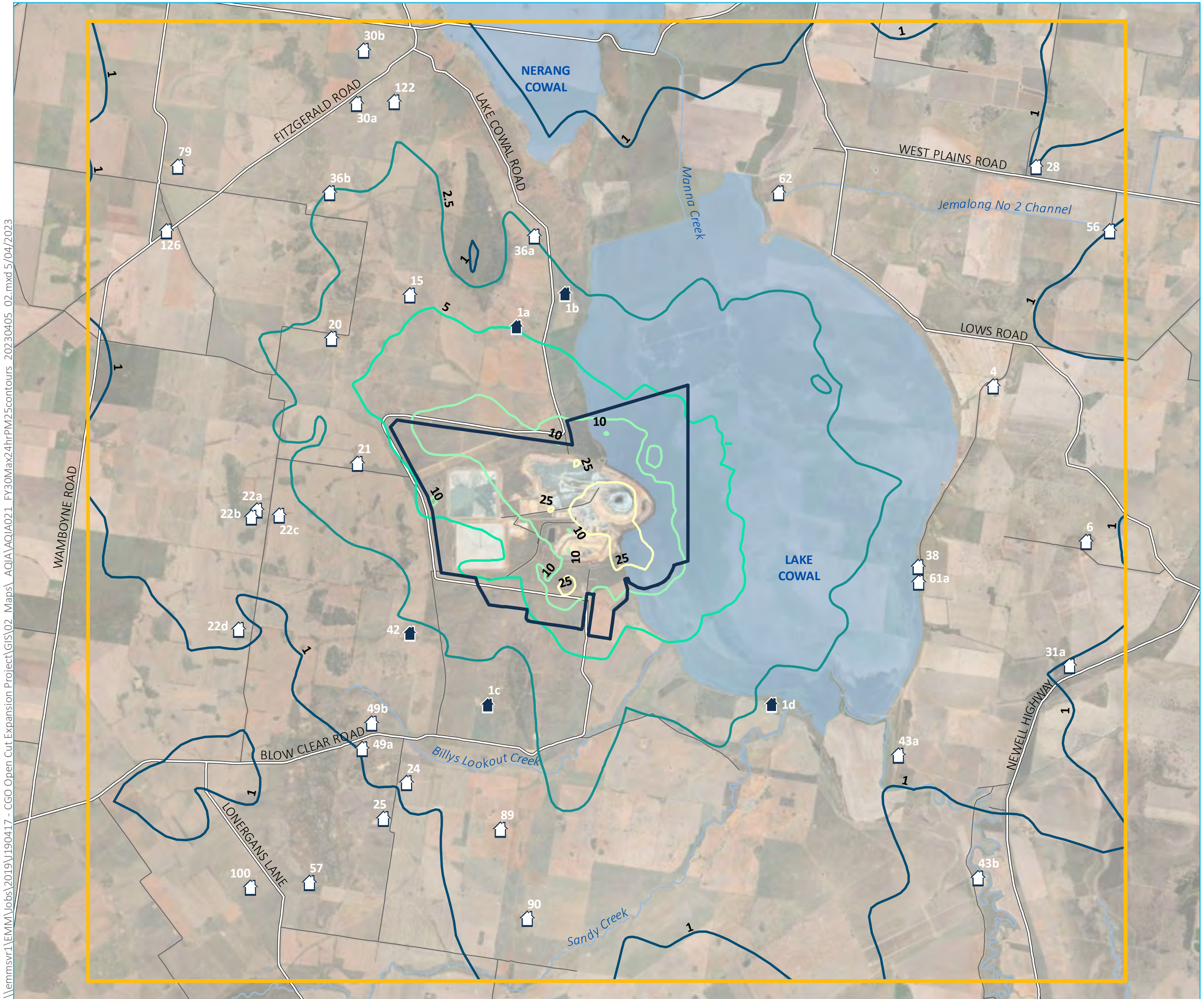
EMM creating opportunities

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps\AQ\AQIA019_FY30Max24hrPM10contours_20230405_02.mxd 5/04/2023



Predicted annual average PM_{10} concentrations (µg/m³) - FY30 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.15



Source: EMM (2023); Evolution (2023); DFSI (2017)

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA021_FY30Max24hrPM25contours_20230405_02.mxd 5/04/2023

KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

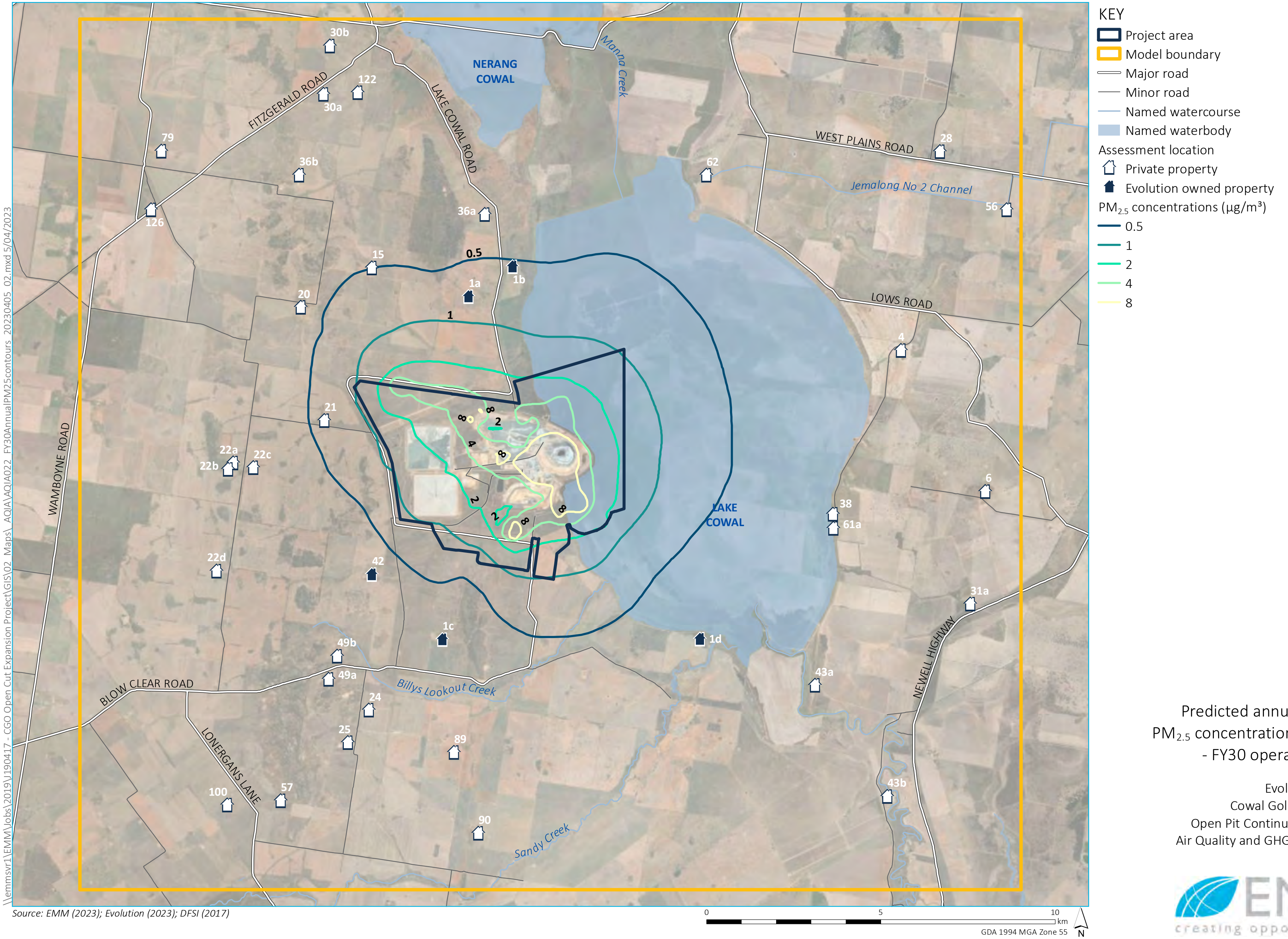
- Private property
- Evolution owned property

$PM_{2.5}$ concentrations (µg/m³)

- 1
- 2.5
- 5
- 10
- 25

Maximum predicted 24-hour average $PM_{2.5}$ concentrations (µg/m³) - FY30 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.16



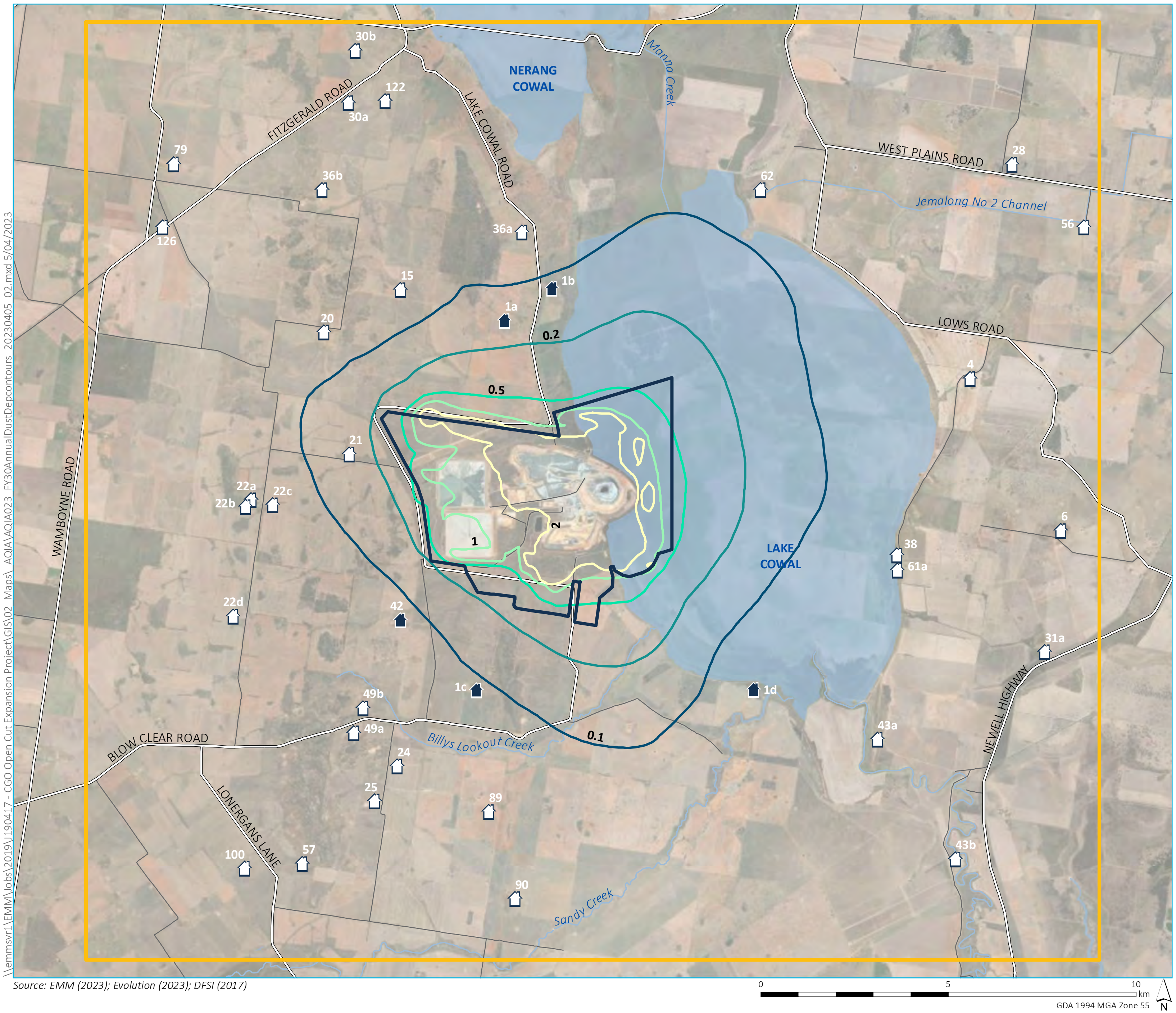
\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA022_FY30AnnualPM25contours_20230405_02.mxd 5/04/2023

Source: EMM (2023); Evolution (2023); DFSI (2017)

Predicted annual average $PM_{2.5}$ concentrations (µg/m³) - FY30 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.17

creating opportunities

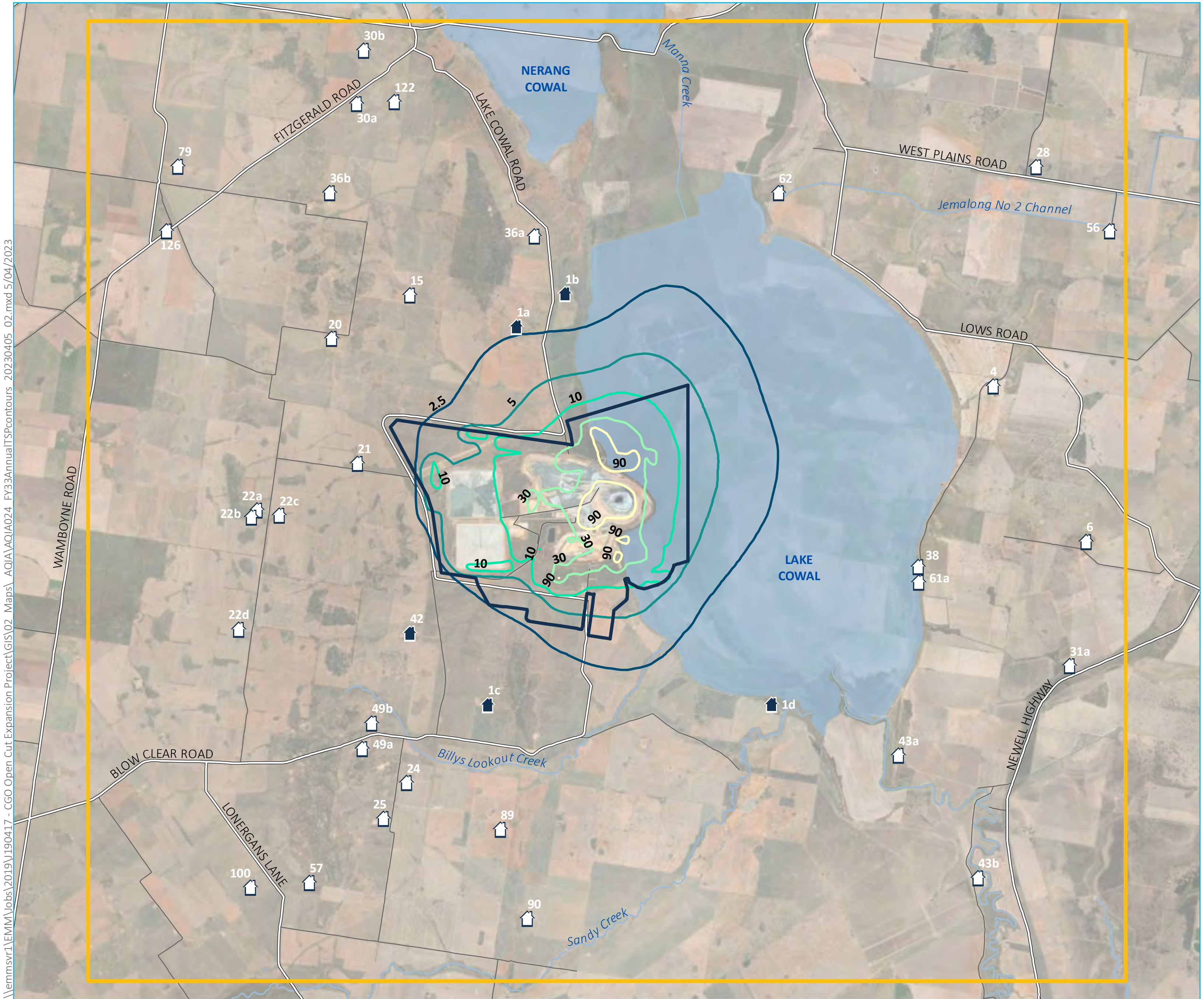


Source: EMM (2023); Evolution (2023); DFSI (2017)

Predicted annual average dust deposition levels (g/m²/month) - FY30 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.18

EMM creating opportunities



KEY
- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location
- Private property
- Evolution owned property

TSP concentration (µg/m³)
- 2.5
- 5
- 10
- 30
- 90

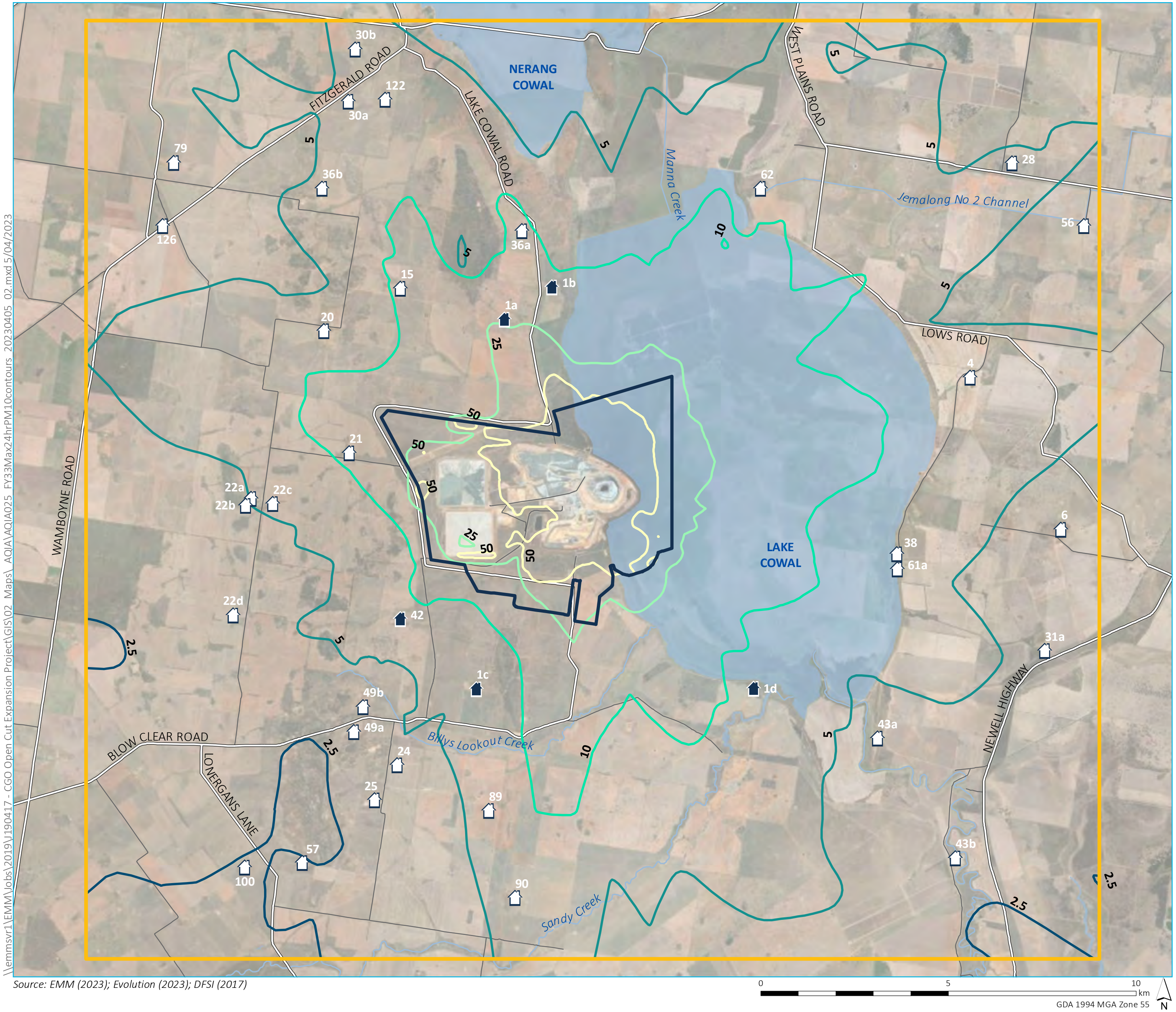
Source: EMM (2023); Evolution (2023); DFSI (2017)

Predicted annual average TSP concentrations (µg/m³) - FY33 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.19

EMM creating opportunities

\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps_AQIA\AQIA024_FY33AnnualTSPcontours_20230405_02.mxd 5/04/2023



Source: EMM (2023); Evolution (2023); DFSI (2017)

KEY
- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location
- Private property
- Evolution owned property

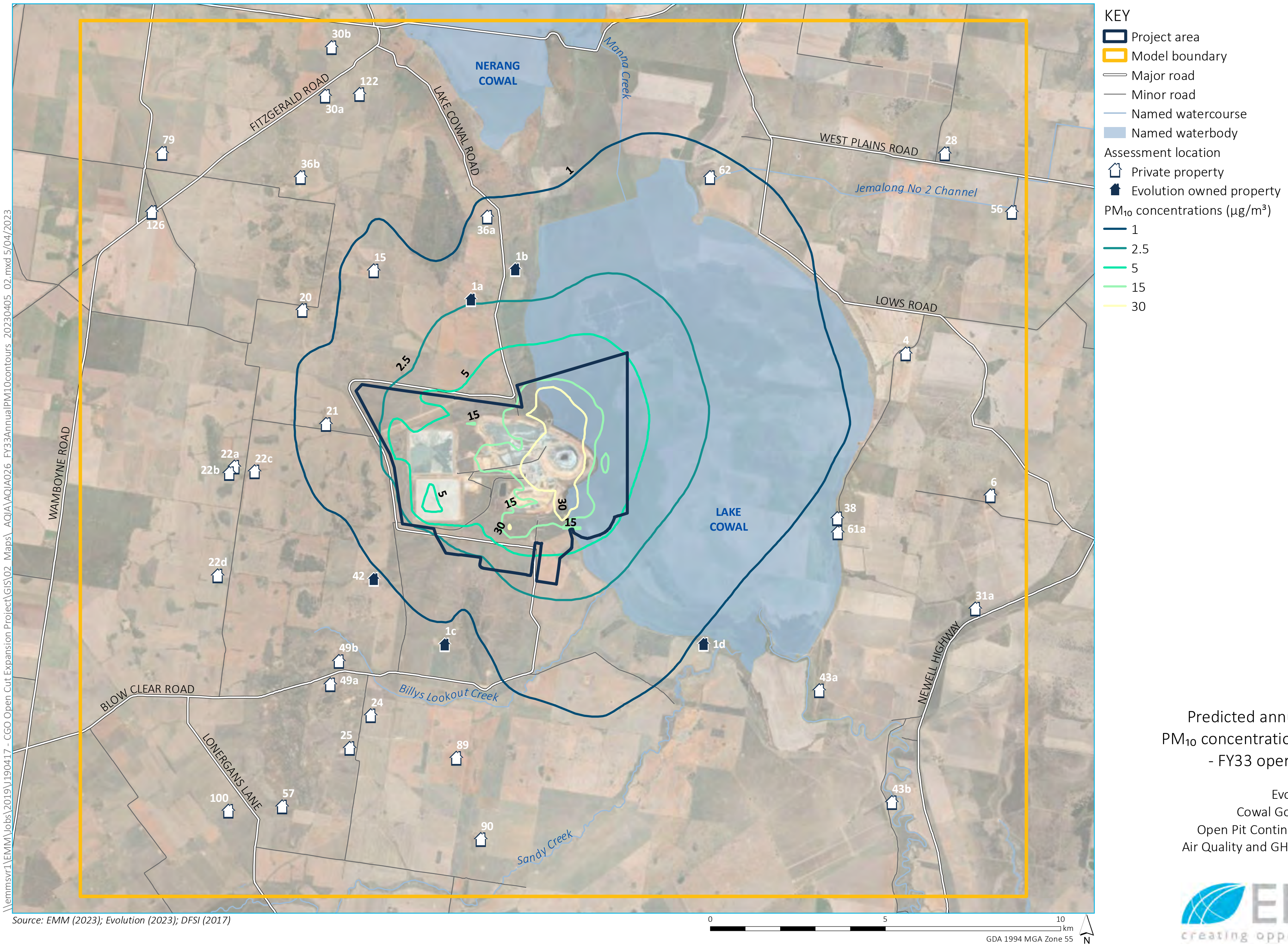
PM_{10} concentrations (µg/m³)
- 2.5
- 5
- 10
- 25
- 50

Maximum predicted 24-hour average PM_{10} concentrations (µg/m³) - FY33 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.20

EMM creating opportunities

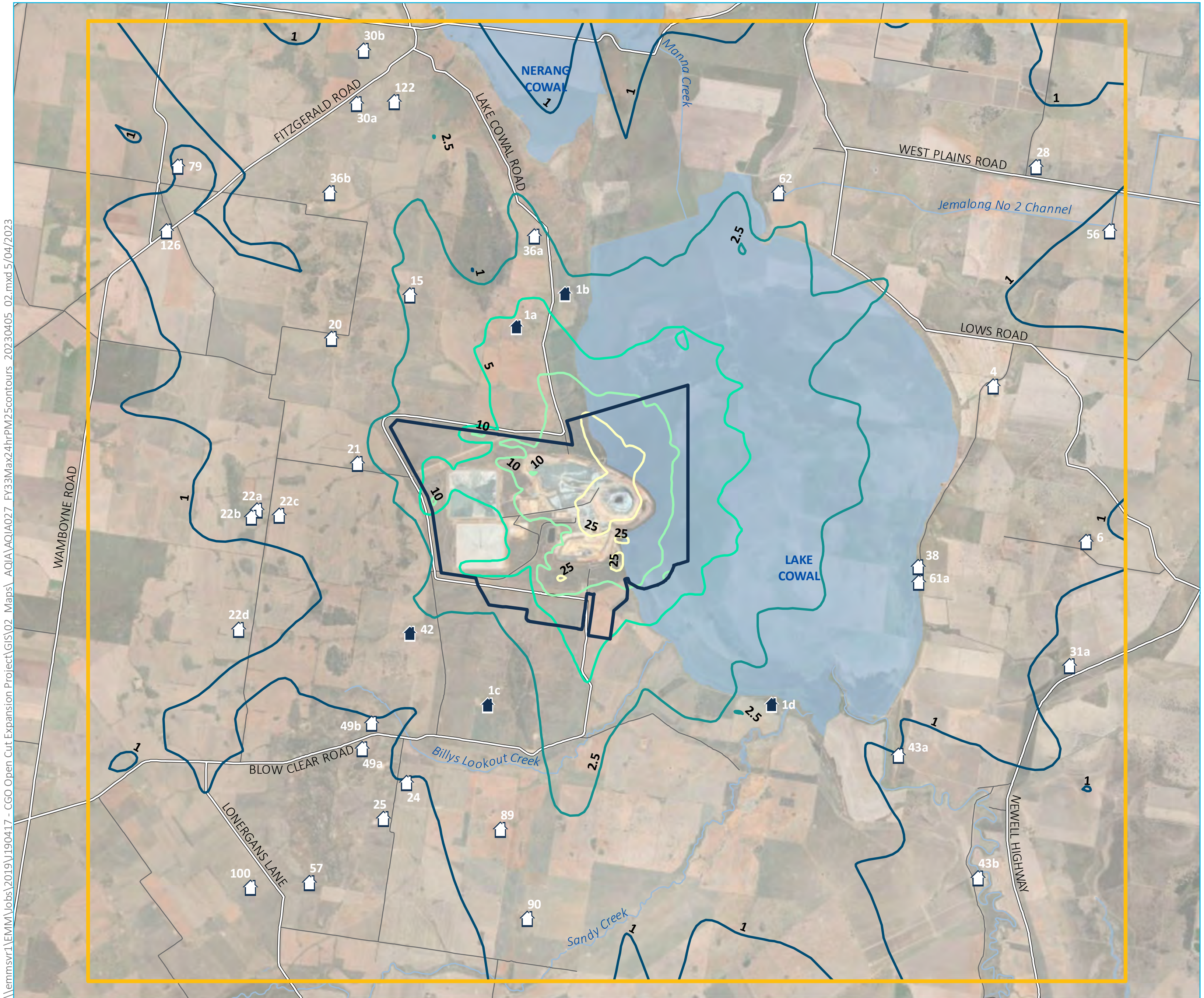
\\emmsvr1\EMM\Jobs\2019\J190417 - CGO Open Cut Expansion Project\GIS\02_Maps\AQIA\AQIA025_FY33Max24hrPM10contours_20230405_02.mxd 5/04/2023



Predicted annual average PM10 concentrations (µg/m³) - FY33 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.21

EMM creating opportunities



Source: EMM (2023); Evolution (2023); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

- Private property
- Evolution owned property

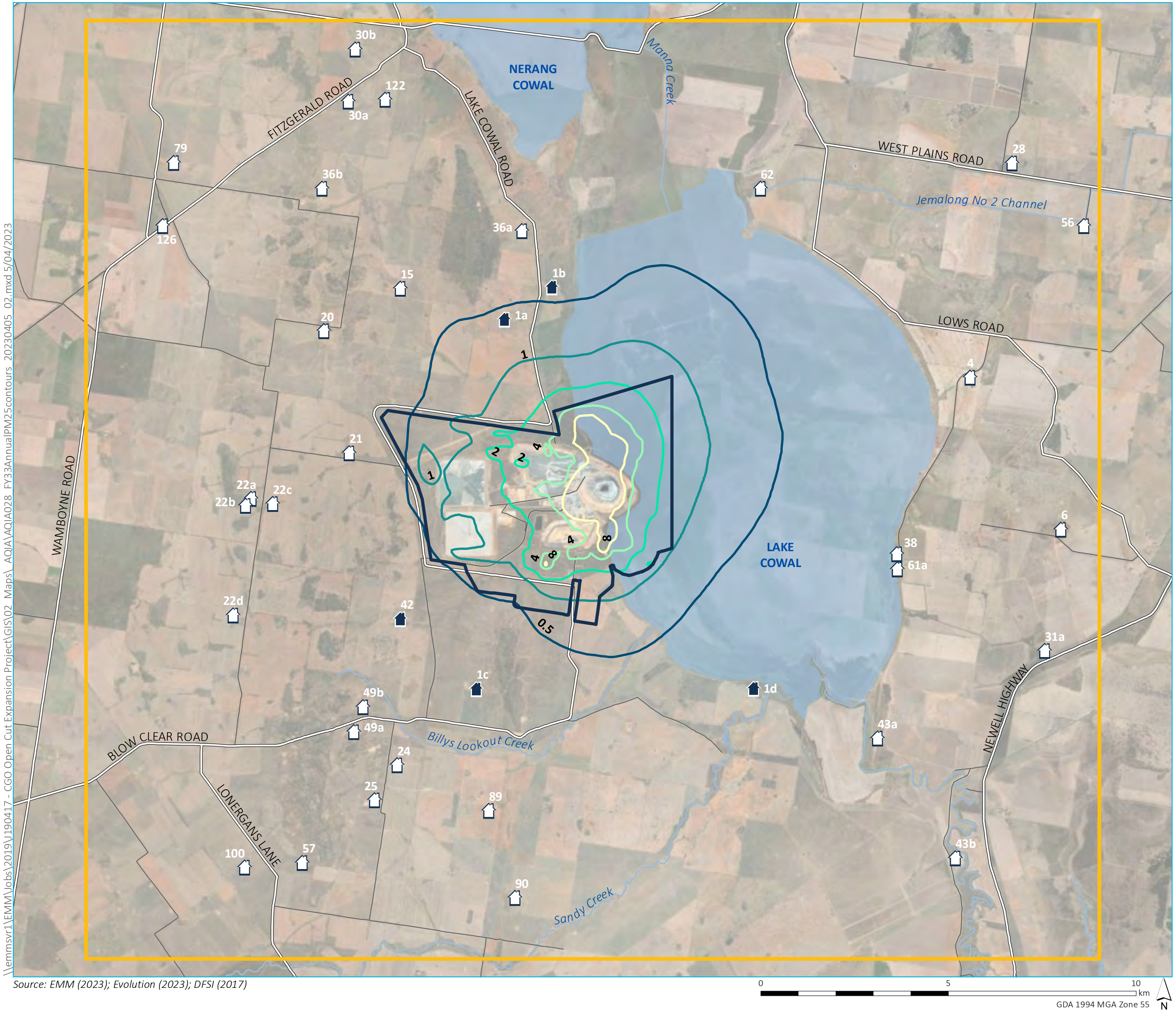
$PM_{2.5}$ concentrations (µg/m³)

- 1
- 2.5
- 5
- 10
- 25

Maximum predicted 24-hour average $PM_{2.5}$ concentrations (µg/m³) - FY33 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.22

EMM creating opportunities



Source: EMM (2023); Evolution (2023); DFSI (2017)

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KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

- Private property
- Evolution owned property

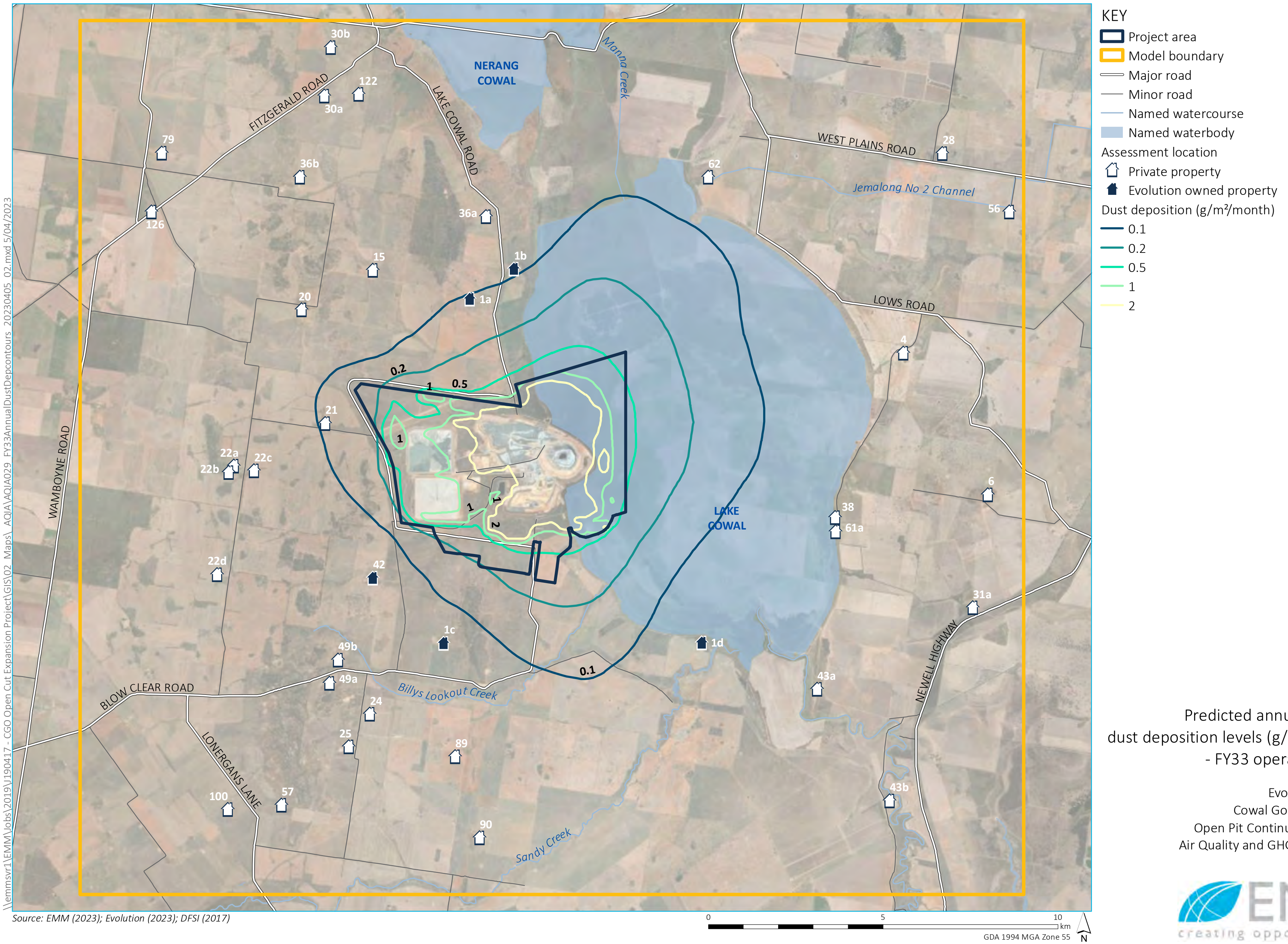
$PM_{2.5}$ concentrations (µg/m³)

- 0.5
- 1
- 2
- 4
- 8

Predicted annual average $PM_{2.5}$ concentrations (µg/m³) - FY33 operations only

Evolution Mining
Cowal Gold Operations
Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.23

EMM creating opportunities



Predicted annual average dust deposition levels (g/m²/month) - FY33 operations only

Evolution Mining
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Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.24

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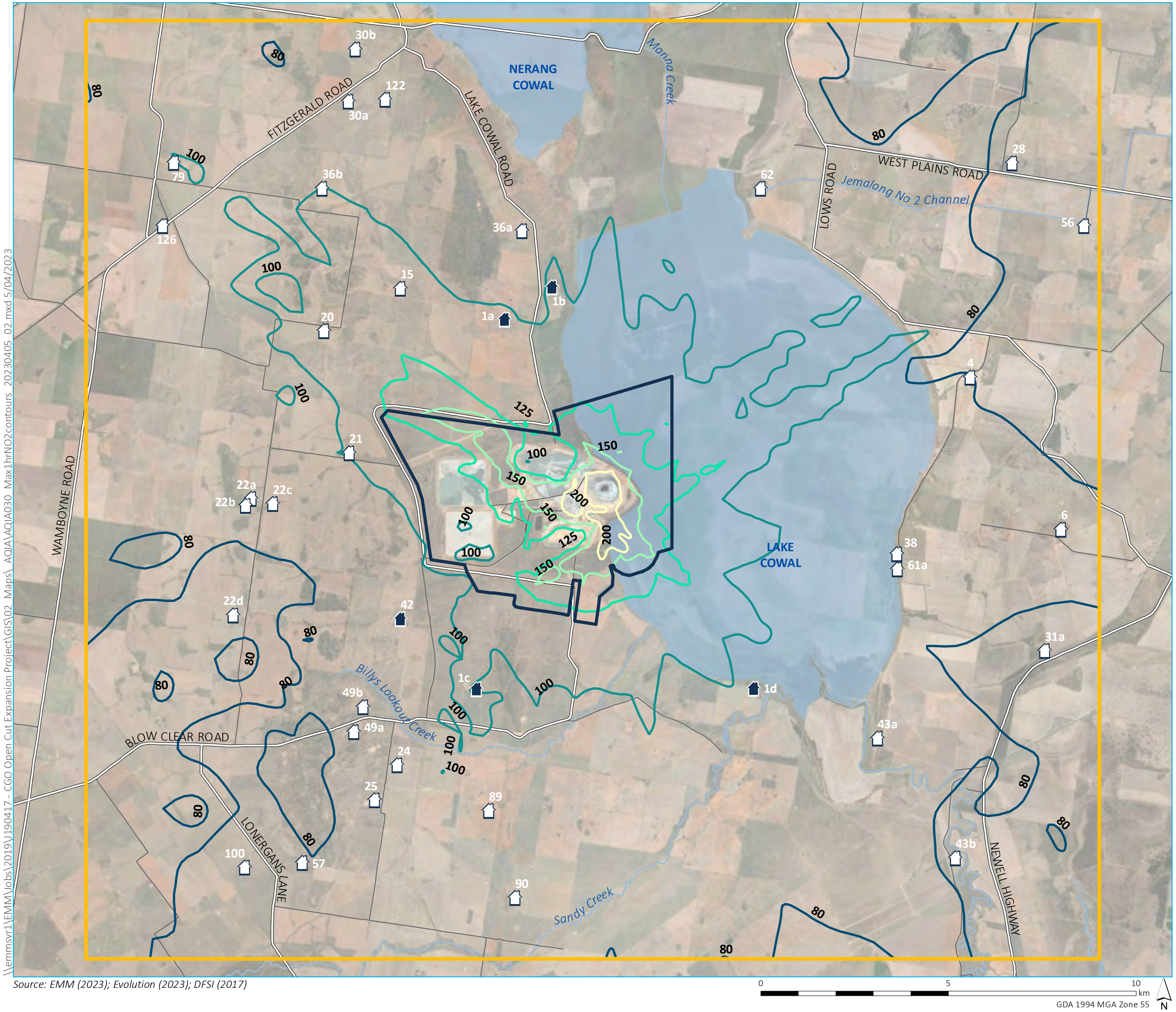

Source: EMM (2023); Evolution (2023); DFSI (2017)

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Maximum predicted 1-hour average NO_2 concentrations (µg/m³) - maximum diesel combustion operations only

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Open Pit Continuation Project
Air Quality and GHG Assessment
Figure C.25

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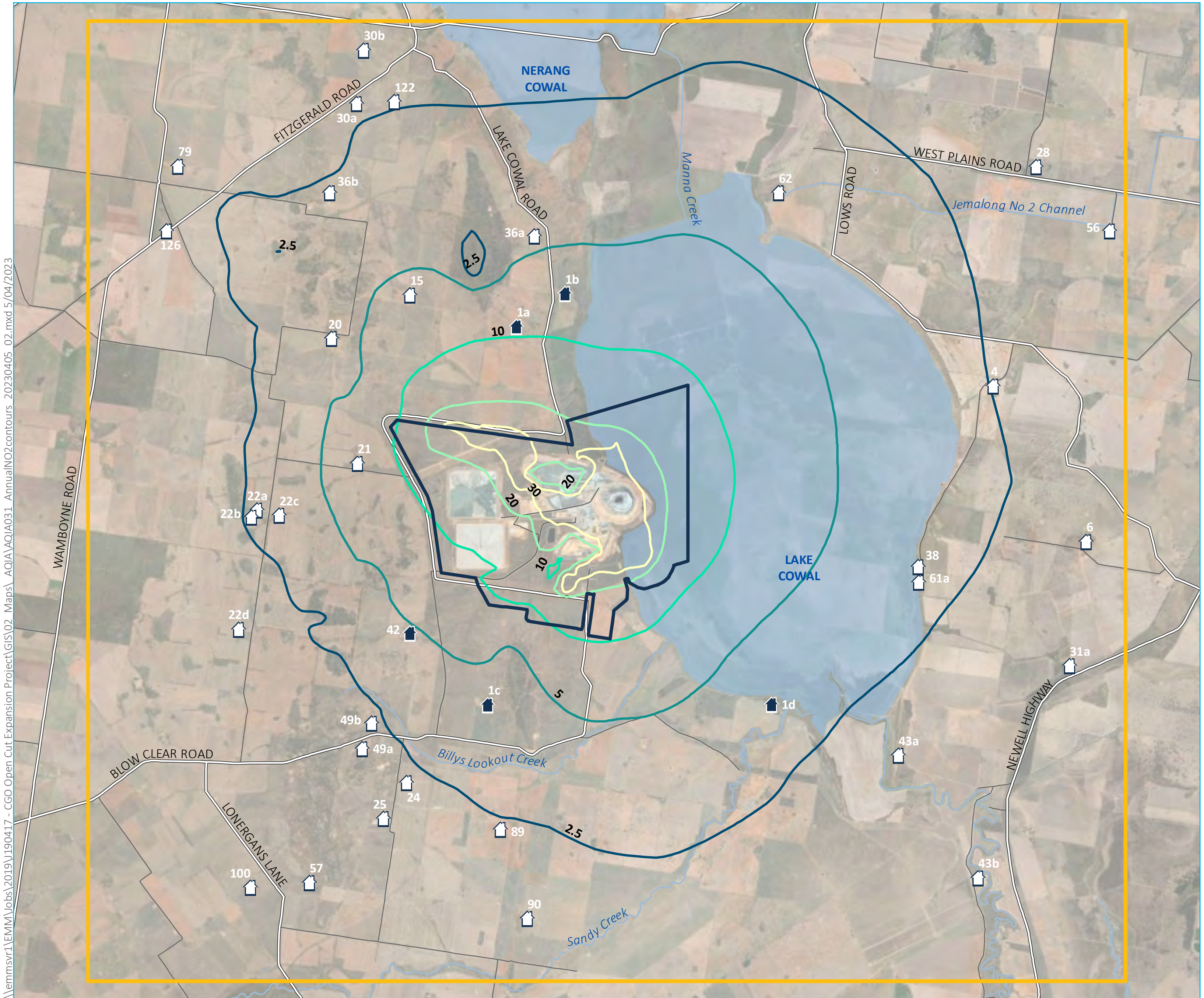

Source: EMM (2023); Evolution (2023); DFSI (2017)

0 5 10 km

GDA 1994 MGA Zone 55

N

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KEY

- Project area
- Model boundary
- Major road
- Minor road
- Named watercourse
- Named waterbody

Assessment location

- Private property
- Evolution owned property

NO_2 concentration (µg/m³)

- 2.5
- 5
- 10
- 20
- 30

Predicted annual average NO_2 concentrations (µg/m³) - maximum diesel combustion operations only

Evolution Mining
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Air Quality and GHG Assessment
Figure C.26

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