Appendix E

Air quality impact assessment

EMM creating opportunities

aurelia METALS Ltd.

New Cobar Complex Project State Significant Development (SSD10419)

Air Quality and Greenhouse Gas Assessment

Prepared for Peak Gold Mines Pty Ltd
December 2020

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New Cobar Complex Project State Significant Development (SSD10419)

Air Quality and Greenhouse Gas Assessment

Report Number

J190278 RP12

Client

Peak Gold Mines Pty Ltd

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Version

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Executive Summary

Peak Gold Mines Pty Ltd (PGM), a wholly owned and operated subsidiary of Aurelia Metals Limited (Aurelia), owns and operates the Peak Gold Mines operation south-east of Cobar, far western New South Wales (NSW). The New Cobar Complex Project State Significant Development (SSD) (the project) is an amalgamation of underground mining at New Cobar, Chesney and Jubilee deposits and development of new underground workings of the Great Cobar and Gladstone deposits to create the New Cobar Complex Project.

This air quality impact assessment (AQIA) has been prepared by EMM Consulting Pty Limited (EMM) on behalf of PGM, to assess potential air quality impacts associated with the Project on the surrounding environment. The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2016).

Existing environmental conditions were quantified primarily using data from the BoM Cobar Airport Automatic Weather Station (AWS) and air quality monitoring data collected in Cobar and Broken Hill.

Emissions of total suspended particulates (TSP), particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) and assorted metals and metalloids were quantified for all existing PGM operational sources at the New Cobar Complex and Peak Complex.

Additional emissions from the Great Cobar ventilation outlet and increased road truck transportation of ore material from New Cobar Complex to Peak Complex were also quantified. Emissions were quantified using publicly available emission estimation techniques and site-specific ventilation outlet monitoring data.

The atmospheric dispersion of air pollutant emissions for each mine development scenario was simulated using the AERMOD model.

The results of the dispersion modelling highlighted the following:

- impacts from existing operations do not result in exceedance of any applicable criteria at any private sensitive receptor location;
- the addition of emissions from the Great Cobar ventilation outlet increases predicted impacts, however all predicted concentrations and deposition rates are below application impact assessment criterion at all private sensitive receptor locations;
- the increase in transportation of ore from New Cobar Complex to Peak Complex by road trucks is not predicted to generate significant air quality impacts; and
- predicted concentrations of all metals and metalloids are negligible to very low at or beyond PGM boundary.

The emissions estimated for the six PGM ventilation outlets, including the Great Cobar ventilation outlet, were highly conservative, assuming constant emissions at full outlet fan capacity for the entire modelling period. Further, conservative emission concentrations were adopted in the emission calculations. Despite the high level of conservatism, the increased emissions from the Great Cobar ventilation outlet is not predicted to adversely impact the populated areas of Cobar.

A greenhouse gas (GHG) assessment was also undertaken for the Project. Annual scope 1 and 2 GHG emissions generated by the Project, accounting for existing and additional sources, represent approximately 0.058% of total GHG emissions for NSW and 0.013% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2018. The changes to emissions associated with the Project do not significantly alter annual GHG emissions from existing operations.

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1 Introduction

1.1 Overview

Peak Gold Mines Pty Ltd (PGM), a wholly owned and operated subsidiary of Aurelia Metals Limited (Aurelia), owns and operates the Peak Gold Mines operation south-east of Cobar, far western New South Wales (NSW) (see Figure 1.1).

The PGM operation comprises the New Cobar Complex located 3 kilometres (km) to the south-east of Cobar town centre and the Peak Complex located 10 km south-east of the town centre. Both complexes are located adjacent to Kidman Way, which connects Cobar to Hillston and Griffith to the south.

PGM has been operational since modern mining commenced at the Peak Complex in 1991 and all current mining operates under development approvals issued by Cobar Shire Council (CSC).

The New Cobar Complex Project State Significant Development (SSD) (the project) is an amalgamation of underground mining at New Cobar, Chesney and Jubilee deposits and development of new underground workings of the Great Cobar and Gladstone deposits to create the New Cobar Complex Project.

PGM is also seeking to consolidate all existing development approvals applicable to the New Cobar Complex into a single modern consent issued by the Department of Planning, Industry and Environment (DPIE). Approval will be sought for project elements accessed from, and undertaken within, the existing New Cobar Complex located within consolidated mining lease (CML) 6, mining purposes lease (MPL) 0854 and mining leases (ML) ML 1483 and ML 1805 (see Figure 1.2).

1.1.1 Background

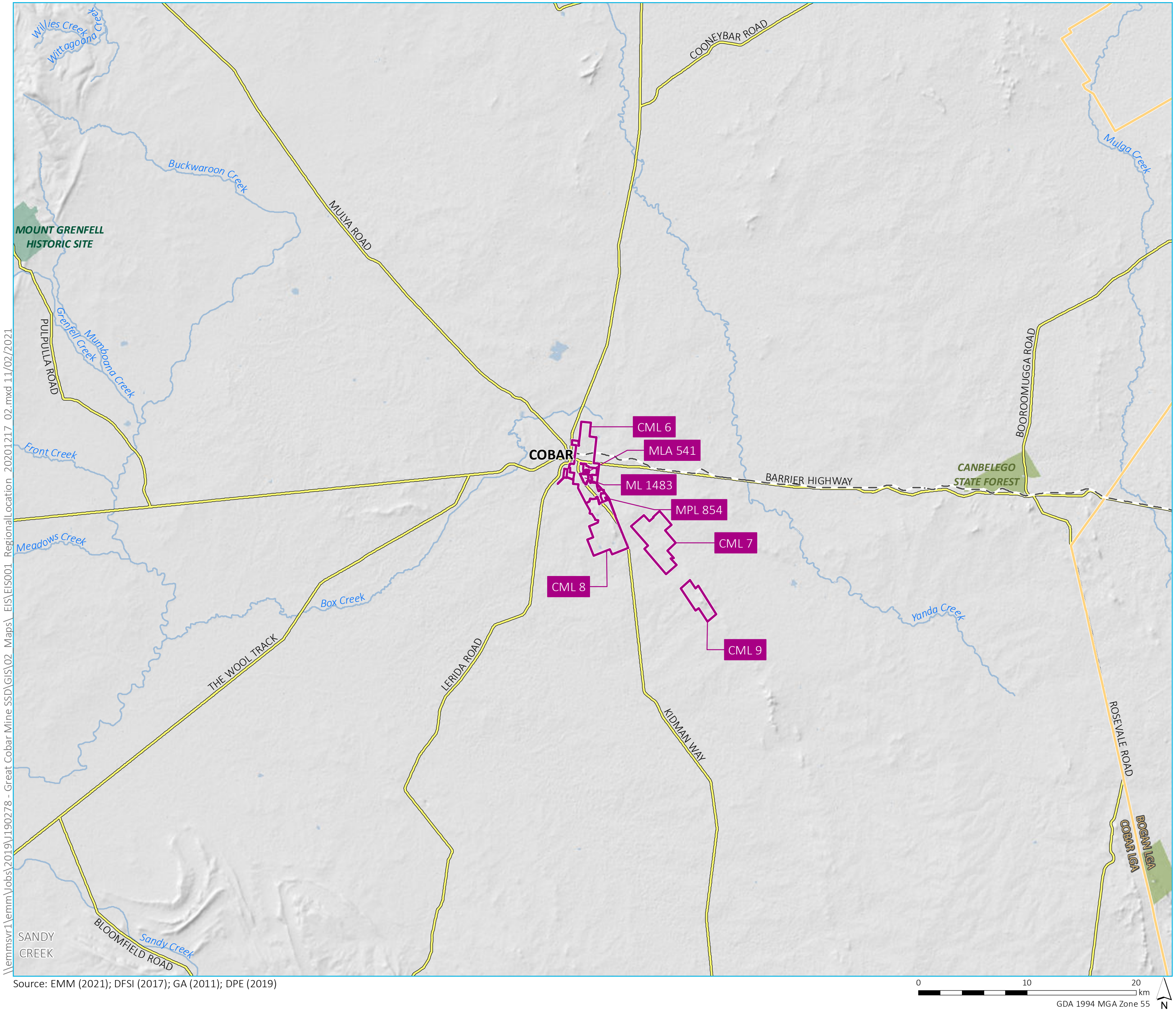
PGM has been operational since mining commenced at the Peak deposit in 1991 producing gold, copper, lead, zinc and silver. Mining at the New Cobar Complex commenced with the open cut in 2000, then transitioned to underground mining in 2004.

The current CSC development approvals at Peak Complex and New Cobar Complex allow for the operations to continue indefinitely and process up to 800,000 tonnes per annum (tpa) of ore. Ore processing, tailings storage and concentrate handling is undertaken at the Peak Complex with ore from the New Cobar Complex trucked by public road to processing facilities at the Peak Complex. Both the processing plant and the tailings storage facility (TSF) are located at the Peak Complex, and activities at those facilities are outside the scope of this project.

PGM has identified the Gladstone and Great Cobar deposits as targets for further mining to extend the life of operations at the New Cobar Complex. The Great Cobar deposit was historically exploited by surface and shallow underground mining between 1870 and 1919, but no mining of that deposit has been undertaken since that time.

PGM has obtained conditional approval for development of an exploration decline to facilitate exploration activities within the Great Cobar deposit. The objectives of the exploration activities are to:

- further define the mineral resource through underground drilling from an exploration decline; and
- taking of a bulk sample to provide further samples for metallurgical, geotechnical and associated test work.



KEY
- Mining lease boundary
- Rail line
- Major road
- Named watercourse
- Waterbody
- Local government area
- NPWS reserve
- State forest

Source: EMM (2021); DFSI (2017); GA (2011); DPE (2019)

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Regional location of the Peak Gold Mine

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure 1.1

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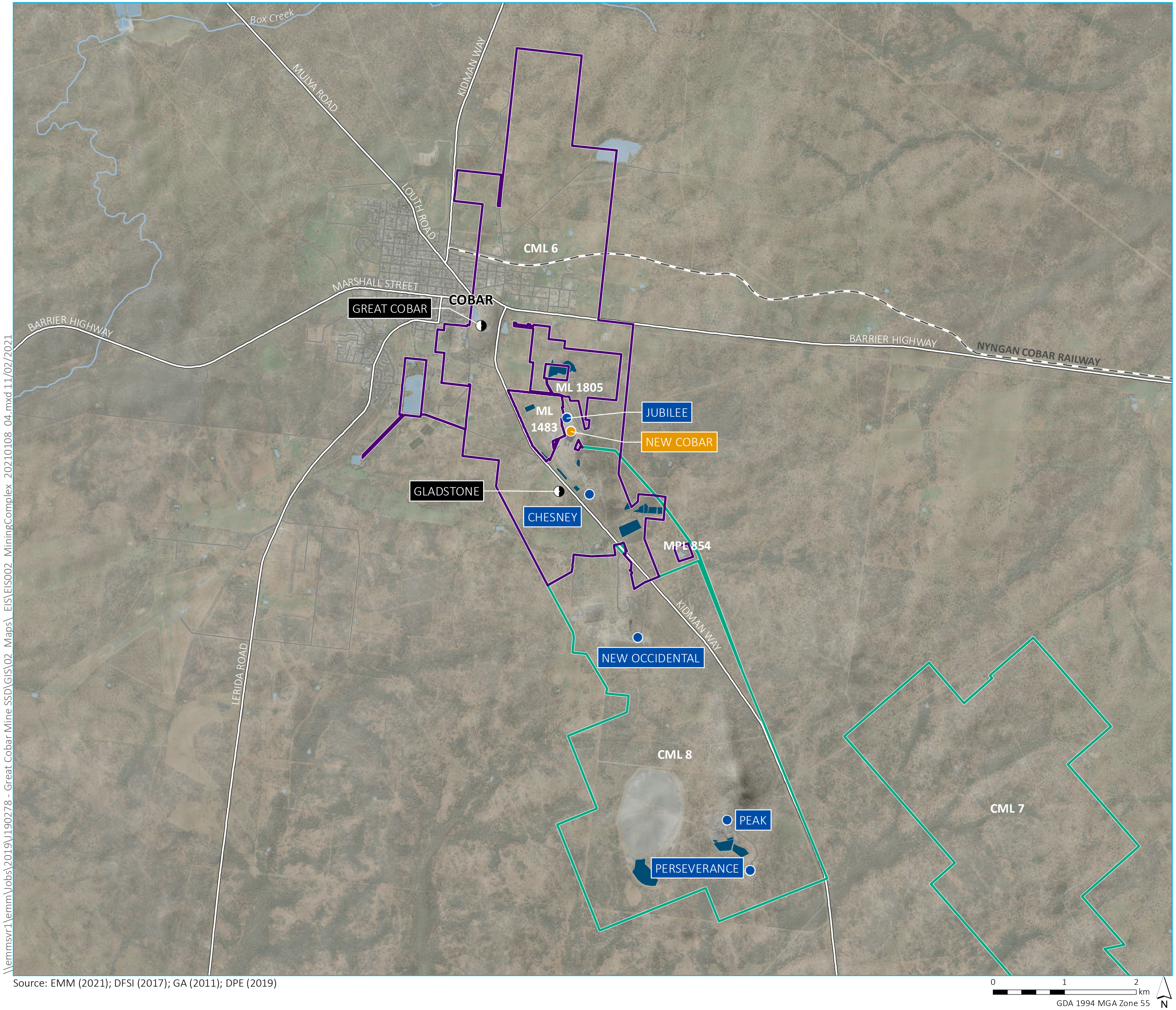

Source: EMM (2021); DFSI (2017); GA (2011); DPE (2019)

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Mining leases and mining complexes

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure 1.2

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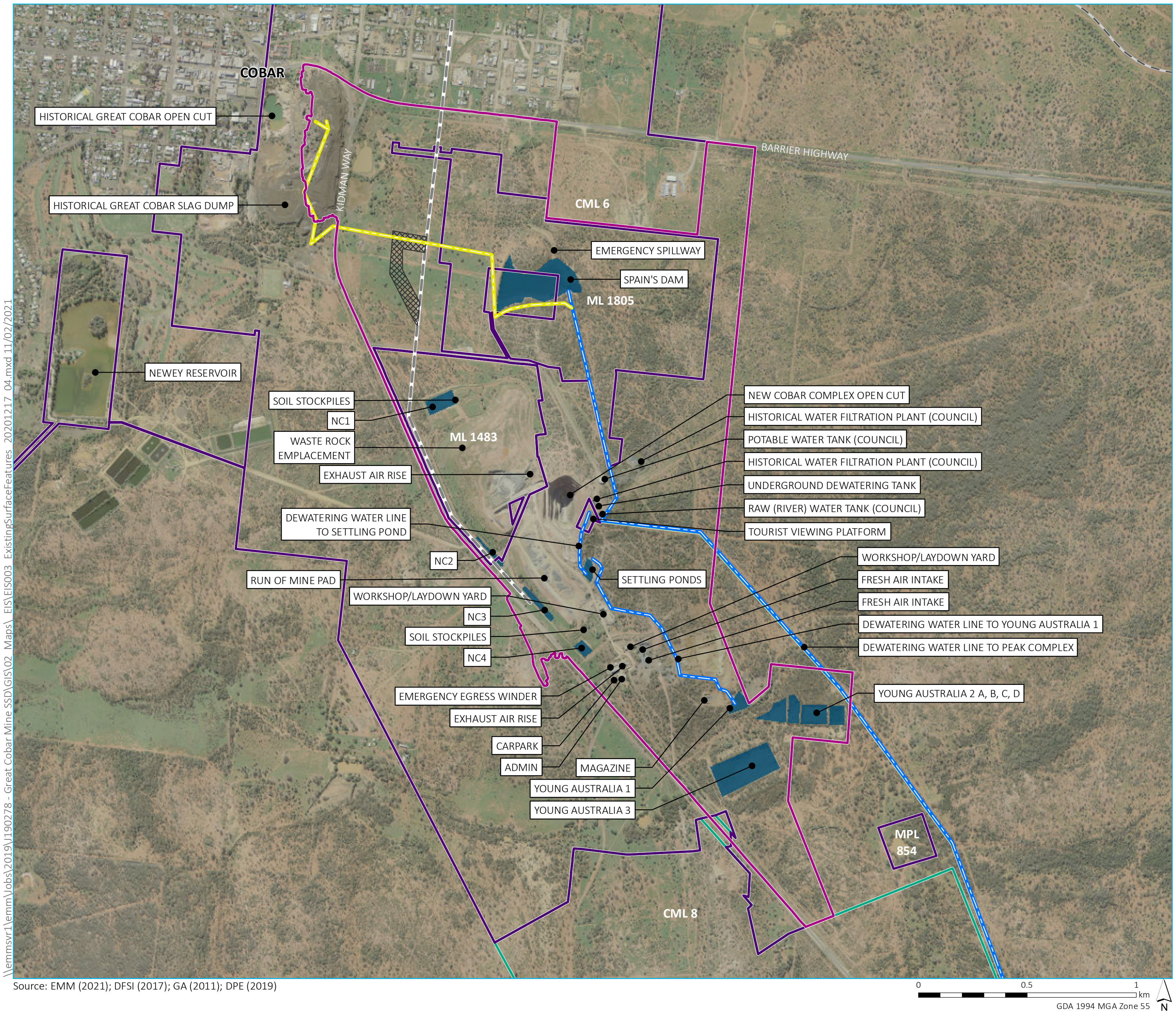
1.1.2 Project overview

All surface works associated with the project will be located underground or in the existing, operational mining New Cobar Complex (Figure 1.3) except for a short (no more than 400 m) power line from an existing 22 kilovolt (kV) line servicing PGM to a compact substation within the fresh air intake footprint (Figure 1.4).

PGM proposes to use the decline, infrastructure and intake and exhaust ventilation elements developed for the Great Cobar exploration decline (approved, but not yet constructed) to facilitate project development. Surface ventilation fans are not required during the development of exploration activities, however as they will be necessary during operation of mining, construction of a new power line and compact substation, to be located adjacent to the fresh air intake is required. The power line will continue to the exhaust air rise where a ventilation fan will be installed at a depth of approximately 100 m or greater below ground level (bgl). An emergency egress winder headframe and winder house will be installed at the fresh air intake for the purpose of mine rescue in the event of an incident below ground preventing evacuation by conventional means. No additional new surface infrastructure is proposed.

The existing surface infrastructure and facilities at the New Cobar Complex currently support underground mining of the New Cobar, Chesney and Jubilee deposits, and will continue to be used for this project. Access to all underground workings in the complex is from a portal and decline at the base of the New Cobar Complex open cut. SSD approval will be sought for the following project elements accessed from, and undertaken within, the existing New Cobar Complex:

- Underground mining of the New Cobar Complex including, but not limited to, New Cobar, Jubilee and Chesney (existing development approval issued by CSC).
- Underground mining of the New Cobar Complex including Great Cobar and Gladstone (not yet approved).
- Groundwater dewatering of the relevant historic and proposed underground workings via the historic Great Cobar Shaft (existing development approval issued by CSC).
- Increase of the number of ore haulage trucks between the New Cobar Complex and Peak Complex from 25 loaded trips per day (50 movements in and out) to 50 loaded trips (100 movements in and out) per day (daylight hours only) averaged over a calendar year. The increase of daily truck movements will provide flexibility to PGM if there are unforeseen production disruptions (eg bad weather).
- Crushing and screening of ore within the existing run-of-mine (ROM) pad (existing approval by CSC).
- Transportation of ore to the Peak Complex via Kidman Way for processing, using road registered heavy vehicles (existing approval by CSC).
- Harvesting of waste rock and:
    - immediately deploying the material underground for use in stope backfilling operations (waste rock will remain underground and will not be transported to the surface as a preference); and
    - transportation of non-acid forming material to the surface and storage within the existing waste rock emplacement (WRE) prior to use across the complexes for construction / rehabilitation tasks (eg tailings dam lifts).
- Deposition of potentially acid forming waste rock brought to the surface and stored within the WRE where at end of mine life it would be capped, or progressively returned underground for disposal.
- Continuation of all other approved activities within the New Cobar Complex.



Source: EMM (2021); DFSI (2017); GA (2011); DPE (2019)

Existing surface features

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure 1.3

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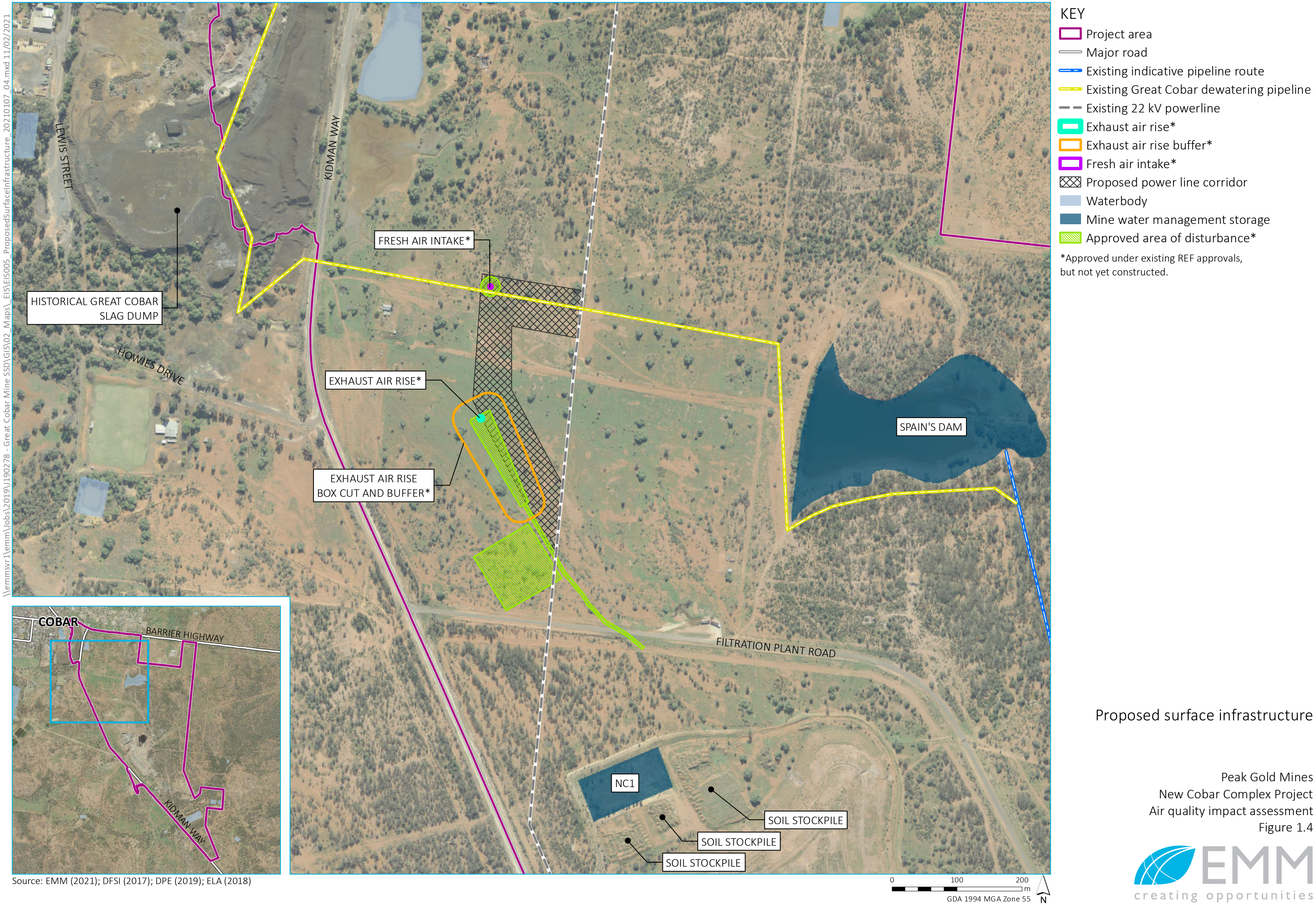

Source: EMM (2021); DFSI (2017); DPE (2019); ELA (2018)

Proposed surface infrastructure

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure 1.4

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Processing will remain at the Peak Complex at the existing approved rate of up to 800,000 tpa, with production of ore from the Great Cobar and Gladstone deposits making up for the future decrease in production from other workings across PGM.

Additionally, there are remaining resources in the New Cobar, Jubilee and Chesney deposits that are mineral rich, but which are currently not economical to mine in isolation. Keeping the New Cobar Complex operational and gaining access to Great Cobar and Gladstone deposits will lead to increases in economies of scale and maximise opportunities to mine these resources, and keep PGM operational until 2035.

1.2 Purpose of this report

EMM Consulting (EMM) has been engaged by PGM to prepare and submit an environmental impact statement (EIS) to support an SSD application for development consent under section 4.12 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). It has been prepared to the form and content requirements set out in clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) as well as clause 8(1) and clause 5 of Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). The Peak Complex, which is not part of this SSD application will continue to operate under local government (CSC) approvals, as there is no proposed change to this arrangement.

PGM requested Secretary's Environmental Assessment Requirements (SEARs) from DPIE for the SSD EIS in December 2019; these were received in February 2020, and were re-issued in October 2020 following the receipt of a Biodiversity Development Assessment Report waiver. The SEARs included a requirement to assess potential air quality risks associated with the construction and operation of the project. This AQIA has been prepared to address the relevant SEARs, provide information to be used in the EIS and support the SSD application for the project. The air quality related matters and EMM responses are tabulated below (Table 1.1).

The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA 2016), referred to from now on as "the Approved Methods for Modelling". This AQIA supports the EIS for the Project.

Table 1.1 Air quality related SEARs and agency requirements

Agency	Requirement	Location in report
DPIE	• **Air Quality –** including:	
	– an assessment of the likely air quality impacts of the development in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*, and having regard to the NSW Government's *Voluntary Land Acquisition and Mitigation Policy*; and	Section 8
	– an assessment of the likely greenhouse gas impacts of the development.	Section 10
NSW EPA	The AQIA should: 1. Dust generation and the management of potential impacts on adjacent rural residences during the construction and operational phases of the project. 2. the EIS must demonstrate the proposals ability to comply with the relevant regulatory framework, specially the Protection of the Environment Operations Act 1997 and the Protection of the Environment Operations (Clean Air) Regulation 2010. 3. The EIS must include an air quality impact assessment (AQIA). 4. The AQIA must be carried out in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2016). 5. The EA must detail emission control techniques/practices that will be employed at the site and identify how the proposed control techniques/practices will meet the requirements of the POEO Act, POEO (Clean Air) Regulation and associate air quality limits or guideline criteria.	1. Section 7, Section 8 2. Sections 3, 4 3. Entire document 4. Entire document 5. Section 7, Section 8

2 Project summary

Specific details of the project are presented in Table 2.1 in the context of existing PGM approvals. For a full, detailed project description, please see Chapter 2 of the New Cobar Complex EIS.

Table 2.1 Detailed overview of the project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Tenement	Development approved to occur within the Development Application areas, including consolidated mining lease (CML) 6, CML 8, mining lease (ML) 1483, ML 1805 and mining purposes lease (MPL) 854. Mining of the following deposits using underground mining methods, with each deposit accessed via the New Cobar Complex open cut: • New Cobar deposit; • Chesney deposit; and • Jubilee deposit. Minerals processing occurs at the Peak Complex within CML 8 and also includes CML 7 and CML 9.	No change to mine lease area. Mining of the following deposits using underground mining methods, with each deposit accessed via the New Cobar open cut: • New Cobar deposit; • Chesney deposit; • Jubilee deposit; • Gladstone deposit; and • Great Cobar deposit. Processing of materials from the New Cobar Complex will continue at the Peak Complex within CML8 under existing approvals and is therefore outside the scope for this project.
Approvals	***Cobar Shire Council Development Consent*** • New Cobar South Open Cut - LDA 98/99:08 • New Cobar Open Cut - LDA 99/00:22 • New Cobar Underground – 2004/LDA 00003 PGM has received approval from CSC and the Resources Regulator (reference number MAAG0006783, approved in May 2020) to construct an exploration decline, ventilation shafts and associated infrastructure to facilitate exploration activities within the Great Cobar deposit. This is detailed in the Mine Operations Plan (MoP) for 2019-2022. ***Other Authorisations and Licences*** • Environment Protection Licence (EPL) -3596 (EPA) • Licence to Manufacture Explosives (New Cobar) - XMNKF200002 (SafeWork NSW) • Dangerous Goods Notification - New Cobar: 35/035154 (SafeWork NSW). • Water Supply Works Approval reference 85WA753861 (Natural Resources Access Regulator)	PGM is seeking to consolidate all existing development consents applicable to the New Cobar Complex including existing mining, proposed underground mining of the Great Cobar and Gladstone deposits and existing surface infrastructure within a single consent issued by DPIE. Once approved, relevant CSC development consents for the New Cobar Complex will be surrendered. The project will used infrastructure that has been approved but not yet constructed as a result of the exploration decline and associated infrastructure. Other approvals related to the Peak Complex, will be unaffected.
Mining method	Underground stope mining operations commence above a centrally positioned crown pillar and stopes will be extracted from the bottom-up. Bench stopes are backfilled progressively using waste from development and rock from the WRE. Upon completion of each stoping level, voids are backfilled. In some instances, mining against rock fill is required. In these instances, a	Expansion of underground stope mining operations will access new deposits at Great Cobar and Gladstone, as well as continued mining of New Cobar, Chesney and Jubilee deposits. The mining method will not change. There is no recorded history of significant subsidence or geotechnical failure associated with the current, modern mining operations at the Peak and New Cobar complexes.

Table 2.1 Detailed overview of the project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
	rock and cement slurry is placed in the stope to provide additional stability. PGM undertake detailed geotechnical assessments of all stopes during the detailed stope design stage prior to mining.	
Blasting	Blasting will be used for the development of the underground workings and is proposed to occur under independent firing conditions (in the preliminary phases). Delays will be used to adjust sequencing and prevent any interaction or vibration enhancement from adjacent blastholes. The approximate number of blasts will be three per 24-hour period, 20 per 7-day period. Explosives are stored in the existing magazine at New Cobar Complex.	No change to blasting method.
Life of mine	Presently, the council approvals have no end date. Current mine plans envisage mining at New Cobar Complex to continue until 2023 under current market assumptions.	The project will extend the life of mine by 12 years to 2035 under current market assumptions.
Production	Approved for the mining and processing of 800,000 tpa of ore to produce lead, zinc, copper, gold and silver from both the Peak and New Cobar complexes. Processing occurs at the Peak Complex.	The project will produce ore within the mining and processing limit of 800,000 tpa for the Peak and New Cobar complexes. Ore will be transported to the existing processing plant at the Peak Complex. The ore will be processed at the Peak Complex processing plant, and tailings will be disposed of at the TSF at the Peak Complex under existing approvals. Processing of ore will only take place at the Peak Complex, therefore is outside the scope of this project.
Mining extent	The New Cobar Complex comprises a surface disturbance area of approximately 425 hectares. The New Cobar open cut pit extends to a depth of approximately 100 mbgl. Development of underground working at Chesney, Jubilee and New Cobar deposits extends from a portal at the base of the New Cobar open cut pit.	Development of New Cobar Complex Project will be in stages. The Great Cobar and Gladstone deposits will be accessed via a decline extending from the existing New Cobar Complex underground workings. The proposed underground working depths are approximately 150–800 mbgl for Great Cobar and 350-500 mbgl for Gladstone. The Great Cobar deposit will be accessed by the approved exploration decline off the existing Jubilee workings at approximately 500 mbgl, and the Gladstone deposit will be accessed by a decline off the existing New Cobar underground workings at approximately 350 mbgl.
Tailings storage	All ore is processed at the Peak Complex, with tailings placed within the TSF.	No change.

Table 2.1 Detailed overview of the project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Site access	Access to the New Cobar and Peak complexes is via Kidman Way.	No change
Ore transportation	Ore is transported from the New Cobar Complex along 5 km of public road (Kidman Way) in road registered trucks at the rate of 25 trucks (50 truck movements) per day, seven days a week.	Ore will continue to be transported from the New Cobar Complex but at a maximum rate of 100 truck movements per day (in and out of site) (daylight hours only), seven days a week averaged over a calendar year. This is an increase in truck movements from a current maximum rate of 50 truck movements per day. The increase of daily truck movements will provide flexibility to PGM if there are unforeseen production disruptions such as poor weather or machinery breakdowns.
Waste rock management	Waste rock generated from underground workings is used preferentially as backfill in previously mined underground stopes. Some waste rock material may be brought to the surface and stored within the existing WRE at the New Cobar Complex until it's required for use in construction or rehabilitation across the Peak and New Cobar complexes.	No change
Soil management	Application of soil resources management strategies/objectives in accordance with the existing Mining Operation Plan 2019-2022 (MOP 2019-2022) (PGM 2019) and Water Management Plan (PGM 2020)).	No change.
Mine ventilation	There are two existing exhaust air rises at the New Cobar Complex – one at the Jubilee workings and one at the Chesney workings. Fresh air is drawn down the portal at the base of the New Cobar Complex open cut and also via two fresh air intakes located near the Chesney ventilation fan. The infrastructure developed as part of the Great Cobar exploration decline will include an exhaust air rise and a fresh air intake.	No new ventilation shafts will be required; the ventilation shafts installed as part of the exploration decline will be required for ongoing mining operations and will remain in place. A new ventilation fan will be required to maintain a safe volume of air flow in the underground workings.
Surface infrastructure	All existing New Cobar Complex surface infrastructure operates under existing CSC approvals.	The project will require the construction of a short (no more than 400 m long) power line spur between an existing 22 kV line and ventilation shaft (approved, but not yet constructed as part of the Great Cobar exploration decline approvals). This power line will connect to a pad-mounted compact substation to supply power for an emergency egress winder at the fresh air intake shaft and a ventilation fan to be installed at the exhaust air rise. No additional surface infrastructure will be required.

Table 2.1 Detailed overview of the project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Water supply sources and infrastructure	The water requirements for the Peak Complex and the New Cobar Complex (combined) are approximately 580 ML/year. The source of this water is typically, comprised of approximately 212 ML/year from dewatering underground workings at the New Cobar Complex and approximately 368 ML/year of town water from Burrendong Dam. PGM is licenced to take up to 1,186ML/year from Burrendong Dam, however approximately 50% of this water is lost through seepage, evaporation and other methods before arriving at the New Cobar Complex. Following approval for the dewatering of the Great Cobar shaft in 2019, up to 400 ML/year can be extracted to replace the town water currently being used. This is as part of a move for PGM's operations to be more self-reliant and sustainable in times of drought. The water from the Great Cobar shaft will be used to make up any shortfall in site demand that cannot be made up by dewatering of underground workings. It will also reduce PGM's reliance on the town water supply during times of drought.	No change
Site water management infrastructure	A water management system is in place at the New Cobar Complex and is operated and managed in accordance with PGM's current water management plan (WMP). Dewatering water that is used in the New Cobar Complex underground workings is pumped to the New Cobar Complex settling pond for re-use. The water from these settling ponds is preferentially pumped back underground for reuse, or to the Peak Complex for use in the processing circuit. While it is PGM's preference to use water from dewatered mine workings for processing, this may not always be possible due to poor water quality and additional treatment requirements. Dewatering water excess to site requirements is pumped to Spain's Dam or Young Australia Dams for evaporation or storage for future reuse.	No change
Power supply	Electricity to the site is via a 22 kilovolt (kV) electricity transmission line (ETL) to the Peak Complex substation.	No change to power supply, but an additional power line spur will be required for the ventilation fan to be installed in the exhaust air rise and the emergency egress winder.
Hours of operation	Underground and above ground activities, 24-hour operations, seven days a week.	No change
Employment	The 2019/2020 workforce at PGM (including both the Peak and New Cobar complexes) totalled 404 full time equivalents (FTE).	Annual labour estimates for New Cobar Complex, being mining and underground maintenance staff range from 57 FTE in 2020/21 to a peak of 272 FTE in 2026/27. These however are not new employees; during the same period, as mining at the Peak Complex ramps down, staff will relocate to New Cobar Complex as their primary location of employment activity. PGM will continue to maintain operational control across the complexes.

Table 2.1 Detailed overview of the project

Development component	Approved New Cobar Complex operations	New Cobar Complex Project SSD
Mining fleet	The existing/approved indicative mobile equipment fleet used for underground ore extraction, transport and waste rock handling includes: • articulated dump trucks; • cabletec; • compactors; • dozers; • drill rigs. • excavators; • graders; • haul trucks (50t); • jumbos; • LHD Loading dump trucks; • loaders; • rollers; • scrapers; • service truck; • underground development drill; • underground diamond drill rigs; • waste rock dump trucks; and • water trucks.	No change
Rehabilitation and mine closure	Current rehabilitation requirements as per MOP	Mine closure concepts and management measures will continue to be developed via the MOP 2019-2022, which outlines specific soil handling, rehabilitation and post mining landform objectives, in consultation with relevant regulatory authorities. The MOP will be updated and extended as required.

3 Assessment approach

This AQIA was conducted in general accordance with the guidelines specified by the NSW EPA in the Approved Methods for Modelling. Consistent with Section 2.1 of the Approved Methods for Modelling, this AQIA is classed as a 'Level 2' assessment, consisting of a refined dispersion modelling approach using site-specific and/or representative inputs.

The AQIA consists of the following sections:

- a description of the local setting and surrounds of the Project;
- the pollutants which are relevant to the assessment, and the applicable impact assessment criteria;
- a description of the existing environment, specifically:
  - the meteorology and climate; and
  - the existing air quality environment;
- a detailed air pollutant emissions inventory for the Project;
- atmospheric dispersion modelling, including an analysis of Project-only and cumulative impacts accounting for baseline air quality;
- an overview of mitigation measures and air quality monitoring for the Project; and
- a greenhouse gas assessment.

The construction phase is expected to take six months to complete. From an air quality perspective, potential air pollutant emissions from the construction phase will be minor and short term in nature. Consequently, there is limited potential for adverse impacts from construction phase emission. No further consideration of construction phase emissions was completed in this assessment.

PGM has obtained approval for development of an exploration decline to target deeper resources (700-800 m bgl) within the Great Cobar deposit for ore evaluation. PGM proposes to use the decline, infrastructure and intake and exhaust ventilation elements developed for the Great Cobar exploration decline to facilitate the proposed development. The approved area of disturbance for the exhaust air rise is 0.47 ha. PGM will micro-site the outlet within this area, with the final location selected based on the best construction and operational (flow and dispersion) performance parameters. For the purpose of modelling air quality effects, the exhaust air rise was modelled at the closest point of the approved disturbance footprint to Cobar Town. Therefore, air quality effects modelled for the assessment of impact are considered to be a realistic worst-case output.

3.1 Surrounding assessment locations

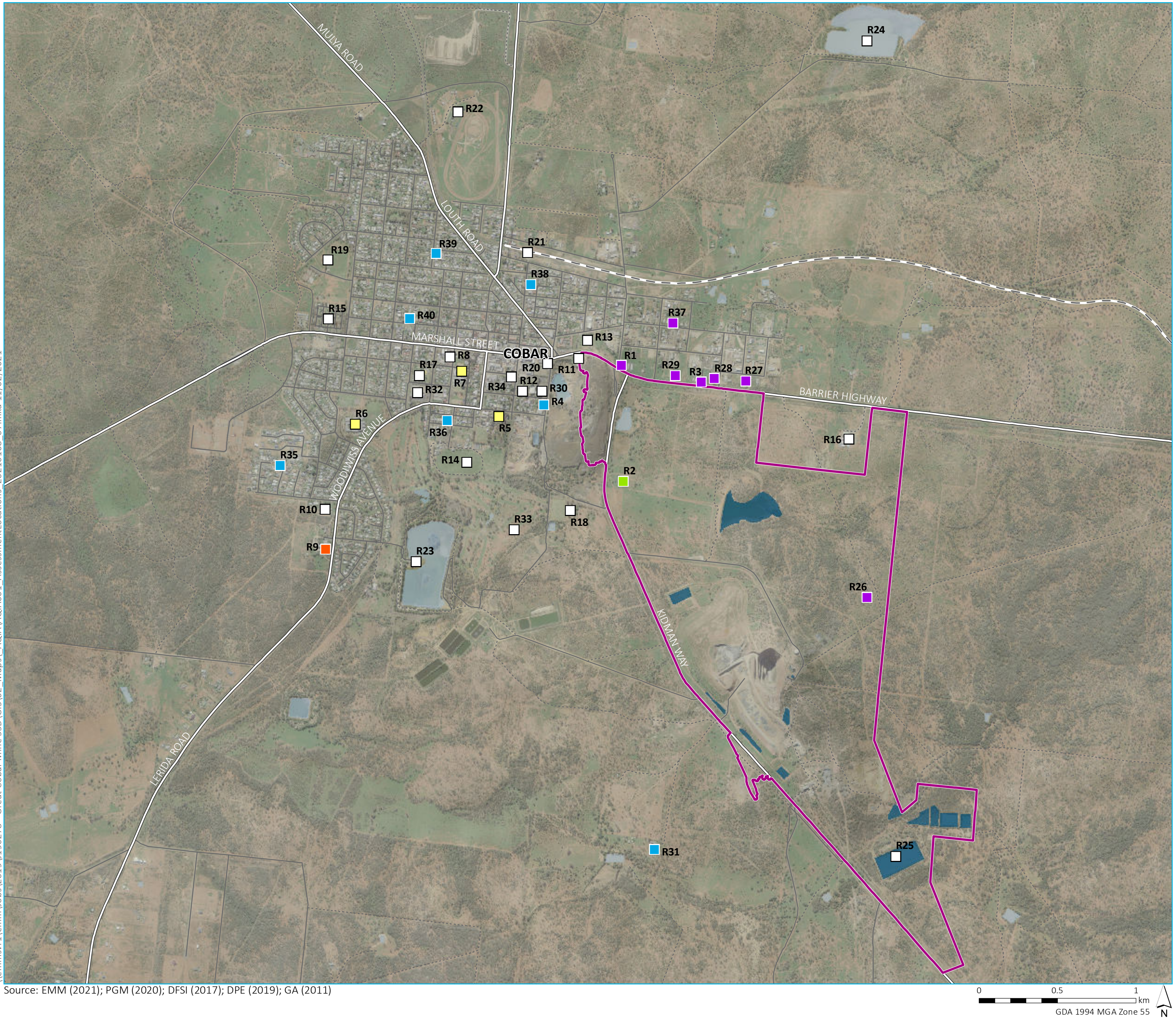
A selection of potential sensitive receptors, considered to be representative of the surrounding environment, were adopted as assessment locations for the prediction of air quality impacts from the Project. A mixture of residential, industrial, educational, commercial, health care and recreational locations have been selected. Details are provided in Table 3.1 and their locations are shown in Figure 3.1.

Table 3.1 Representative assessment locations

Assessment location ID	Type	Description	Easting	Northing
R1	Industrial (residence)	82 Old Bourke Road	390352	6514550
R2	Mine-owned residence	Cornish Town House (PGM Owned)	390363	6513810
R3	Industrial (residence)	13 Nyngan Road	390861	6514443
R4	Privately-owned residence	2-4 Harcourt Street	389856	6514298
R5	School	Cobar Public School	389571	6514224
R6	School	Cobar High School	388655	6514176
R7	School	St Johns Primary School	389332	6514512
R8	Child Care Centre	Kubby Child Care	389258	6514603
R9	Hospital	Cobar Hospital	388463	6513378
R10	Nursing Home	Lillian Brady Nursing Home	388460	6513631
R11	Cultural centre	Great Cobar Heritage Centre	390079	6514596
R12	Active recreation	Drummond Park	389722	6514385
R13	Passive recreation	Cobar Miners Heritage Park	390135	6514712
R14	Active recreation	Ward Oval	389366	6513933
R15	Caravan Park	Cobar Caravan Park	388481	6514847
R16	Mine camp	TJ Hospitality Group Accommodation	391805	6514080
R17	Active recreation	Cobar Swimming Pool	389063	6514487
R18	Active recreation	Cobar Rugby Union Club (ground)	390025	6513624
R19	Active recreation	Cobar Rugby League Club (ground)	388479	6515223
R20	Commercial	Cobar Memorial Services Club	389880	6514562
R21	Commercial	Cobar Railway Station	389752	6515270
R22	Commercial	Cobar Race Track	389308	6516170
R23	Passive recreation	Newey Reserve	389042	6513297
R24	Passive recreation	Old Reservoir	391920	6516624
R25	Passive recreation	Young Australia Reservoir	392104	6511417
R26	Industrial	Cobar water treatment plant	391920	6513070
R27	Industrial (residence)	10 Dapville Street	391145	6514450
R28	Industrial (residence)	12 Dunstan Street	390945	6514467
R29	Industrial (residence)	27 Nyngan Street	390695	6514486
R30	Child Care Centre	Ngali Child Care Centre, Harcourt Street	389846	6514386
R31	Privately-owned residence	Kidman Way – Dellavale	390563	6511460
R32	Commercial	Cobar Bowling and Golf Club	389051	6514377
R33	Active recreation	Cobar Golf Course	389666	6513501

Table 3.1 Representative assessment locations

Assessment location ID	Type	Description	Easting	Northing
R34	Child Care Centre	Far West Family Day Care	389649	6514476
R35	Privately-owned residence	15 James Place	388174	6513910
R36	Privately-owned residence	3 Maidens Ave	389242	6514198
R37	Industrial (residence)	39 Cornish Street	390680	6514822
R38	Privately-owned residence	10 Linsley Street	389773	6515067
R39	Privately-owned residence	24 Leah Street	389170	6515264
R40	Privately-owned residence	49 Becker Street	389000	6514850



Source: EMM (2021); PGM (2020); DFSI (2017); DPE (2019); GA (2011)

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KEY
- Project area
- Rail line
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Waterbody
- Mine water management storage

Assessment location type
- Hospital
- Mine-owned residence
- Privately-owned residence
- Industrial
- School
- Other

Assessment locations

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure 3.1

EMM
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4 Pollutants and assessment criteria

4.1 Potential air pollutants

Operational emission sources associated with the Project include a mixture of the following:

- fugitive sources of particulate matter, such as material handling and processing activities, movement of mobile plant and equipment, and wind erosion of exposed surfaces;
- point sources, specifically ventilation outlets for emissions from underground mining operations; and
- combustion sources, such as exhaust emissions from site equipment fleet and ore transportation road trucks.

A detailed description of emission sources associated with the Project is presented in Section 7.

The primary air pollutants emitted by the Project comprise of:

- particulate matter, specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$).
- oxides of nitrogen (NO_x)[1], including nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- carbon monoxide (CO);
- volatile organic compounds (VOCs); and
- assorted metals and metalloids[2].

On the basis of ventilation outlet monitoring data provided by PGM and the fact that the majority of fuel combustion activities occur in underground operations, emissions of fuel combustion pollutants (NO_x, SO_2, CO and VOCs) are expected to be minor. Monitoring of the Perseverance ventilation outlet was completed in 2019 (Ektimo 2019), with the results for NO_x, SO_2 and CO returning as below the limit of detection. consequently, fuel combustion emissions are not considered further in this assessment. Focus is given instead to particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) and the associated emissions of metals and metalloids.

The Project must demonstrate compliance with the impact assessment criteria for these pollutants, as defined in the Approved Methods for Modelling (NSW EPA 2016). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being. The applicable criteria are presented in Section 4.2.

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

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

4.2 Impact assessment criteria

4.2.1 Particulate matter

The NSW EPA's impact assessment criteria for particulate matter, as documented in Section 7 of the Approved Methods for Modelling, are presented in Table 4.1. The assessment criteria for PM_{10} and $PM_{2.5}$ are consistent with the national air quality standards that are defined in the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM) (Department of the Environment 2016).

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

For dust deposition, the NSW EPA (2016) 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)

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

3 NSW EPA (2016) 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.

4.2.2 Metals and metalloids

Emissions of assorted individual metals and metalloids contained within the waste, ore and tailings material may occur during the life of the Project. The NSW EPA specifies impact assessment criteria for many principal and individual toxic air pollutants in the Approved Methods for Modelling.

Geochemistry profiles for ventilation shafts, waste rock, ore and tailings based on site sampling results were provided by PGM. Of the detected elements, those with a NSW EPA impact assessment criterion are presented in Table 4.2.

It is noted that for each of the pollutants listed in Table 4.2, with the exception of lead, the impact assessment criterion specified by the NSW EPA must be applied at and beyond the boundary of the project, with the incremental impact (ie predicted impacts due to the pollutant source alone) for each pollutant reported as the 99.9th percentile 1-hour average concentration. The criterion for lead is an annual average and is applied at assessment locations.

Table 4.2 Impact assessment criteria – metals and metalloids

Element	Impact assessment criterion (µg/m³)	Averaging period
Antimony and compounds (Sb)	9.0	99.9th percentile 1-hour
Arsenic and compounds (As)	0.09	99.9th percentile 1-hour
Barium (soluble compound) (Ba)	9.0	99.9th percentile 1-hour
Beryllium and compounds (Be)	0.004	99.9th percentile 1-hour
Cadmium and compounds (Cd)	0.018	99.9th percentile 1-hour
Chromium (III) compounds (Cr)	9.0	99.9th percentile 1-hour
Copper dusts and mists (Cu)	18.0	99.9th percentile 1-hour
Lead (Pb)	0.5	Annual average
Manganese and compounds (Mn)	18.0	99.9th percentile 1-hour
Mercury organic (Hg)	0.18	99.9th percentile 1-hour
Nickel and compounds (Ni)	0.18	99.9th percentile 1-hour
Silver (soluble compounds) (Ag)	0.18	99.9th percentile 1-hour

4.3 POEO (Clean Air) regulation

The statutory framework for managing air emissions in NSW is provided in the *Protection of the Environment Operations Act 1997*[4] (POEO Act). The primary regulations for air quality made under the POEO Act are:

- Protection of the Environment Operations (Clean Air) Regulation 2010[5].
- Protection of the Environment Operations (General) Regulation 2009[6].

[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

[6] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N

The Project will comply with the POEO regulations as follows:

- as a scheduled activity under the POEO regulations, the Project is required to operate under an environment protection licence (EPL) issued by the NSW EPA and comply with requirements including emission limits, monitoring and pollution-reduction programmes (PRPs);
- the Project does not feature significant odour-generating emission sources and is therefore unlikely to generate odourous emissions; and
- no open burning is performed on-site.

4.4 Voluntary land acquisition and mitigation policy

In September 2018, the Department of Planning, Industry and Environment (DPIE) released the *Voluntary Land Acquisition and Mitigation Policy (VLAMP) for State Significant Mining, Petroleum and Extractive Industry Developments* (DPIE 2018). 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 rights apply when a development contributes to exceedances of the criteria set out in Table 4.3. Voluntary acquisition rights apply when a development contributes to exceedances of the criteria set out in Table 4.4. 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.

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 4.3 VLAMP mitigation criteria

Pollutant	Averaging period	Mitigation criterion	Impact type
PM_{10}	24-hour	50 µg/m³**	Human health
	Annual	25 µg/m³*	Human health
$PM_{2.5}$	24-hour	25 µg/m³**	Human health
	Annual	8 µg/m³*	Human health
TSP	Annual	90 µg/m³*	Amenity
Deposited dust	Annual	2 g/m²/month**	Amenity
		4 g/m²/month*	

Note: * - cumulative impact (project + background); ** - incremental impact (project only) with zero allowable exceedances of the criteria over the life of the development

Table 4.4 VLAMP acquisition criteria

Pollutant	Averaging period	Mitigation criterion	Impact type
PM_{10}	24-hour	50 µg/m³**	Human health
	Annual	25 µg/m³*	Human health
$PM_{2.5}$	24-hour	25 µg/m³**	Human health
	Annual	8 µg/m³*	Human health
TSP	Annual	90 µg/m³*	Amenity
Deposited dust	Annual	2 g/m²/month**	Amenity
		4 g/m²/month*	

Note: * - cumulative impact (project + background); ** - incremental impact (project only) with five allowable exceedances of the criteria over the life of the development

5 Meteorology and climate

5.1 Monitoring data resources

PGM maintains a meteorological monitoring station as part of the air quality monitoring network approximately 1.3 km north-northwest of the Peak Complex open cut pit (see Section 6.2). Monitoring at the PGM meteorological station commenced in May 2019. At the time of commencement of modelling, the PGM meteorological station dataset did not contain sufficient monitoring data to meet the requirements of the Approved Methods for Modelling (NSW EPA 2016) and therefore could not be used as direct inputs to the air pollutant dispersion modelling conducted (Section 8). Furthermore, the period from May 2019 to January 2020 featured a peak in NSW-wide extreme drought conditions, with ambient particulate matter levels recorded during the period not considered representative of background conditions in the area (see Section 6). Therefore, alternative resources of meteorological monitoring data for earlier time periods were investigated.

The Bureau of Meteorology (BoM 2020) maintain two automatic weather station (AWS) locations in Cobar:

- Cobar Meteorological Office (MO) (048027) located 3 km north-northwest of the PGM meteorological station; and
- Cobar Airport (048237) located 6 km southwest of the PGM meteorological station.

To determine the most appropriate dataset for use in this assessment, concurrent measurements of wind speed and direction at the PGM, BoM Cobar MO and BoM Cobar Airport AWS recorded between May 2019 and March 2020 were compared against the PGM data. Wind roses, illustrating wind speed and wind direction (blowing from), recorded at the three meteorological monitoring stations are presented in Figure 5.1. From this figure, of the two BoM AWS locations, the BoM Cobar Airport AWS is more closely aligned to the PGM meteorological station.

It is noted that the BoM Cobar Airport AWS dataset features a higher proportion of calm wind conditions (wind speeds less than 0.5 m/s) than the PGM and BoM Cobar MO AWS locations. The use of this dataset in the modelling could lead to a higher proportion of stable atmospheric conditions in dispersion calculations, leading to more conservative model predictions, ie predictions overstated.

The BoM Cobar Airport AWS has therefore been adopted as the primary meteorological monitoring resource for input to the dispersion modelling completed in this assessment. Measurements of wind speed, wind direction, standard deviation of wind direction, temperature, relative humidity, station-level pressure and cloud cover were used in the modelling.

The meteorological data recorded by the BoM Cobar Airport AWS were analysed for the five-year period between 2015 and 2019 (Appendix A). The analysis demonstrated a similarity across years in the most important parameters for pollutant dispersion, such as wind speed and wind direction. The recorded winds across all five years were predominately from the south to southwest and northeast quadrants. Across the five years of data, the annual average recorded wind speed ranged from 3.5 m/s to 3.6 m/s, while the frequency of calm conditions occurred between 7.7% and 10.4% of the time.

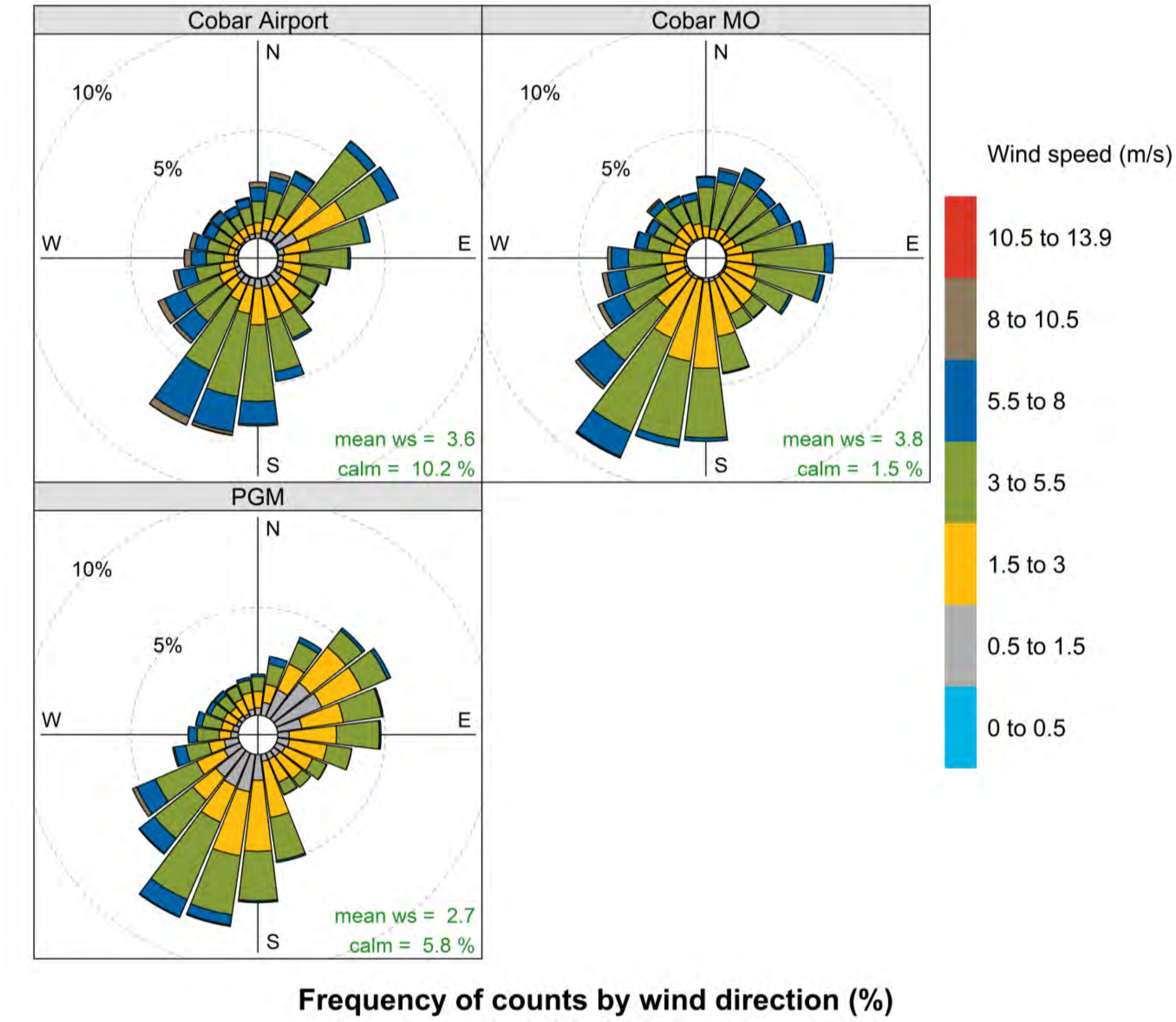


Figure 5.1 **Wind speed and direction comparison – May 2019 to March 2020 – PGM, BoM Cobar Airport and BoM Cobar MO**

The inter-annual profiles for air temperature and relative humidity were also comparable between 2015 and 2019, however it is noted that the 2018 and 2019 datasets showed slightly higher temperature and lower relative humidity. This is considered reflective of the increasing drought conditions through 2018 and 2019. Ambient concentrations of particulate matter were elevated during 2018 and 2019 (see Section 6.3.1). While 2019 is the most recent calendar year from the BoM Cobar AWS, it was therefore not considered to be representative due to the influence of the drought. Further discussion on ambient particulate matter levels and drought conditions is presented in Section 6.3.1.

The 2017 calendar year was adopted as the 12-month modelling period for the purpose of this AQIA. Details relating to the selection of meteorological year and the representativeness of the dataset are provided in Appendix A.

5.2 Meteorological modelling and processing

Atmospheric dispersion modelling for this assessment was completed using the AMS[7]/USEPA[8] regulatory model AERMOD (model version v19191, further discussion presented in Section 8). The meteorological inputs for AERMOD were generated using the AERMET meteorological processor (model version v19191), using local surface observations and upper air profiles generated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) TAPM meteorological modelling module.

Further details of the TAPM meteorological modelling and AERMET data processing completed to prepare the inputs for AERMOD are documented in Appendix A.

5.3 Wind speed and direction

A wind rose showing the wind speed and direction recorded at the BoM Cobar Airport AWS during 2017 is presented in Figure 5.2. Similar to the inter-annual wind roses presented in Appendix A, the recorded wind pattern for 2017 was dominated by south to south-westerly and north-easterly winds. The annual average recorded wind speed for 2017 was 3.5 m/s, with a frequency of calm conditions (wind speeds less than 0.5 m/s) in the order of 9.5% of the time.

Seasonal and diurnal wind roses for the on-site meteorological station during 2017 are provided in Figure 5.3 and Figure 5.4 respectively. Some seasonal variation in both wind speed and direction is observed, with winds typically lower in winter and autumn than spring and summer. The northeasterly component is most pronounced in spring and autumn, while the south to southwesterly component is observed in all seasons.

Wind speed and wind direction varied on a diurnal basis. The night-time hours feature a higher proportion of northeasterly winds than daytime hours. The wind speeds at night were slightly lower on average than during the daytime, with average wind speeds of 4 m/s during the day and 3 m/s during the night. Calm conditions were more prevalent during night hours.

7 AMS - American Meteorological Society

8 USEPA - United States Environmental Protection Agency

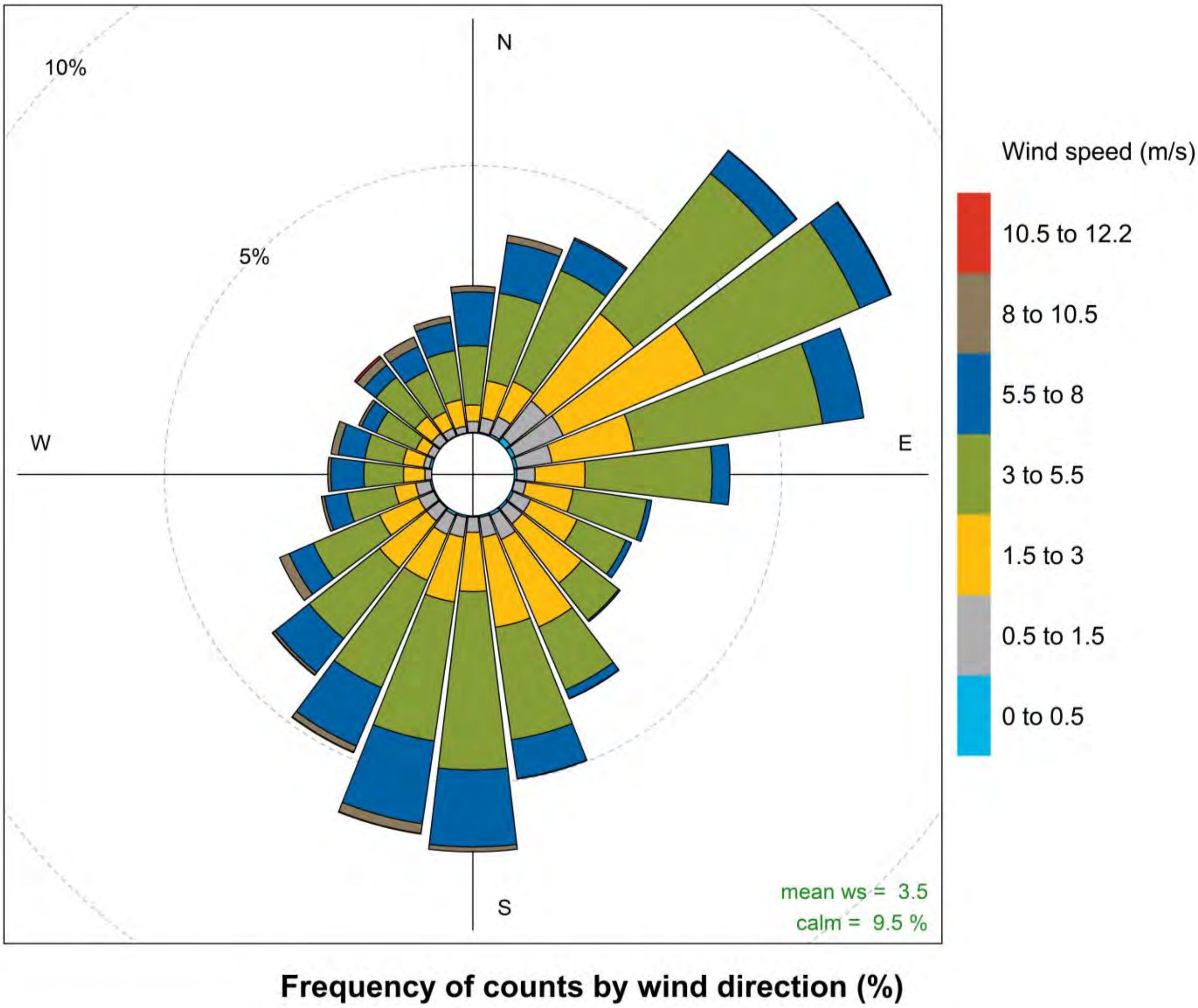


Figure 5.2 Recorded wind speed and direction – BoM Cobar Airport AWS – 2017

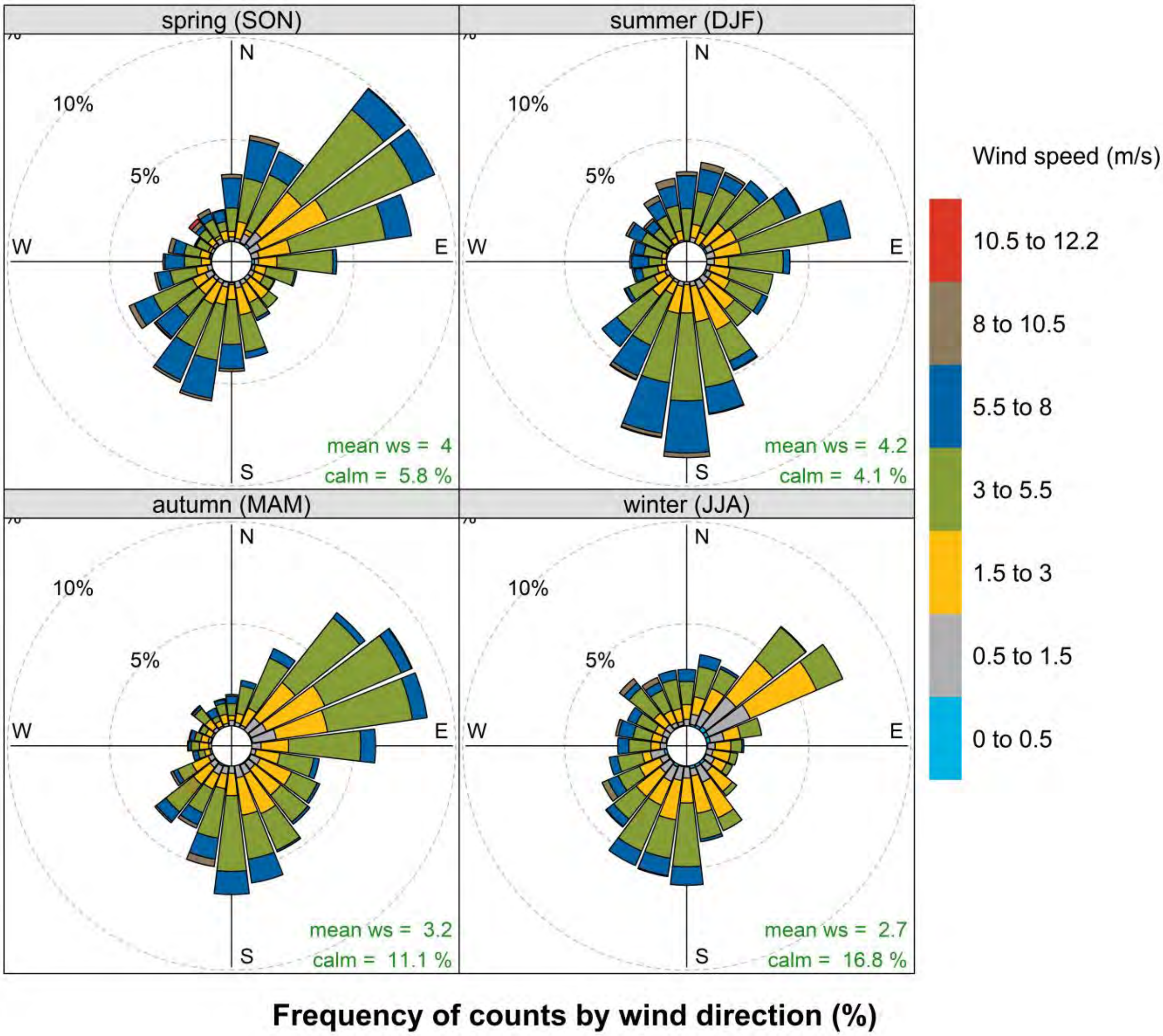


Figure 5.3 Seasonal wind speed and direction – BoM Cobar Airport AWS – 2017

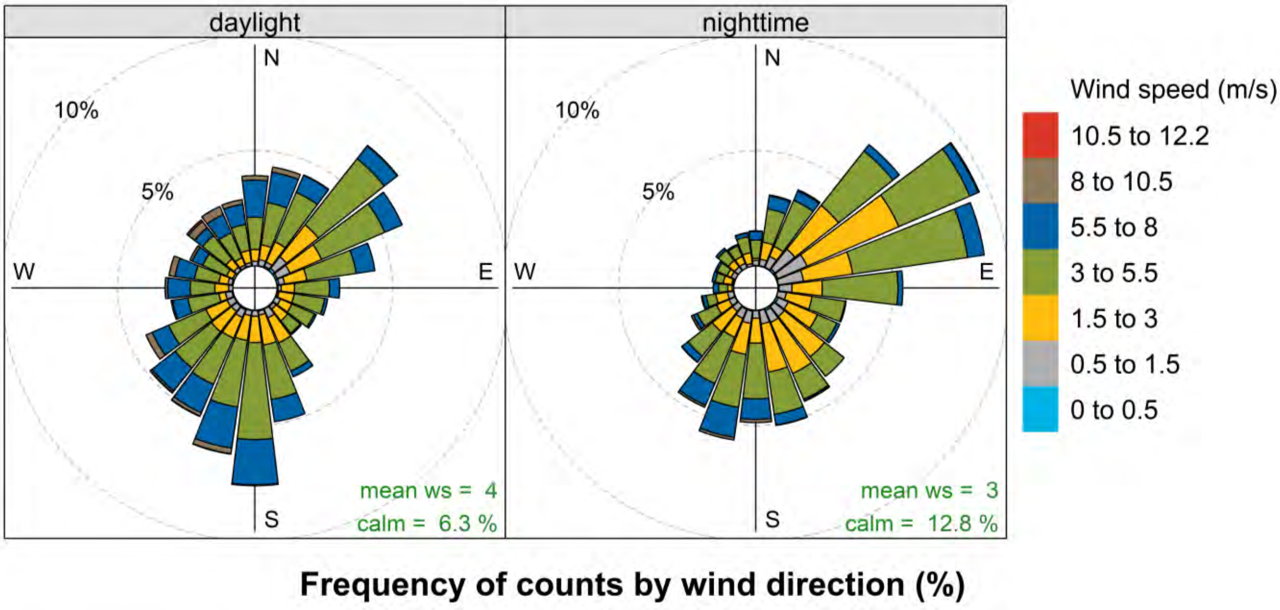


Figure 5.4 Diurnal wind speed and direction – BoM Cobar Airport AWS – 2017

5.4 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 (ie the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 5.5 illustrates the overall diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET based on the 2017 BoM Cobar Airport AWS dataset. 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 day-time hours and lowest during evening through to early morning hours.

Mixing depth refers to the height of the atmosphere above ground level within which 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 (where mixing takes place), 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 5.6. Greater boundary layer depths occur during the daytime hours, peaking in the mid to late afternoon.

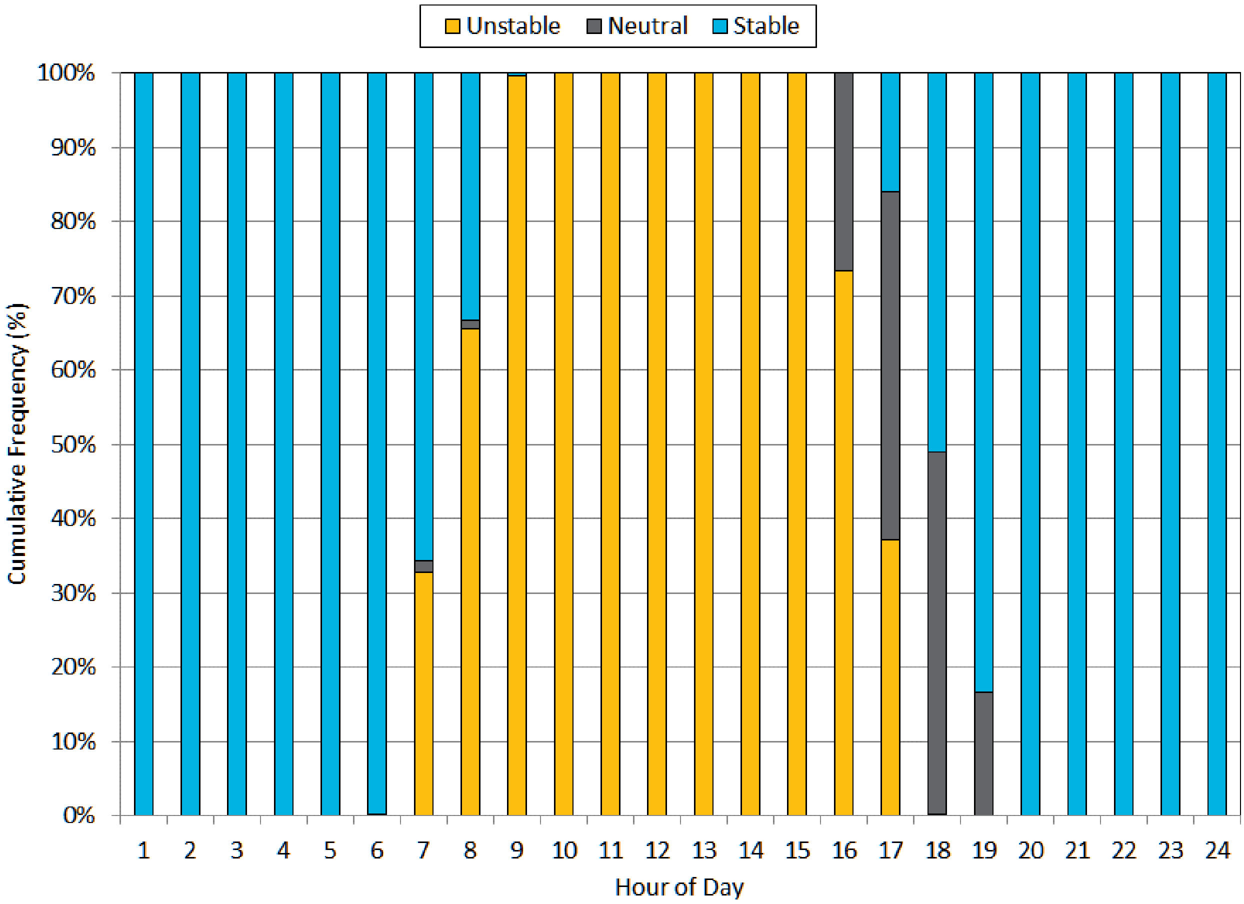


Figure 5.5 AERMET-calculated diurnal variation in atmospheric stability – BoM Cobar Airport AWS - 2017

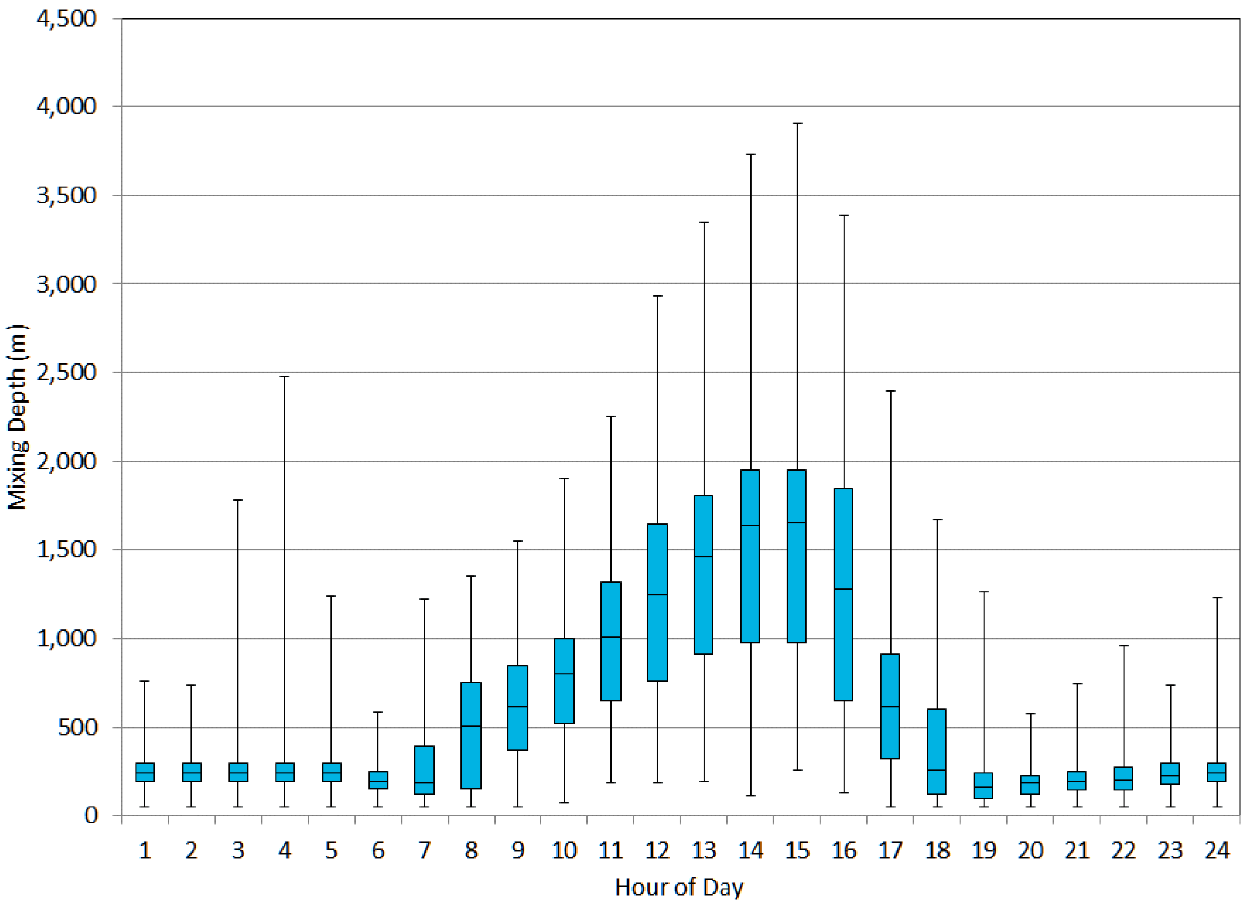


Figure 5.6 AERMET-calculated diurnal variation in atmospheric mixing depth – BoM Cobar Airport AWS - 2017

6 Baseline air quality

6.1 Existing sources of emissions

The National Pollutant Inventory (NPI 2020) and NSW EPA (2013) environment protection licence databases have been reviewed to identify significant existing sources of air pollutants in the local region. The PGM operations and the CSA Copper Mine, located approximately 10 km north of Cobar, are the only significant existing industrial emission sources surrounding Cobar. Emissions from the CSA Mine are unlikely to cause direct cumulative impacts with emissions from PGM operations, likely owing to the distance from the project and prevailing wind direction.

Other contributing non-Project sources of air pollutant emissions to baseline air quality include:

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

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

6.2 Air quality monitoring data resources

PGM maintains an air quality monitoring network in the vicinity of the Project. The network consists of the following monitoring equipment:

- one beta attenuation monitor (BAM) unit for the recording PM_{10} concentrations on a continuous basis;
- two high-volume air sampler (HVAS) units for the recording of TSP and PM_{10} concentrations on a one-in-six day routine;
- 10 dust deposition gauges for recording monthly dust deposition rates; and
- one meteorological station recording weather conditions, including wind speed and direction, temperature, solar radiation, rainfall and atmospheric pressure.

The locations of the PGM monitoring equipment are illustrated in Figure 6.3.

The PGM BAM and HVAS units were installed in late 2019 and consequently there is limited monitoring data that can be used to characterise existing ambient particulate matter concentrations. To supplement the PGM data, PM_{10} monitoring data recorded on a one-in-six day schedule by HVAS from the Aurelia Metals Hera Mine (located approximately 80 km south-west of the New Cobar Complex near Nymagee) and continuous PM_{10} monitoring data recorded by tapered element oscillating microbalance (TEOM) adjacent to the CBH Resources Rasp Mine[9] in Broken Hill (located approximately 420 km west of the New Cobar Complex), have been referenced. While both locations are spatially distant from Cobar, based on Köppen climate classification maps provided by the BoM[10], the climate classification of the Cobar, Nymagee and Broken Hill are closely aligned; grassland/persistently dry/hot (Cobar and Broken Hill) or warm (Nymagee).

For the period of PM_{10} measurements across all three locations (October 2019 to March 2020), the frequency distribution of concurrent recorded concentrations was calculated. The cumulative frequency distributions of the three datasets is presented in Figure 6.1.

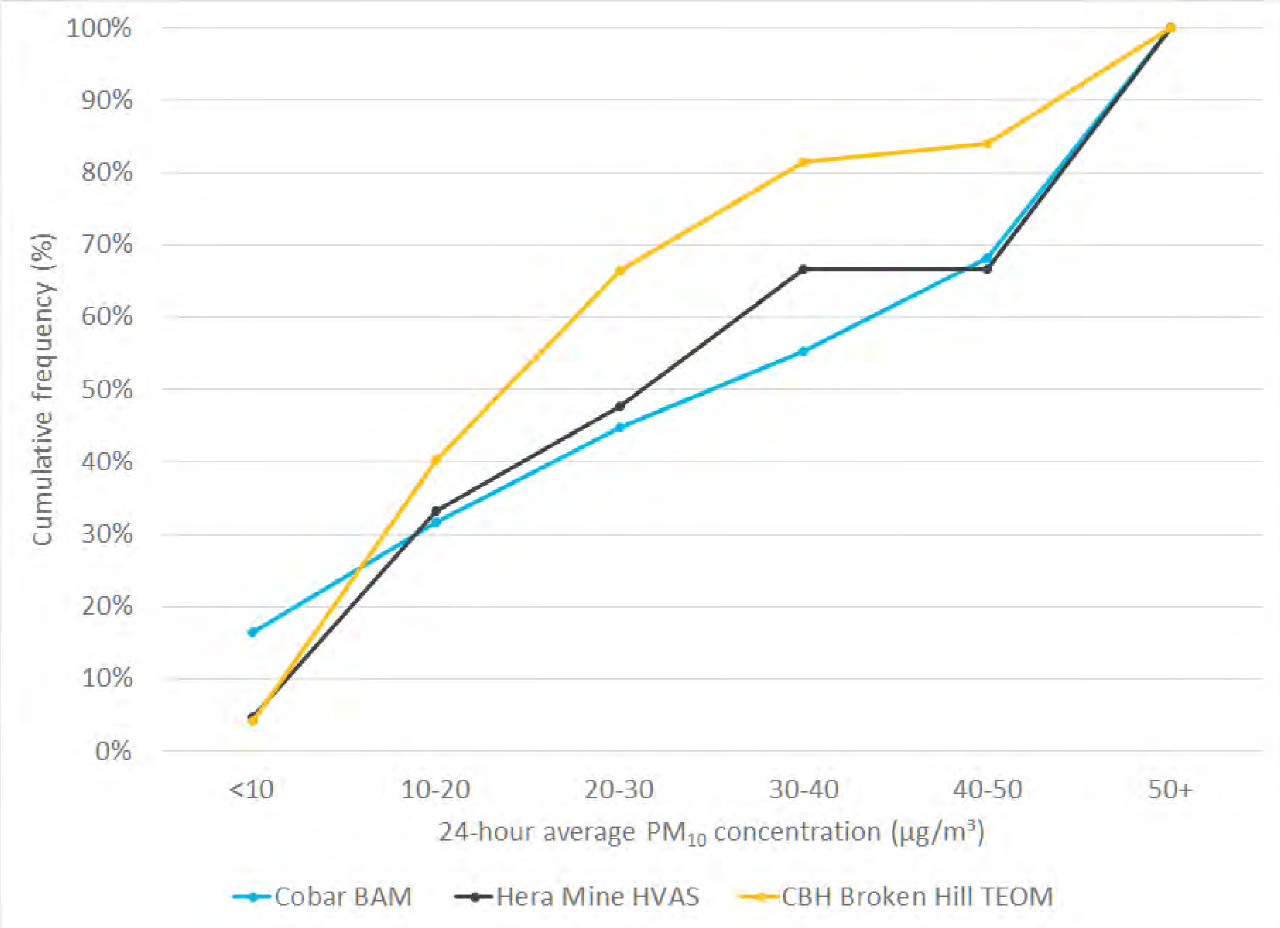


Figure 6.1 Frequency distribution of concurrent PM_{10} concentrations – Cobar BAM, Hera Mine HVAS and CBH Broken Hill TEOM – October 2019 to March 2020

While based on a limited set of data points, Figure 6.1 illustrates that the distribution of concentrations recorded at the Cobar BAM and the Hera Mine HVAS are closely aligned, while the CBH Broken Hill TEOM dataset features a higher proportion of concentrations in the range of 10 µg/m³ to 50 µg/m³. From a cumulative impact assessment perspective and compliance with the NSW EPA impact assessment criterion of 50 µg/m³ for 24-hour average PM_{10}, the use of a background dataset with a higher proportion of concentrations below the impact assessment criterion is considered conservative. The CBH Broken Hill TEOM therefore provides a conservative and daily varying PM_{10}

9 TEOM PM_{10} data collated from publicly available monthly monitoring reports https://www.cbhresources.com.au/operations/rasp-mine/sustainablity/environment/environmental-monitoring/ (CBH 2020)

10 http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp

dataset (compared with the one-in-six day measurement frequency for the Hera Mine HVAS) and will be referenced as representative of background concentrations for the Cobar.

6.3 Background air quality environment

6.3.1 PM_{10}

A summary of key statistics for the five years of analysed data from the CBH Resources Broken Hill TEOM is presented in Table 6.1. Exceedances of the NSW EPA 24-hour average criterion of 50 µg/m³ were recorded for all years except 2016. Exceedances are shown in bold.

The data in Table 6.1 illustrates that PM_{10} concentrations increased notably from 2016 through to 2019, which is linked to intensifying drought conditions across eastern Australia. A timeseries of recorded 24-hour PM_{10} concentrations is presented in Figure 6.2. From this timeseries, the increasing frequency of elevated PM_{10} concentrations is obvious from 2017 through to 2019, particularly during the summer months.

Table 6.1 Statistics for PM_{10} concentrations – Broken Hill – 2015 to 2019

Year	Maximum	99^{th} percentile	90^{th} percentile	75^{th} percentile	Median	Average	Days > 50 µg/m³
	24-hour average PM_{10} concentration (µg/m³)						
2015	**91.7**	**53.9**	22.1	16.8	12.1	14.1	**5**
2016	36.1	26.2	19.2	15.4	12.0	13.0	0
2017	**183.7**	43.0	23.6	17.7	13.0	15.1	**3**
2018	**712.3**	**160.9**	38.3	23.1	16.3	24.5	**25**
2019	**594.4**	**162.6**	43.5	25.3	16.8	**26.2**	**28**

Note: Data source CBH Resources 2020

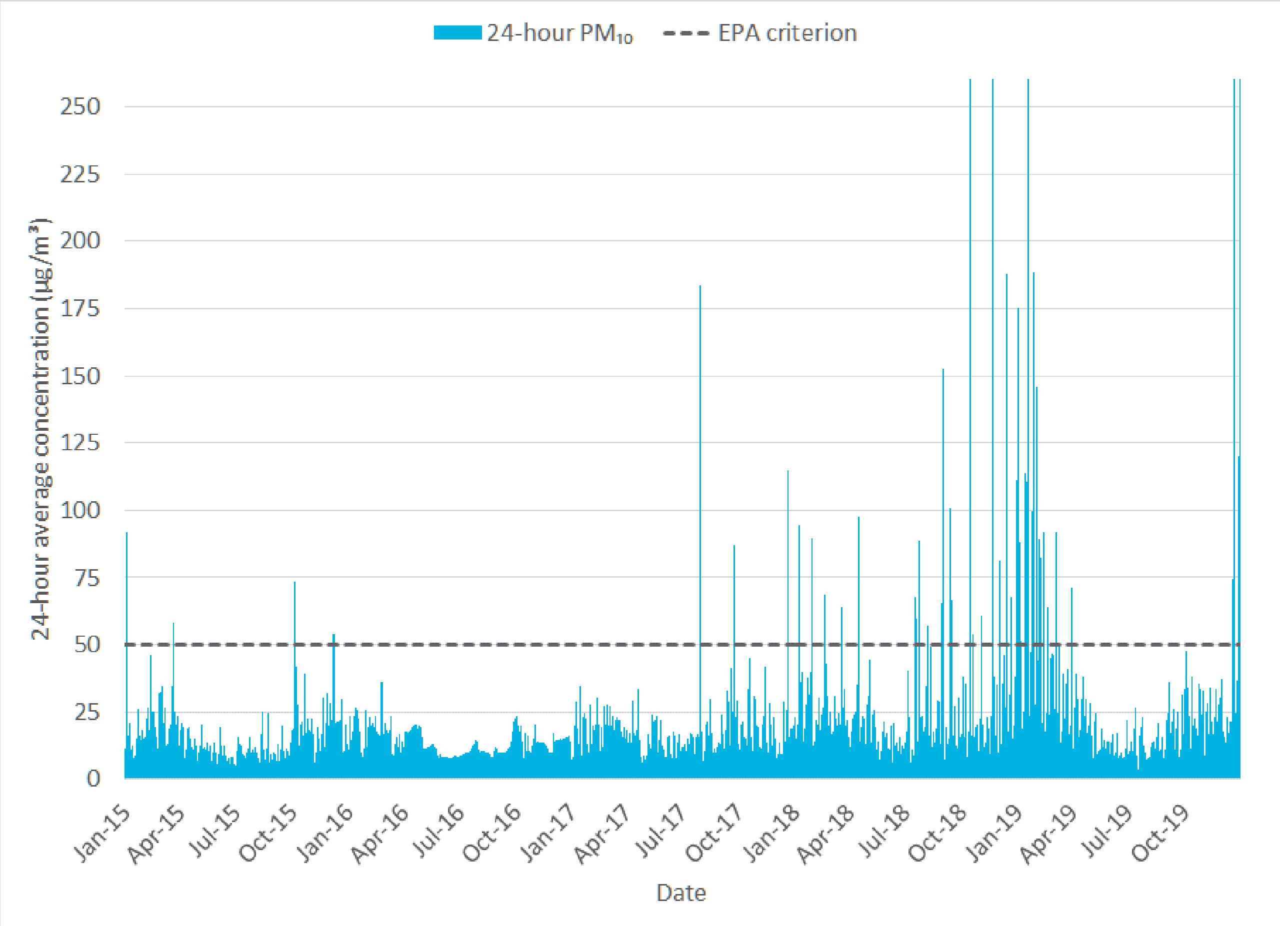
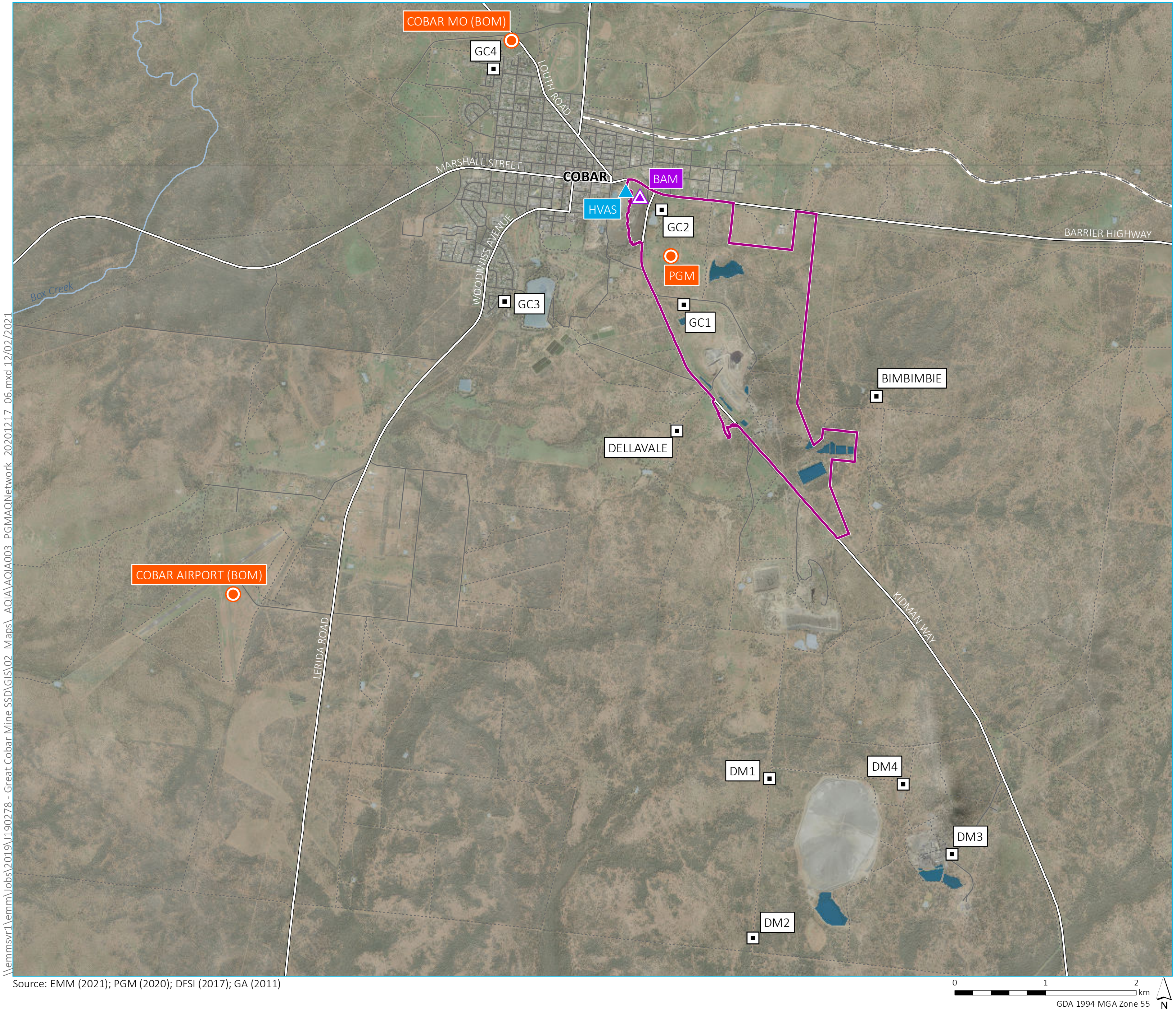


Figure 6.2 **Timeseries of 24-hour average PM_{10} concentrations – CBH Resources Broken Hill - 2015 to 2019**

Note: For data visualisation purposes, the Y-axis in this chart was capped at 260 µg/m³



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Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

PGM air quality monitoring network

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure 6.3

EMM
creating opportunities

The frequency of recorded PM_{10} concentrations at the CBH Broken Hill TEOM by year for the period 2015 to 2019 is shown in Figure 6.4. The distribution of recorded PM_{10} concentrations for 2018 and 2019 featured a notably higher occurrence of concentrations greater than 30 µg/m³ than the other three years of data.

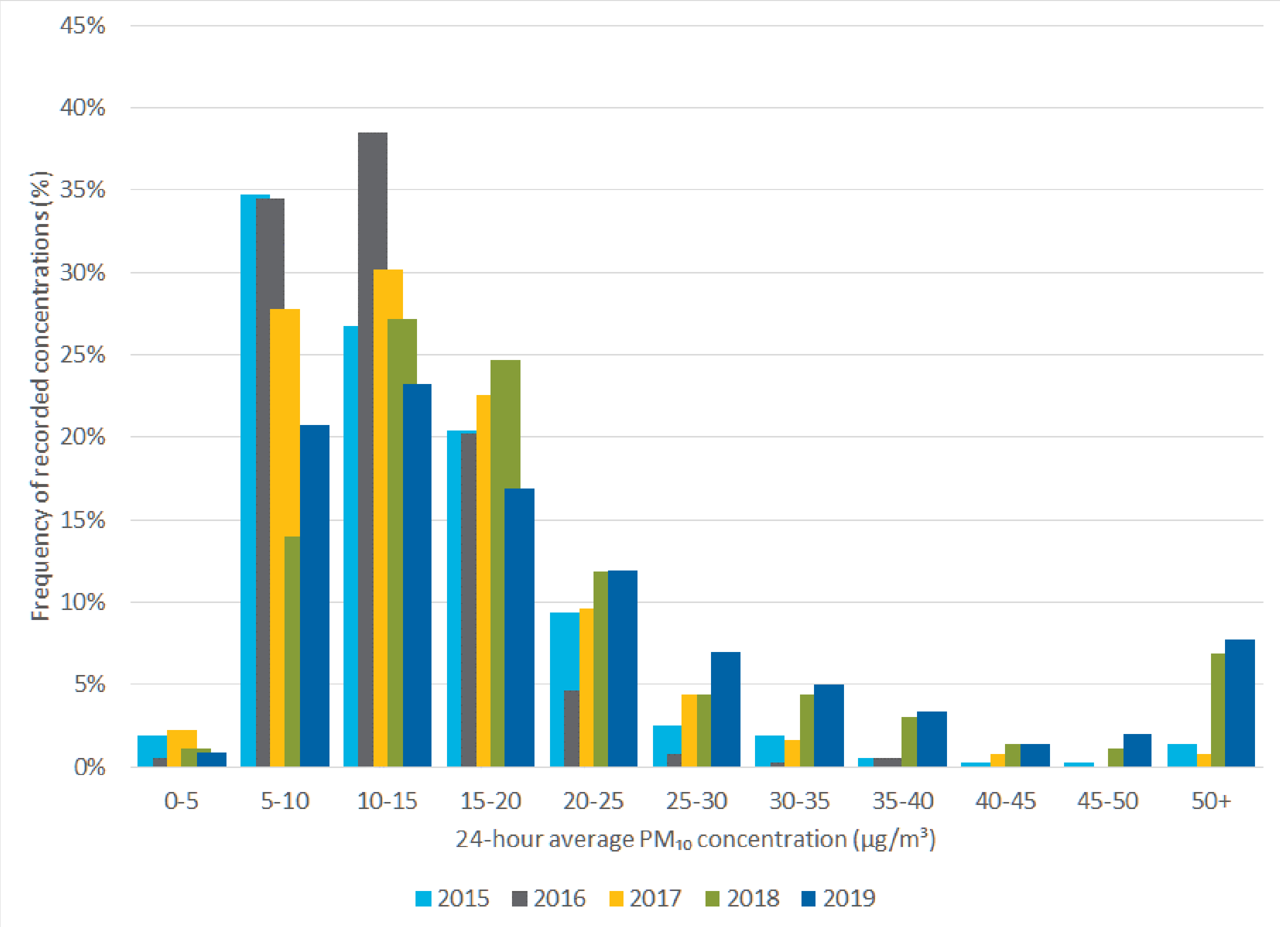

Figure 6.4 Frequency distribution of PM_{10} monitoring data – CBH Resources Broken Hill - 2015 to 2019

For the purpose of adopting a calendar year that is representative of background conditions, 2018 and 2019 were excluded on the basis of adverse influence from the drought conditions. 2017, while still affected by drought conditions, was adopted as a conservative background dataset for use in cumulative impact assessment in this study. The 2017 calendar year featured three exceedances of the NSW EPA 24-hour average criterion of 50 µg/m³, which were highly likely to be associated with regional scale dust storm events. The highest 24-hour average PM_{10} concentration not in exceedance of the NSW EPA criterion (criterion 50 µg/m³) was 44.8 µg/m³.

The annual average PM_{10} concentration for the CBH Resources Broken Hill 2017 PM_{10} dataset is 15.2 µg/m³.

6.3.2 $PM_{2.5}$

No monitoring of $PM_{2.5}$ is conducted by the PGM air quality monitoring network. Further, the alternative monitoring resources referenced for PM_{10} measurements (Hera Mine and CBH Broken Hill) do not record $PM_{2.5}$ concentrations. To provide an analysis of background $PM_{2.5}$ concentrations in the absence of local measurements, the relationship between concurrent PM_{10} and $PM_{2.5}$ concentrations recorded by four DPIE air quality monitoring stations located in regional NSW was analysed; specifically, Narrabri (400 km east-northeast of Cobar), Gunnedah (425 km east of Cobar), Tamworth (480 km east of Cobar) and Wagga Wagga North (420 km southeast of Cobar) (DPIE 2020).

All available concurrent 24-hour average PM_{10} and $PM_{2.5}$ concentrations recorded by the four DPIE air quality monitoring stations between 2015 and 2019 inclusive, were collated, with the daily $PM_{2.5}$:PM_{10} ratio calculated. The average ratios ranged from 0.44 at Wagga Wagga North to 0.51 at Tamworth. The average ratio across the four sites and five years of data was 0.47. This value has been applied to the daily-varying 2017 PM_{10} background dataset (see Section 6.3.1) to generate a suitable synthetic 24-hour average $PM_{2.5}$ background dataset for use in cumulative impact assessment purposes.

The 2017 synthetic 24-hour average $PM_{2.5}$ concentration dataset featured three exceedances of the NSW EPA 24-hour average criterion of 25 µg/m³. The highest 24-hour average $PM_{2.5}$ concentration not in exceedance of the NSW EPA criterion (criterion 25 µg/m³) is 21.1 µg/m³.

The annual average $PM_{2.5}$ concentration for the synthetic 2017 $PM_{2.5}$ dataset is 7.1 µg/m³.

6.3.3 TSP

While a HVAS configured to record ambient TSP concentrations was installed in 2019 as part of the PGM air quality monitoring network, there is insufficient data available at the time of reporting to quantify annual average ambient background TSP concentrations for cumulative assessment purposes.

Concurrent TSP and PM_{10} concentrations from both the Cobar HVAS units (2020 only) and the long-term records (2013 to 2020) from the Hera Mine HVAS were reviewed. For the analysed datasets, the average PM_{10}:TSP ratio at Cobar and Hera Mine were 0.51 and 0.48 respectively.

To derive an annual average TSP concentration consistent with the 2017 background period, the ratio of 0.48 has been applied to the annual average PM_{10} concentration for the 2017 CBH Broken Hill dataset (see Section 6.3.1), returning a TSP background concentration of 31.7 µg/m³.

6.3.4 Dust deposition

As stated in Section 6.3.1, the PGM air quality monitoring network comprises of 10 dust deposition gauges. Dust deposition rates recorded between January 2015 and December 2019 were analysed to determine existing dust deposition levels. It is noted that dust deposition gauges GC1 to GC4 were installed in April 2019. The annual average dust deposition results from the 10 monitoring locations are presented in Table 6.2.

Table 6.2 Annual dust deposition results – PGM monitoring network – 2015 to 2019

Monitoring year	Annual average dust deposition levels (g/m²/month)									
	Bimbimbie	Dellavale	DM1	DM2	DM3	DM4	GC1	GC2	GC3	GC4
2015	0.9	0.7	0.7	0.8	1.9	1.2	-	-	-	-
2016	1.1	1.4	0.8	1.0	2.8	1.7	-	-	-	-
2017	0.8	1.0	0.8	1.2	2.0	0.8	-	-	-	-
2018	2.7	1.7	2.3	2.7	3.6	3.2	-	-	-	-
2019	3.3	1.8	2.1	2.5	3.5	2.8	1.7	2.1	2.4	2.2
Criterion	**4**									

Consistent with PM_{10} data, the recorded dust deposition rates increased notably in 2018 and 2019 coinciding with the intensification of drought conditions. For all years of monitoring, the NSW EPA impact assessment criterion (criterion 4 g/m²/month) was not exceeded at any monitoring location.

The highest recorded annual average dust deposition level for 2017 was 2.0 g/m^2/month at DM2 (refer to Figure 6.1). This value has been adopted as background for this assessment.)

6.3.5 Lead

The impact assessment criterion for lead (Pb) specified by the NSW EPA in the Approved Methods for Modelling is applicable to cumulative concentrations (background plus project increment). As part of the TSP and PM_{10} HVAS sampling conducted by PGM at Cobar, the Pb content of the samples is also analysed by the reporting laboratory.

For the limited period of data available, the average Pb concentration in the TSP and PM_{10} HVAS samples is very low, in the order of 0.02% to 0.04%. The Hera Mine TSP and PM_{10} HVAS monitoring also undertakes Pb analysis of collected samples. For the period between 2017 and 2020, the average Pb content is in the order of 0.03% to 0.04%.

On the basis of the annual average TSP concentration adopted of this assessment (see Section 6.3.3) and a Pb content value of 0.04%, the annual average Pb concentration is 0.01 µg/m^3. This is considered to be negligible.

6.3.6 Adopted background summary

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

- annual average TSP – 31.7 µg/m^3, derived from the annual average PM_{10} concentration;
- 24-hour PM_{10} – daily varying concentrations from the CBH Resources Broken Hill TEOM during 2017. Concentrations range from 1.9 µg/m^3 to 183.7 µg/m^3;
- annual average PM_{10} – 15.2 µg/m^3, from the CBH Resources Broken Hill TEOM during 2017;
- 24-hour $PM_{2.5}$ – synthetic daily varying concentration dataset derived through application of regional NSW $PM_{2.5}$:PM_{10} ratio to the CBH Resources Broken Hill TEOM 2017 dataset. Concentrations range from 0.9 µg/m^3 to 86.4 µg/m^3;
- annual average $PM_{2.5}$ – 7.1 µg/m^3, from the synthetic daily varying $PM_{2.5}$ concentration dataset for 2017;
- annual dust deposition – 2.0 g/m^2/month, from the PGM air quality monitoring network; and
- annual Pb – negligible (0.01 µg/m^3 vs criterion of 0.5 µg/m^3) based on Pb in TSP and PM_{10} samples from Cobar and Hera Mine, focus given to incremental concentration.

7 Emissions inventory

7.1 Emission scenario

From an air pollutant emission perspective, the Project will change existing operational emissions from the Peak Complex and New Cobar Complex in the following ways:

- increased ventilation flow and emissions from the Great Cobar ventilation outlet; and
- increased ore transportation by road trucks between New Cobar Complex and Peak Complex.

For the purpose of this assessment, these changed sources are referred to as "additional" emission sources. All unchanged emission sources are referred to as "existing" emission sources.

To understand the implications of these changes to existing Project emission sources, a single future operations emissions scenario has been configured comprising of existing operational sources from both the Peak Complex and New Cobar Complex and the identified altered/additional sources of emissions. The adopted processing rate is 800,000 tpa.

7.2 Sources of emissions

Sources of atmospheric emissions associated with the Project include:

- New Cobar Complex:
  - haulage of material on unpaved roads from the underground portal to the waste rock emplacement or ore stockpile;
  - unloading of ore material to the surface stockpile;
  - unloading of waste rock material to the WRE area;
  - loading and return haulage of waste material on unpaved roads to underground portal;
  - loading of ore material to road trucks;
  - haulage on unpaved roads of ore material in road trucks to Kidman Way; and
  - wind erosion of exposed surfaces (open cut, WRE area, stockpiles).
- Peak Complex:
  - haulage of material on paved and unpaved roads from the Kidman Way to the processing plant ore stockpile;
  - haulage of material on unpaved roads from the Peak Complex underground portal to the processing plant ore stockpile;
  - unloading of ore material to the ore stockpile;
  - transfer of ore to the processing plant;

- ore crushing, screening and grinding circuit and associated conveyor transfers; and
- wind erosion of exposed surfaces (ore stockpile, exposed surfaces and TSF).

• Underground mining operations emitted through ventilation outlets:
  - five existing ventilation outlets at four locations; and
  - increased flow rate at the Great Cobar ventilation outlet; and
• 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. Particulate matter emissions were quantified for the three size fractions identified in Section 3.1, 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).

7.3.1 Particulate matter emission reduction factors

Particulate matter control measures adopted across the New Cobar Complex and Peak Complex, and the associated emission reduction factors, are presented in Table 7.1. These emission reduction factors have been applied to annual emission calculations.

Table 7.1 Particulate matter control measures

Emission sources	Control measures	Emission reduction factors (%)[1]
Material haulage using watering	Route watering	75
ROM ore stockpiles	Water sprays	50
Processing circuit	Water sprays	50
	Wet process (following SAG Mill)	100

[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).

7.3.2 Particulate matter emissions

A summary of annual site emissions by source type is presented in Table 7.2, while the contribution of existing and additional emission sources is presented in Table 7.3. Further, total annual emissions by particle size are illustrated in Figure 7.2, with the contribution of existing and proposed additional emissions highlighted. Particulate matter control measures, as documented in Section 7.3.1 are accounted for in these emission totals.

Across all particle sizes, the most significant source of emissions are the ventilation outlets (five existing plus additional Great Cobar ventilation outlet). Given that the majority of activities associated with the New Cobar and Peak Complex occur underground, it is assumed for the purpose of this assessment that the ventilation outlet emissions account for diesel combustion emissions from mining operations. Unpaved road vehicle movements and wind erosion of exposed surfaces are also notable contributing sources of particulate matter on an annual basis. Further details regarding emission estimation factors and assumptions are provided in Appendix B.

It is noted with regards to the processing plant components (eg crushers, screens, etc) that the emission factors adopted account for all associated processes, including conveying to and transfer from the component.

Table 7.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – existing and proposed additional

Location	Emissions source	Calculated annual emissions (tonnes/annum) by source		
		TSP	PM_{10}	$PM_{2.5}$
New Cobar Complex	In pit haulage ore/waste from underground to surface	12.30	3.11	0.31
	Surface haulage ore to ROM stockpile	2.61	0.66	0.07
	Surface haulage waste to waste emplacement	4.33	1.09	0.11
	Surface haulage waste to underground	10.87	2.75	0.27
	In pit haulage waste to underground from surface	2.42	0.61	0.06
	Ore haulage to exit - existing	3.98	1.01	0.10
	Ore haulage to exit - proposed increased	3.98	1.01	0.10
	Unloading of ore at ROM stockpile	0.43	0.21	0.03
	Unloading of waste at waste emplacement	0.59	0.28	0.04
	Loading of ore to road trucks	0.43	0.21	0.03
	Loading of waste rock to underground trucks	0.90	0.43	0.06
	Road truck diesel combustion – existing and proposed increased	0.007	0.007	0.007
	Wind erosion – open cut	4.97	2.48	0.37
	Wind erosion - Waste emplacement	10.68	5.34	0.80
	Wind erosion - ROM stockpile	2.81	1.41	0.21
Peak Complex	Ore haulage from New Cobar - paved - existing	21.45	4.12	1.00
	Ore haulage from New Cobar - paved - proposed increased	21.45	4.12	1.00
	Ore haulage from New Cobar - unpaved - existing	7.40	1.87	0.19
	Ore haulage from New Cobar - unpaved - proposed increased	7.40	1.87	0.19
	Haulage from Peak Underground portal to ROM stockpile	2.90	0.73	0.07
	Unloading of ore at ROM stockpile	0.87	0.41	0.06
	Unloading of ore from underground conveyor	0.87	0.41	0.06
	FEL transfer of ore to processing circuit	1.74	0.82	0.12
	SAG Mill	1.08	0.48	0.09
	Scalping screen	5.00	1.72	0.12
	Ball mill	1.08	0.48	0.09
	Trash screen	5.00	1.72	0.12

Table 7.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – existing and proposed additional

Location	Emissions source	Calculated annual emissions (tonnes/annum) by source		
		TSP	PM_{10}	$PM_{2.5}$
	Road truck diesel combustion – existing and proposed increased	0.035	0.035	0.034
	Wind erosion - ROM pad	0.59	0.29	0.04
	Wind erosion - exposed areas	2.22	1.11	0.17
	Wind erosion - TSF	18.04	9.02	1.35
Ventilation outlets	Ventilation outlets – five existing outlets	98.32	26.94	12.29
	Ventilation outlets - Great Cobar outlet	44.40	12.17	5.55
	Total	**301.17**	**88.90**	**25.12**

Table 7.3 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – existing and additional sources

Location	Calculated annual emissions (tonnes/annum) by source category		
	TSP	PM_{10}	$PM_{2.5}$
Existing emission sources	231.3	71.6	18.4
Additional emission sources	69.8	17.3	6.6

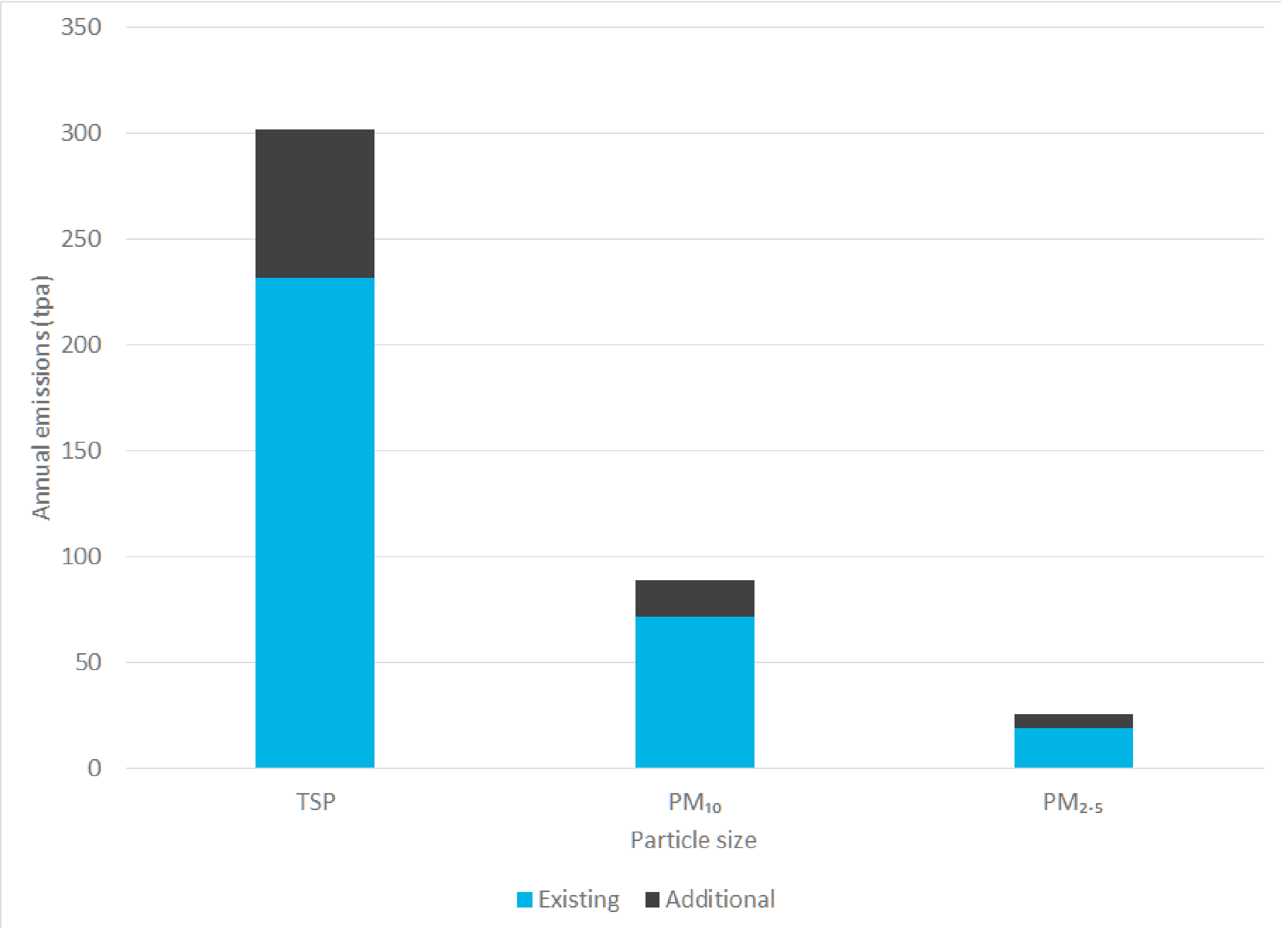

Figure 7.1 Annual emission totals by particle size – contribution from existing and additional emission sources

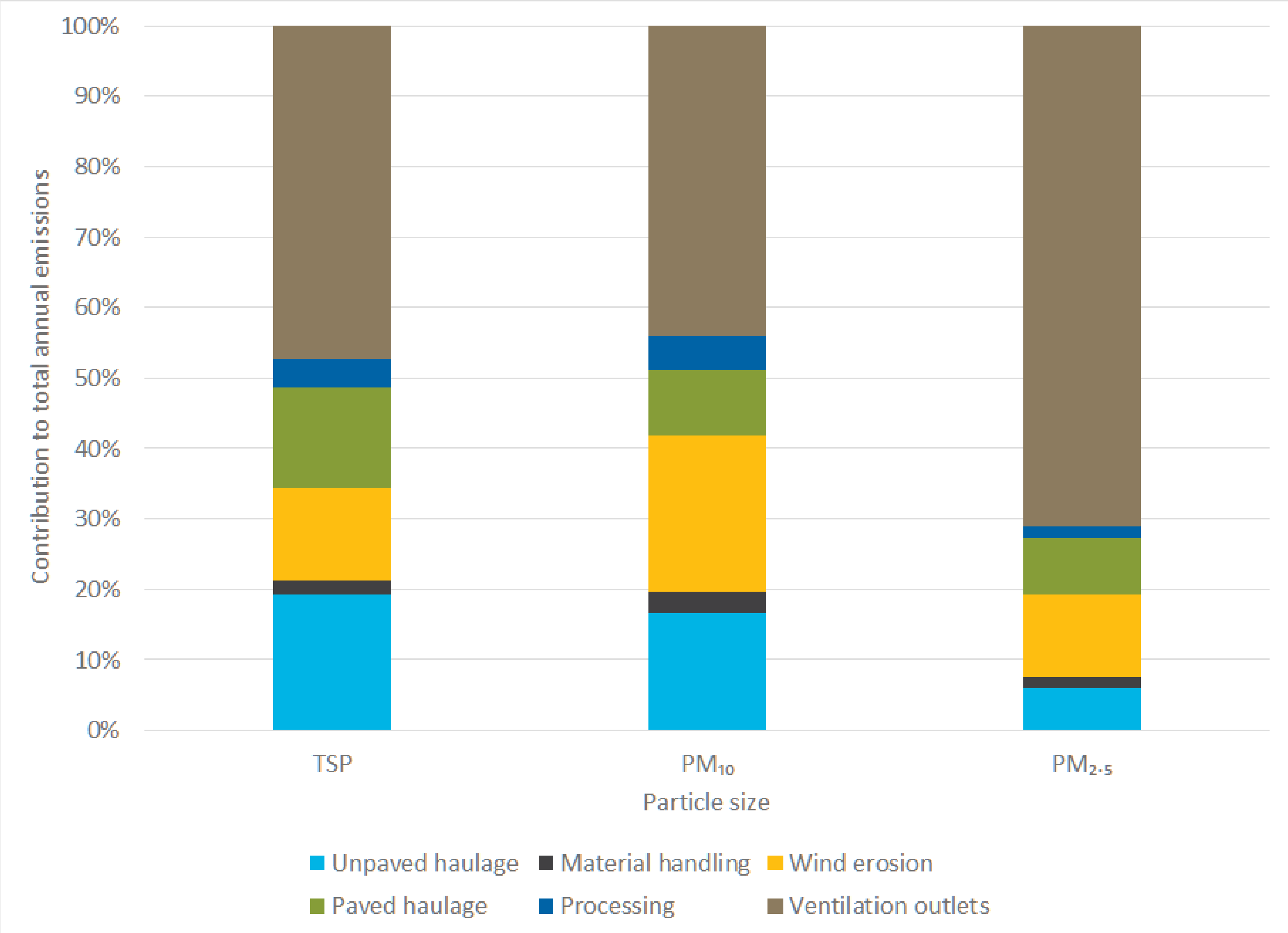

Figure 7.2 Contribution to annual emissions by emissions source type and particle size – all scenarios

7.4 Ventilation outlet emissions

Emissions from ventilation outlets associated with the New Cobar Complex and Peak Complex were estimated based on site-specific sampling that was commissioned by PGM and conducted by Ektimo in July 2019. Sampling was conducted at the Perseverance ventilation outlet. PGM have advised that the ore body in the mining area serviced by this ventilation outlet is representative of the Great Cobar ore body.

The Ektimo 2019 sampling was conducted over two days and multiple sampling runs, returning the following results:

- total solid particles concentration of 1.8 mg/m^3 and 4.2 mg/m^3;
- particle size analysis of the total solid particles indicating that the less than 10 µm fraction was between 26% and 27.4% and the less than 2.5 µm fraction was between 10% and 12.5%;
- trace concentrations of a number of metals/metalloids were detected in the particulate matter monitoring, including chromium, copper, lead, manganese and zinc (Zn) (see Section 7.5 for further discussion); and
- concentrations of fuel combustion pollutants (NO_x, SO_2 and CO) were below the limit of detection.

In order to estimate particulate matter emissions from the various ventilation outlets, the highest total solid particles from the Ektimo 2019 sampling was adopted for emissions of TSP (4.2 mg/m^3), a PM_{10} percentage of 27.4% and $PM_{2.5}$ percentage of 12.5%.

The following additional points are noted:

- All ventilation outlets are assumed to operate at full capacity for every hour of the year with the maximum emission concentration applied continually. PGM have advised that in reality this would not ever occur (power requirements would be restrictive and PGM do not use all areas of the mine simultaneously), consequently the emission estimates and modelling for the ventilation outlets are highly conservative.
- All ventilation outlets were configured as point sources within AERMOD (see Section 8).
- The Great Cobar ventilation outlet is located within a box cut and consequently the release of emissions is below ground level. The release height was conservatively configured to ground level (0 m).
- The Perseverance ventilation outlet features two adjacent horizontal releases; #2 and #3. These ventilation outlet sources were configured as individual point sources with horizontal releases in AERMOD.
- All ventilation outlets were given a constant exit temperature of 292°K (18.9°C) based on the Ektimo 2019 sampling. This is likely to underestimate the exit temperature during summer months, reducing the thermal buoyancy component in plume dispersion calculations and potentially overstating resultant concentrations.

A summary of the key parameters for each ventilation outlet are presented in Table 7.4.

Table 7.4 Ventilation outlet emissions

Ventilation outlet	Location (m, MGA55)		Flow rate (m^3/s)	Exit diameter (m)	Release height (m)	Exit temperature (°K)	Emission rate (g/s)		
	Easting	Northing					TSP	PM_{10}	$PM_{2.5}$
Great Cobar	390504	6513647	320	5.6	0 (ground level)	297	1.41	0.39	0.18
Jubilee	391178	6512749	165.7	4.5	5	297	0.73	0.20	0.09
Peak	393487	6507422	152.4	4	5	297	0.67	0.18	0.08
Perseverance #2	393830	6506605	178.9	4	2.5	297	0.79	0.22	0.10
Perseverance #3	393846	6506608	178.9	4	2.5	297	0.79	0.22	0.10
Chesney	391568	6511876	32.7	6	5	297	0.14	0.04	0.02

7.5 Metals and metalloids

Emissions of individual metals and metalloids have been estimated based on the following:

- ventilation outlets – the sampled percentage of metal/metalloid relative to the corresponding sample total solid particles was applied to the maximum total solid particles concentration adopted for TSP emissions (see Section 7.4);
- ore and waste rock – site geochemistry analysis was provided by PGM for ore and waste rock material, with the 90th percentile metals/metalloid percentages adopted; and

- tailings – geochemistry analysis from a number of samples collected across the TSF were provided, with the maximum metals/metalloid percentages adopted.

A summary of the adopted profiles is presented in Table 7.5. Only the metals/metalloids with an applicable NSW EPA impact assessment criteria (as specified in Section 4.2.2) are listed in Table 7.5.

Table 7.5 Adopted metals/metalloid profiles

Metal/metalloid	Metals/metalloid content percentage by material type			
	Ore	Tailings	Waste rock	Ventilation outlets
Sb	0.001%	0.001%	nd	nd
As	0.005%	0.018%	0.002%	nd
Ba	0.063%	0.016%	nd	nd
Be	<0.001%	<0.001%	nd	nd
Cd	<0.001%	0.004%	<0.001%	nd
Cr	0.008%	0.013%	0.002%	0.019%
Cu	1.210%	nd	0.065%	0.068%
Pb	0.020%	0.835%	0.025%	0.074%
Mn	0.137%	nd	0.045%	0.063%
Hg	nd	<0.001%	<0.001%	nd
Ni	0.004%	0.004%	0.001%	nd
Ag	<0.001%	<0.001%	nd	nd

Note: nd – not detected

The material geochemistry profiles have been applied to the following source types:

- ventilation outlets – applied to the six ventilation outlets across the New Cobar Complex and Peak Complex sites;
- waste rock – road sources, waste rock emplacement and handling and wind erosion of waste emplacement area;
- ore – ore material handling and transfers, processing plant, ore stockpile wind erosion; and
- tailings – wind erosion from the Peak Complex TSF.

Annual emission totals of metals and metalloids are presented in Table 7.6.

Table 7.6 Annual metal and metalloid emission totals by particle size fraction

Metal/metalloid	Annual emission (kg/annum) by metal or metalloid		
	TSP	PM_{10}	$PM_{2.5}$
Sb	0.4	0.2	<0.1
As	6.8	2.7	0.4
Ba	15.4	6.6	0.8
Be	0.1	<0.1	<0.1
Cd	0.9	0.4	0.1
Cr	33.3	9.9	3.7
Cu	417.1	146.7	27.2
Fe	290.1	114.0	25.9
Hg	170.9	50.3	14.8
Mg	<0.1	<0.1	<0.1
Mn	3.0	1.1	0.2
Ni	0.1	0.1	<0.1
Pb	555.8	200.4	57.6
Ag	0.4	0.2	<0.1

8 Air dispersion modelling

8.1 Dispersion model selection and configuration

The atmospheric dispersion modelling completed for this assessment used the AERMOD dispersion model (version v19191). 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 40 assessment locations (documented in Section 3.1), air pollutant concentrations were predicted over a 12 km by 13 km model domain featuring the following nested grids:

- a 1 km by 1 km domain with 100 m resolution;
- a 5 km by 5 km domain with 250 m resolution; and
- a 12 km by 13 km domain with 1 km resolution.

Specific activities (road movements, material handling areas, wind erosion etc) were represented by a series of volume sources and area sources which were located according to the layout of each mining complex. The modelled source locations are shown in Appendix B.

Simulations were undertaken for the 12 month period of 2017 using the AERMET-generated file based largely on the BoM Cobar Airport AWS dataset as input (see Section 5 for a description of input meteorology).

8.2 Incremental (Project-only) results

As stated previously, emissions were quantified for a single emission scenario accounting for existing operational emission sources at the New Cobar Complex and Peak Complex and additional emission sources (Great Cobar ventilation outlet and additional road truck ore haulage emissions). The predicted incremental (Project-only) concentrations and deposition rates are presented in the following tables:

- Table 8.1 – predicted incremental TSP, PM_{10}, $PM_{2.5}$ and Pb concentrations and dust deposition rates from existing operational emissions sources at the New Cobar Complex and Peak Complex.
- Table 8.2 - predicted incremental TSP, PM_{10}, $PM_{2.5}$ and Pb concentrations and dust deposition rates from the additional operational emission sources, specifically the Great Cobar ventilation outlet and additional road truck ore haulage emissions within the New Cobar Complex and Peak Complex.
- Table 8.3 – predicted incremental TSP, PM_{10}, $PM_{2.5}$ and Pb concentrations and dust deposition rates from the combination of existing operational emission sources and additional emission sources. It is noted that while annual average concentrations and deposition rates will be the sum of existing and additional sources, the 24-hour average maximums will not due to hourly varying dispersion meteorology.
- Table 8.4 - predicted incremental metal and metalloid concentrations for existing operational emission sources, additional emission sources and combined existing and additional emission sources. Presented concentrations are the maximum predicted at PGM boundary, rather than specific assessment locations.

The predicted concentrations and deposition rates for all pollutants and averaging periods presented in these four tables are below the applicable NSW EPA assessment criteria, with the exception of the mine-owned residence at assessment location R2. It is noted that, excluding dust deposition and the assorted metals and metalloids, the assessment criteria listed are applicable to cumulative concentrations. Analysis of cumulative impact compliance is presented in Section 8.3.

Contour plots illustrating spatial variations in incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates from the additional sources only (ie Great Cobar ventilation outlet and the additional truck movements at New Cobar Complex and Peak Complex) are provided in Appendix C. Isopleth plots of the maximum 1-hour or 24-hour average concentrations presented in Appendix C do not represent the dispersion pattern on any individual hour or day, but rather illustrate the maximum hourly or daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2017 modelling period.

Table 8.1 Incremental (Project-only) concentration and deposition results – existing operational emissions

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)						
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition	Pb
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**	**0.5**
R1	0.4	4.3	0.4	0.7	0.1	<0.1	<0.1
R2	0.7	5.2	0.6	1.3	0.1	0.1	<0.1
R3	0.6	3.8	0.5	1.0	0.1	0.1	<0.1
R4	0.3	3.0	0.4	0.8	0.1	<0.1	<0.1
R5	0.3	2.4	0.3	0.6	0.1	<0.1	<0.1
R6	0.2	2.3	0.2	0.6	<0.1	<0.1	<0.1
R7	0.2	2.0	0.3	0.5	0.1	<0.1	<0.1
R8	0.2	1.9	0.3	0.5	0.1	<0.1	<0.1
R9	0.2	2.0	0.2	0.4	<0.1	<0.1	<0.1
R10	0.2	1.5	0.2	0.4	<0.1	<0.1	<0.1
R11	0.3	3.4	0.4	0.7	0.1	<0.1	<0.1
R12	0.3	2.7	0.3	0.7	0.1	<0.1	<0.1
R13	0.3	3.5	0.4	0.7	0.1	<0.1	<0.1
R14	0.3	2.6	0.3	0.6	0.1	<0.1	<0.1
R15	0.1	1.3	0.2	0.3	<0.1	<0.1	<0.1
R16	0.7	4.2	0.7	0.9	0.1	0.1	<0.1
R17	0.2	1.8	0.3	0.4	0.1	<0.1	<0.1
R18	0.5	3.6	0.5	0.8	0.1	<0.1	<0.1
R19	0.1	1.4	0.2	0.3	<0.1	<0.1	<0.1
R20	0.3	3.1	0.3	0.6	0.1	<0.1	<0.1
R21	0.2	2.5	0.3	0.5	0.1	<0.1	<0.1
R22	0.1	1.8	0.2	0.4	<0.1	<0.1	<0.1
R23	0.2	2.5	0.3	0.5	0.1	<0.1	<0.1
R24	0.2	1.2	0.2	0.4	<0.1	<0.1	<0.1
R25	0.5	2.7	0.5	0.8	0.1	<0.1	<0.1
R26	1.2	6.4	1.0	1.1	0.2	0.1	<0.1
R27	0.6	3.2	0.5	0.8	0.1	0.1	<0.1
R28	0.6	3.7	0.5	0.9	0.1	0.1	<0.1
R29	0.5	3.6	0.5	1.0	0.1	<0.1	<0.1
R30	0.3	2.8	0.4	0.7	0.1	<0.1	<0.1
R31	0.8	4.6	0.8	1.1	0.2	0.1	<0.1

Table 8.1 Incremental (Project-only) concentration and deposition results – existing operational emissions

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)						
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition	Pb
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**	**0.5**
R32	0.2	1.7	0.3	0.4	0.1	<0.1	<0.1
R33	0.4	4.4	0.4	1.0	0.1	<0.1	<0.1
R34	0.3	2.6	0.3	0.7	0.1	<0.1	<0.1
R35	0.1	1.3	0.2	0.3	<0.1	<0.1	<0.1
R36	0.2	1.9	0.3	0.4	0.1	<0.1	<0.1
R37	0.4	2.9	0.4	0.8	0.1	<0.1	<0.1
R38	0.2	2.7	0.3	0.5	0.1	<0.1	<0.1
R39	0.2	1.9	0.2	0.5	<0.1	<0.1	<0.1
R40	0.2	1.7	0.2	0.4	<0.1	<0.1	<0.1

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

Table 8.2 Incremental (Project-only) concentration and deposition results – additional emission sources

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)						
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition	Pb
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**	**0.5**
R1	1.1	15.8	0.5	7.2	0.2	0.1	<0.1
R2	6.7	**97.0**	3.1	**44.2**	1.4	0.8	<0.1
R3	1.2	9.6	0.4	4.3	0.2	0.2	<0.1
R4	0.8	8.9	0.3	4.0	0.1	0.1	<0.1
R5	0.5	10.7	0.3	4.9	0.1	0.1	<0.1
R6	0.2	3.1	0.1	1.4	0.1	<0.1	<0.1
R7	0.3	5.3	0.2	2.4	0.1	<0.1	<0.1
R8	0.3	3.6	0.2	1.6	0.1	<0.1	<0.1
R9	0.3	4.2	0.2	1.9	0.1	<0.1	<0.1
R10	0.2	3.1	0.2	1.4	0.1	<0.1	<0.1
R11	0.8	7.4	0.4	3.3	0.2	0.1	<0.1
R12	0.6	9.9	0.3	4.5	0.1	0.1	<0.1
R13	0.7	8.3	0.4	3.7	0.1	0.1	<0.1
R14	0.4	5.8	0.3	2.7	0.1	<0.1	<0.1
R15	0.1	4.2	0.1	1.9	<0.1	<0.1	<0.1
R16	0.2	2.6	0.1	1.2	<0.1	<0.1	<0.1
R17	0.2	7.0	0.2	3.2	0.1	<0.1	<0.1
R18	3.2	23.9	1.4	10.8	0.6	0.4	<0.1
R19	0.1	1.3	0.1	0.6	<0.1	<0.1	<0.1
R20	0.7	5.4	0.3	2.4	0.1	0.1	<0.1
R21	0.3	3.4	0.2	1.5	0.1	<0.1	<0.1
R22	0.2	1.8	0.1	0.8	<0.1	<0.1	<0.1
R23	0.5	4.1	0.3	1.9	0.1	0.1	<0.1
R24	0.1	1.1	0.1	0.5	<0.1	<0.1	<0.1
R25	0.1	1.6	0.1	0.7	<0.1	<0.1	<0.1
R26	0.2	3.0	0.2	1.3	<0.1	<0.1	<0.1
R27	0.6	5.3	0.2	2.4	0.1	0.1	<0.1
R28	0.9	9.0	0.3	4.1	0.1	0.1	<0.1
R29	1.1	7.2	0.4	3.3	0.2	0.1	<0.1
R30	0.7	8.9	0.3	4.0	0.1	0.1	<0.1
R31	0.2	2.6	0.2	1.2	<0.1	<0.1	<0.1

Table 8.2 Incremental (Project-only) concentration and deposition results – additional emission sources

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)						
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition	Pb
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**	**0.5**
R32	0.2	5.1	0.2	2.3	0.1	<0.1	<0.1
R33	1.4	13.4	0.7	6.1	0.3	0.2	<0.1
R34	0.5	7.4	0.2	3.4	0.1	0.1	<0.1
R35	0.1	2.0	0.1	0.9	<0.1	<0.1	<0.1
R36	0.3	5.4	0.2	2.4	0.1	<0.1	<0.1
R37	0.6	11.0	0.3	5.0	0.1	0.1	<0.1
R38	0.4	4.2	0.2	1.9	0.1	<0.1	<0.1
R39	0.2	3.6	0.1	1.6	<0.1	<0.1	<0.1
R40	0.2	2.7	0.1	1.2	0.1	<0.1	<0.1

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

Table 8.3 Incremental (Project-only) concentration and deposition results – combined existing and additional sources

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)						
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition	Pb
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**	**0.5**
R1	1.5	16.2	0.9	7.2	0.3	0.2	<0.1
R2	7.4	**101.7**	3.7	**45.4**	1.5	0.9	<0.1
R3	1.7	11.9	1.0	5.0	0.3	0.2	<0.1
R4	1.1	10.0	0.7	4.2	0.2	0.1	<0.1
R5	0.8	11.6	0.6	5.1	0.2	0.1	<0.1
R6	0.3	3.7	0.4	1.6	0.1	<0.1	<0.1
R7	0.5	6.0	0.5	2.6	0.1	<0.1	<0.1
R8	0.5	4.3	0.5	1.8	0.1	<0.1	<0.1
R9	0.4	4.4	0.4	1.9	0.1	<0.1	<0.1
R10	0.4	3.5	0.4	1.5	0.1	<0.1	<0.1
R11	1.2	9.9	0.7	4.0	0.2	0.1	<0.1
R12	0.9	10.9	0.6	4.7	0.2	0.1	<0.1
R13	1.1	9.4	0.7	4.0	0.2	0.1	<0.1
R14	0.7	6.0	0.6	2.7	0.2	0.1	<0.1
R15	0.3	5.2	0.3	2.1	0.1	<0.1	<0.1
R16	1.0	4.3	0.8	1.2	0.2	0.1	<0.1
R17	0.4	8.1	0.4	3.4	0.1	<0.1	<0.1
R18	3.7	25.7	2.0	11.2	0.7	0.5	<0.1
R19	0.3	2.3	0.3	0.8	0.1	<0.1	<0.1
R20	1.0	7.8	0.6	3.1	0.2	0.1	<0.1
R21	0.5	5.2	0.5	2.0	0.1	<0.1	<0.1
R22	0.3	3.1	0.3	1.2	0.1	<0.1	<0.1
R23	0.8	4.5	0.6	2.0	0.2	0.1	<0.1
R24	0.3	1.6	0.3	0.7	0.1	<0.1	<0.1
R25	0.6	3.2	0.6	1.2	0.1	0.1	<0.1
R26	1.4	6.9	1.2	1.4	0.2	0.2	<0.1
R27	1.2	6.3	0.7	2.5	0.2	0.1	<0.1
R28	1.5	10.4	0.9	4.4	0.2	0.2	<0.1
R29	1.6	8.2	0.9	3.5	0.3	0.2	<0.1
R30	1.1	11.7	0.7	4.7	0.2	0.1	<0.1
R31	1.0	5.3	0.9	1.3	0.2	0.1	<0.1

Table 8.3 Incremental (Project-only) concentration and deposition results – combined existing and additional sources

Assessment location ID	Predicted incremental concentrations (µg/m³) or deposition rates (g/m²/month)						
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition	Pb
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**	**0.5**
R32	0.4	6.4	0.4	2.6	0.1	<0.1	<0.1
R33	1.8	14.1	1.1	6.3	0.4	0.2	<0.1
R34	0.8	8.3	0.6	3.6	0.2	0.1	<0.1
R35	0.3	2.2	0.3	1.0	0.1	<0.1	<0.1
R36	0.5	5.7	0.5	2.6	0.1	<0.1	<0.1
R37	1.0	11.4	0.7	5.1	0.2	0.1	<0.1
R38	0.6	6.0	0.5	2.4	0.1	<0.1	<0.1
R39	0.4	5.5	0.4	2.1	0.1	<0.1	<0.1
R40	0.4	4.0	0.4	1.5	0.1	<0.1	<0.1

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

Table 8.4 Incremental (Project-only) metal/metalloid concentrations – existing, additional and combined emission sources – PGM boundary maximum

Element	Maximum predicted 99.9th percentile 1-hour average concentration at PGM boundary (µg/m³)			Criterion (µg/m³)
	Existing sources	Additional sources	Combined	
Sb	0.00057	-	0.00057	9.00
As	0.00101	0.00016	0.00101	0.09
Ba	0.005	-	0.005	9.0
Be	0.00002	-	0.00002	0.004
Cd	0.00015	0.00001	0.00015	0.018
Cr	0.01	0.11	0.11	9.00
Cu	0.10	0.40	0.40	18.00
Mn	0.03	0.37	0.37	18.00
Hg	0.00001	0.00006	0.00006	0.18
Ni	0.00055	0.00009	0.00055	0.18
Ag	0.00003	-	0.00003	0.18

8.3 Cumulative (Project + background) results

Predicted cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates at surrounding assessment locations are presented in Table 8.5.

Cumulative impacts at each assessment location have been quantified in the following way:

- for 24-hour average concentrations, each daily varying model predicted PM_{10} and $PM_{2.5}$ concentration from existing and additional emission sources has been combined with the corresponding concentration from the 2017 CBH Resources Broken Hill PM_{10} background dataset (Section 6.3.1) and synthetic daily varying $PM_{2.5}$ background dataset (Section 6.3.2); and

- for annual average concentrations, the predicted annual average concentrations have been paired with the corresponding background annual average concentration (Section 6.3.6).

As detailed in Section 6.3, there are three existing exceedances of the applicable criteria for 24-hour average PM_{10} and $PM_{2.5}$ in the adopted background datasets. For cumulative impact assessment purposes, these are therefore 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.

To analyse if emissions from the Project will lead to additional exceedances of the applicable criteria, the 4^{th} highest 24-hour cumulative PM_{10} and $PM_{2.5}$ concentrations at each assessment location are reported in Table 8.5. If the presented 4^{th} highest cumulative concentration is above the relevant criteria, this is therefore classed as an additional exceedance event.

The predicted cumulative concentrations for all pollutants and averaging periods comply with the applicable NSW EPA assessment criterion for all assessment locations, with the following exception:

- PGM-owned residence R2 – exceedance of the cumulative 24-hour average PM_{10}, 24-hour average $PM_{2.5}$ and annual average $PM_{2.5}$ criteria.

The modelling results presented therefore indicate that the existing sources associated with the Project do not adversely impact sensitive receptor locations in the surrounding environment. Further, the introduction of additional emissions from the Great Cobar vent shaft and increased ore transportation does not result in exceedance of applicable criteria at private receptor locations across Cobar.

Table 8.5 Cumulative (Project + background) concentration and deposition results

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	4th highest 24-hour	Annual	4th highest 24-hour	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
R1	33.2	44.8	16.1	21.1	7.4	2.2
R2	39.1	**87.3**	18.9	**41.1**	**8.6**	2.9
R3	33.4	44.8	16.2	21.1	7.4	2.2
R4	32.8	44.8	15.9	21.1	7.4	2.1
R5	32.4	44.8	15.8	21.1	7.3	2.1
R6	32.0	44.8	15.6	21.1	7.2	2.0
R7	32.2	44.8	15.7	21.1	7.3	2.0
R8	32.2	44.8	15.6	21.1	7.3	2.0
R9	32.1	44.8	15.6	21.1	7.3	2.0
R10	32.1	44.8	15.6	21.1	7.3	2.0
R11	32.9	44.8	15.9	21.1	7.4	2.1
R12	32.5	44.8	15.8	21.1	7.3	2.1
R13	32.7	44.8	15.9	21.1	7.4	2.1
R14	32.3	44.8	15.8	21.1	7.3	2.1
R15	31.9	44.8	15.5	21.1	7.2	2.0
R16	32.7	44.8	16.0	21.1	7.3	2.1
R17	32.1	44.8	15.6	21.1	7.3	2.0
R18	35.4	44.9	17.2	21.1	7.9	2.5
R19	31.9	44.8	15.5	21.1	7.2	2.0
R20	32.6	44.8	15.8	21.1	7.3	2.1
R21	32.2	44.8	15.6	21.1	7.3	2.0
R22	32.0	44.8	15.5	21.1	7.2	2.0
R23	32.4	44.9	15.8	21.1	7.3	2.1
R24	31.9	44.8	15.5	21.1	7.2	2.0
R25	32.3	44.8	15.8	21.1	7.3	2.1
R26	33.0	44.8	16.3	21.1	7.4	2.2
R27	32.9	44.8	15.9	21.1	7.3	2.1
R28	33.2	44.8	16.1	21.1	7.4	2.2
R29	33.3	44.8	16.1	21.1	7.4	2.2
R30	32.7	44.8	15.9	21.1	7.3	2.1
R31	32.7	46.2	16.1	21.3	7.3	2.1
R32	32.1	44.8	15.6	21.1	7.3	2.0
R33	33.4	44.9	16.3	21.1	7.5	2.2

Table 8.5 Cumulative (Project + background) concentration and deposition results

Assessment location ID	Predicted cumulative concentrations (µg/m³) or deposition rates (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	4th highest 24-hour	Annual	4th highest 24-hour	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
R34	32.4	44.8	15.7	21.1	7.3	2.1
R35	31.9	44.8	15.5	21.1	7.2	2.0
R36	32.2	44.8	15.7	21.1	7.3	2.0
R37	32.7	44.8	15.9	21.1	7.3	2.1
R38	32.3	44.8	15.7	21.1	7.3	2.0
R39	32.0	44.8	15.5	21.1	7.2	2.0
R40	32.0	44.8	15.6	21.1	7.2	2.0

Note: Due to three existing exceedance events in the 2017 dataset (see Section 6.3.1), the fourth highest cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented. A bold value indicates an exceedance of impact assessment criteria

To illustrate the contribution of background, existing emission sources and additional emission sources to cumulative concentrations, the following figures have been generated:

- Figure 8.1 – cumulative 24-hour average PM_{10} concentrations at the most impacted non-mine related assessment location (R18 – Cobar Rugby Club sports ground);
- Figure 8.2 – cumulative 24-hour average $PM_{2.5}$ concentrations at the most impacted non-mine related assessment location (R18 – Cobar Rugby Club sports ground)
- Figure 8.3 – cumulative annual average PM_{10} concentrations at all assessment locations; and
- Figure 8.4 – cumulative annual average $PM_{2.5}$ concentrations at all assessment locations.

These figures illustrate that the predicted daily-varying cumulative concentrations are below applicable impact assessment criteria at all non-PGM owned receptor locations. Further, the figures illustrate that ambient background concentrations are the major contributor to cumulative concentrations.

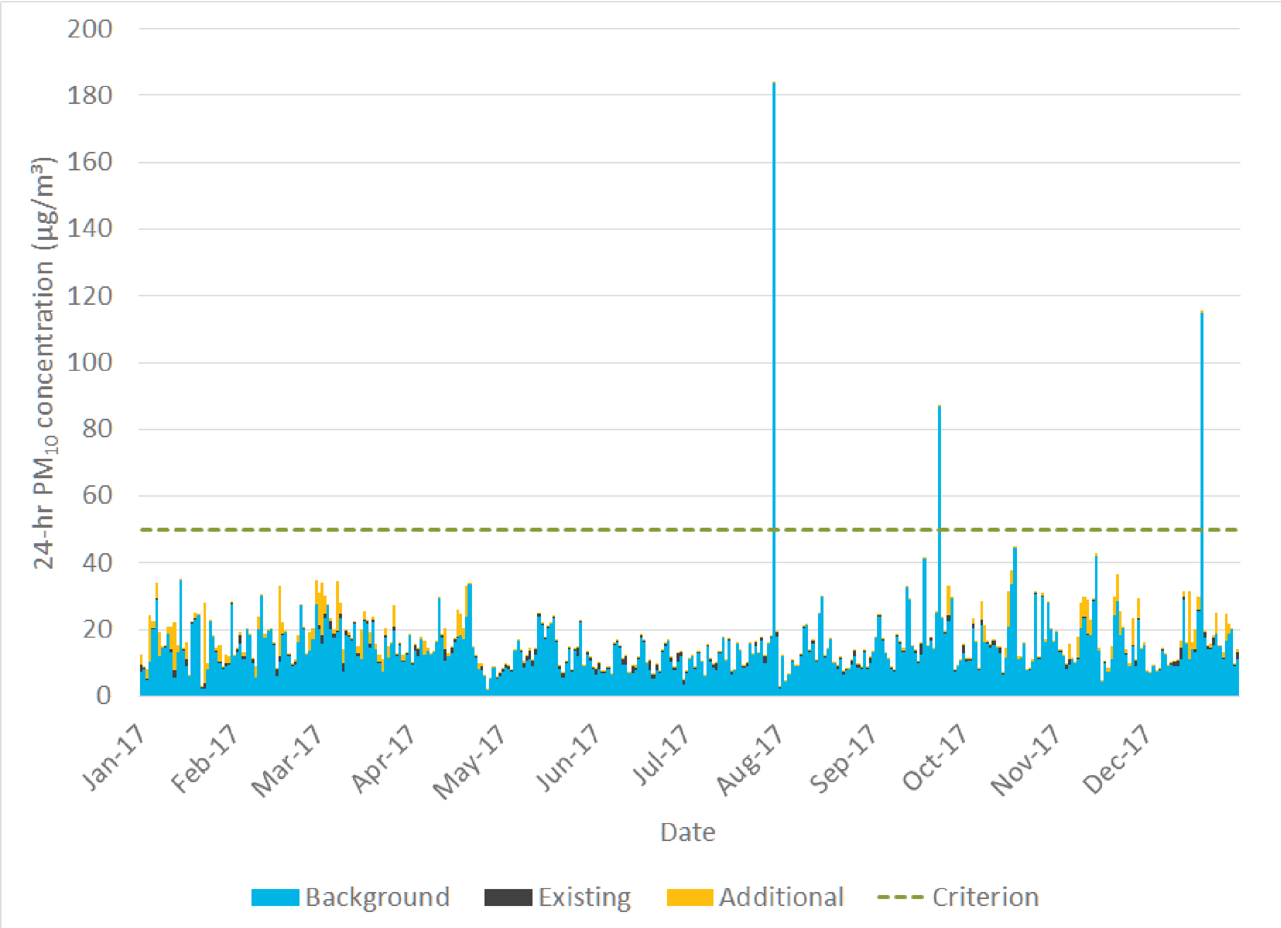

Figure 8.1 Daily-varying cumulative 24-hour average PM_{10} concentrations – assessment location R18

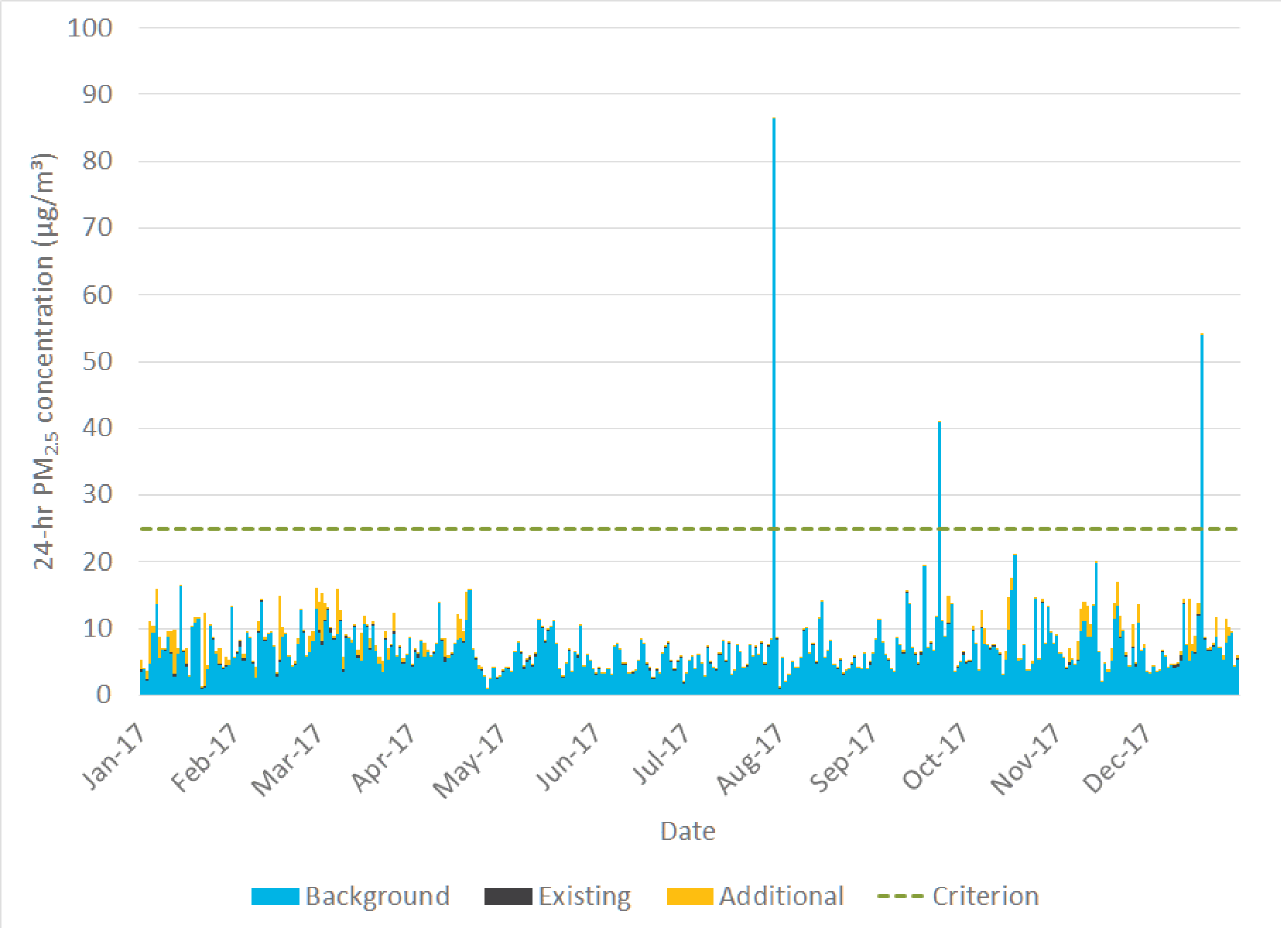

Figure 8.2 **Daily-varying cumulative 24-hour average $PM_{2.5}$ concentrations – assessment location R18**

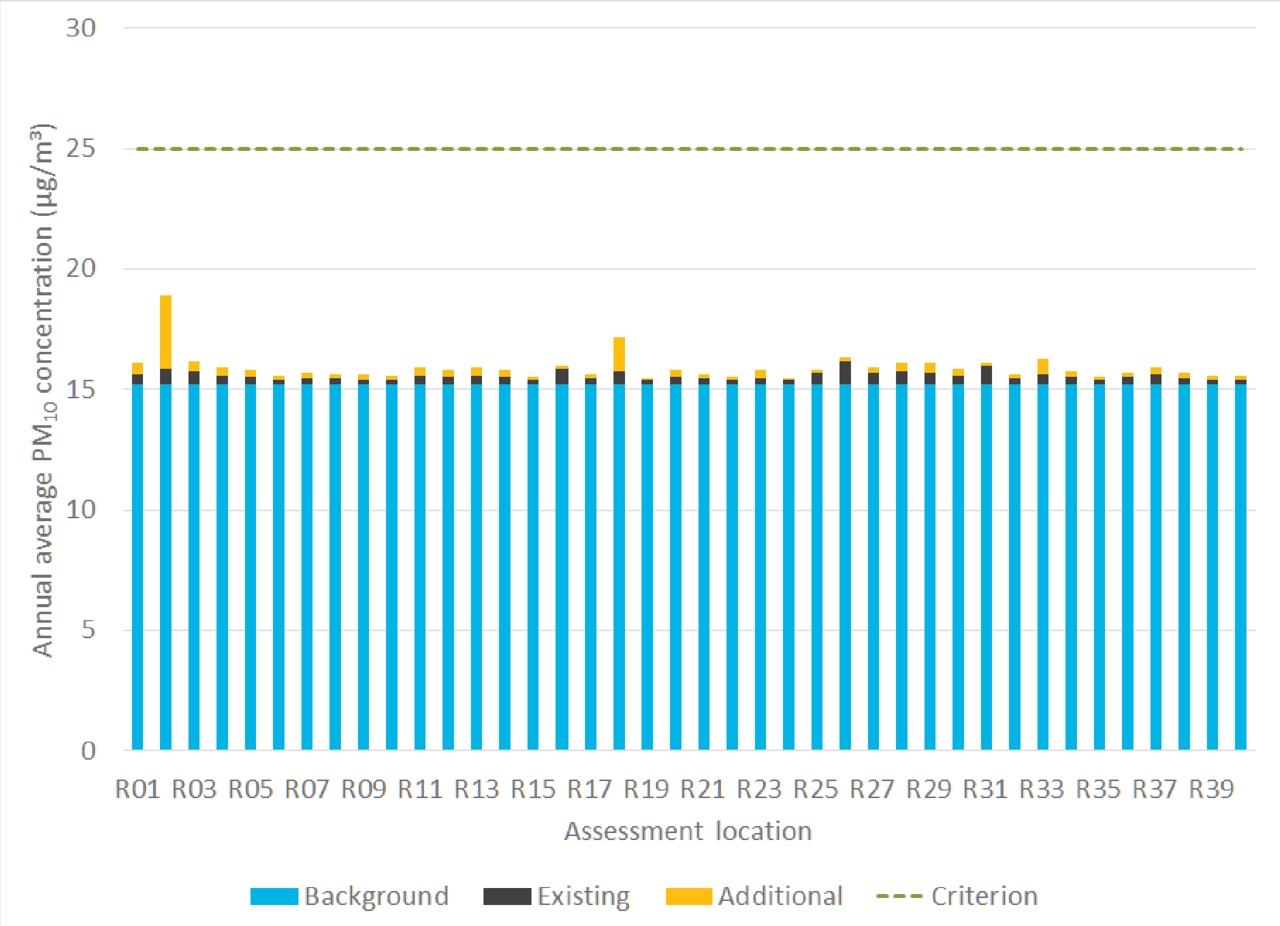

Figure 8.3 Cumulative annual average PM_{10} concentrations – all assessment locations

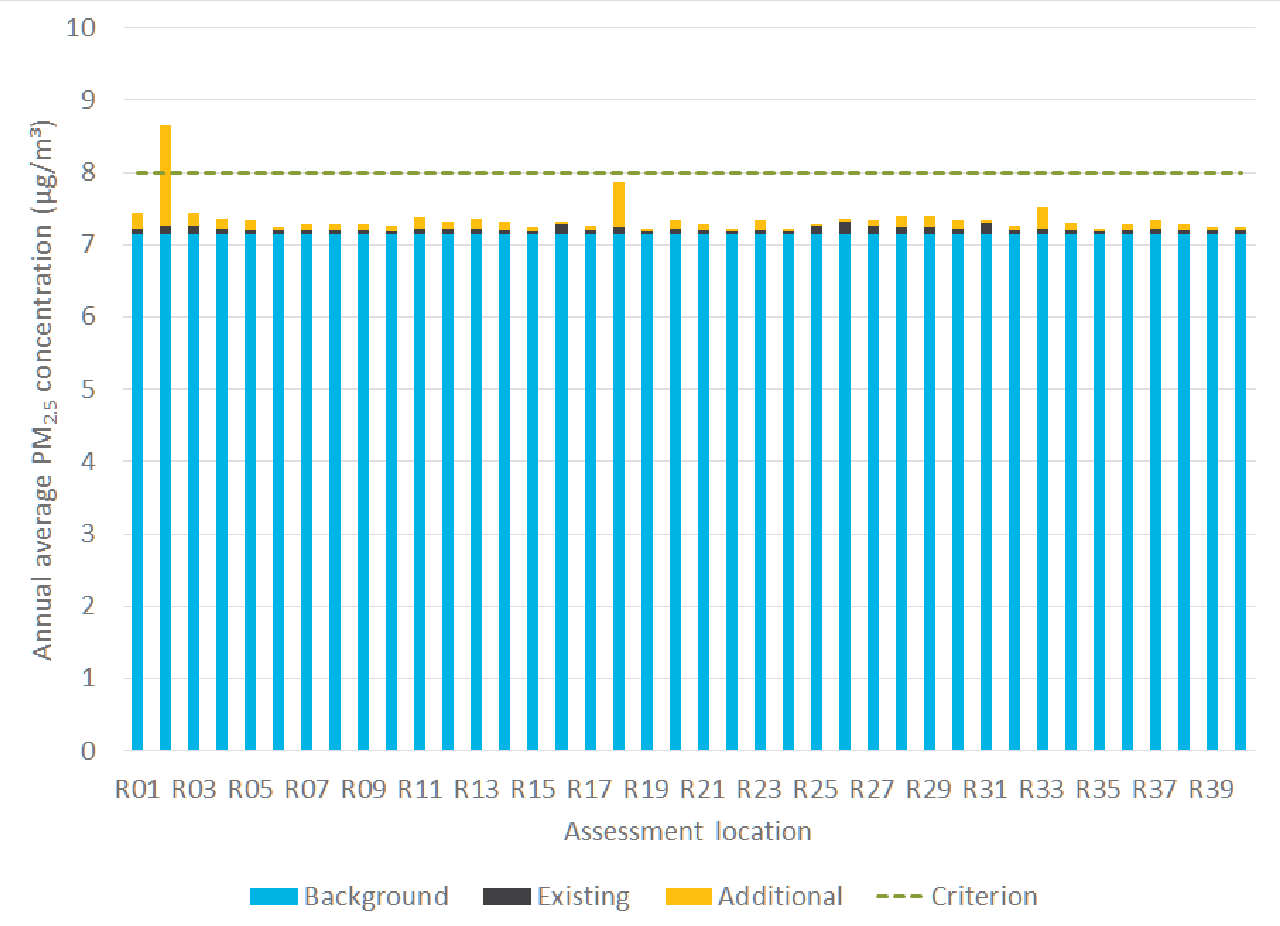

Figure 8.4 Cumulative annual average $PM_{2.5}$ concentrations – all locations

8.4 Voluntary land acquisition criteria

The results presented in Section 8.2 and Section 8.3 demonstrate compliance with the relevant VLAMP criteria for both mitigation and acquisition presented in Section 4.4. 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 Appendix 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.

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 6.3.6 was added to the incremental contour plots presented in Appendix C. This analysis highlighted that no exceedance of relevant VLAMP criteria across more than 25% of any privately-owned land would occur.

9 Air quality monitoring

As documented in Section 6.2, PGM maintain an air quality monitoring network surrounding the New Cobar Complex and Peak Complex. The monitoring network comprises of one BAM (continuous PM_{10}), two HVAS units (one-in-six day TSP and PM_{10}), 10 dust deposition gauges (monthly dust deposition gauges) and a meteorological monitoring station. PGM also receive laboratory metal/metalloid analysis from collected HVAS filter paper and dust deposition samples.

This monitoring network will continue to be maintained for the life of the Project. The combination of continuous measurements of PM_{10} by the installed BAM and the PGM meteorological station will allow PGM to undertake detailed investigations into any potential criteria exceedances (ie identify regional exceedance events through the pairing of PM_{10} and wind speed/direction measurements). Expansion of the monitoring network is not proposed at this point in time and is not considered required on the basis of the modelling presented.

Daily and annual average TSP and PM_{10} concentrations and monthly average dust deposition results will continue to be recorded and reported in monthly and annual environmental management reports. Monitoring results are also made available to the public through Aurelia Metal's website.

10 Greenhouse gas assessment

10.1 Introduction

The estimation of greenhouse gas (GHG) emissions for the Project was based on the Australian Government Department of the Environment and Energy (DoEE) *National Greenhouse Accounts Factors* (NGAF) workbook (DoEE 2019). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the "Method 1" approach outlined in the *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoEE 2019). Indirect emissions are further defined as scope 2 and scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (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. Specific scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels and purchased electricity, making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

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.

Table 10.1 Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (diesel) 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 and petrol.
		Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.

Emissions of GHGs have been quantified based on 2019 production year totals provided by PGM. Specifically:

- annual diesel fuel consumption of 3,155,451 L; and
- annual purchased electricity consumption of 74,834,541 kWh.

PGM have advised that the additional sources are unlikely to significantly change the energy consumption of the Project relative to existing operations. The following notes relate to additional emission sources:

- While the increased intensity of Great Cobar ventilation outlet will increase electricity consumption from that source, this will be offset by a reduction in electricity consumption intensity at other ventilation outlets. Furthermore, ventilation outlet fans are not run at full capacity continuously. Therefore, there is not anticipated to be a change in annual purchased electricity consumption relative to existing operations.

- The additional haulage of ore from New Cobar Complex to Peak Complex by road trucks is expected to increase truck movements by 50 per day (25 additional truck loads per day). Based on a one-way haulage distance of 7.5 km and an articulated truck consumption rate of 52.3 L/100 km (ABS 2019), the additional haulage of ore from New Cobar Complex to Peak Complex by road trucks will consume an additional 71,585 L of diesel per year.

GHG emissions from the diesel and electricity consumption from existing and additional sources are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and scope 1, 2 and 3 emission factors for diesel and electricity use in NSW.

10.3 Excluded emissions

There are a number of GHG emissions that are considered minor relative to diesel and electricity consumption and have been excluded from this GHG assessment. Excluded sources are:

- Liquid petroleum gas (LPG) and petrol consumption (scope 1);
- fugitive leaks from high voltage switch gear and refrigeration (scope 1);
- explosives detonation in underground operations (scope 1);
- use of paints, solvents, oils and grease (scope 1);
- disposal of solid waste at landfill (scope 3);
- transport of product to market (scope 3); and
- travel of employees to and from the Project (scope 3).

10.4 Emission estimates

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

- diesel consumption on-site (scope 1) – diesel oil factors from Table 4 of the NGAF workbook (2019);
- electricity consumption (scope 2) – NSW Scope 2 emission factor from Table 5 of the NGAF workbook (2019);
- diesel consumption on-site (scope 3) – diesel oil factor from Table 43 of the NGAF workbook (2019);
- electricity consumption (scope 3) - NSW Scope 3 emission factor from Table 44 of the NGAF workbook (2019).

The estimated annual GHG emissions for each emission source are presented in Table 10.2.

Table 10.2 Estimated annual GHG emissions

Emission sources	Scope 1 tonnes carbon dioxide equivalent per year (t CO_2-e/year)	Scope 2 (t CO_2-e/year)	Scope 3 (t CO_2-e/year)		
	Diesel	Electricity	Diesel	Electricity	Total
Existing	8,550.4	60,616.0	438.5	6,735.1	7,173.6
Additional	194.0	-	9.9	-	9.9
Total	**8,744.4**	**60,616.0**	**448.4**	**6,735.1**	**7,183.5**

It can be seen that the additional emissions associated with the Project represent a minor change in GHG emissions relative to existing operations. It is clear that the changes to emissions associated with the Project do not significantly alter annual GHG emissions from existing operations.

The significance of 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 2018[11]) for NSW (131,684.9 kt CO_2-e) and Australia (537,446.4 kt CO_2-e).

Annual scope 1 and 2 GHG emissions generated by the Project, accounting for existing and additional sources, represent approximately 0.058% of total GHG emissions for NSW and 0.013% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2018.

The contribution of the Project to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions.

The calculated annual scope 1 and 2 emissions from the Project are greater than the NGER Scheme facility reporting threshold of 25,000 tpa CO_2-e. PGM currently calculate and report scope 1 and 2 GHG emissions annually in accordance with the requirements of the NGER Act and will continue to do so as long as scope 1 and 2 GHG emissions are above the reporting threshold.

[11] https://ageis.climatechange.gov.au/SGGI.aspx

11 Conclusions

An AQIA focusing on the quantification of emissions and resultant air quality impacts from existing operations and proposed additional activities associated with the New Cobar Complex has been conducted by EMM.

Emissions of TSP, PM_{10}, $PM_{2.5}$ and assorted metals/metalloids were quantified for all existing PGM operational sources at the New Cobar Complex and Peak Complex. Additional emissions from the Great Cobar ventilation outlet and increased road truck transportation of ore material from New Cobar Complex to Peak Complex were also quantified. Emissions were quantified using publicly available emission estimation techniques and site-specific ventilation outlet monitoring data.

Atmospheric dispersion modelling predictions of air pollution emissions were undertaken using the AERMOD dispersion model.

The results of the dispersion modelling highlighted the following:

- impacts from existing operations do not result in exceedance of any applicable criteria at any private assessment location;
- the addition of emissions from the Great Cobar ventilation outlet increases predicted impacts, however all predicted concentrations and deposition rates are below application impact assessment criterion at all private assessment locations;
- the increase in transportation of ore from New Cobar Complex to Peak Complex by road trucks is not predicted to generate significant air quality impacts; and
- predicted concentrations of all metals and metalloids are negligible to very low at or beyond PGM boundary.

The emissions configured for the six PGM ventilation outlets, including the Great Cobar ventilation outlet, were highly conservative, assuming constant emissions at full outlet fan capacity for the entire modelling period. Further, conservative emission concentrations were adopted in the emission calculations. Despite the high level of conservatism, the increased emissions from the Great Cobar ventilation outlet is not predicted to adversely impact the populated areas of Cobar.

A GHG assessment was also undertaken for the Project. Annual scope 1 and 2 GHG emissions generated by the Project, accounting for existing and additional sources, represent approximately 0.058% of total GHG emissions for NSW and 0.013% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2018.

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US-EPA 2013, AERSURFACE User's Guide

Abbreviations

AERMOD	AMS/US-EPA regulatory model
Approved Methods for Modelling *in New South Wales*	*Approved Methods for the Modelling and Assessment of Air Pollutants*
Ag	Silver
AQIA	air quality impact assessment
As	Arsenic
AWS	Automatic weather station
Ba	Barium
BAM	beta attenuation monitor
Be	Beryllium
bgl	Below ground level
BoM	Bureau of Meteorology
CML	Consolidated mining lease
CO_2-e	Carbon dioxide equivalent
CO	Carbon monoxide
Cd	Cadmium
Cr	Chromium
CSC	Cobar Shire Council
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cu	Copper
DPIE	Department of Planning and Environment
DoEE	Department of the Environment and Energy
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Ltd
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPA	Environment Protection Authority
EPL	Environment protection licence
FTE	full time equivalent
GHG	Greenhouse gas

Hg	Mercury
HVAS	High volume air sampler
Km	kilometre
kV	kilovolt
LPG	Liquid petroleum gas
ML	mining lease
Mn	Manganese
MO	Meteorological Office
MoP	Mining Operations Plan
MPL	mining purposes lease
nd	not detected
NGAF	National Greenhouse Accounts Factors
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
Ni	Nickel
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NPI	National Pollutant Inventory
NSW	New South Wales
Pb	Lead
PGM	Peak Gold Mine
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*
PRP	Pollution reduction program
ROM	Run-of-mine
Sb	Antimony
SEARs	Secretary's Environmental Assessment Requirements
SO_2	Sulphur dioxide
SSD	State Significant Development
TAPM	The Air Pollution Model
TEOM	tapered element oscillating microbalance
Tpa	tonnes per annum

TSF	Tailings storage facility
TSP	total suspended particulate
US-EPA	United States Environmental Protection Agency
VLAMP	Voluntary Land Acquisition and Mitigation Policy
VOC	Volatile organic compounds
WRE	Waste rock emplacement
Zn	Zinc
µm	micrometre

Appendix A

Meteorological modelling and processing

A.1 Meteorological monitoring datasets

As discussed in Section 5.1, meteorological datasets were collated from the following monitoring stations:

- PGM meteorological monitoring station;
- BoM Cobar MO AWS, located 3 km to the north-northwest of the PGM meteorological station; and
- BoM Cobar Airport AWS, located 6 km to the southwest of the PGM meteorological station.

Due to data availability issues with the PGM meteorological station, the BoM Cobar Airport AWS monitoring station is the primary resource for meteorological data in this assessment. Data from this station was collected for the period between January 2015 and December 2019. Data availability and analysis of inter-annual trends for this five-year period is presented in the following sections.

A.1.1 Data availability

A summary of data availability for the BoM Cobar Airport AWS dataset for the period between 2015 and 2019 is provided in Figure A.1. The following points are noted:

- with the exception of missing cloud measurements between 2015 and 2017, data completeness is close to 100% for all parameters for all years between 2015 and 2019 meeting the minimum 90% data completeness requirements for all parameters specified with Section 4.1 of the Approved Methods for Modelling (NSW EPA 2016);
- cloud observations from the BoM Cobar MO were used to substitute missing cloud observations from the analysed period;
- as highlighted in Section 6, 2018 and 2019 were excluded as representative on the basis of extreme drought conditions influencing ambient particulate matter levels; and
- the 2017 calendar year was adopted as the representative calendar year for use in the dispersion modelling.

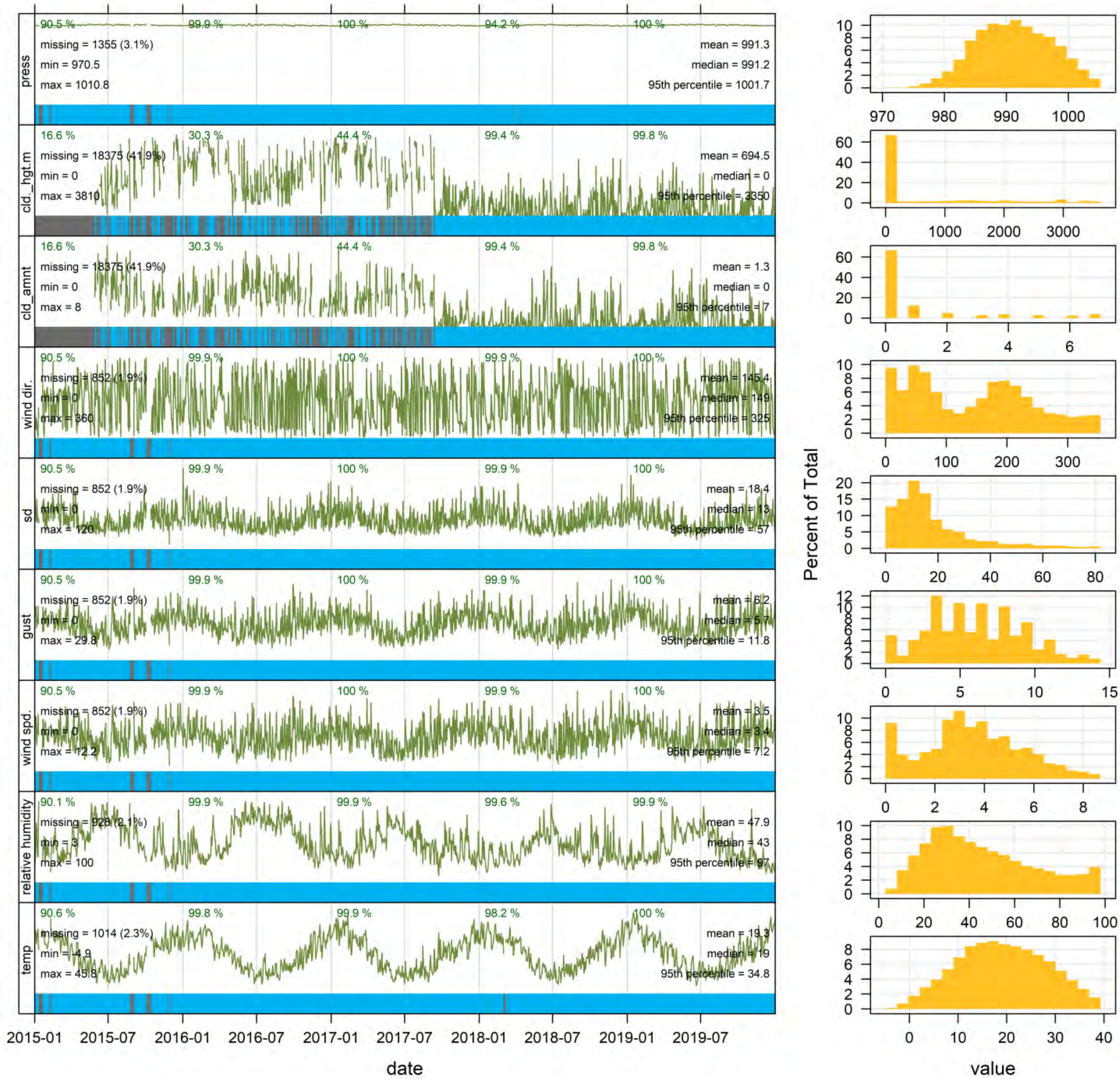


Figure A.1 Five-year data completeness analysis plot – BoM Cobar Airport – 2015 to 2019

A.1.2 Selection of a representative year

While 2019 was the most recent and complete year of monitoring data from the BoM Cobar Airport, in order to determine the most representative year of data for modelling an analysis of inter-annual trends was conducted. Inter-annual wind roses are presented in Figure A.2, while the diurnal distribution of wind speed (Figure A.3), wind direction (Figure A.4), temperature (Figure A.5) and relative humidity (Figure A.6) recorded between 2015 and 2019 are also analysed.

The following points are noted from these figures:

- Wind speed and direction measurements are relatively consistent across the five years of data. It is noted that day time wind speeds are slightly higher for 2018 and 2019 than the previous three years of data.
- Afternoon to night time air temperatures (midday to midnight) were typically higher during 2018 and 2019 relative to the previous three years of data. It is expected that this difference is associated with the intensifying drought conditions.
- The relative humidity was typically lower during 2018 and 2019 relative to the previous three years of data. Similar to air temperature, this is considered to be representative of drought conditions.

As discussed in Section 5 and Section 6, the 2017 calendar year was selected as representative of the local area without the elevated influence of drought conditions on ambient particulate matter levels. From the charts presented, 2017 is representative of meteorological conditions experienced at Cobar.

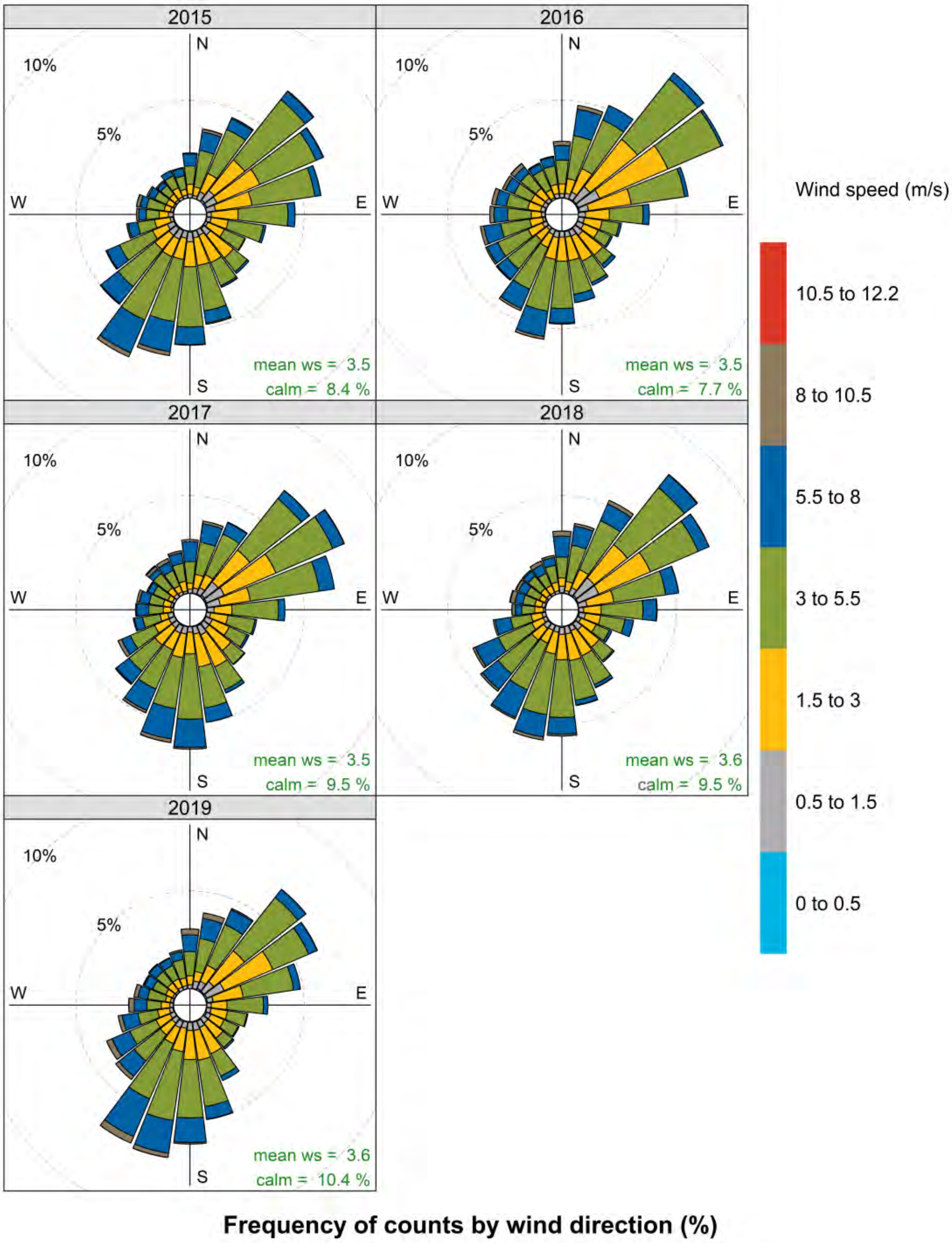


Figure A.2 Inter-annual wind roses – BoM Cobar Airport AWS – 2015 to 2019

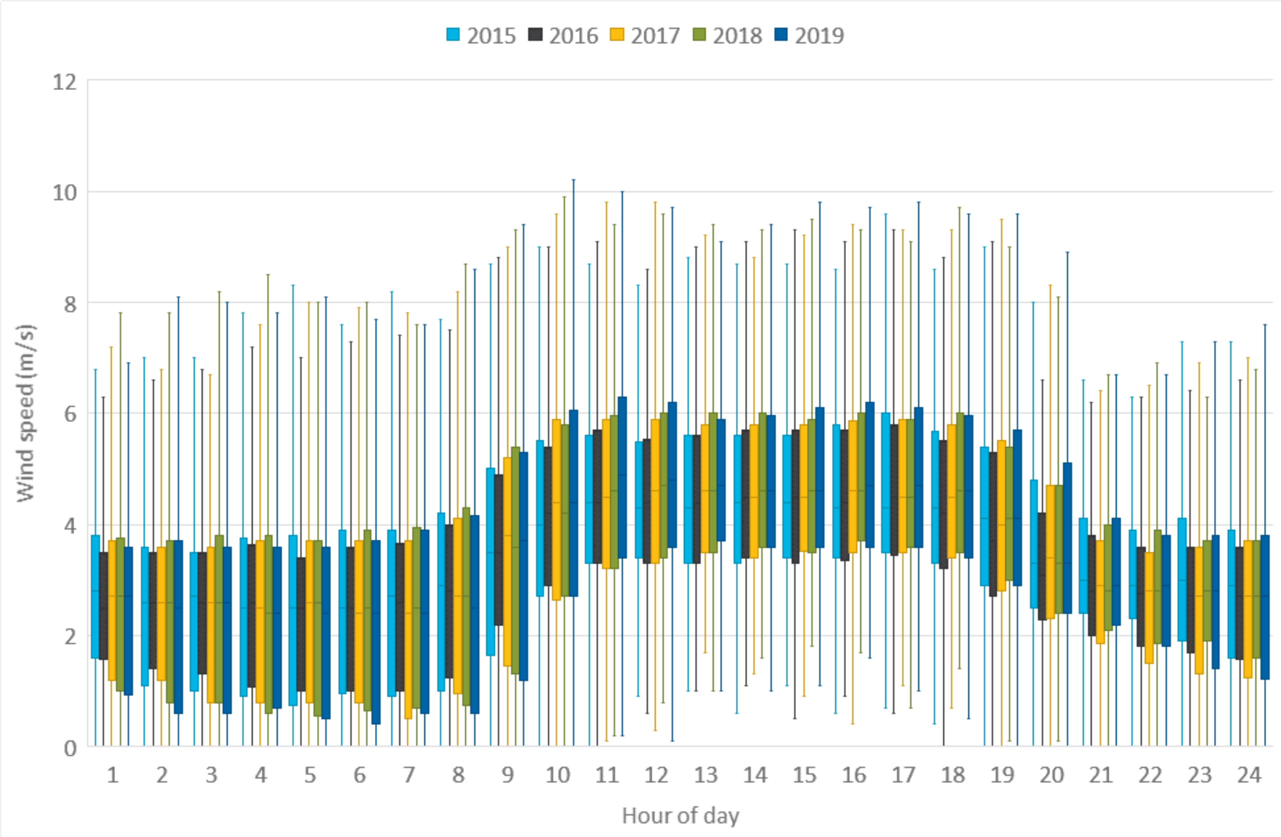


Figure A.3 Inter-annual variability in diurnal wind speed – BoM Cobar Airport AWS – 2015 to 2019

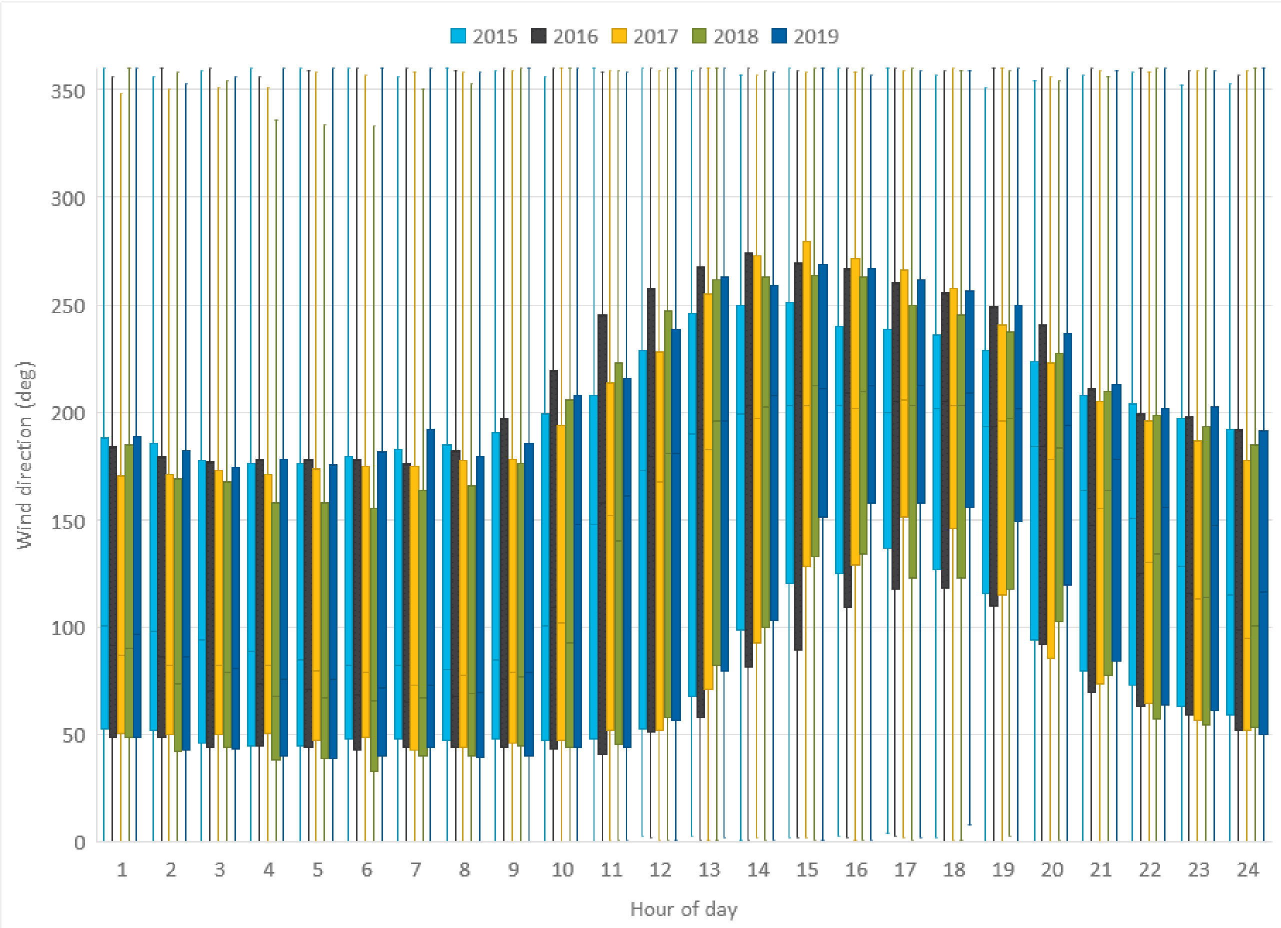


Figure A.4 **Inter-annual variability in diurnal wind direction – BoM Cobar Airport AWS – 2015 to 2019**

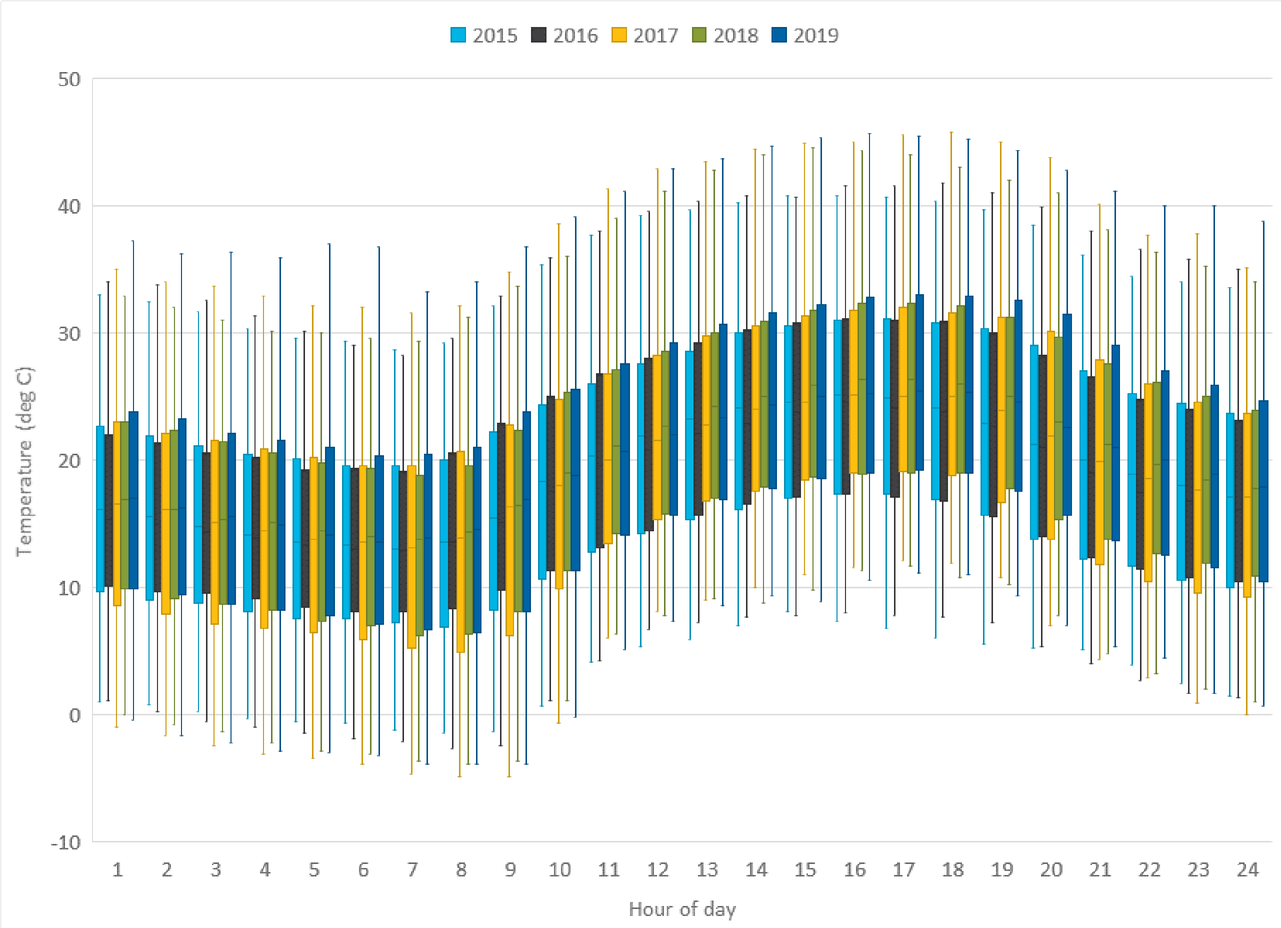


Figure A.5 Inter-annual variability in diurnal air temperature – BoM Cobar Airport AWS – 2015 to 2019

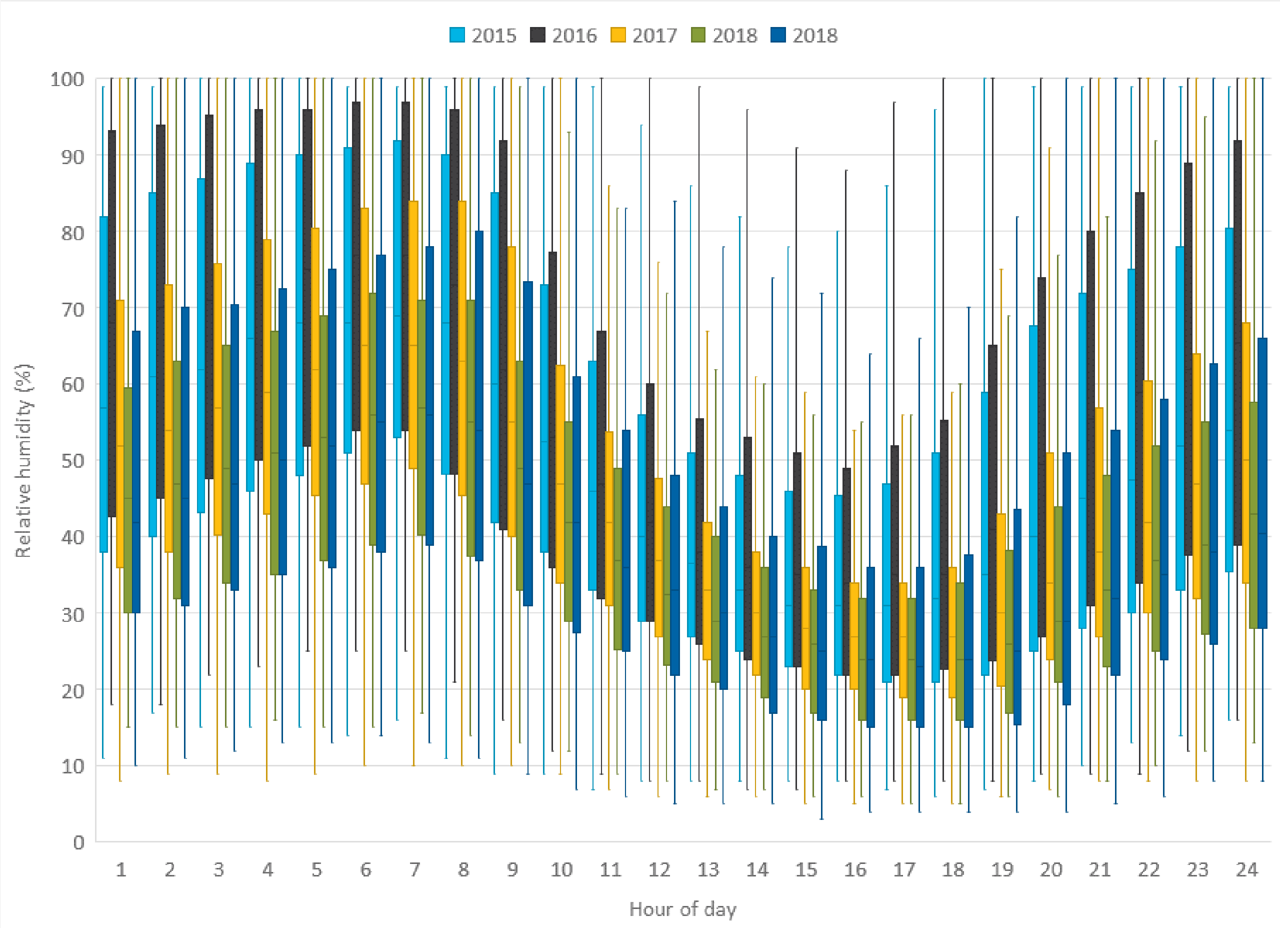


Figure A.6 Inter-annual variability in diurnal relative humidity – BoM Cobar Airport AWS – 2015 to 2019

A.2 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, 1 km and 0.3 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; and
- TAPM defaults for advanced meteorological inputs.

A.3 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.3.1 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; and
- Bowen ratio.

As detailed by USEPA (2013), the surface roughness length is related to the height of obstacles to the wind flow (eg 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 on-site meteorological station was mapped (see Figure A.7). 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 10 km by 10 km area. Monthly-varying values for surface roughness, Bowen ratio and albedo were allocated to each sector based on the values prescribed by USEPA (2013), as specified in Table A.1 and Table A.2. The following profiles were applied to individual months:

- Midsummer – January, February, December;
- Autumn – March, April, May;
- Late autumn / winter without snow – June, July, August; and
- Transitional spring – September, October, November.

The surface moisture characteristics for the 2017 calendar year was determined by comparing annual rainfall for 2017 to the previous 30-year rainfall records from the BoM Cobar MO rainfall station (BoM Cobar Airport does not contain 30 years of rainfall records). Annual rainfall for 2017 was 259 mm, which places the year in the middle 40th-percentile for the previous 30 years, and therefore an ‘average’ surface moisture classification was allocated.

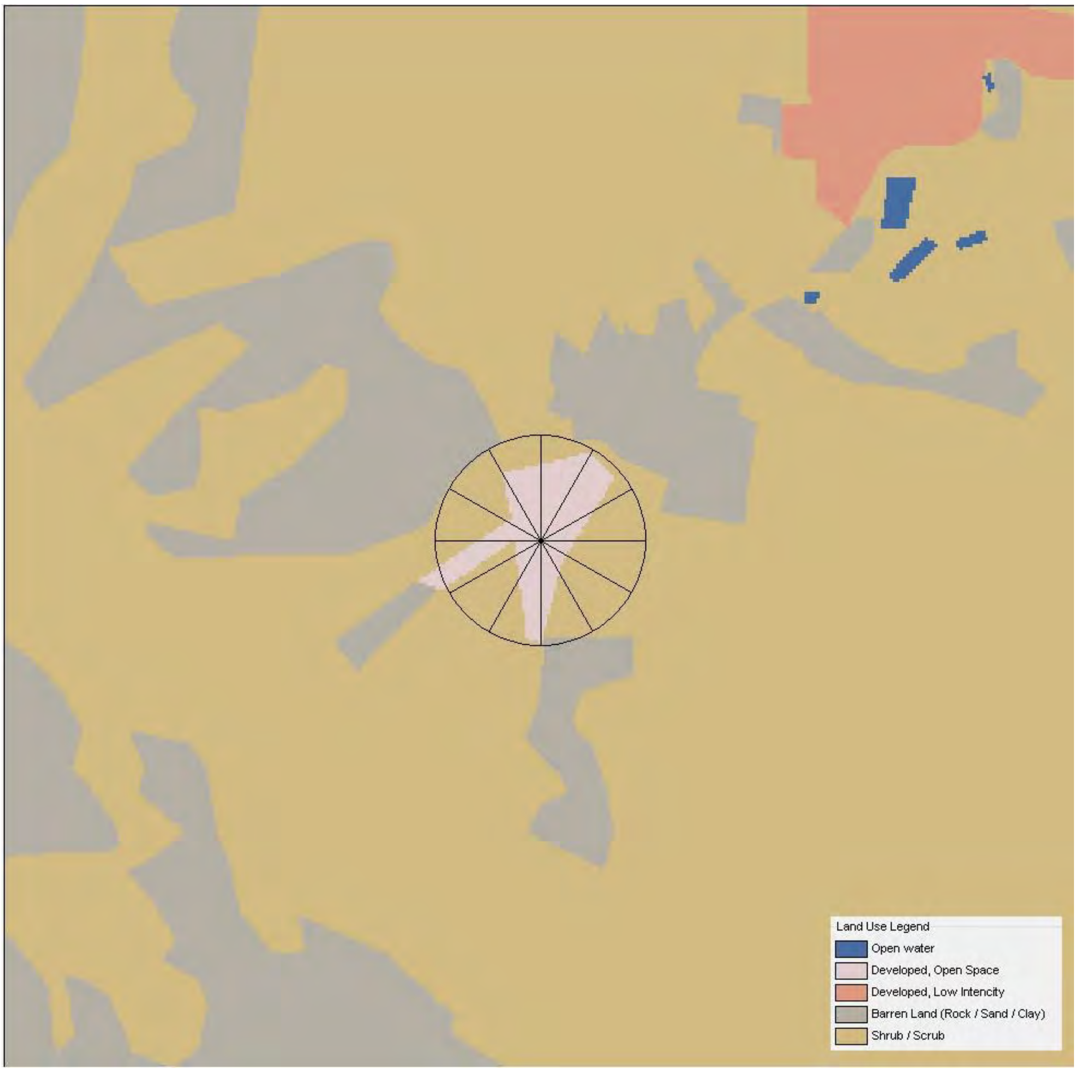


Figure A.7 Land use map for AERSURFACE processing – BoM Cobar Airport AWS

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)

Table A.1 Monthly surface roughness length values by sector

Month	Surface roughness length (m) by sector (degrees)											
	0-30	30-60	60-90	90-120	120-150	150-180	180-210	210-240	240-270	270-300	300-330	330-0
Jan	0.036	0.033	0.073	0.088	0.086	0.06	0.052	0.08	0.05	0.064	0.066	0.043
Feb	0.036	0.033	0.073	0.088	0.086	0.06	0.052	0.08	0.05	0.064	0.066	0.043
Mar	0.036	0.033	0.073	0.088	0.086	0.06	0.052	0.08	0.05	0.064	0.066	0.043
Apr	0.036	0.033	0.066	0.082	0.08	0.052	0.043	0.08	0.05	0.064	0.066	0.043
May	0.036	0.033	0.066	0.082	0.08	0.052	0.043	0.08	0.05	0.064	0.066	0.043
Jun	0.028	0.025	0.057	0.075	0.072	0.043	0.034	0.072	0.04	0.056	0.057	0.035
Jul	0.028	0.025	0.057	0.075	0.072	0.043	0.034	0.072	0.04	0.056	0.057	0.035
Aug	0.028	0.025	0.057	0.075	0.072	0.043	0.034	0.072	0.04	0.056	0.057	0.035
Sep	0.028	0.025	0.066	0.082	0.08	0.052	0.043	0.072	0.04	0.056	0.057	0.035
Oct	0.028	0.025	0.066	0.082	0.08	0.052	0.043	0.072	0.04	0.056	0.057	0.035
Nov	0.036	0.033	0.073	0.088	0.086	0.06	0.052	0.08	0.05	0.064	0.066	0.043
Dec	0.036	0.033	0.073	0.088	0.086	0.06	0.052	0.08	0.05	0.064	0.066	0.043

Table A.2 Monthly Bowen ratio and albedo values (all sectors)

Month	Monthly value (all sectors)	
	Bowen ratio	Albedo
January	3.69	0.24
February	3.69	0.24
March	3.69	0.24
April	5.49	0.24
May	5.49	0.24
June	5.49	0.24
July	5.49	0.24
August	2.79	0.24
September	2.79	0.24
October	2.79	0.24
November	3.69	0.24
December	3.69	0.24

A.3.2 Meteorological inputs

Monitoring data from the on-site meteorological station and BoM Cobar Airport AWS 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 – BoM Cobar Airport AWS;
- sigma-theta (standard deviation of wind direction) - BoM Cobar Airport AWS;
- temperature (heights of 10 m and 50 m) - BoM Cobar Airport AWS and TAPM at 50 m adjusted for 10 m observation;
- relative humidity - BoM Cobar Airport AWS;
- station level pressure – BoM Cobar Airport AWS;
- cloud cover - BoM Cobar Airport AWS (with substitution from BoM Cobar MO);
- net radiation – TAPM at BoM Cobar Airport AWS; and
- mixing depth – TAPM at BoM Cobar Airport AWS.

The period of meteorological data input to AERMET was 1 January 2017 to 31 December 2017.

A.3.3 Upper air profile

Due to the absence of necessary local upper air meteorological measurements, the hourly profile file generated by TAPM at the BoM Cobar Airport AWS 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 (10m) temperature observations from the BoM Cobar Airport AWS.

Appendix B

Emissions inventory background

B.1 Introduction

Air emission sources associated with the Project were identified and quantified through the application of accepted published emission estimation factors, collated from a combination of United States Environmental Protection Agency (US-EPA) AP-42 Air Pollutant Emission Factors and NPI emission estimation manuals (NPI 2012).

Particulate matter emissions were quantified for various particle size fractions. The emission and dispersion of TSP emissions was simulated to predict dust deposition rates. Coarse and fine particulate matter (PM_{10} and $PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the US-EPA AP-42), as documented in subsequent sections. Emissions of metals and metalloids were estimated based on the content within relevant material and calculated TSP and PM_{10} emissions.

B.2 Emissions inventory assumptions

Material parameters, annual material throughputs, haulage calculations and wind erosion areas contained within the emissions inventory are presented in Table B.1 to Table B.4.

Table B.1 Assumed material parameters

Material	Parameter	Value	Source
Waste rock/ore	Moisture content	2%	NPI default (NPI 2012)
Unpaved road	Silt content	4.6%	ACARP Report C20023 - average of uncontrolled haul roads
Paved road	Silt loading	8.2 g/m^2	Default for Quarry - AP42 13.2.1

Table B.2 Assumed material throughputs

Mine area	Description	Amount of material (tpa)	
		Ore	Waste
New Cobar Complex	Material from underground	200,000	271,860
	Return haulage to underground	-	416,990
Peak Complex	Material from underground (road)	200,000	-
	Material from underground (conveyor)	400,000	-

Table B.3 Haulage calculations

Mine site	Haulage source	Distance (km)	Truck capacity (t)	Truck Weight empty (t)	Truck weight full (t)	Truck weight average (t)	Throughput (tpa)	Loads per year
New Cobar	In pit haulage ore/waste from underground to surface	0.9	55	50	105	77.5	471,860	8,579
	Surface haulage ore to ROM stockpile	0.45	55	50	105	77.5	200,000	3,636
	Surface haulage waste to waste dump	0.55	55	50	105	77.5	271,860	4,943
	Surface haulage waste to underground	0.9	55	50	105	77.5	416,990	7,582
	In pit haulage waste to underground from surface	0.2	55	50	105	77.5	416,990	7,582
	Ore haulage to exit - existing	0.35	50	20	70	45	200,000	9,125
	Ore haulage to exit - proposed increased	0.35	50	20	70	45	200,000	9,125
Peak	Ore haulage from New Cobar - paved - existing	1	50	20	70	45	200,000	9,125
	Ore haulage from New Cobar - paved - proposed increased	1	50	20	70	45	200,000	9,125
	Ore haulage from New Cobar - unpaved - existing	0.65	50	20	70	45	200,000	9,125

Table B.3 Haulage calculations

Mine site	Haulage source	Distance (km)	Truck capacity (t)	Truck Weight empty (t)	Truck weight full (t)	Truck weight average (t)	Throughput (tpa)	Loads per year
	Ore haulage from New Cobar - unpaved - proposed increased	0.65	50	20	70	45	200,000	9,125
	Haulage from Peak Underground portal to ROM pile	0.5	55	50	105	77.5	200,000	3,636

Table B.4 Wind erosion areas

Mine site	Wind erosion source	Area (ha)
New Cobar	Wind erosion - pit	5.8
New Cobar	Wind erosion - Waste dump	12.6
New Cobar	Wind erosion - ROM stockpile	6.6
Peak	Wind erosion - ROM pad	1.4
Peak	Wind erosion - exposed areas	2.6
Peak	Wind erosion - TSF	21.2 (this value equals 25% of total area - active for WE purposes)

B.3 Emissions inventory table

A summary of the emissions inventory is presented in Table B.5.

Table B.5 Emissions inventory – existing and additional emission sources

Mine site	Source name	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	Reduction factor	Emission control	Emission factor source
New Cobar Complex	In pit haulage ore/waste from underground to surface	12,302	3,109	311	15,443	VKT/year	3.1865	0.8052	0.0805	kg/VKT	4.6	Road silt content (%)	1.8	Return haul distance (km)	8,579	Loads/year	77.5	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Surface haulage ore to ROM stockpile	2,607	659	66	3,273	VKT/year	3.1865	0.8052	0.0805	kg/VKT	4.6	Road silt content (%)	0.9	Return haul distance (km)	3,636	Loads/year	77.5	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Surface haulage waste to waste emplacement	4,331	1,095	109	5,437	VKT/year	3.1865	0.8052	0.0805	kg/VKT	4.6	Road silt content (%)	1.1	Return haul distance (km)	4,943	Loads/year	77.5	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Surface haulage waste to underground	10,871	2,747	275	13,647	VKT/year	3.1865	0.8052	0.0805	kg/VKT	4.6	Road silt content (%)	1.8	Return haul distance (km)	7,582	Loads/year	77.5	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	In pit haulage waste to underground from surface	2,416	611	61	3,033	VKT/year	3.1865	0.8052	0.0805	kg/VKT	4.6	Road silt content (%)	0.4	Return haul distance (km)	7,582	Loads/year	77.5	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Ore haulage to exit - existing	3,984	1,007	101	6,388	VKT/year	2.4950	0.6305	0.0630	kg/VKT	4.6	Road silt content (%)	0.7	Return haul distance (km)	9,125	Loads/year	45	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Ore haulage to exit - proposed increased	3,984	1,007	101	6,388	VKT/year	2.4950	0.6305	0.0630	kg/VKT	4.6	Road silt content (%)	0.7	Return haul distance (km)	9,125	Loads/year	45	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Unloading of ore at ROM stockpile	434	205	31	200,000	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation
	Unloading of waste at waste emplacement	590	279	42	271,860	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation
	Loading of ore to road trucks	434	205	31	200,000	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation

Table B.5 Emissions inventory – existing and additional emission sources

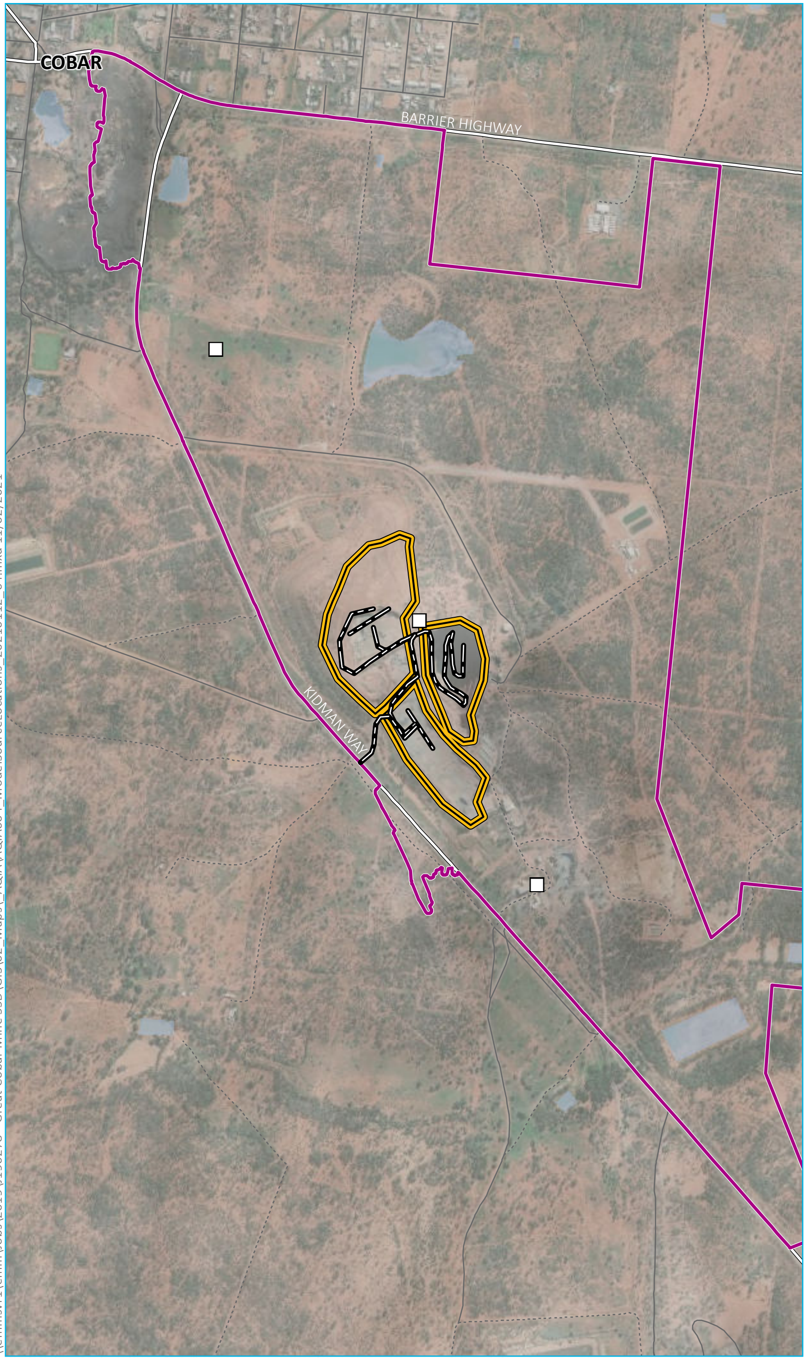
Mine site	Source name	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Reduction factor	Emission control	Emission factor source
	Loading of waste rock to underground trucks	905	428	65	416,990	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation
	Wind erosion - pit	4,966	2,483	372	6	Area (ha)	850	425	64	kg/ha/year											USEPA AP-42 11.9.2 - Wind erosion of exposed areas
	Wind erosion - Waste emplacement	10,683	5,342	801	13	Area (ha)	850	425	64	kg/ha/year											USEPA AP-42 11.9.2 - Wind erosion of exposed areas
	Wind erosion - ROM stockpile	2,814	1,407	211	7	Area (ha)	850	425	64	kg/ha/year									0.5	Watering	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Peak Complex	Ore haulage from New Cobar - paved - existing	21,452	4,118	996	18,250	VKT/year	1.1754	0.2256	0.0546	kg/VKT	8.2	Road silt loading (g/m²)	2	Return haul distance (km)	9,125	Loads/year	45	Average weight (t)			USEPA AP-42 13.2.1 - Paved roads
	Ore haulage from New Cobar - paved - proposed increased	21,452	4,118	996	18,250	VKT/year	1.1754	0.2256	0.0546	kg/VKT	8.2	Road silt loading (g/m²)	2	Return haul distance (km)	9,125	Loads/year	45	Average weight (t)			USEPA AP-42 13.2.1 - Paved roads
	Ore haulage from New Cobar - unpaved - existing	7,399	1,870	187	11,863	VKT/year	2.4950	0.6305	0.0630	kg/VKT	4.6	Road silt content (%)	1.3	Return haul distance (km)	9,125	Loads/year	45	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.1 - Paved roads
	Ore haulage from New Cobar - unpaved - proposed increased	7,399	1,870	187	11,863	VKT/year	2.4950	0.6305	0.0630	kg/VKT	4.6	Road silt content (%)	1.3	Return haul distance (km)	9,125	Loads/year	45	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads
	Haulage from Peak Underground portal to ROM pile	2,897	732	73	3,636	VKT/year	3.1865	0.8052	0.0805	kg/VKT	4.6	Road silt content (%)	1	Return haul distance (km)	3,636	Loads/year	77.5	Average weight (t)	0.75	Watering	USEPA AP-42 13.2.2 - Unpaved roads

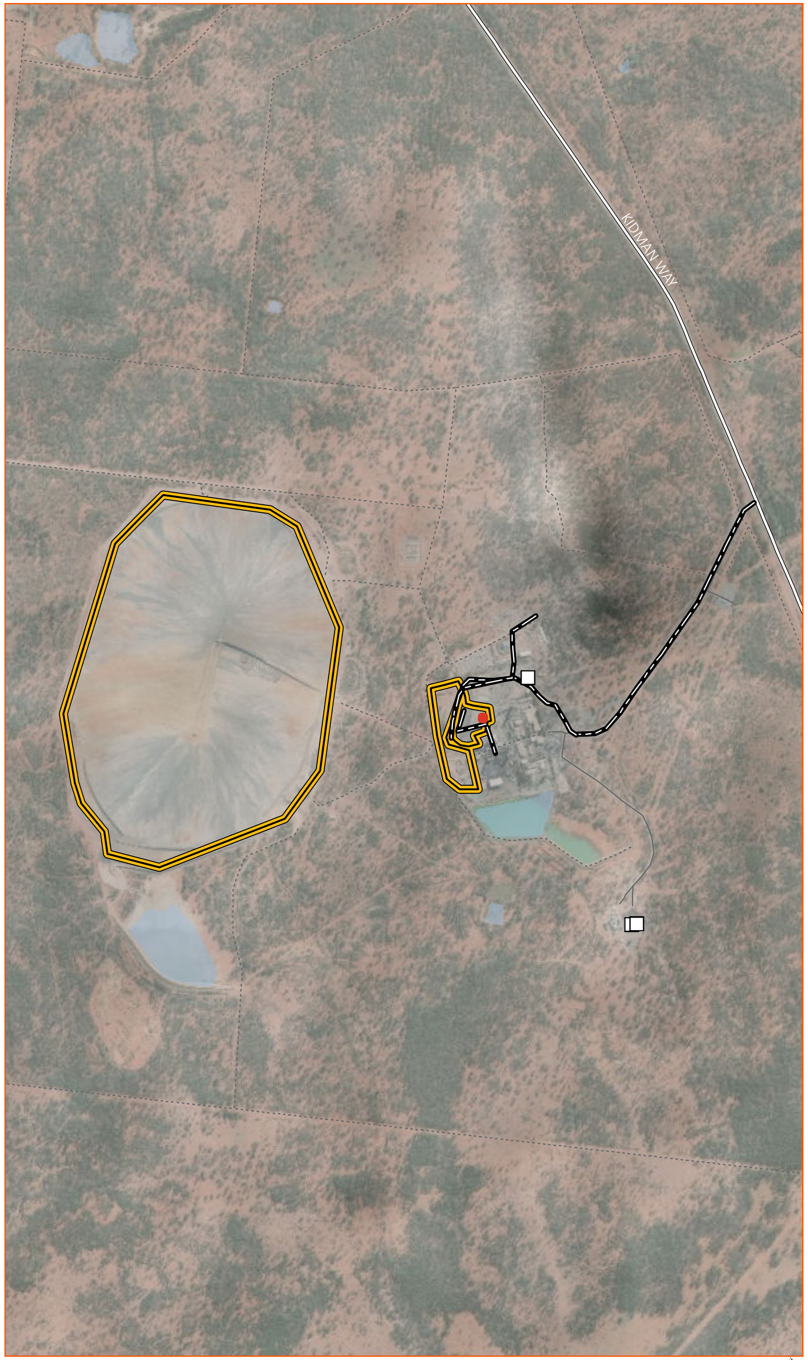
Table B.5 Emissions inventory – existing and additional emission sources

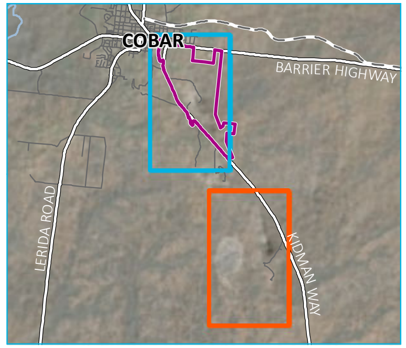
Mine site	Source name	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Reduction factor	Emission control	Emission factor source
	Unloading of ore at ROM stockpile	868	411	62	400,000	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation
	Unloading of ore from underground conveyor	868	411	62	400,000	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation
	FEL transfer of ore to processing circuit	1,736	821	124	800,000	t/y	0.0022	0.0010	0.0002	kg/t	3.51	Average wind speed (m/s)	2	Moisture content (%)							USEPA AP-42 13.2.4 - Materials handling equation
	SAG Mill	1,080	480	89	800,000	t/y	0.0027	0.0012	0.0002	kg/t									0.5	Watering	USEPA AP-42 11.19.2 - tertiary crushing
	Scalping screen	5,000	1,720	116	800,000	t/y	0.0125	0.0043	0.0003	kg/t									0.5	Watering	USEPA AP-42 11.19.2 - screening
	Ball mill	1,080	480	89	800,000	t/y	0.0027	0.0012	0.0002	kg/t									0.5	Watering	USEPA AP-42 11.19.2 - tertiary crushing
	Trash screen	5,000	1,720	116	800,000	t/y	0.0125	0.0043	0.0003	kg/t									0.5	Watering	USEPA AP-42 11.19.2 - screening
	Wind erosion - ROM pad	589	294	44	1	Area (ha)	850.0	425.0	63.8	kg/ha/year									0.5	Watering	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
	Wind erosion - exposed areas	2,221	1,111	167	3	Area (ha)	850.0	425.0	63.8	kg/ha/year											USEPA AP-42 11.9.2 - Wind erosion of exposed areas
	Wind erosion - TSF	18,036	9,018	1,353	21	Area (ha)	850.0	425.0	63.8	kg/ha/year											USEPA AP-42 11.9.2 - Wind erosion of exposed areas

Table B.5 Emissions inventory – existing and additional emission sources

Mine site	Source name	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	Reduction factor	Emission control	Emission factor source
Total site	Vent shafts - existing	98,324	26,941	12,291																	Site monitoring data
	Vent shafts - New Cobar	44,403	12,166	5,550																	Site monitoring data







KEY

- Project area
- Major road
- Minor road
- Vehicular track
- Waterbody

Model sources

- Point
- Area
- Line
- Volume

Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

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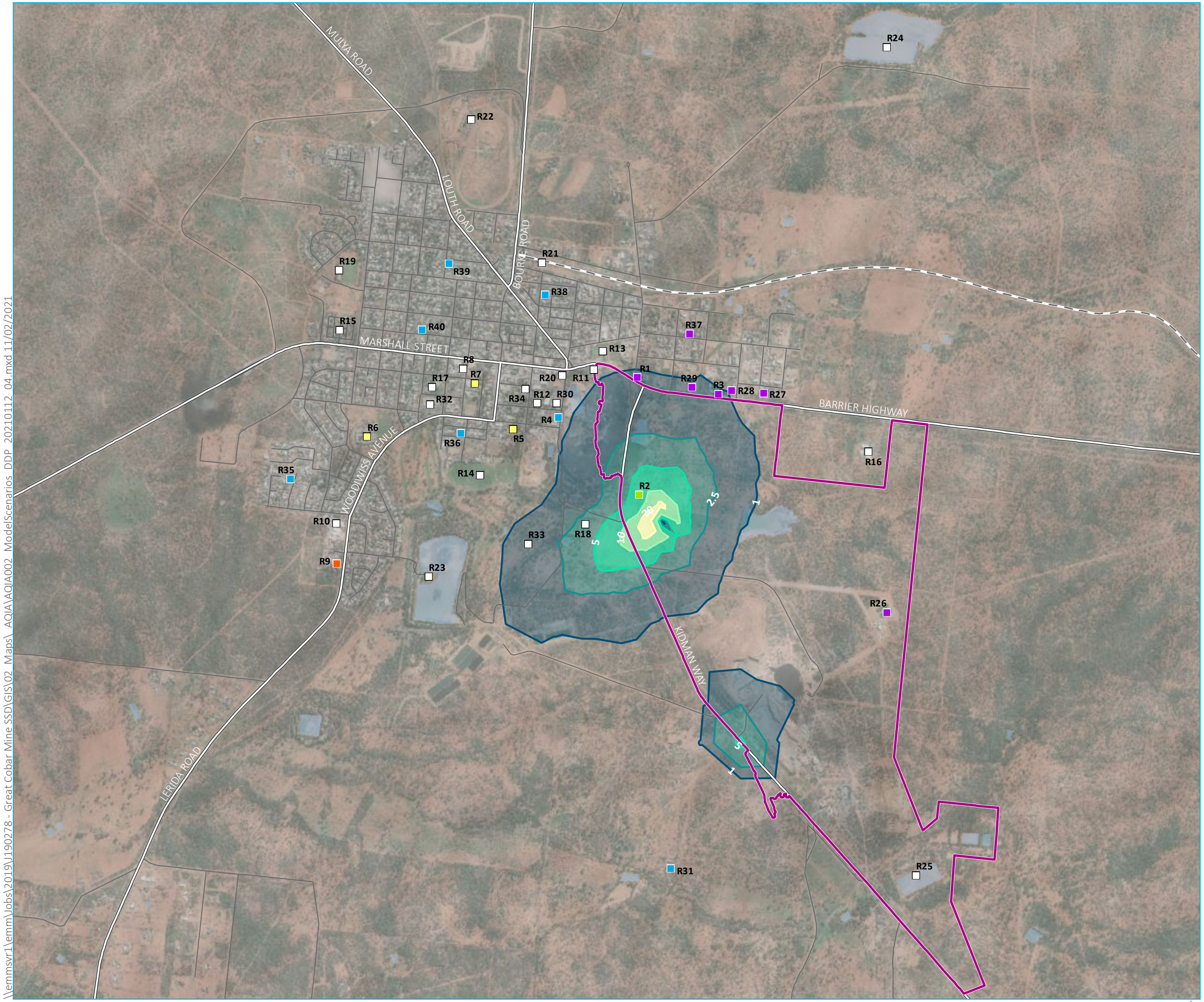
Model source locations - existing and future emission sources

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure B.1

EMM creating opportunities

Appendix C

Predicted incremental isopleth plots



KEY
Project area
Rail line
Major road
Minor road
Waterbody
Assessment location
Hospital
Mine-owned residence
Privately-owned residence
Industrial
School
Other
Average TSP concentrations (μg/m³)
1
2.5
5
10
20

Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

0 0.5 1 km
GDA 1994 MGA Zone 55
N

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Predicted annual average TSP concentrations – additional sources only

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure C.1

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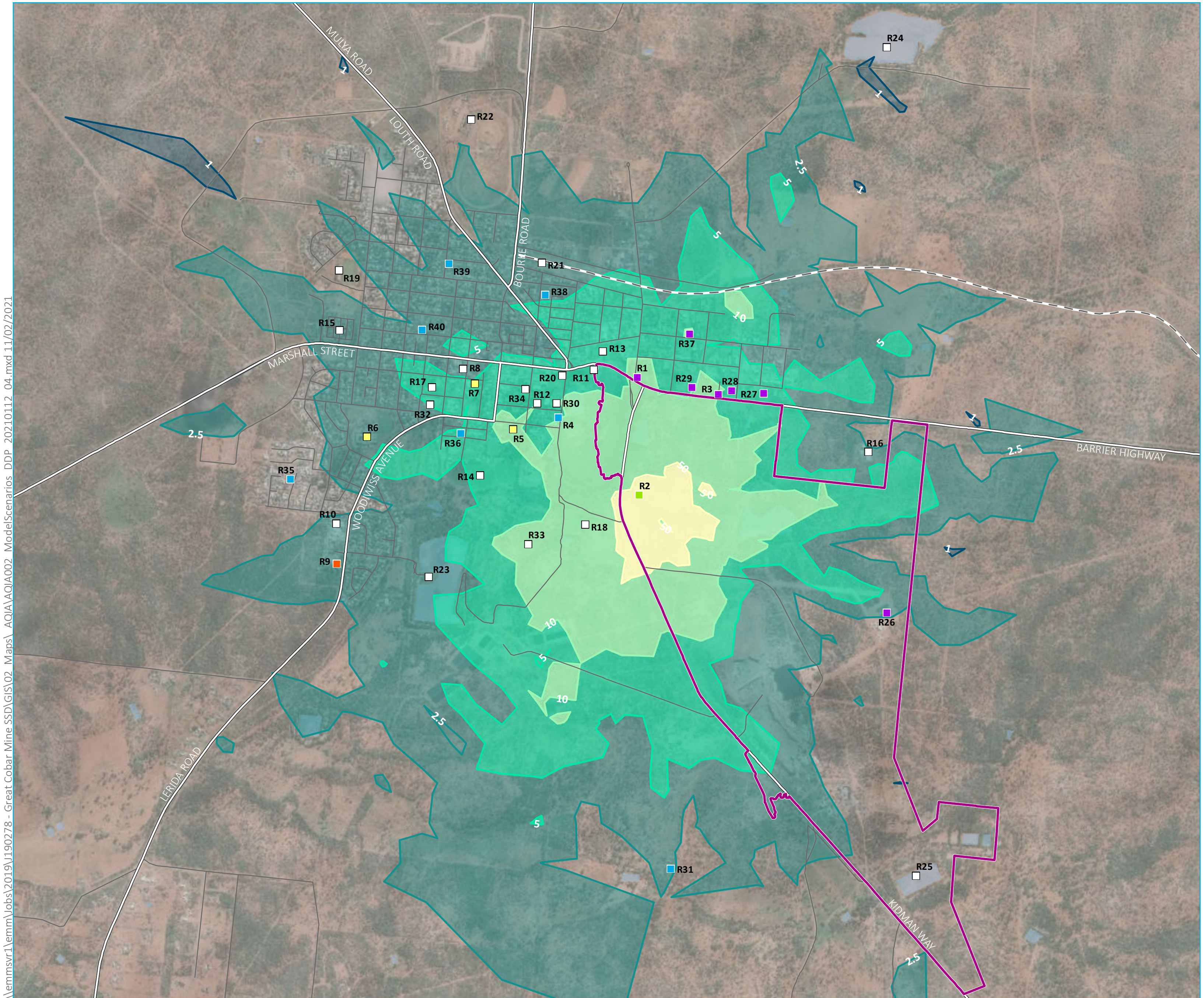


KEY

- Project area
- Rail line
- Major road
- Minor road
- Waterbody

Assessment location

- Hospital
- Mine-owned residence
- Privately-owned residence
- Industrial
- School
- Other

Average PM_{10} concentrations (µg/m³)

- 1
- 2.5
- 5
- 10
- 50

Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

0 0.5 1 km

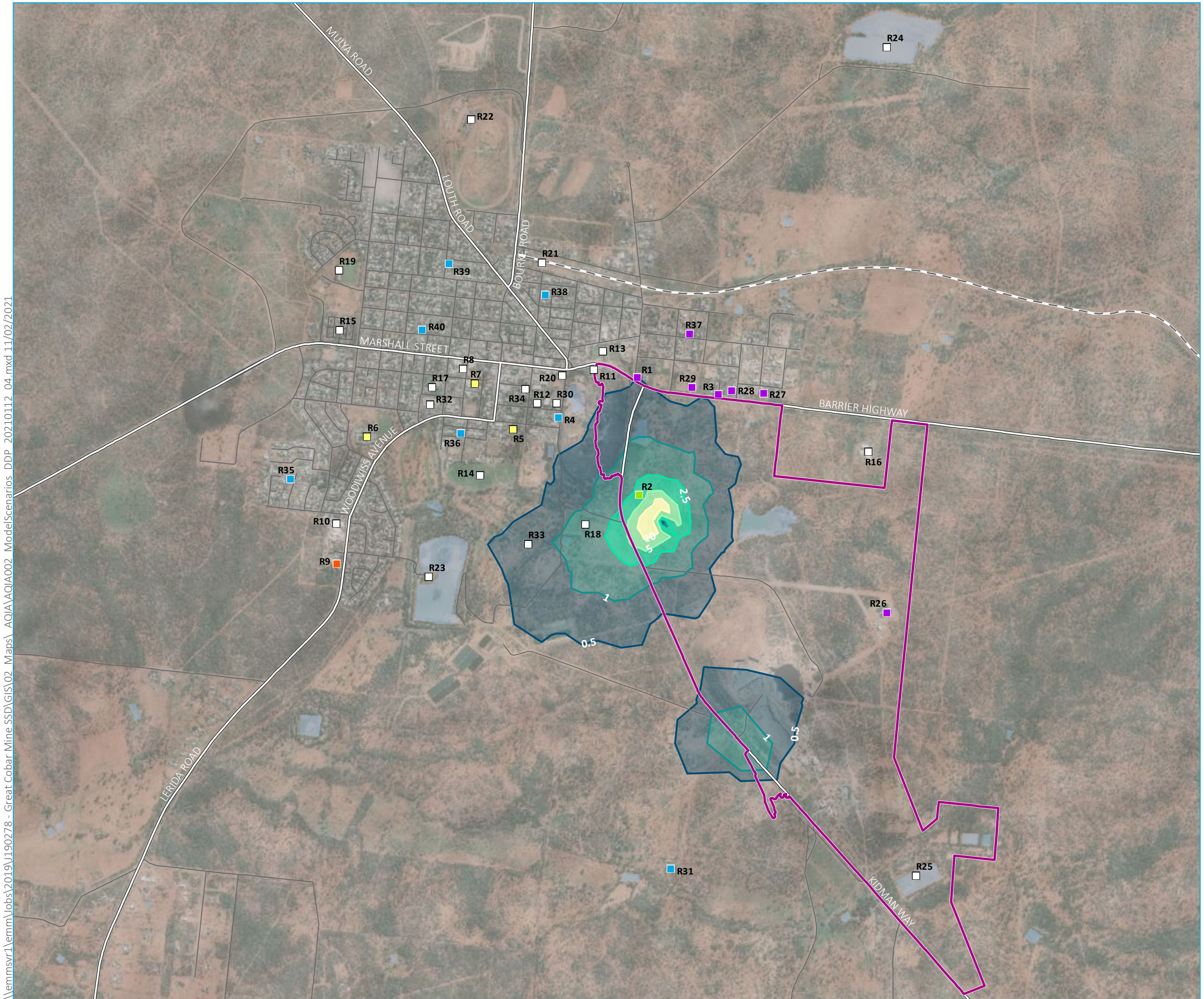
GDA 1994 MGA Zone 55

N

Maximum predicted 24-hour average PM_{10} concentrations – additional sources only

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure C.2

EMM
creating opportunities



Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

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KEY

Project area

Rail line

Major road

Minor road

Waterbody

Assessment location

- Hospital
- Mine-owned residence
- Privately-owned residence
- Industrial
- School
- Other

Average PM_{10} concentrations (µg/m³)

- 0.5
- 1
- 2.5
- 5
- 10

Predicted annual average PM_{10} concentrations – additional sources only

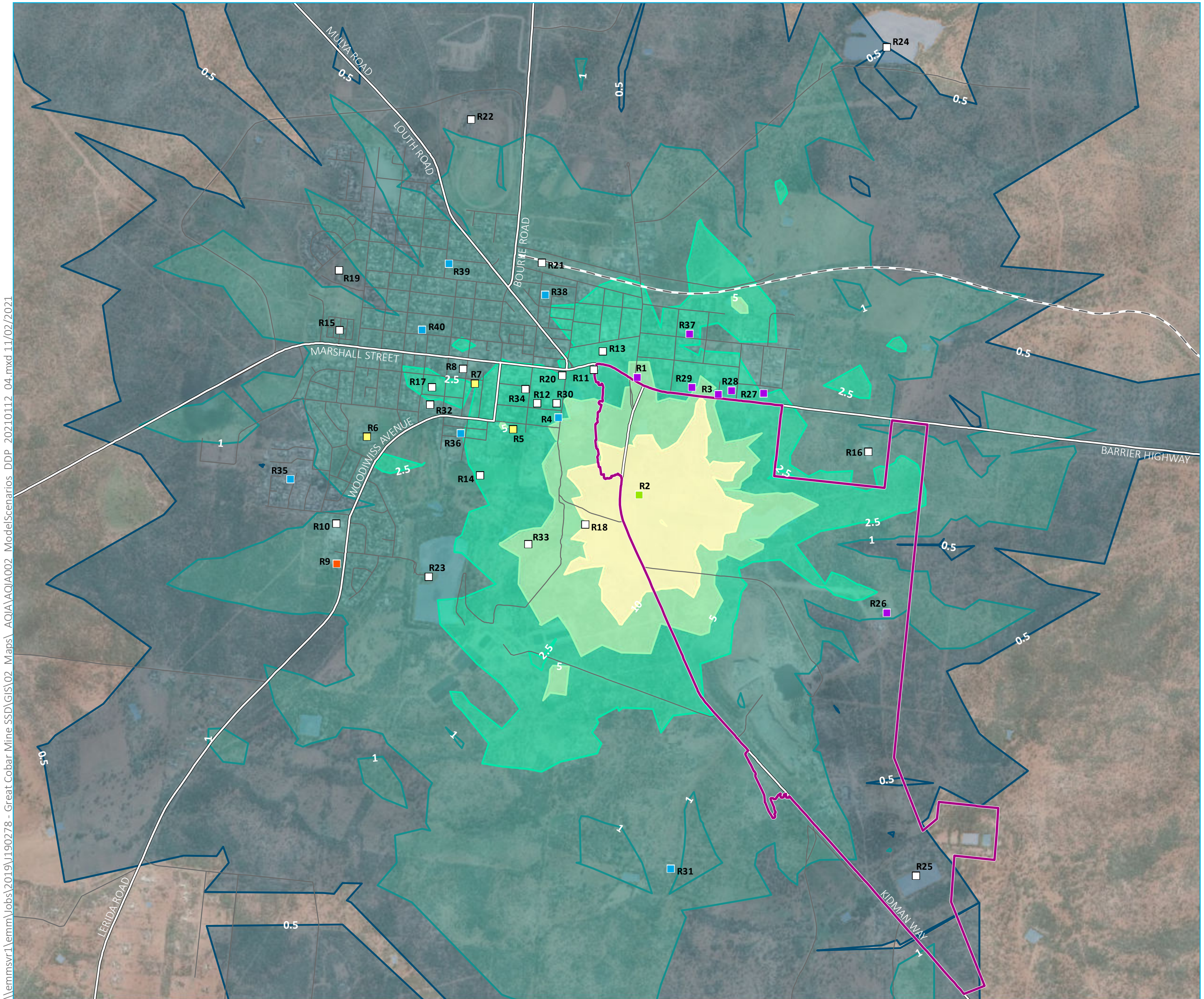
Peak Gold Mines

New Cobar Complex Project

Air quality impact assessment

Figure C.3

creating opportunities



Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

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KEY

- Project area
- Rail line
- Major road
- Minor road
- Waterbody

Assessment location

- Hospital
- Mine-owned residence
- Privately-owned residence
- Industrial
- School
- Other

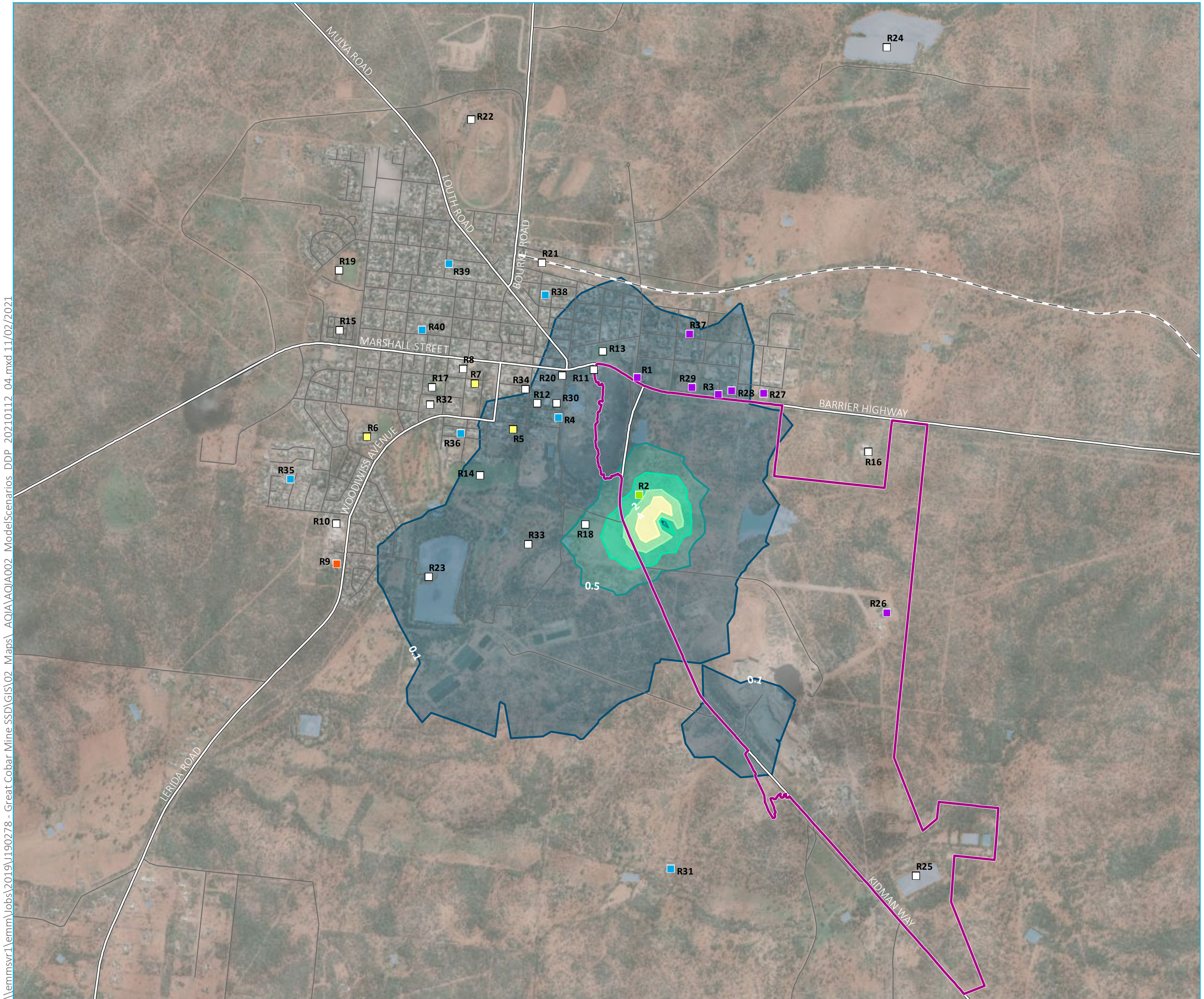
Average $PM_{2.5}$ concentrations (µg/m³)

- 0.5
- 1
- 2.5
- 5
- 10

Maximum predicted 24-hour average $PM_{2.5}$ concentrations – additional sources only

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure C.4

creating opportunities



KEY

- Project area
- Rail line
- Major road
- Minor road
- Waterbody

Assessment location

- Hospital
- Mine-owned residence
- Privately-owned residence
- Industrial
- School
- Other

Average $PM_{2.5}$ concentrations (µg/m³)

- 0.1
- 0.5
- 1
- 2
- 4

Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

0 0.5 1 km
GDA 1994 MGA Zone 55
N

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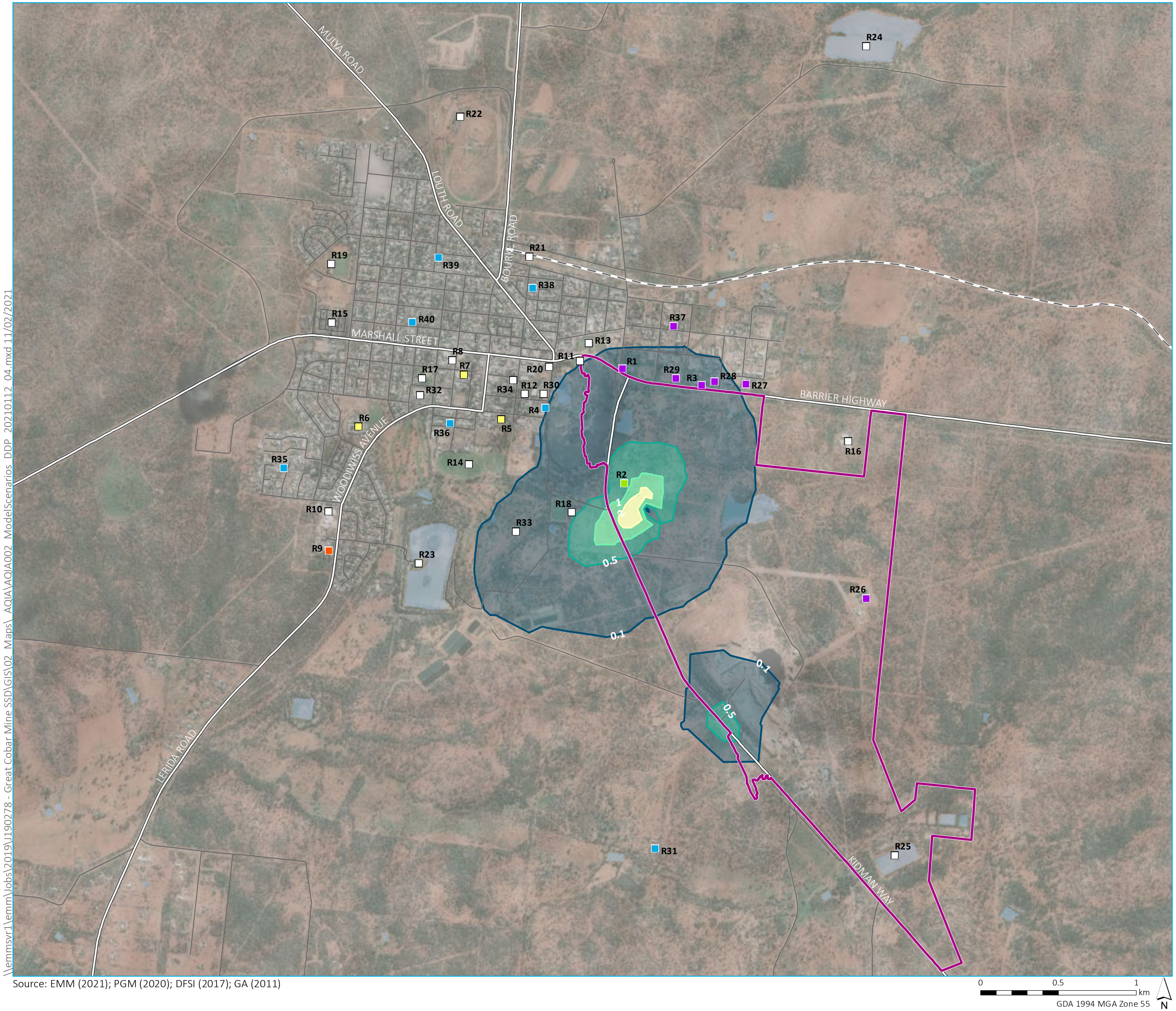
Predicted annual average $PM_{2.5}$ concentrations – additional sources only

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure C.5

creating opportunities



Source: EMM (2021); PGM (2020); DFSI (2017); GA (2011)

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Predicted annual average dust deposition levels – additional sources only

Peak Gold Mines
New Cobar Complex Project
Air quality impact assessment
Figure C.6

EMM creating opportunities