

New Cobar Complex Project, State Significant Development (SSD10419)

Environmental Impact Assessment

Prepared for Peak Gold Mines
February 2021

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Part C-1 Impact assessment

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6 Air quality and greenhouse gas

6.1 Introduction

An air quality impact assessment (AQIA) was completed by EMM to assess the predicted air quality impacts and generation of greenhouse gases associated with the project. The AQIA was prepared in general accordance with the guidelines specified by the NSW EPA in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA 2016) (the Approved Methods for Modelling).

The AQIA is provided in full in Appendix E.

6.2 Assessment requirements

The SEARs require an assessment of the likely air quality and greenhouse gas impacts of the project. The specific requirements relating to air quality are provided in Table 6.1.

Table 6.1 Air quality and greenhouse gas assessment requirements

Relevant authority and assessment requirement	Relevant section of the EIS
DPIE	
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.	Appendix E and Chapter 6
An assessment of the likely greenhouse gas impacts of the development.	Section 6.6
EPA	
Dust generation and the management of potential impacts on adjacent rural residences during the construction and operational phases of the project.	Section 6.7
The EIS must demonstrate the proposals ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation 2010.	Section 6.5
The EIS must include an air quality impact assessment (AQIA).	Appendix E
The AQIA must be carried out in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2016).	Appendix E
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.	Section 6.7

6.2.1 Methodology

The AQIA was completed in general accordance with the Approved Methods for Modelling (EPA 2016) and included a refined dispersion modelling approach focusing on project operations. The full method employed for the AQIA is described in the technical report (Appendix E).

6.3 Existing environment

The area surrounding the project includes a mixture of rural and residential areas, as well as industrial, educational, commercial, health care and recreational land uses. A selection of sensitive receivers, considered to be representative of the surrounding environment and different land uses, were adopted as assessment locations for the prediction of air quality impacts from the project. Assessment locations are shown in Figure 6.1. The majority of the assessment locations are located within and near the township of Cobar.

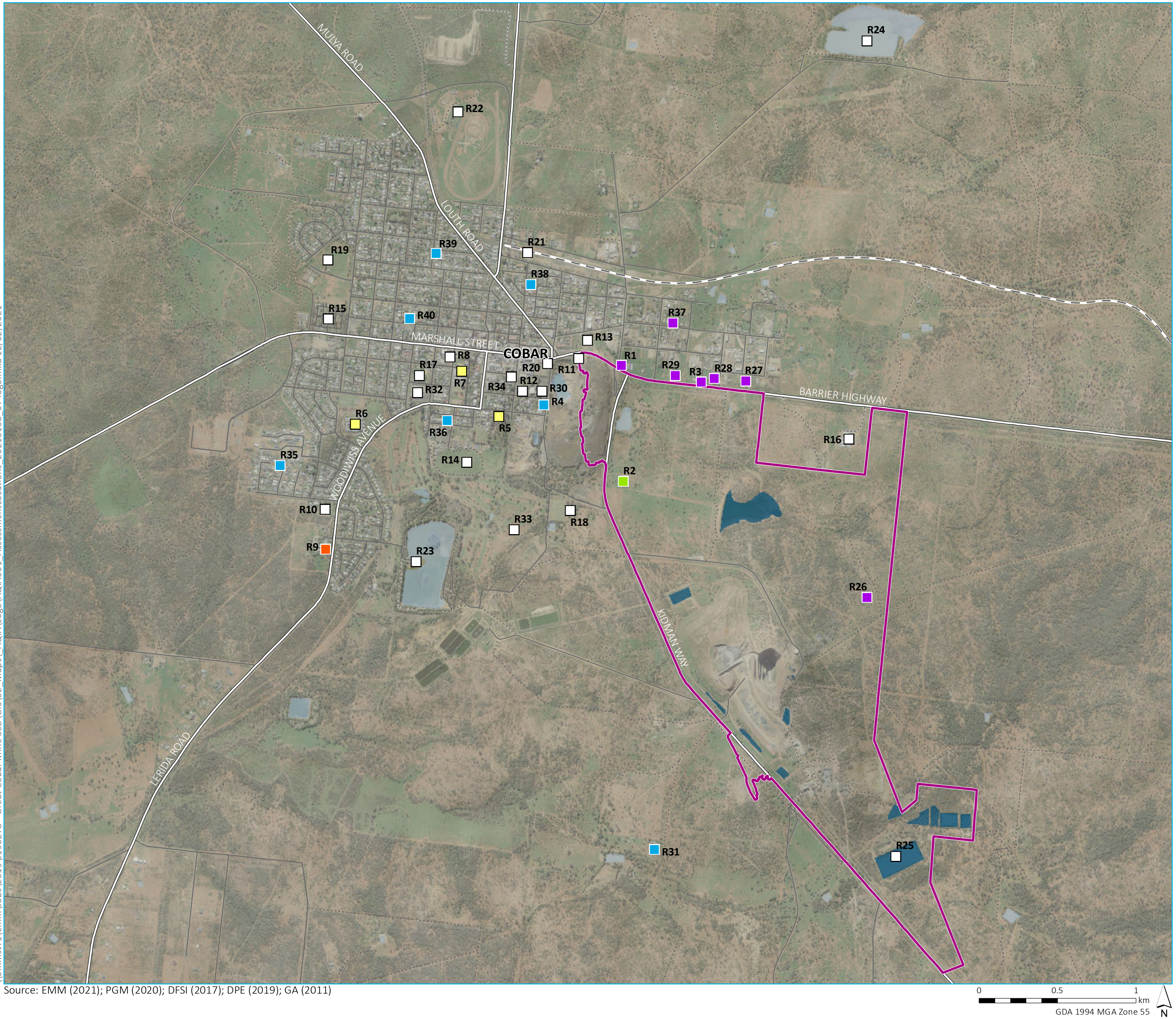
The surrounding background air quality is influenced by a range of particulate-generating sources including:

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

The National Pollutant Inventory (NPI 2020) identifies that the existing PGM operations as well as the CSA Copper Mine, located approximately 10 km north of Cobar, are the only significant existing industrial emission sources surrounding the project. 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 to estimate background air quality in the AQIA.

PGM maintains an air quality monitoring network in the vicinity of the project, illustrated in Figure 6.2. The network consists of the following monitoring equipment:

- one beta attenuation monitor (BAM) unit for the recording of concentrations of particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}) on a continuous basis (installed in 2019);
- two high-volume air sampler (HVAS) units for the recording of total suspended particulates (TSP) and PM_{10} concentrations on a one-in-six day routine (installed in 2019);
- ten 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.



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

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Assessment locations

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Figure 6.1

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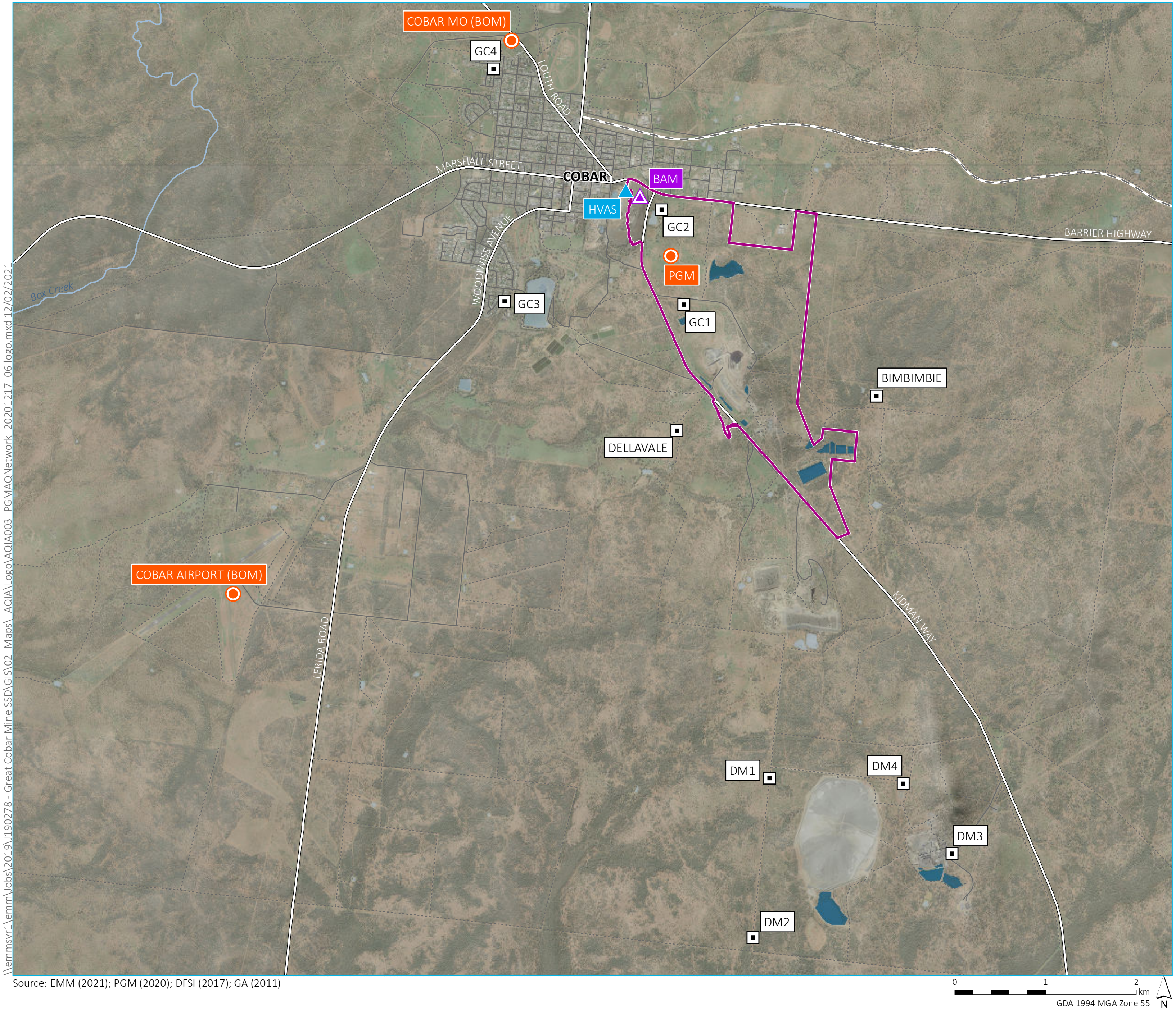
PGM also receives laboratory metal/metalloid analysis from collected HVAS filter paper and dust deposition samples. To supplement the data available from the PGM air quality monitoring network, a range of datasets from the region were analysed to quantify levels of particulate matter in the background air quality environment. The analysis focussed on TSP, PM_{10}, particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) as well as assorted metals and metalloids. Data was sourced from:

- Aurelia Metals Hera Mine near Nymagee, approximately 80 km south-west of the New Cobar Complex; and
- CBH Resources Rasp Mine in Broken Hill, approximately 420 km west of the New Cobar Complex (CBH 2020).

While both locations are spatially distant from Cobar, based on Köppen climate classification maps provided by the BoM, the climate classification of the Cobar, Nymagee and Broken Hill are closely aligned (grassland/persistently dry/hot (Cobar and Broken Hill) or warm (Nymagee)) and they are considered suitable for characterising background air quality levels for the AQIA. An important observation was the increasing frequency of elevated dust deposition and particulate matter concentrations from 2017 through to 2019, particularly during the summer months, linked to intensifying drought conditions across eastern Australia.

A summary of the adopted background levels from the analysed and modelled datasets used in the AQIA to characterise the existing quality is presented below:

- annual average TSP – 31.7 µg/m^3, derived from the annual average PM_{10} concentration from the Hera mine HVAS between 2013 and 2020;
- 24-hour PM_{10} – daily concentrations range from 1.9 µg/m^3 to 183.7 µg/m^3, from the CBH Resources Broken Hill during 2017;
- annual average PM_{10} – 15.2 µg/m^3, from the CBH Resources Broken Hill during 2017;
- 24-hour $PM_{2.5}$ – synthetic daily varying concentration dataset derived with concentrations ranging from 0.9 µg/$m^3$to 86.4 µg/m^3 (through application of regional NSW $PM_{2.5}$:PM_{10} ratio to the CBH Resources Broken Hill TEOM 2017 dataset);
- annual average $PM_{2.5}$ – concentration of 7.1 µg/m^3 (from the synthetic daily varying $PM_{2.5}$ concentration dataset for 2017);
- annual dust deposition – 1.2 g/m^2/month, from the PGM air quality monitoring network; and
- annual lead (Pb) – negligible (0.01 µg/m^3 vs criterion of 0.5 µg/m^3) from the Hera mine HVAS between 2013 and 2020.



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

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

Monitoring network
- BAM (PM_{10})
- HVAS (TSP and PM_{10})
- Dust deposition gauge
- Weather station

PGM air quality monitoring network

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Figure 6.2

6.3.1 Meteorological inputs for modelling

Meteorological data for use in the atmospheric dispersion modelling was sourced from a combination of monitoring data from a variety of sources, coupled with meteorological modelling. Meteorological conditions adopted in the dispersion modelling are described in the AQIA and summarised in this section.

The primary monitoring data was sourced from the Bureau of Meteorology (BoM) automatic weather station (AWS) at Cobar Airport (048237). This dataset was determined to be most closely aligned with a limited dataset available from the PGM meteorological monitoring station located 1.3 km north-northwest of the Peak Complex open cut pit. PGM's monitoring station commenced operation in 2019 and therefore did not contain sufficient data for use in the AQIA.

Data from the period 2015-2019 were analysed, with the 2017 calendar year adopted as the 12-month modelling period for the purpose of the AQIA. Measurements of wind speed, wind direction, standard deviation of wind direction, temperature, relative humidity, station-level pressure and cloud cover from the AWS at Cobar Airport were used in the modelling. This dataset will likely result in more conservative model predictions (ie predictions are likely to be overstated rather than underestimated). This is primarily due to a higher proportion of calm wind conditions (wind speeds less than 0.5 m/s) in the dataset compared the PGM monitoring station.

The meteorological inputs for dispersion modelling 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) the Air Pollution Model (TAPM) meteorological modelling module. A detailed description of the TAPM meteorological modelling and AERMET data processing completed to prepare the inputs for AERMOD are documented in the AQIA (Appendix E).

6.4 Assessment criteria

6.4.1 Emission sources and pollutants

The project involves the development of new underground workings to mine the Great Cobar and Gladstone deposits. This will be an extension of the existing operation as the mining of the New Cobar and Chesney deposits will ramp down as the mining of the Great Cobar and Gladstone deposits ramp up. As existing surface infrastructure within the New Cobar Complex is suitable and adequate to facilitate mining of these deposits, emissions would continue to be similar to existing operations. New emissions as a result of the project will arise from the Great Cobar exhaust air rise and increased road truck transportation of ore material from the New Cobar Complex to the Peak Complex.

Operational emission sources associated with the project include:

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

To assess the impacts of the emissions from the pollutant sources defined above, relevant impact assessment criteria are defined in the Approved Methods for Modelling (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 for particulate matter are presented in Table 6.2.

Table 6.2 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

Emissions of assorted individual metals and metalloids contained within the waste, ore and tailings material may occur during the life of the project. Impact assessment criteria for many principal and individual toxic air pollutants are defined in the Approved Methods for Modelling. Relevant assessment criteria are presented in Table 6.3.

Table 6.3 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

It is noted that for each of the pollutants listed in Table 6.3, 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.

6.4.2 Voluntary land acquisition and mitigation policy

The Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (the VLAMP) (DPIE 2018a) describes the voluntary mitigation and land acquisition policy to address dust and noise impacts, and outlines mitigation and acquisition criteria for particulate matter.

Voluntary acquisition rights apply to any residence on privately-owned land if, even with the implementation of best practice management at the mine site, emissions exceed the relevant air quality criteria. The VLAMP and its application is discussed in further detail in the AQIA in Appendix E.

6.5 Impact assessment

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

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

For the purpose of the AQIA, these changed sources are referred to as 'additional' emission sources. All unchanged emission sources are referred to as 'existing' emission sources. To assess the impact of these changes, the AQIA adopted a single future operations emissions scenario for dispersion modelling comprising existing emission sources plus the additional emission sources.

Emissions were quantified using publicly available emission estimation techniques and site-specific exhaust air rise monitoring data. A detailed description of emissions estimates is provided in the AQIA.

The atmospheric dispersion of air pollutant emissions was simulated using the AERMOD model. Modelling was completed for two scenarios: project-only (or incremental) which included all existing and additional emission sources, and cumulative (background air quality plus the project).

The dispersion modelling predicted that, for the project-only scenario, the predicted concentrations and deposition rates for all pollutants and averaging periods comply with the applicable NSW EPA assessment criteria at all privately-owned residence assessment locations.

For the cumulative impact scenario, the predicted cumulative concentrations for all pollutants and averaging periods comply with the applicable NSW EPA assessment criteria for all privately owned residence assessment locations. One assessment location, R2, a PGM-owned residence, was estimated to exceed the cumulative 24-hour average PM_{10}, 24-hour average $PM_{2.5}$ and annual average $PM_{2.5}$ criteria.

To illustrate the contribution of background, existing emission sources and additional emission sources to the cumulative impact scenario, Figure 6.3 and Figure 6.4 provide a breakdown of background concentrations, and existing and additional contributions to the annual average PM_{10} (Figure 6.3) and $PM_{2.5}$ (Figure 6.4) concentrations from the project at each assessment location.

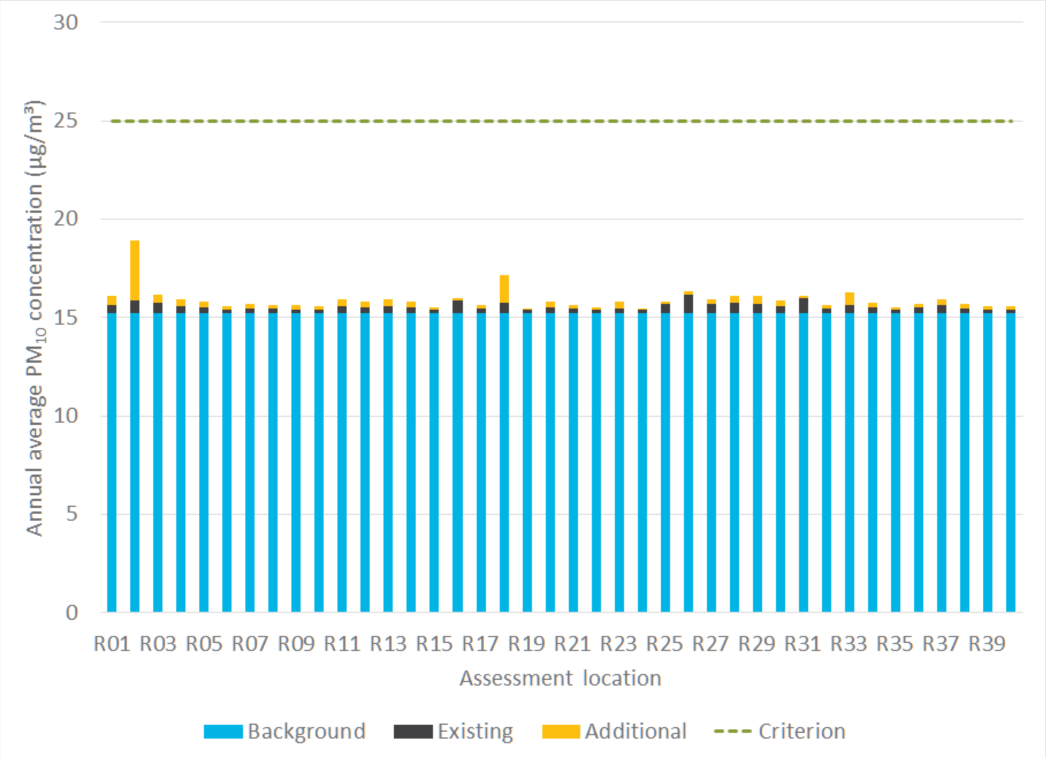


Figure 6.3 Cumulative annual average PM_{10} concentrations – all assessment locations

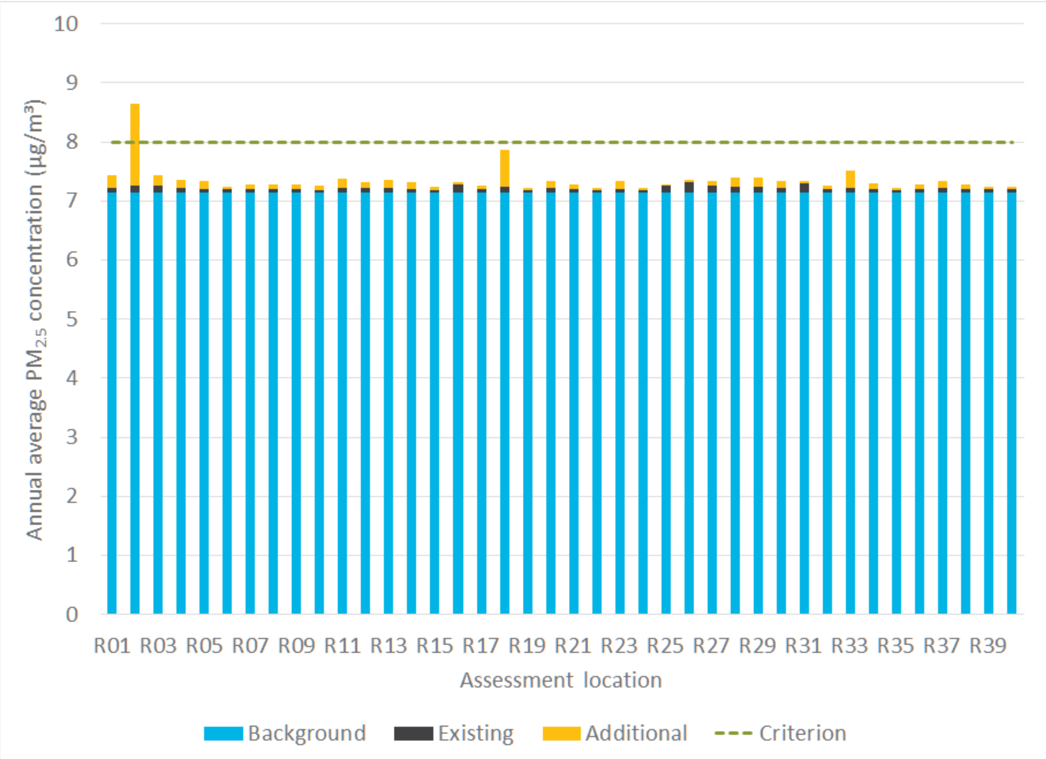


Figure 6.4 Cumulative annual average $PM_{2.5}$ concentrations – all assessment locations

These figures illustrate that the predicted daily-varying cumulative concentrations are below applicable impact assessment criteria at all assessment locations except R2 (a PGM-owned residence). Further, the figures illustrate that ambient background concentrations are the major contributor to cumulative air emissions.

The results of the dispersion modelling highlighted the following:

- impacts from existing operations do not result in exceedance of any applicable criteria at any privately owned residence assessment locations;
- the addition of emissions from the Great Cobar exhaust air rise increases cumulative concentrations, however the predicted concentrations and deposition rates are below relevant impact assessment criteria at all privately owned residence assessment locations;
- the increase in transportation of ore from the New Cobar Complex to the Peak Complex by road trucks is not predicted to generate significant air quality impacts;
- predicted concentrations of all metals and metalloids are negligible to very low at or beyond the project area; and
- the modelling results indicate that the project will not exceed the relevant VLAMP criteria.

The emissions estimated for the PGM exhaust air rises, including the Great Cobar exhaust air rise, 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 exhaust air rise are not predicted to result in exceedances of criteria at privately owned residence assessment locations.

6.6 Greenhouse gases

A GHG assessment was 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, therefore the impact will be negligible.

6.7 Commitments and management measures

Existing dust control measures currently used at the New Cobar and Peak complexes include watering of material haulage routes and water sprays at the ROM stockpile and the processing circuit. These were included in the emissions database developed for the AQIA and their effectiveness accounted for through relevant emission reduction factors. These measures will continue to be implemented for the project.

PGM maintains an air quality monitoring network surrounding the project area, as described in Section 6.3. This monitoring network will continue to be maintained for the life of the project. The existing monitoring network was recently improved (in 2019) and is considered adequate for ongoing monitoring 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). 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 will continue to be made available to the public through Aurelia Metal's website.

6.8 Conclusion

The project will result in additional emissions from the Great Cobar exhaust air rise and increased road truck transportation of ore material from New Cobar Complex to Peak Complex. Emissions were quantified using publicly available emission estimation techniques and site-specific exhaust air rise 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 indicate that impacts from existing operations do not result in exceedance of any applicable criteria at any privately owned residence assessment location. The project will increase emissions; however, all predicted concentrations and deposition rates are below relevant impact assessment criteria at all privately owned residence assessment locations.

A GHG assessment was also undertaken for the project. The changes to emissions associated with the project do not significantly alter annual GHG emissions from existing operations.

Conservative emission concentrations were adopted in the emission calculations for the AQIA. Despite the high level of conservatism, the increased emissions from the project are not predicted to adversely impact the air quality environment in the populated areas of Cobar.

7 Human health risk assessment

7.1 Introduction

A human health risk assessment (HHRA) was completed by SLR to assess potential health impacts to the local community associated with air quality emissions from the project. Specifically, impacts to health from air quality emissions are related to the dust and ventilation emissions and their potential to contain trace metals, and exposure of the local community to these metals. Health impacts relating to dust emissions are discussed in this chapter.

Impacts to the local community resulting from noise from the project were assessed by EMM and are discussed in Chapter 8: Noise, vibration and blasting. Health impacts relating to noise emissions are discussed in this chapter.

The HHRA is provided in full in Appendix F.

7.2 Assessment requirements

The SEARs require an assessment of the likely human health impacts from air quality and noise impacts of the project. The specific requirements relating to human health are provided in Table 7.1.

Table 7.1 Human health risk assessment requirements

Authority comments	Relevant section of the EIS
DPIE Key issues	
Human Health – including:	
a Human Health Risk Assessment addressing how the development's environmental impacts in relation to air quality (including heavy metals) and noise may impact on the health of the local community; and	Section 7.4, Section 7.5, and Appendix F.
monitoring and management measures to reduce risk to human health;	Section 7.6.

In addition to above SEARs, the following agencies have raised additional comments:

- NSW Health, Western and Far West NSW Public Health Unit – email date 9 March 2020.

Agency comments and EMM responses are provided below (Table 7.2).

Table 7.2 Human health risk assessment responses from NSW Health

Authority comments	Relevant section of the EIS
NSW Health	
A suitable experienced toxicologist should be engaged to conduct a risk assessment." "The framework that we would suggest you follow for your assessment can be found at….enHealth (2012a, b).	A suitably qualified toxicologist has prepared the assessment to enHealth guidelines. See Appendix F (HHRA).

7.2.1 Methodology

The air quality and noise impacts of the project are assessed against the relevant guidelines and criteria outlined in Chapter 6: Air quality and Chapter 8: Noise, vibration and blasting and the relevant technical studies (Appendices E and G). These reports outline the methodologies developed to carry out those studies. The SEARs require a more detailed consideration of the consequential impact of changes to air quality and noise on the health of the local community. A HHRA was completed which focuses on the emission of pollutants to the air (mainly pollutants related to dust) and exposure to the local community; the methods adopted in are detailed in the HHRA in Appendix F. Health impacts due to noise emissions are discussed in Section 7.5.

A component of the HHRA was to assess the background level of lead and other metals/metalloids in the environment arising from dust generated from mine-related activities (including truck movements along Kidman Way). No existing information was identified for background soil/dust metal concentrations in residential areas of Cobar. Consequently, a comprehensive sampling program to determine background levels was undertaken. The full sampling program is described in detail in the CLM report appended to the HHRA (Appendix F).

7.3 Existing environment

Cobar is classified as 'remote' under the Accessibility/Remoteness Index for Australia (ARIA 2020). Australians living in remote areas typically experience poorer health outcomes than people living in metropolitan areas, including:

- on average, shorter lives, higher levels of disease and injury and poorer access to, and use of, health services, compared with people living in metropolitan areas (AIWH 2020);
- according to the 2015 Australian Burden of Disease Study, remote and very remote areas experienced disease burden 1.4 times higher than that of major cities (AIWH 2020); and
- life expectancy (measured at birth) in remote areas of NSW is approximately three years less than that of major cities for women, and five years less for men (HealthStats NSW 2019).

People in remote areas of NSW also experience higher rates of hospitalisations attributable to certain causes such as smoking and high body mass. Levels of children who have ever had asthma are also higher in remote areas of NSW (24.9%) when compared to the state average (20.6%) (HealthStats NSW 2019).

The project is located adjacent to the town of Cobar. No publicly available information on the health status of the local Cobar population was identified.

Land uses in Cobar include a mix of residential, industrial, educational, commercial, health care and recreational uses. To assess the impacts of the project on the local population, a selection of sensitive receivers considered to be representative of the surrounding environment and different land uses, were adopted as assessment locations. These are the same assessment locations that were used in the AQIA (R1-R40, shown in Figure 7.1).

The existing air quality and noise environments for Cobar surrounding the project are discussed in Section 7.4 and Section 7.5.

7.4 Dust hazard and exposure assessment

7.4.1 Chemicals of potential concern

The chemicals of potential concern for the project related to mining operations which have been assessed in the HHRA are metals embedded within the dust generated from mine-related activities (which includes the increased truck movements along Kidman Way). No existing information was identified for background soil/dust metal concentrations in residential areas of Cobar.

Lead (Pb) is the principal chemical of potential concern due to Cobar's long mining history as well as increased awareness within the community of exposure to lead. As comprehensive data for existing soil and dust lead levels in Cobar were not available, a sampling program was undertaken by EMM. The sampling program is described in detail in Appendix L of the HHRA and summarised briefly in Section 7.4.3.

Twelve other metals of potential concern were identified based on mineralogy analysis undertaken for ore within emitted dust. These occur in a mineralised form (and require solubilisation and absorption into the body in order for potential health effects to occur) and include silver, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, mercury, manganese, nickel and zinc. As with lead, these metals within the dust are part of the geology of the mined ore at Cobar. Exposure pathways are described in Section 7.5.4.

7.4.2 Dose response values

i Lead

The health effects of lead, both for the public and workers in lead related industries throughout the world, are managed by maintaining blood lead (BPb) concentrations below nominated target levels. In Australia, the National Health and Medical Research Council (NHMRC) identifies a BPb level of 5 micrograms per decilitre (µg/dL). It is noted that this does not represent a 'safe' level of exposure, but rather a BPb level above which the individual's lead exposures should be investigated and reduced (see Section 3.2 of the HHRA). Levels of greater than 5 µg/dL suggest a person has been, or continues to be, exposed to lead at a level that is above what is considered the average 'background' exposure in Australia. The Safe Work (2020) management goal for lead of 5 µg/dL has also been adopted for workers at commercial/industrial assessment locations.

ii Other metals

For the 12 other metals assessed in the HHRA, calculation of lifetime time-weighted average daily intakes from ingestion of soil/dust and ingestion of drinking water from rainwater tanks (primarily residential) and comparison of these with tolerable daily intakes (TDIs), as well as calculation of an inhalation exposure concentration and comparison with chronic air guideline values. TDIs were adjusted for 'background' exposures. The resulting ratio of the intake or inhalation exposure concentration to the background-adjusted TDI or air guideline value is called a hazard quotient (HQ).

The exposure pathways considered are the same as those described in section 7.5.4 for lead. Plant uptake of metals from soil may or may not be significant for the metals/metalloids considered in the HHRA. This was incorporated by adjusting the TDI to account for this pathway (and background intakes) for each individual metal. An overall HQ for each metal was calculated by combining the inhalation and oral exposure pathways.

For one of the metals assessed in the HHRA, nickel, the health effect of concern is cancer via inhalation or ingestion and direct alteration of genetic material. Excess lifetime cancer risks were calculated. The resulting estimated excess cancer risk was compared with a target acceptable risk of 1×10^{-5} as recommended by enHealth (2012a) and the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM 2013).

Hazard indices were calculated by summing the HQs of individual metals. Calculation of an overall hazard index assumes the toxicological effects of the assessed individual metals are additive, and that possibly multiple subthreshold exposures may result in an effect. In toxicological terms this assumption of additivity is only valid if the compounds assessed have a similar mode of toxicological action and affect the same target tissues. In the HHRA, all metals included in the HQ assessment were conservatively assumed to act in an additive manner, and the HQs were summed to calculate an overall hazard index. These methods are in accordance with internationally recognised risk assessment procedures and are discussed further in the HHRA.

Oral TDIs for all metals/metalloids assessed in the HHRA (excluding lead) were determined. Adjusted TDIs were determined taking into account background levels and represent the dose of metal (adjusted for background intakes) which can be ingested every day over a lifetime without adverse health effects. Table 7.3 summarises oral TDIs for all metals/metalloids assessed in the HHRA (excluding lead).

Chronic air guideline values (AGVs) were sourced for all metals/metalloids assessed in the HHRA in order to calculate a HQ for the inhalational exposure pathway. The AGVs represent a concentration of metal which can be inhaled every day over a lifetime without adverse health effects.

Table 7.3 TDIs and AGVs for metals/metalloids (excluding lead) assessed in the HHRA

	TDI			AGV (µg/m³)
Metal/metalloid	**TDI (µg/KG/d)**	**Assumed background intake as a % of TDI**	**Adjusted TDI used in HHRA (µg/KG/d)**	
Silver	400	0%	400	1,560
Antimony	6	0%	6	0.2
Arsenic	2	54.5%	0.91	1.0
Barium	67	25%	50	1.0
Beryllium	2	38.4%	1.2	0.007
Cadmium	0.8	93.4%	0.053	0.011
Chromium	300	0%	300	0.14 (converted to trivalent chromium)
Copper	130	70%	39	1
Mercury	0.6	60.5%	0.24	0.03
Manganese	Adult: 6.4 Child/adolescent: 270	0%	Adult: 6.4 Child/adolescent: 270	0.15
Nickel	12	85.2%	1.8	0.02
Zinc	320	0%	320	1,248

7.4.3 Sampling program

A sampling program was completed to inform potential background metal exposures to the general public. The program involved collection of 30 samples in residential and recreational areas around Cobar, 13 samples from various locations on the mine site, one sample near the water treatment plant located on the mine lease, and three samples collected upwind of the mine site which considered, designated 'background' but not within the Cobar township. Sampling locations are presented in Figure 7.1 and Figure 7.2.

Where practical, samples were selected close to assessment locations to represent the different land uses in the surrounding environment. The sampling methodology, quality control aspects and certificates of analysis are provided in Appendix L of the HHRA.

The data collected confirmed existing lead levels in soil and dust around Cobar are low with only one marginally elevated result relative to the NEPM (2013) residential health investigation level in soil. This indicates lead exposure by the general population in Cobar is also likely to be low. The sampling program identified that existing concentrations of other metals/metalloids in Cobar are relatively low, with many samples returning concentrations less than the respective limits of reporting.

Bioaccessibility of contaminants of potential concern was evaluated based on the sampling program completed for the HHRA. The bioaccessibility is a measure of the amount of contaminant released, when ingested, that is available to be absorbed through the gastrointestinal tract into the systemic circulation. The solubility of the substance in gastrointestinal media is a major determinant of bioaccessibility. Absorption of contaminants is also an important factor, with usually only part of the bioaccessible fraction being absorbed in the gastrointestinal tract. Bioaccessibility values for lead and arsenic were determined based on the sampling program. The methods for determining bioaccessibility are described in Section 2.5 of the HHRA.

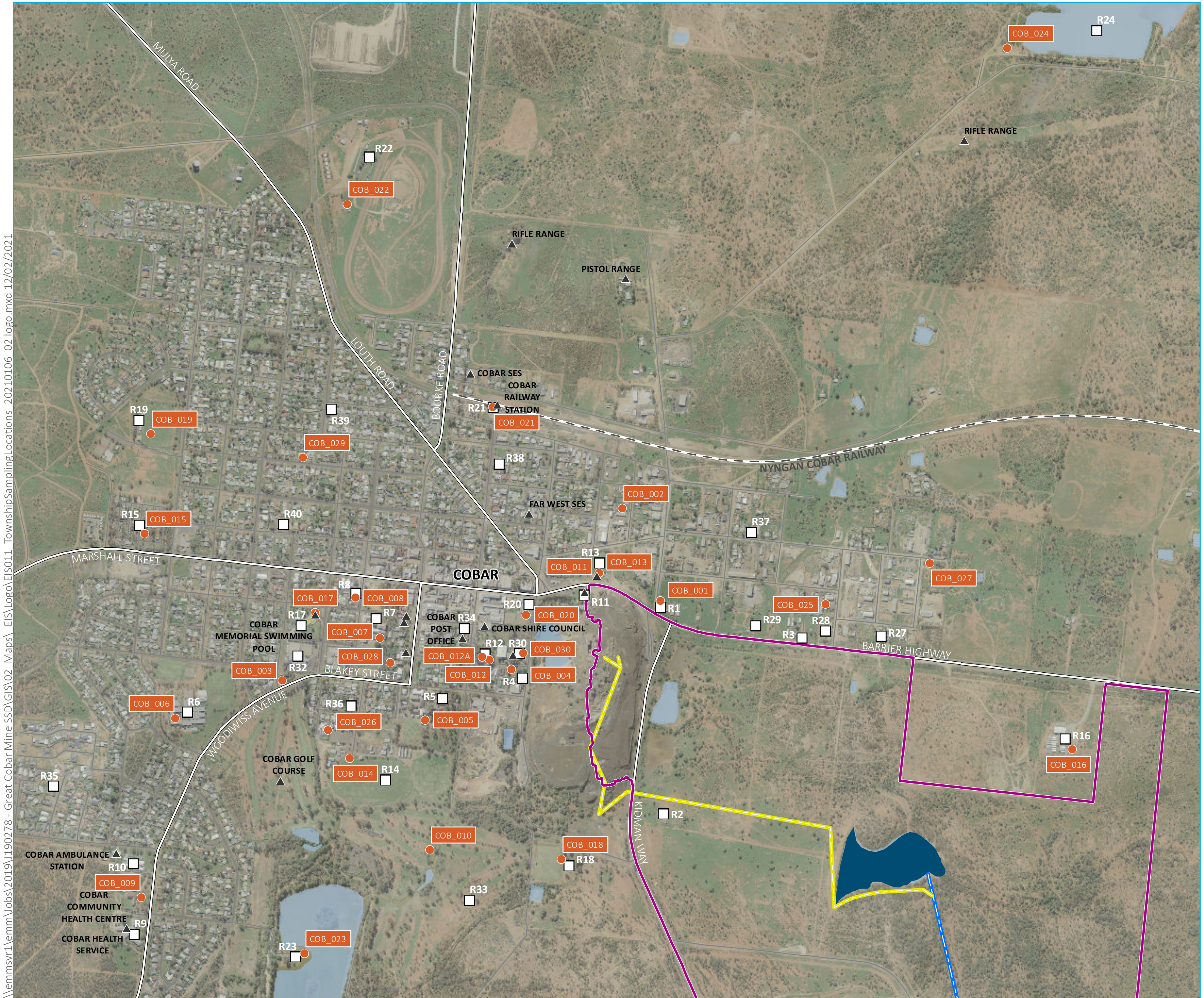
7.4.4 Conceptual model for exposure to metals in dust

Conceptual exposure pathways considered for mine derived lead and other metals are presented in Figure 7.3. Exposure to mine derived metal may occur through several pathways which have been included quantitatively in exposure estimates in the HHRA:

- incidental ingestion of soil;
- incidental ingestion of indoor dust which has either been walked in or which has infiltrated from outdoor air;
- inhalation of indoor and/or outdoor airborne dust; and
- ingestion of tank water containing metal deposited as dust on roofs.

Two pathways that were identified, but not quantitatively assessed in the HHRA.

Consumption of vegetables or fruits grown in home garden soil – lead is not readily translocated to edible plant parts from soil, and typically, consumption of home-grown produce is only a portion of total vegetable intake (see Appendix A of the HHRA). Therefore, ingestion of home-grown vegetables and fruits is not considered to be a major exposure pathway for lead and ingestion of lead by Cobar residents from vegetables is assumed to be similar to that of people residing in unimpacted communities elsewhere in Australia. For other metals, this exposure pathway was considered by adjusting the relevant TRV for background intakes and potential contribution from home-grown produce.



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

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KEY

- Project area
- Surface soil/dust sampling location
- Assessment location
- Landmark
- Great Cobar dewatering pipeline
- Pipeline route
- Rail line
- Major road
- Minor road
- Waterbody
- Mine water management storage

Location ID	Description
COB_001	Residence, 82 Old Bourke Rd - beside fence in driveway
COB_002	7 Fourteenth St - backyard beside clothes line
COB_003	Cobar Lions Club Children's Playground (next to Bowling and Golf Club) - beside slide
COB_004	Residence, 6 Harcourt Street - next to eastern boundary (no. 2/4) on nature strip
COB_005	Cobar Public School - mud kitchen
COB_006	Cobar High School - picnic table in top quad
COB_007	St Johns Primary School - beside playground
COB_008	Kubbi Child Care - beside sand pit
COB_009	Cobar District Hospital - near old hospital building
COB_010	Golf Course - next to fairway near creek
COB_011	Heritage Museum - car park
COB_012	Drummond Park - nature strip beside playground
COB_012a	Drummond Park - inside playground area beside swing set
COB_013	Miners Heritage Park - beside pear tree
COB_014	Ward Oval - oval
COB_015	Caravan Park
COB_016	TI Hospitality Group - between carpark and accommodation units
COB_017	Swimming pool - garden bed beside main entrance
COB_018	Rugby Club, Lewis St - beside spectator steats near clubhouse
COB_019	Tom Knight Oval - near goal posts
COB_020	Memorial Services Club - former bowling green
COB_021	Railway Station - beside main building
COB_022	Dalton Park Race Course - Pony Club playground
COB_023	Newey Reserve - picnic area
COB_024	Old Reservoir
COB_025	Western Auto & Engineering, 7-9 Dunstan St - within rear yard beside fence
COB_026	Cobar Preschool Centre - beside playground
COB_027	1 Cornish St - across road from residence in vacant lot
COB_028	Cobar Uniting Church COOSH - beside sand pit
COB_029	Residence, 25 Green Street - nature strip in front of front garden fence
COB_030	Ngali Preschool

Sampling locations - Cobar township

Peak Gold Mines
New Cobar Complex Project
Environmental impact assessment
Figure 7.1

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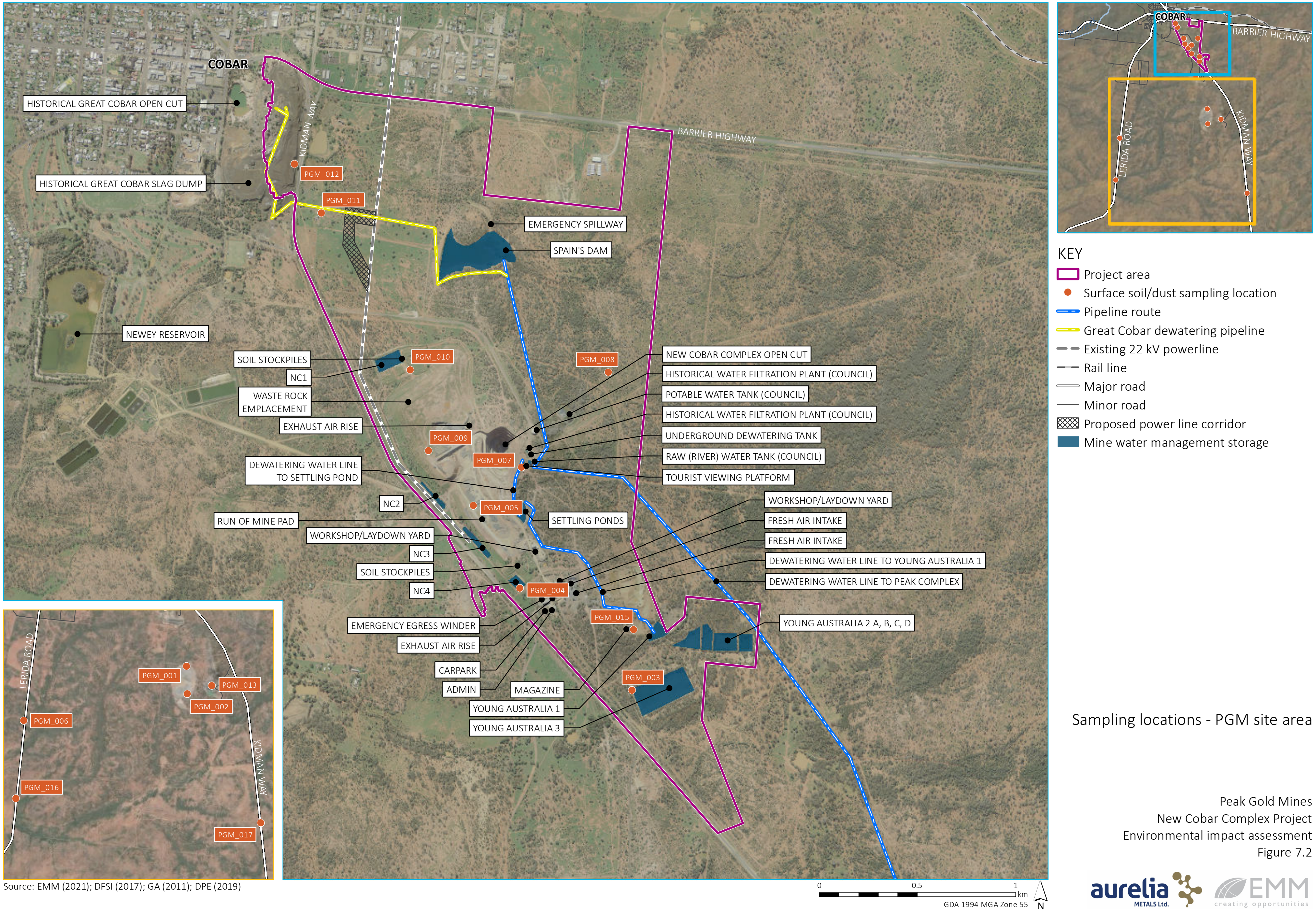

Sampling locations - PGM site area

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

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New Cobar Complex Project
Environmental impact assessment
Figure 7.2

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EMM creating opportunities

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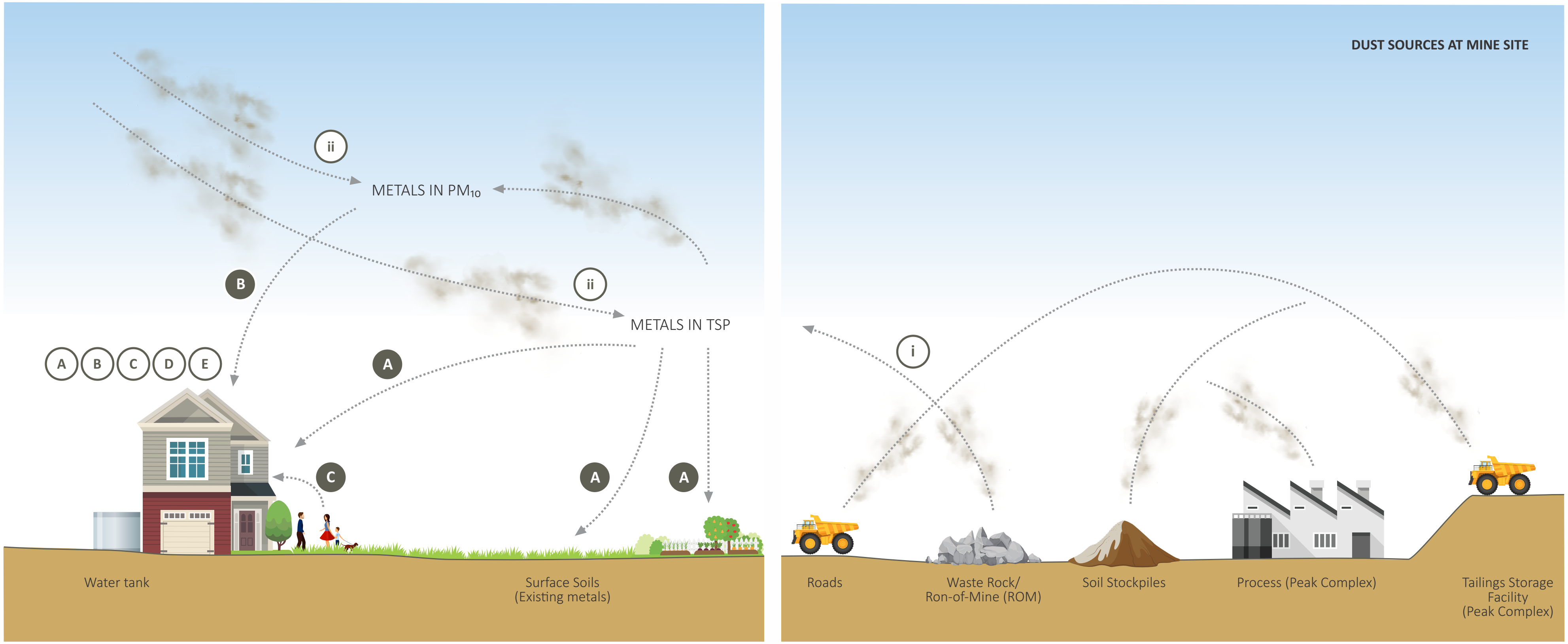

Sources		Migration Pathways		Exposure Pathways			
i	Dust from mine-related sources	A	Wet/dry deposition	A	Inhalation of dust	D	Ingestion of metals in water from rain water tanks
ii	Dust from non-mining related sources	B	Infiltration into home	B	Incidental ingestion of soilk/dust	E	Dermal contact with soil/dust
		C	Soil and dust tracked indoors	C	Consumption of home grown produce		

TSP – Total suspended particles

Source: Human Health Risk Assessment for New Cobar Complex, SLR report 2020

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Representation of potential dust sources, migration pathways and residential pathways to metals in dust/soil

Peak Gold Mines

Environmental impact assessment

Figure 7.3

Dermal contact (ie through the skin) with contaminated soil and dust – dermal contact with contaminated soil and dust could theoretically occur, however dermal absorption of inorganic metals is considered to be a minor route of entry into the body and was therefore not considered in the HHRA.

7.4.5 Exposure scenarios

The existing approval for the New Cobar and Peak complexes allows an indefinite mine life. While there is no proposed alteration to the mine life, the project would extend the proposed mine life by an additional 12 years, from 2023 to 2035 (ie 15 years remaining mine life in total, from 2020). To be able to discern and assess the incremental metal exposure (ie the change in public exposure that might occur from the project), metal emissions associated with existing conditions, with the project, and background emissions were estimated in the following combinations:

- **Scenario 1:** Current operations (including background). This scenario evaluated the health risks from metals in dust for the existing situation. This scenario also included estimated background metal concentrations in air (for lead only) and measured background metal concentrations in soil from other sources (eg previous and currently active mining in Cobar, metals in windblown dust from non-mining areas). It assumes the same 'background' exposures will occur for the remainder of the proposed mine life.

- **Scenario 2:** Project only increment. This scenario assessed the health risk of metals from the project only (ie no existing operations and no background included). As such, this scenario excluded any existing metals in soil/dust as well as any metals in air or soil from sources other than the project. It also assumed the same emissions will occur for the duration of the remainder of the proposed mine life (ie 15 years).

- **Scenario 3:** Cumulative project situation (including background). This scenario assessed the health risks of metals from the project (Scenario 2) plus those from current operations including background (Scenario 1). This scenario also assumed emissions will occur for the duration of the remainder of the project mine life (ie 15 years). It is noted background concentrations of metals in air were only available for lead, therefore background levels have not been included for other metals.

7.4.6 Lead risk

For each of the three exposure scenarios, BPb concentrations have been modelled for children and adults as follows:

- Children (1-2 years of age) – the United States Environmental Protection Agency (US EPA 2010) Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children software was used which models BPb concentrations for 1-2 year old children. This age bracket was previously identified as the most vulnerable and sensitive age range, having the highest potential BPb increase relative to the same level of exposure across all other age groups.

- Adults (and unborn children) – the US EPA Adult Lead Methodology (ALM) spreadsheet for adults was adapted to model concentrations in adults at commercial/industrial assessment locations.

Potential health risks to children exposed to mine dust containing lead (in combination with existing background lead exposures and sources other than the project) was assessed by comparing the modelled BPb concentration results for each scenario with the NHMRC (2015) BPb level of 5 µg/dL. Similarly, modelled

BPb concentrations in the foetus of female workers at commercial/industrial assessment locations were compared with the Safe Work (2020) management goal for lead of 5 µg/dL.

i IEUBK model results – children

The IEUBK model was used to estimate geometric mean BPb in hypothetical populations of 1-2 year-old children living in Cobar. The modelling incorporated incidental ingestion of lead in soil/dust, inhalation of lead in air (PM_{10}), ingestion of lead in rainwater tanks which has resulted from dust (TSP containing lead) deposition onto roofs, as well as (for Scenarios 1 and 3) inclusion of modelled 'background' intakes of lead from the diet, reticulated drinking water, soil (from measured 'existing' soil concentrations), and contribution from maternal BPb.

The modelled geometric mean BPb in populations of 1-2 year-old children assumed to live at the assessment locations ranged from 1.75–2.64 µg/dL for Scenario 1 (the existing situation) and 1.75–2.66 µg/dL for Scenario 3 (the project cumulative situation). All estimates were consistent with the range of geometric mean BPb reported for Australian children in communities not impacted by point sources of lead (0.97–2.6 µg/dL).

ii ALM model results – adults

The ALM model was used to estimate the median BPb of adult females who are pregnant (as well as corresponding 95th percentile foetal BPb) at each commercial/industrial sensitive receiver location. The model, which typically only incorporates incidental ingestion of soil lead was adapted to also include inhalation exposure to lead in dust as well as incidental ingestion of soil/dust. The results predicted no change to BPb for either adult females or their unborn offspring as a result of the project. It is noted the 95th percentile modelled foetal BPb (2.1−2.6 µg/dL) for Scenario 3 at the commercial/industrial locations assessed was consistent with that expected for other communities in Australia which are not impacted by point sources of lead.

7.4.7 Other metals

Hazard quotients were estimated for each assessment location under each of the three scenarios. The HQs were calculated by adding up the HQ from:

- intake via air calculated by dividing the modelled metal concentration in PM_{10} by the respective chronic AGV; and
- intake via soil/dust and rainwater (collected on roofs) calculated by dividing the estimated overall lifetime weighted daily intake for all life stages (also called the time weighted average daily intake) by the TDI adjusted for potential background exposures from diet, water and air; the latter included consideration of metal intake from home-grown produce.

The total HQs for each metal were summed to calculate an overall hazard index. HQs and hazard indices with a value less than one indicate that under the exposure scenarios being considered, there is little likelihood of health effects occurring.

Hazard indices (which represent the sum of HQs for all 12 metals/metalloids assessed) were calculated as follows and are graphed in Figure 7.4:

- Scenario 1 (existing situation): hazard indices range from 0.008 (for R21, Cobar Railway station – a commercial/industrial property which is no longer in use) to 0.06 (for R3, a residence).

- For Scenario 2 (proposal increment): hazard indices range from 0.001 (for R19, Cobar Rugby Leagues Club) to 0.08 (for R2, a residence owned by PGM).
- Scenario 3 (cumulative proposed situation): hazard indices range from 0.01 (for R21, Cobar Railway station) to 0.11 (for R2, a residence owned by PGM).

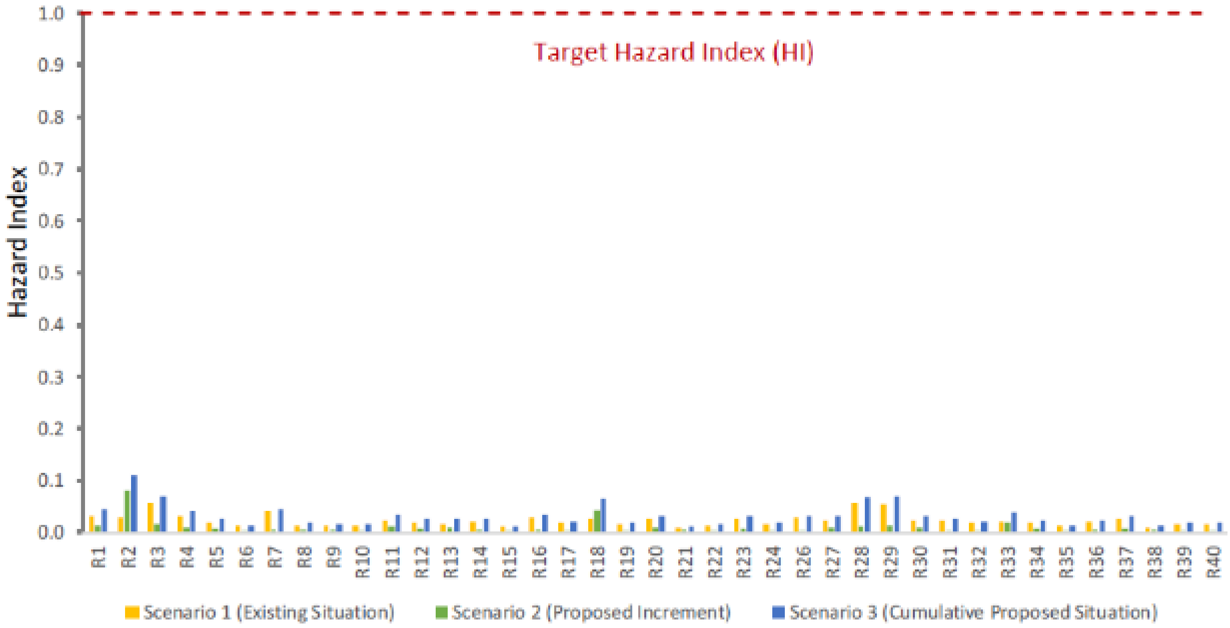


Figure 7.4 Chronic hazard indices for all evaluated sensitive receivers

All hazard indices were markedly less than one. Therefore, the risk of exceeding health-based TDIs and AGVs as a result of the project is very low, and consequently the risk of harm to human health is also very low. The assessment is conservative in that it assumes additivity between metals.

For the chemicals of potential concern evaluated in the HHRA, one metal, nickel, was assessed for cancer risk via inhalation exposure. The estimated 'cancer risk' from the project was compared with a target acceptable risk of 1×10^{-5} as recommended by enHealth (2012a) and NEPM (2013). The highest estimated cancer risk is 7.6×10^{-10} (at assessment location R26 for Scenario 3). This is almost five orders of magnitude below the commonly accepted risk of one in one hundred thousand. Therefore, it is concluded that the emissions from Scenario 3 (project cumulative scenario) is well below the target range of acceptable risk.

7.5 Noise impacts

There is potential for the project to contribute to environmental noise which can result in adverse impacts to human health (enHealth 2018). Noise from the project was modelled and compared to existing operational noise levels, as summarised in Chapter 8: Noise, vibration and blasting and detailed in Appendix F. The changes to operational noise resulting from the project were primarily associated with the new ventilation fan, as well as noise from road traffic.

Noise modelling for the project predicted negligible noise impacts at assessment locations, including all assessed residential locations. The modelling completed in the NVIA predicted the following:

- Operational noise – for existing and future site noise levels, there will be no material increase at any of the assessment locations, including all residential locations.
- Sleep disturbance – all predicted noise levels are below the sleep disturbance screening criteria defined in the Noise Policy for Industry (EPA 2017).
- Road traffic – increases in road traffic noise levels were predicted to be negligible. Therefore, road traffic noise from the project is not likely to cause an impact at any of the residential receivers along Kidman Way between the New Cobar Complex and the Peak Complex.

The operational noise results for residential assessment locations are summarised in Table 7.4, which demonstrates that there is no change between modelled existing noise levels and predicted future operational noise levels from the project.

The enHealth (2018) guideline suggests there is a causal relationship between environmental noise and sleep disturbance above 55 decibel (A-weighted) (dB(A)) ($L_{night,outside}$). The noise levels predicted for the assessment of sleep disturbance in the NVIA, shown in Table 7.4, were less than 35 dB at all residential assessment locations. The predicted night time noise $L_{Aeq,15min}$ levels were substantially lower than the target environmental noise level of 55 dB(A) ($L_{night,outside}$) specified by enHealth (2018) for managing human health effects. Furthermore, the project is expected to have a negligible change in noise levels compared to existing operations. Therefore, the project is not expected to result in a significant impact to human health due to noise emissions.

Table 7.4 Predicted future operational noise levels

Assessment location	Modelled existing $L_{Aeq,15min}$ operational noise levels, dB			Predicted future $L_{Aeq,15min}$ operational noise levels, dB			Predicted night-time maximum noise levels, dB	
	Day	Evening	Night	Day	Evening	Night	Night, $L_{Aeq,15min}$	Night, L_{Amax}
R4 (residential)	<40	<35	<35	<40	<35	<35	<35	39
R31 (residential)	<40	<35	<35	<40	<35	<35	<35	46
R35 (residential)	<40	<35	<35	<40	<35	<35	<35	<35
R36 (residential)	<40	<35	<35	<40	<35	<35	<35	37
R38 (residential)	<40	<35	<35	<40	<35	<35	<35	35
R39 (residential)	<40	<35	<35	<40	<35	<35	<35	<35
R40 (residential)	<40	<35	<35	<40	<35	<35	<35	<35
R41 (residential)	<40	<35	<35	<40	<35	<35	<35	37

7.6 Commitments and management measures

The HHRA concluded that the project will not result in impacts to human health. Chapter 6: Air quality and Appendix E describe the mitigation measures relating to management of dust emissions and air quality from the project. This includes continued implementation of PGM's air quality monitoring program. The project is not predicted to result in an increase in noise emissions. No additional mitigation measures relating to human health impacts are required.

7.7 Conclusion

An HHRA was completed focussing on the emission of pollutants to the air (primarily pollutants related to dust) and exposure to the local community; the method adopted in the HHRA was consistent with recognised risk assessment frameworks. Health impacts due to noise emissions were assessed based on the noise modelling completed for the project (Chapter 8).

For health risks relating to dust and metals/metalloids, the ALM and IEUBK modelling predicted negligible change to BPb concentrations for both adults and children as a result of the project, with predictions well below the target action level. All estimates were consistent with the range of blood lead levels reported for Australian children in communities not affected by point sources of lead. Both models incorporated incidental oral exposure to lead in soil and dust, inhalation exposure to lead in air, as well as 'background' exposures such as from diet and water. In addition, the IEUBK model also incorporated ingestion of tank water which may contain lead deposited in dust.

Estimated exposure to the 12 other metals were all well below their respective health guidelines. There is also very low probability of additive effects between the metals. It is concluded the risk of exceeding health-based toxicity reference values as a result of the project is very low. The assessment is conservative. The highest estimated cancer risk (for nickel) was 7.6 x 10-10, which is almost 10,000 to 100,000 times less than the risk that NSW and other jurisdictions consider as negligible or acceptable. Therefore, the project is not expected to result in a significant impact to the health of the local community relating to noise and air quality emissions.

8 Noise, vibration and blasting

8.1 Introduction

A noise and vibration impact assessment (NVIA) was completed by EMM to assess the predicted noise and vibration impacts associated with the construction and operation of the project. The NVIA was prepared in accordance with the policies and guidelines set out in the SEARs, including the Noise Policy for Industry (EPA 2017) (NPfI). The NVIA is provided in full in Appendix G.

8.2 Assessment requirements

The SEARs require an assessment of the likely noise and vibration impacts of the project. The specific requirements relating to noise and vibration are provided in Table 8.1.

Table 8.1 Noise and blasting assessment requirements

Relevant authority and assessment requirement	Relevant section of the EIS
DPIE	
Noise, Vibration and Blasting – including an assessment of: - the likely construction, operational and off-site noise impacts of the development, in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry (EPA) and NSW Road Noise Policy, and having regard to the Voluntary Land Acquisition and Mitigation Policy;	Section 8.5
- the likely blasting impacts of the development on people, animals, buildings and infrastructure, and significant natural features, having regard to the relevant ANZECC guidelines;	Section 8.5.6
EPA	
1.2. Impacts related to the following environmental issues need to be assessed, quantified and reported on: • Noise and vibration impacts associated with blasting, and operational noise particularly fixed infrastructure, machinery and plant movements;	Section 8.5
4.1. Construction noise associated with the proposed development should be assessed using the Interim Construction Noise Guideline (DECC 2009).	Section 8.5.3
4.2. Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in Assessing Vibration: a technical guideline (DEC 2006).	No vibration intensive plant or equipment items are proposed as part of the project.
4.3. If blasting is required for any reason during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC 1990).	Section 8.5.6
4.4. Operational noise from all industrial activities, including private haul roads and private railway lines, should be assessed using the Noise Policy for Industry (EPA 2017).	Section 8.5.1
4.5. Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the NSW Road Noise Policy and associated application notes (EPA 2011).	Section 8.5.5

8.2.1 Methodology

The NVIA referenced the New Cobar Complex development consent and EPL, noise policies and blasting assessment guidelines as follows:

- CSC, Development Consent (2004/LDA-00003), reviewed in June 2004;
- NSW Industrial Noise Policy (EPA 2000) (superseded);
- Noise Policy for Industry (EPA 2017);
- EPL 3596;
- Interim Construction Noise Guideline (DECC 2009);
- Road Noise Policy (DECCW 2011);
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration, (ANZEC 1990); and
- PGM, approved MOP (Amendment A), amended in May 2020.

The method and a detailed summary of modelling and the impact assessment for the projects against key policy requirements is contained in the NVIA (Appendix G).

8.3 Existing environment

The area surrounding the project includes a number of privately-owned residential properties with the closest located approximately 900 m to the south-west of the New Cobar Complex. The majority of the assessment locations are located near the town of Cobar. No further potentially affected residential receivers were identified further south of the New Cobar Complex or the Peak Complex.

The NVIA considered 41 sensitive receivers surrounding the project area (R1 to R41). These residences are referred to as assessment locations and are illustrated in Figure 8.1.

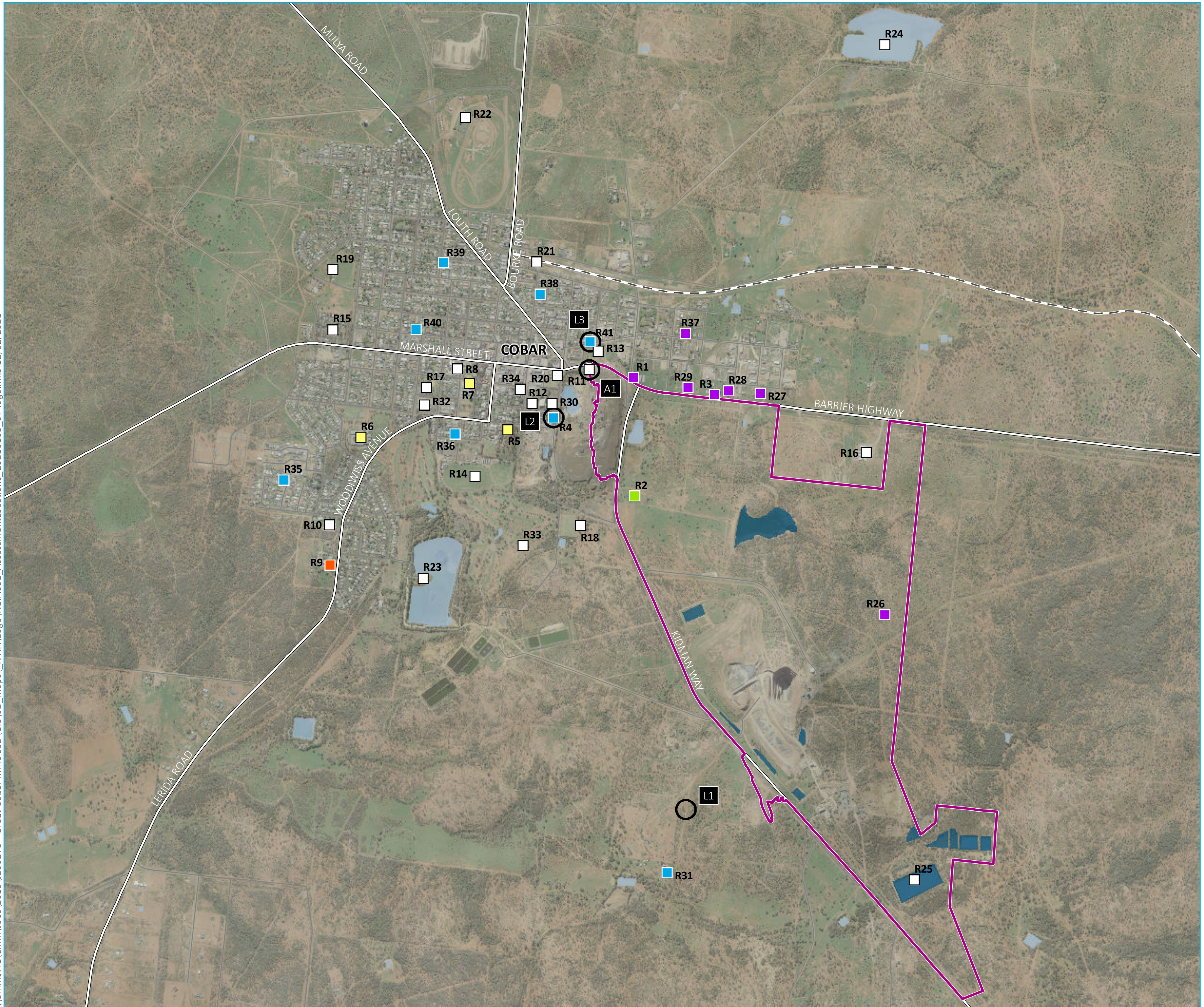
8.3.1 Existing noise and blasting limits and emissions

The NVIA also considered the existing noise and blasting limits and emissions set out within the EPL 3596 and the development consent 2004/LDA 00003.

i Existing noise limits and emissions

Condition L4 of the EPL (3596) provides noise limits the site's approved existing operations must meet. These noise limits are based on the $L_{A10,15min}$ noise descriptor and were derived from noise guidelines prior to the release of the Industrial Noise Policy (EPA 2000). It is noted that the Industrial Noise Policy is now superseded by the NPfI (EPA 2017).

Operational noise limits from the EPL are provided in Table 8.2.



KEY
- Noise monitoring location
- Project area
- Rail line
- Major road
- Minor road
- Named watercourse
- Waterbody
- Mine water management storage

Type of receiver
- Hospital
- Mine-owned residence
- Privately-owned residence
- Industrial
- School
- Other

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

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Noise monitoring and assessment locations

Peak Gold Mines
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Environmental impact assessment
Figure 8.1

Table 8.2 EPL noise limits

Location	Operational noise limits, $L_{A10,15min}$, dB		
	Monday to Friday (7 am – 6 pm) and Saturday (7 am – 1 pm)	Monday to Friday (6 pm – 10 pm)	All other times
Nearest or most affected privately-owned residence	45	40	35

The EPL states that the noise limits in Table 8.2 apply under all meteorological conditions except during the following:

- rain and wind speeds (at 10 m height) greater than 3 m/s; and
- "non-significant weather conditions" (as described in Chapter 5 and Appendix E of the Industrial Noise Policy).

It is noted that the noise limits presented in Table 8.2 do not apply if PGM owns the residence or land or has an agreement with the owner(s) of the relevant residence or land to generate higher noise levels, and PGM has advised DPIE in writing of this agreement.

PGM undertakes attended noise monitoring at the nearest privately-owned residence to the New Cobar Complex, assessment location R31 (Dellavale). A review of the attended noise monitoring data recorded at R31 since January 2017 during the day, evening and night periods identified that noise from the New Cobar Complex complied with the relevant noise limits during all monitoring surveys. This shows a compliant history and good performance of noise emissions from the New Cobar Complex.

ii Existing blasting limits and emissions

Condition 4 of the development consent (2004/LDA 00003) and Condition L4 of the EPL (3596) provide blasting limits the site must meet. The development consent includes ground vibration limits and the EPL includes limits for both airblast overpressure and ground vibration. Ground vibration limits provided in the development consent and EPL are consistent. Airblast overpressure and ground vibration limits are summarised in Table 8.3.

Table 8.3 Existing blasting limits

Location	Airblast overpressure (LinPeak)	Ground vibration	Allowable exceedance
Any residence or noise sensitive location (eg school or hospital) that is not owned by the licensee or subject of a private agreement between the owner of the residence or noise sensitive location and the licensee as to an alternative overpressure level or ground vibration level.	120 dB	10 mm/s	0%
	115 dB	5 mm/s	5% of the total number of blasts within the 12 months annual reporting period.

All operational blast activities at the New Cobar Complex and the Peak Complex are conducted underground. Therefore, potential impacts associated with airblast overpressure are negligible. Potential impacts from ground vibration at off-site receivers is currently managed by PGM through the implementation of mitigation measures including the following:

- reducing the MIC;
- optimising blasting underground through the use of electronic detonators; and
- using a ground vibration prediction model throughout the planning process and altering the blast design where required.

PGM undertakes blast ground vibration monitoring at six monitoring locations, consisting of four near field on-site locations and two offsite locations. A review of the blast monitoring data since May 2014 identified three blasts at the New Cobar deposit where ground vibrations were above 5 mm/s. With more than 600 blasts in 2015, 688 blasts in 2017, 342 blasts in 2018 and 423 blast 2019, the recorded ground vibration levels did not exceed the 5% allowable exceedance threshold for total blasts within the relevant 12 months annual reporting periods. Furthermore, no blast ground vibration levels have been recorded above the strict 10 mm/s limit at noise sensitive receivers. This shows a compliant history and good performance of ground vibration from blasts at the New Cobar Complex

8.3.2 Ambient noise environment

To establish the ambient noise levels in the area, noise surveys were conducted at representative monitoring locations in general accordance with the procedures described in Australian Standard 'AS 1055-2018 – Acoustics – Description and Measurement of Environmental Noise'.

Noise monitoring using attended and unattended noise loggers was completed at representative residential properties potentially affected by project noise. Three noise loggers were deployed as follows:

- Logger 1 – 'Dellavale' on Kidman Way, Cobar (L1);
- Logger 2 – Harcourt Street, Cobar (L2); and
- Logger 3 – Conduit Street, Cobar (L3).

EMM also completed 15-minute attended noise measurements on 29 October 2019 at the three logger locations (L1, L2 and L3), as well as A1 (the Great Cobar Heritage Centre), to identify noise sources contributing to the ambient noise environment.

The results of the noise monitoring showed that the ambient noise environment is dominated by noise from road traffic, urban and suburban noise (such as air conditioner fans) and insect and bird noise. Industrial noise as a result of current activity at the New Cobar Complex was inaudible except for at location L1, located 1 km from the ROM pad. Ambient noise levels at location L1 were typically lower than at other monitored locations.

A summary of the results of attended and unattended noise monitoring is given in Table 8.4.

8.3.3 Meteorology

Noise propagation over distance can be significantly affected by meteorological conditions. Of most interest are source-to-receiver winds, the presence of temperature inversions and drainage flow (katabatic winds), as these conditions can enhance received noise levels. To account for the influence of weather conditions in the noise impact assessment, the NPfI requires assessment of noise under standard and noise-enhancing weather conditions, if found relevant.

The NVIA assessment found that source-to-receiver wind, temperature inversions and wind as a result of topography (drainage winds) were not significant enough to affect the assessment.

8.4 Noise criteria

Noise criteria for operational noise, construction noise, road traffic noise and blasting in NSW are regulated by the local council, DPIE and/or the EPA. The objectives of noise criteria are to protect the community from excessive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location. Full details of noise and vibration criteria can be found in Appendix G.

Table 8.4 Summary of existing background and ambient noise levels

	Unattended noise monitoring			Attended noise monitoring			
				Measured noise levels (15-minute), dB			
Monitoring location	**Assessment period[1]**	**RBL[2], dB**	**Measured $L_{Aeq,period}$ noise level[3], dB**	**Time of day**	**L_{A90}**	**L_{Aeq}**	**L_{Amax}**
L1 – Kidman Way, Cobar	Day	28	43	16:58	28	42	76
	Evening	28	40	21:18	29	33	50
	Night	27	41	22:30	27	37	63
L2 – Harcourt St, Cobar	Day	35	57	15:43	36	52	71
	Evening	29	48	21:05	35	48	72
	Night	26	46	22:18	34	51	77
L3 – Conduit St, Cobar	Day	38	53	14:51	36	48	77
	Evening	33	49	21:23	39	45	67
	Night	29	47	22:36	37	45	65
A1 – Great Cobar Heritage Centre (attended only)	Not measured			16:02	43	54	69
				21:41	40	54	72
				22:00	40	56	75

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: remaining periods.
2. The RBL is an NPfI term and is used represent the background noise level.
3. The energy averaged noise level over the measurement period and representative of general ambient noise.

8.4.1 Project noise trigger levels

The NPfI's project noise trigger levels (PNTL) are the lower of the calculated intrusiveness or amenity noise levels and are provided in Table 8.5 for all assessment locations.

Table 8.5 Project noise trigger levels

Assessment location	Project intrusiveness noise level $L_{Aeq,15min}$, decibel (dB)			Project amenity noise level[1] $L_{Aeq,15min}$, dB			PNTL[2] $L_{Aeq,15min}$, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
R1 (industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R2 (PGM)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
R3 (industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R4 (residential)	40	35	35	53	43	38	40	35	35
R5 (school)	N/A	N/A	N/A	40[3]	N/A	N/A	40	N/A	N/A
R6 (school)	N/A	N/A	N/A	40[3]	N/A	N/A	40	N/A	N/A
R7 (school)	N/A	N/A	N/A	40[3]	N/A	N/A	40	N/A	N/A
R8 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R9 (hospital)	N/A	N/A	N/A	48[3]	48[3]	48[3]	48	48	48
R10 (nursing home)	N/A	N/A	N/A	53	48	43	53	48	43
R11 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R12 (recreation)	N/A	N/A	N/A	53	53	53	53	53	53
R13 (recreation)	N/A	N/A	N/A	48	48	48	48	48	48
R14 (recreation)	N/A	N/A	N/A	53	53	53	53	53	53
R15 (caravan park)	N/A	N/A	N/A	53	48	43	53	48	43
R16 (mine camp)	N/A	N/A	N/A	53	48	43	53	48	43
R17 (recreation)	N/A	N/A	N/A	53	53	53	53	53	53
R18 (recreation)	N/A	N/A	N/A	53	53	53	53	53	53
R19 (recreation)	N/A	N/A	N/A	53	53	53	53	53	53
R20 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R21 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R22 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R23 (recreation)	N/A	N/A	N/A	48	48	48	48	48	48
R24 (recreation)	N/A	N/A	N/A	48	48	48	48	48	48
R25 (recreation)	N/A	N/A	N/A	48	48	48	48	48	48
R26 (industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R27 (industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R28 (industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R29 (industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R30 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R31 (residential)	40	35	35	48	43	38	40	35	35
R32 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63

Table 8.5 Project noise trigger levels

Assessment location	Project intrusiveness noise level $L_{Aeq,15min}$, decibel (dB)			Project amenity noise level[1] $L_{Aeq,15min}$, dB			PNTL[2] $L_{Aeq,15min}$, dB		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
R33 (recreation)	N/A	N/A	N/A	53	53	53	53	53	53
R34 (commercial)	N/A	N/A	N/A	63	63	63	63	63	63
R35 (residential)	40	35	35	53	43	38	40	35	35
R36 (residential)	40	35	35	53	43	38	40	35	35
R37 (Industrial)	N/A	N/A	N/A	68	68	68	68	68	68
R38 (residential)	43	38	35	53	43	38	43	38	35
R39 (residential)	40	35	35	53	43	38	40	35	35
R40 (residential)	40	35	35	53	43	38	40	35	35
R41 (residential)	43	38	35	53	43	38	43	38	35

Notes: 1. Project amenity $L_{Aeq,15min}$ noise level is the Project amenity noise level $L_{Aeq,period}$ + 3 dB as per the NPfI.
2. PNTLs are the lower of the calculated intrusiveness or amenity noise levels.
3. External amenity noise level was adopted.
4. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: remaining periods.

It is noted that the PNTLs shown in Table 8.5 for assessment location R31 (Dellavale) differ from the existing EPL limits of 45 dB $L_{A10,15min}$, 40 dB $L_{A10,15min}$, 35 dB $L_{A10,15min}$ for the day, evening and night periods respectively. Existing limits were established prior to the release of the Industrial Noise Policy in 2000 (now superseded) and the subsequent release of the NPfI in 2017.

i Sleep disturbance

The potential for sleep disturbance was also assessed as the site will continue to operate during the night-time period. All residential locations have an adopted night RBL of 30 dB(A) and maximum noise level event screening criteria of 40 dB $L_{Aeq,15min}$ and 52 dB L_{Amax} (whichever is greater).

ii Voluntary land acquisition and mitigation policy

The NSW Government VLAMP policy describes the voluntary mitigation and land acquisition policy to address dust and noise impacts, and outlines mitigation and acquisition criteria for noise.

Voluntary acquisition rights apply to any residence on privately-owned land if, even with the implementation of best practice management at the mine site, the noise exceeds the criteria set out in the NPfI.

8.4.2 Construction noise

The SEARs specifically reference the NSW Department of Environment and Climate Change (DECC) Interim Construction Noise Guideline (2009) for the assessment of noise from proposed construction activities. However, noise associated with construction activities for extractive industries are generally assessed as operational noise, as noise emissions from plant and equipment items associated with construction are similar to those used for operations. Furthermore, operational noise trigger levels are generally more stringent than those provided in the Interim Construction Noise Guideline. Therefore, the PNTLs presented in Table 8.5 have been adopted as the construction noise criteria for the project.

8.4.3 Road traffic noise

Construction and operation related traffic require assessment for potential noise impact. The principal guidance to assess the impact of road traffic noise at assessment locations is in the NSW Department of Environment, Climate Change and Water (DECCW) Road Noise Policy (RNP) (2011). The road traffic noise assessment criteria for residential assessment locations, reproduced from Table 3 of the RNP for road categories relevant to the project are provided in Table 8.6.

Table 8.6 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	60 $L_{Aeq,15hr}$	55 $L_{Aeq,9hr}$
	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq(15hr)}$ + 12 dB	Existing traffic $L_{Aeq(9hr)}$ + 12 dB

Source: RNP (DECCW 2011).

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB.

8.4.4 Blasting

The criteria adopted by EPA for blasting are provided in the Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZEC 1990).

The blasting criteria address two main effects of blasting:

- airblast overpressure; and
- ground vibration.

Airblast overpressure does not apply to this project as blasting will only occur underground, so is not considered further.

Ground vibration limits exist for the site (see Table 8.3) as specified in the development consent and EPL. The development consent includes ground vibration limits and the EPL includes limits for both airblast overpressure and ground vibration. Ground vibration limits provided in the development consent and EPL are consistent with the criteria recommended in the ANZECC guideline, as shown in the following sections.

Peak particle velocity (PPV) from ground vibration should not exceed 5 mm/s for more than 5% of the total number of blasts over 12 months. However, the maximum level should not exceed 10 mm/s at any time. Ground vibration criteria are summarised in Table 8.7.

Table 8.7 Ground vibration limits

Sensitive receiver type	PPV (mm/s)	Allowable exceedance
Residential receiver	5	5% of the total number of blasts over 12 months
Structural damage to buildings	10	0%

8.5 Impact assessment

The potential noise and vibration impacts of the project are summarised in the following sub-sections. Full details of predicted noise levels are presented in Appendix G.

8.5.1 Operational noise

To assess potential noise impacts from the project, proposed future operational noise predictions were compared to modelled existing operational noise levels. Modelled existing operational noise levels and predicted proposed future operational noise levels following the commissioning of the new ventilation fan are shown in Table 8.8.

When comparing modelled existing and predicted future site noise levels during noise-enhancing (ISO 9613) meteorological conditions for the day, evening and night periods, no material increase in noise levels is predicted at any assessment location. Therefore, no operational noise impact is anticipated as a result of mining.

Table 8.8 Predicted future operational noise levels

Assessment location	Modelled existing $L_{Aeq,15min}$ noise levels, dB			Predicted future $L_{Aeq,15min}$ noise levels, dB			PNTLs, $L_{Aeq,15min}$, dB			Future exceedance, dB		
	ISO 9613			ISO 9613						ISO 9613		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
R1 (industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R2 (PGM)	<40	<35	<35	<40	<35	<35	N/A	N/A	N/A	N/A	N/A	N/A
R3 (industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R4 (residential)	<40	<35	<35	<40	<35	<35	40	35	35	Nil	Nil	Nil
R5 (school)	<40	N/A	N/A	<40	N/A	N/A	40	N/A	N/A	Nil	N/A	N/A
R6 (school)	<40	N/A	N/A	<40	N/A	N/A	40	N/A	N/A	Nil	N/A	N/A
R7 (school)	<40	N/A	N/A	<40	N/A	N/A	40	N/A	N/A	Nil	N/A	N/A
R8 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R9 (hospital)	<48	<48	<48	<48	<48	<48	48	48	48	Nil	Nil	Nil
R10 (nursing home)	<53	<48	<43	<53	<48	<43	53	48	43	Nil	Nil	Nil
R11 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R12 (recreation)	<53	<53	<53	<53	<53	<53	53	53	53	Nil	Nil	Nil
R13 (recreation)	<48	<48	<48	<48	<48	<48	48	48	48	Nil	Nil	Nil

Table 8.8 Predicted future operational noise levels

Assessment location	Modelled existing $L_{Aeq,15min}$ noise levels, dB			Predicted future $L_{Aeq,15min}$ noise levels, dB			PNTLs, $L_{Aeq,15min}$, dB			Future exceedance, dB		
	ISO 9613			ISO 9613						ISO 9613		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
R14 (recreation)	<53	<53	<53	<53	<53	<53	53	53	53	Nil	Nil	Nil
R15 (caravan park)	<53	<48	<43	<53	<48	<43	53	48	43	Nil	Nil	Nil
R16 (mine camp)	<53	<48	<43	<53	<48	<43	53	48	43	Nil	Nil	Nil
R17 (recreation)	<53	<53	<53	<53	<53	<53	53	53	53	Nil	Nil	Nil
R18 (recreation)	<53	<53	<53	<53	<53	<53	53	53	53	Nil	Nil	Nil
R19 (recreation)	<53	<53	<53	<53	<53	<53	53	53	53	Nil	Nil	Nil
R20 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R21 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R22 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R23 (recreation)	<48	<48	<48	<48	<48	<48	48	48	48	Nil	Nil	Nil
R24 (recreation)	<48	<48	<48	<48	<48	<48	48	48	48	Nil	Nil	Nil
R25 (recreation)	<48	<48	<48	<48	<48	<48	48	48	48	Nil	Nil	Nil
R26 (industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R27 (industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R28 (industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R29 (industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R30 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R31 (residential)	<40	<35	<35	<40	<35	<35	40	35	35	Nil	Nil	Nil
R32 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R33 (recreation)	<53	<53	<53	<53	<53	<53	53	53	53	Nil	Nil	Nil
R34 (commercial)	<63	<63	<63	<63	<63	<63	63	63	63	Nil	Nil	Nil
R35 (residential)	<40	<35	<35	<40	<35	<35	40	35	35	Nil	Nil	Nil
R36 (residential)	<40	<35	<35	<40	<35	<35	40	35	35	Nil	Nil	Nil
R37 (Industrial)	<68	<68	<68	<68	<68	<68	68	68	68	Nil	Nil	Nil
R38 (residential)	<40	<35	<35	<40	<35	<35	43	38	35	Nil	Nil	Nil
R39 (residential)	<40	<35	<35	<40	<35	<35	40	35	35	Nil	Nil	Nil
R40 (residential)	<40	<35	<35	<40	<35	<35	40	35	35	Nil	Nil	Nil
R41 (residential)	<40	<35	<35	<40	<35	<35	43	38	35	Nil	Nil	Nil

Notes: 1. Day period: 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sunday and public holidays.
2. Evening period: 6 pm to 10 pm on any day.
2. Night period: 10 pm to 7 am Monday to Saturday and 10 pm to 8 am on Sunday and public holidays.

8.5.2 Sleep disturbance

Maximum noise events from future night operations considered in this assessment included potential maximum noise events from the following operations at the New Cobar Complex:

- front-end loader loading material into a road truck at the ROM pad; or
- front-end loader bucket hitting the ground; or
- haul truck unloading material at the WRE; or
- haul truck unloading material at the ROM pad.

A sound power level 125 dB L_{Amax} was conservatively adopted to cover any of these possible events in the prediction of sleep disturbance impacts at residential assessment locations during night-time noise-enhancing (ISO 9613) meteorological conditions. Results are therefore considered conservative and are provided in Table 8.9.

Noise modelling results show that maximum L_{Aeq} and L_{Amax} noise levels are predicted to satisfy the NPfI screening criteria for sleep disturbance at all residential assessment locations during night-time noise-enhancing (ISO 9613) meteorological conditions. Therefore, no sleep disturbance impacts at residential receivers are anticipated as a result of this project.

Table 8.9 Predicted night-time maximum noise levels at residential assessment locations

Residential assessment location	Predicted night-time maximum noise levels, dB ISO 9613		Sleep disturbance screening criteria, dB		Exceedance, dB ISO 9613	
	$L_{Aeq,15min}$	L_{Amax}	$L_{Aeq,15min}$	L_{Amax}	$L_{Aeq,15min}$	L_{Amax}
R4	<35	39	40	52	Nil	Nil
R31	<35	46	40	52	Nil	Nil
R35	<35	<35	40	52	Nil	Nil
R36	<35	37	40	52	Nil	Nil
R38	<35	35	40	52	Nil	Nil
R39	<35	<35	40	52	Nil	Nil
R40	<35	<35	40	52	Nil	Nil
R41	<35	37	40	52	Nil	Nil

Notes: 1. Night: 10 pm to 7 am Monday to Saturday, 10 pm to 8 am Sundays and public holidays.

8.5.3 Construction

Predicted site noise levels from the construction of the power line, substation and emergency egress winder during noise-enhancing (ISO 9613) meteorological conditions for the relevant periods are predicted to satisfy the relevant PNTLs during the day and night periods at all assessment locations.

8.5.4 VLAMP assessment

Predicted noise levels from proposed future operations for the day, evening and night periods show that noise from the project will satisfy the PNTLs at all privately-owned residential assessment locations including VLAMP criteria.

8.5.5 Road traffic noise

i Construction

Road traffic movements associated with the power line construction are anticipated to be minimal: between two to four vehicle movements per day during the six-month construction period. All roads that will be used to access the power line construction site where adjacent residential assessment locations exist will experience nil to negligible (<2 dB) noise level increases. Therefore, road traffic noise levels associated with the power line construction are predicted to satisfy the relevant RNP criteria.

ii Operations

The only change proposed for the project during operations is an increase in HV movements for the dispatch of ore from the New Cobar Complex to the Peak Complex and the backloading of backfill material from the Peak Complex to the New Cobar Complex via Kidman Way. Existing road traffic movements adopted in this assessment were derived from data recorded during the road traffic survey completed by EMM in April 2020 (Appendix M) at the intersection of Kidman Way and the New Cobar Complex access road.

The nearest residential assessment location on Kidman Way is R31 (Dellavale) and is located approximately 850 m to the west of Kidman Way. Road traffic noise levels calculated at the nearest residential assessment location (ie R31) for the day and night periods are presented in Table 8.10. Increases in road traffic noise levels due to project related road traffic movements during operations have also been provided for comparison.

Road traffic noise levels for all periods are predicted to satisfy the relevant RNP criteria during operations. Furthermore, the increases in road traffic noise levels are predicted to be negligible (<2 dB). Therefore, no road traffic noise impacts are anticipated as a result of the project.

Table 8.10 Road traffic noise assessment during operations

Road section	Distance to nearest residence	Speed	Assessment period	Existing road traffic noise levels $L_{Aeq,period}$, dB	Future[1] road traffic noise levels $L_{Aeq,period}$, dB	RNP criteria $L_{Aeq,period}$, dB	Increase due to the project, dB
Kidman Way – east of R31	850 m	100 kilometres per hour (km/h)	Day (7 am to 10 pm)	44	45	60	1.1
			Night (10 pm to 7 am)	39	40	55	0.9

Notes: 1. Existing and project related road traffic movements combined.

8.5.6 Blasting

All operational blast activities at the New Cobar Complex are conducted underground. Accordingly, potential impacts associated with airblast overpressure are negligible, and the only potential impact is related to ground vibration.

The results of the allowable MIC calculations based on the model developed for ground vibration predictions from blasting demonstrate that strict control of MIC values will be required to achieve the 95% 5 mm/s PPV ground vibration criteria at the nearest residential receivers. Accordingly, the MIC values used in some of the upper stopes near residential receivers will be reduced (in comparison to a typical MIC used) in order to achieve compliance.

Blasting has the potential to impact on non-residential receivers (eg buildings or structures of historical heritage significance) within and close to the project area. The blast ground vibration criterion used in this assessment for residential receivers (ie 5 mm/s PPV) is lower than the criterion for structural damage to buildings (10 mm/s PPV). Therefore, no impacts from blasting on non-residential receivers (ie structural damage to buildings) is anticipated from the project if the MIC is limited to achieve compliance with residential receivers.

8.6 Commitments and management measures

8.6.1 Noise

The application of project-specific noise management measures is not required as noise impacts as a result of construction and operation activities associated with the project are not predicted to exceed the relevant criteria at any sensitive receivers.

8.6.2 Vibration

Potential impacts from blast ground vibration at off-site receivers are currently managed by PGM through limiting MIC, blast design and blast monitoring in accordance with the limits provided in the EPL (3596). PGM will continue to implement mitigation measures currently in place at the New Cobar Complex to reduce the potential impact of blast ground vibration at nearby receivers.

PGM has a vibration prediction model that is used throughout the planning process for blasting programs. The purpose of this model is to provide a maximum vibration estimation by assessing the MIC (kg) and the distance (m) to the closest residents. If the vibration level is predicted to be too high, PGM will alter the blast design, to reduce impacts on surrounding residents. This model will continue to be used for all blasts at the New Cobar Complex.

8.6.3 Monitoring

Monthly noise monitoring is conducted to ensure compliance with the limits set out in the EPL.

PGM also has six permanent vibration monitors which operate on a 24-hour basis to record all development and production blasts at the New Cobar Complex. These monitors are installed at Fort Bourke Hill, Dellavale, New Occidental, the Great Cobar Heritage Centre and immediately east and west of the Great Cobar historical slag dump.

All PGM monitoring results are recorded in the Annual Environmental Management Report (AEMR) and made available to the public on the Aurelia Metals website.

8.6.4 Feedback

A 24-hour, 7-days per week complaints phone line is available to all stakeholders and the greater Cobar community. The details of the complaints line is advertised in the local newspaper and on Aurelia's website, in accordance with Condition M5 of PGM's EPL.

8.7 Conclusion

The findings of the NVIA are summarised as follows:

- Proposed future operational noise levels were assessed for the day, evening and night periods for noise-enhancing (ISO 9613) meteorological conditions. The assessment found that noise levels during operation are predicted to satisfy the relevant criteria at all assessment locations. No material increase is predicted at all assessment locations when comparing modelled existing and predicted future site noise levels. Therefore, operational noise impacts from the project are unlikely to cause noise impacts at any sensitive receivers.

- The sleep disturbance assessment demonstrated that night-time maximum noise levels are predicted to satisfy the relevant screening criteria at all residential assessment locations. Accordingly, project activities are unlikely to cause sleep disturbance impacts at any sensitive receivers.

- Noise levels during the construction of the power line were assessed against the operational PNTLs for the day and night periods. Predictions satisfied the relevant PNTLs at all assessment locations. Accordingly, project activities associated with construction are unlikely to cause noise impacts at any sensitive receivers.

- A VLAMP assessment was completed for the project. Night $L_{Aeq,15min}$ noise contours for proposed future operations were produced and reviewed in the context of land ownership for properties surrounding the New Cobar Complex. The VLAMP assessment showed that the noise levels from proposed future operations are predicted to satisfy the VLAMP 25% privately-owned land assessment.

- The project will result in additional road traffic movements during proposed future operations. However, the overall increase in average road traffic noise at nearest residential facades is predicted to satisfy relevant RNP criteria during both the day and night periods. Therefore, road traffic is unlikely to cause noise impacts at any sensitive receivers.

- A blasting assessment was completed for the project. Site specific relationships between the level of blast emissions and scaled distances were developed based on site specific monitoring data. The results demonstrate that the 95% 5 mm/s PPV ground vibration criteria will be achieved at the nearest residential receivers if the MIC values are controlled appropriately. Recommendations in relation to the MIC values for the project based on distance to receiver are provided in Appendix G.

- Noise and vibration will continue to be monitored to ensure compliance with relevant guidelines, conditions and licences.

9 Subsidence

9.1 Introduction

A geotechnical and subsidence assessment was completed by Beck Engineering to assess the predicted geotechnical and subsidence impacts of the project. The purpose of the geotechnical and subsidence assessment was to:

- forecast mine subsidence and surface deformation, including impacts to surface infrastructure and environmentally sensitive sites;
- simulate the planned underground mining sequence and forecasting the geotechnical response in ore drives, level accesses, declines and infrastructure;
- forecast potential for additional instability in the New Cobar open cut due to underground mining;
- provide general guidance on the stoping sequence and recommend changes as required; and
- provide feedback on ground support requirements, based on the model forecasts and experience at other mines in similar conditions.

The geotechnical and subsidence assessment is provided in full in Appendix H.

9.2 Assessment requirements

The SEARs require an assessment of the likely subsidence impacts of the project. The specific requirements relating to geotechnical and subsidence impacts are provided in Table 9.1.

Table 9.1 Geotechnical and subsidence assessment requirements

Relevant authority and assessment requirement	Relevant section of the EIS
DPIE (geotechnical)	
The Proponent is to supply a full geotechnical assessment that supports mining methods and mine design that includes, but is not limited to:	
1. Consideration of local geological structure and its influence on rock stability.	Section 9.4.3 and Appendix H
2. An analysis of ground behaviour and ground management strategies in deep underground mining.	Section 9.5.1, Section 9.5.2 and Appendix H
3. Description of ground support system design for static and dynamic conditions that includes performance monitoring methods.	Section 9.4.2, Section 9.5 and Appendix H
4. Evaluation of stress management and quality control and support elements during mining operations.	Section 9.6 and Appendix H
DPI (subsidence)	
To justify proposed underground mining projects, the Proponent must demonstrate the feasibility of:	

Table 9.1 Geotechnical and subsidence assessment requirements

Relevant authority and assessment requirement	Relevant section of the EIS
1. The proposed strategies to manage subsidence risks to surface or sub-surface features that are considered to have significant economic, social, cultural or environmental value.	Section 9.5 and Appendix H

9.2.1 Assessment criteria

The method and a complete discussion of the assessment criteria, background data collection, synthesis and model composition for the geotechnical and subsidence assessment can be found in Appendix H.

9.3 Existing environment

9.3.1 Historical, current and future mine workings

Given the historical and current mining operations at the New Cobar Complex, the geotechnical and subsidence investigations reflected the underground and open cut mining methods employed at:

- the Chesney historical, current and future workings;
- the New Cobar open cut and underground workings;
- the Jubilee workings; and
- the Great Cobar open cut and historical workings.

These historical and current workings in relation to the planned future mining of the Gladstone and Great Cobar workings are presented in Figure 2.2.

9.3.2 Mining method and subsidence management

PGM presently employs underground stope mining methods for current mining at the New Cobar Complex. These methods will also be employed for the Great Cobar and Gladstone workings.

Stope mining operations commence above a centrally positioned crown pillar and stopes are extracted from the base upwards. Bench stopes are backfilled progressively using waste rock from development of mine workings and rock from the waste rock emplacement. Upon completion of each stoping level, voids are backfilled. In some instances, mining against rock fill is required; in these instances, a mixture of rock and cement slurry (CAF) is placed in the stope to provide additional stability. Production blast holes are fired in slots located at the extremities of each stope. Stopes have blast holes drilled parallel to the stope-hanging wall.

There is no recorded history of significant subsidence or geotechnical failure issues associated with the current, modern mining operations at the Peak and New Cobar complexes. PGM undertakes detailed geotechnical assessments of all stopes during the detailed stope design stage prior to mining.

9.3.3 Mine geology

The deposits mined from the New Cobar Complex and Peak Complex are located within the GCS, on a major north to north-west striking, steeply dipping shear zone known as the Great Chesney Fault (see Figure 3.1). There is another secondary, north south trending fault which runs through the Great Cobar historical workings (Figure 3.1).

Except for the open cuts and the WRE, there are no surface features of geotechnical significance for the underground mine.

9.4 Impact assessment

9.4.1 Subsidence

Subsidence of less than 20 mm is considered negligible (IESC 2014). The majority of future displacement due to planned underground mining is horizontal closure as stopes are mined. The forecast displacements are low and normal for stoping in moderate to strong rock at the planned mining depths at the New Cobar Complex:

- Maximum surface subsidence forecasts are less than 15 mm and are considered negligible. It is noted that this level of deformation is within the levels of precision of a mine scale model.
- Forecast displacement of up to 50-60 mm is forecast in isolated sections of pit wall crests within the New Cobar Complex open cut at the end of mining across the entire complex, and is likely to have already occurred as a result of current and historical underground mining. Planned underground mining of the Great Cobar and Gladstone deposits are not close to the New Cobar Complex open cut and there will be no significant stress interaction with future mining and minimal subsidence in the vicinity of the Great Cobar open cut. Proposed underground mining does not result in instability in the New Cobar or Great Cobar open cuts in the model forecasts.
- Negligible subsidence is expected for the proposed underground mining due to:
  - small footprint of future underground mining;
  - the depth of mining is mostly >200 mbgl;
  - relatively strong rockmass conditions;
  - small (narrow) stopes with a small footprint;
  - low extraction ratio due to the narrow stopes and small amount of rock planned to be mined (compared to other larger stoping mines); and
  - use of backfill.

9.4.2 Stability and deformation

Noting that the overall mine scale subsidence across the mine is less than 15 mm, which is considered negligible, this section forecasts actual rock behaviours and longer-term stability in relation to each of the existing and proposed mined deposits at Great Cobar (proposed), Gladstone (proposed), New Cobar/Jubilee (existing) and Chesney (existing).

Detailed stability and deformation information is provided in the full geotechnical and subsidence assessment contained in Appendix H.

i Proposed new mining

a Great Cobar

The model forecasts for Great Cobar include:

- overall stress concentration up to 60 Mpa in pillars and in the abutments;
- minor to moderate levels of rockmass damage are forecast close to some stopes. Moderate level of rockmass damage with potential for increased levels of stope overbreak is forecast along the Great Cobar fault which bounds the hangingwall of some planned stopes. Rockmass damage forecasts in long term access drives and the declines is low;
- no significant rockmass damage is forecast in the level accesses or decline; and
- the bottom-up mining sequence has a central access for some stoping levels. Stopes that form diminishing pillars are subject to stress concentration and higher potential for stope instability and overbreak.

b Gladstone

The model forecasts for the Gladstone mine include:

- Stress concentration in the abutments up to ~50 Mpa. Low stress occurs in stope hanging walls and footwalls due to progressive mining and stress shadowing.
- Minor to moderate levels of rockmass damage is forecast in proximity to stopes. The potential for overbreak will be governed by stope scale structures which are not yet identified, however there is potential for minor to moderate levels of overbreak.
- No significant rockmass damage is forecast in the level accesses or decline.
- Stopes on the upper most level are in close proximity to the zone of oxidation. These stopes have a crown pillar thickness of approximately 4−5 m. The stope width is approximately 5m wide. A minimum crown pillar thickness to height ratio of 2:1 is generally recommended. PGM will confirm top of fresh rock boundary and crown pillar thickness required for stability when more detailed geotechnical information is available.
- Historical mining at the Chesney and New Cobar underground workings demonstrates that stopes in the weathered layers have been mined successfully without significant overbreak or chimneying to surface. However, historical underground mining (pre-1950s) in the oxidised zone was most likely undertaken using cut and fill methods and not open stoping.

- The two stopes closest to the top of fresh rock are short up hole stopes. As these stopes are up-hole stopes, backfilling of the stopes is not possible with rockfill. While the potential for long term instability of these stopes is low, alternative backfilling methods of these stopes will be used at these locations.

ii Existing mining

a New Cobar / Jubilee

Due to proximity of the New Cobar and Jubilee deposits (see Figure 2.2), they have been grouped together by the geotechnical assessment under New Cobar. Actual mining in the New Cobar deposit has ceased (remnant mining may continue in the future pending future market conditions) and mining activities have transferred to the Jubilee workings, which for geotechnical assessment purposes is an augmentation of New Cobar. The model forecasts for New Cobar include:

- Stress concentration up to 60 Mpa in pillars and stress abutments near proposed stoping.
- Similar to forecasts for Great Cobar, minor to moderate levels of rockmass damage is forecast in proximity to stopes. A moderate level of rockmass damage with potential for increased levels of stope overbreak is forecast along the Great Chesney fault which bounds the hangingwall of some planned stopes. Rockmass damage forecasts in long term access drives and the declines is low.
- The upper most level of planned stopes at New Cobar intersect the oxidised rockmass layers. The oxidised (or weathered) rockmass layers are weaker than the fresh rock domains and stopes are more susceptible to overbreak or failure, including chimney failure. The model does not forecast high levels of rockmass damage above these stopes. However, unravelling, chimney type failure of small spans and time-dependant instability are difficult to forecast in a mine scale model.
- Planned underground mining is not in proximity to the New Cobar Complex open cut and there is no significant stress interaction and minimal subsidence in the vicinity of the open cut. Proposed underground mining does not result in instability in the open cut in the model forecasts.

b Chesney

The model forecasts for the Chesney mine include:

- Stress concentration in pillars sufficiently high to cause failure of the rib pillars between the planned future stopes.
- Moderate levels of stress and minor levels of rockmass damage in the sill pillars between the historical stopes and planned stopes. PGM will review rib pillar dimensions once more detailed geotechnical information becomes available. This review will be conducted as part of the stope design assessment.
- Moderate level of rockmass damage with potential for increased levels of stope overbreak is forecast along the Great Chesney fault which bounds the hangingwall of the planned stopes.
- Rockmass damage forecasts in long term access drives and the declines is low.
- The planned bottom up sequence with rockfill causes a diminishing pillar sill pillar. The sill pillar is forecast to remain stable, however the concentration of stress may result in minor seismicity as the pillar is loaded. The levels of seismicity are not anticipated to be damaging given the relatively benign

history of mining and limited rocknoise reporting in the information provided in previous geotechnical assessments.

9.5 Commitments and management measures

Based on the model forecasts for stress, strain and deformation, ground support requirements for the future mine will be similar to those used in previous mining to date. PGM does not anticipate damaging levels of seismicity or dynamic support to be required due to the rockmass properties, low extraction ratio and mining depth.

The following management measures will be reflected in future revisions of PGM's existing Ground Control Management Plan (GCMP). The GCMP will be updated post-approval to reflect the mitigation and management measures recommended within the full geotechnical and subsidence assessment prepared by Beck Engineering.

To address identified stability and deformation risk the following ground support management measures will be applied as appropriate:

- resin bolts with fibrecrete or weld mesh for long term accesses;
- friction bolts (or resin bolts) with fibrecrete or weld mesh for short term accesses;
- cablebolting of all intersections, wide spans and stope brows, including temporary brows;
- some stope hangingwalls may require cablebolting pending local ground conditions. Stope crowns below sill pillars may warrant cablebolting to reinforce the sill pillar and prevent potential unravelling of the sill pillar as this could result in significant dilution from rockfill in the previously mined stopes above;
- dynamic ground support will generally not be required as damaging levels of seismicity is not expected at the mining depths of the New Cobar Complex; and
- an observational approach with continuous evaluation of rockmass response to mining and iterative adjustment of the mine plan, if required, as mining continues and as additional geotechnical information becomes available.

9.5.1 Subsidence

Rigorous subsidence monitoring such as regular surveying, laser scanning or InSAR is not required given the model forecasts and negligible amount of subsidence expected. Low levels of monitoring such as annual survey pick-ups of key locations will be undertaken.

9.5.2 Stability and deformation management

The following general mitigation and management measures are proposed to reduce stability and deformation risk for the project:

- Review mining of any stopes near the top of fresh rock boundary. Any stopes planned close to the oxidised layers should be risk assessed and have a stable crown pillar. A crown pillar stability assessment will be performed during the detailed stone design phase.

- Ongoing stope stability assessment and observation of stope performance. Adjustment of stope design may be required, including stope dimensions should instability and overbreak be excessive.
- A thorough risk assessment will be completed prior to the commencement of mining. Consideration may need to include not mining particular stopes or reducing the height of the stopes to allow for a larger crown pillar to be left in place.

i Great Cobar

Stopes in the close out pillars are considered "higher" risk tonnes in terms of recovery and dilution. To address this risk:

- disciplined mining with careful geotechnical controls and monitoring will be adopted to maximise recovery;
- future mine scheduling will reflect more difficult mining conditions in these areas and reflect reduced productivity for the final stope on each level (ie the diminishing pillar); and
- the stope strike length will be adjusted so the final stope is smaller and less susceptible to overbreak and dilution.

Overcut drives in bottom-up sequences are susceptible to damage and undercutting from stope instability. This impacts re-accessing the overcut drive for the next stope above in the mining sequence. This is a problem in some bottom-up stoping mines where stope instability is frequent. PGM will manage hangingwall overbreak through means such as appropriate stope sizing using geotechnical assessment of local ground conditions, timely filling of nearby stopes, ground support and careful drill and blast techniques.

ii Gladstone

The two stopes closest to the top of fresh rock are short up hole stopes. As these stopes are up-hole stopes, backfilling of the stopes is not possible with rockfill. Potential for long term instability of these stopes is low; however, to manage risk these stopes will be backfilled by either:

- developing an overcut drive and rock filling the stopes, including pushing up as much rockfill into the stopes as possible to minimise the unfilled void in the stope;
- backfill with cemented hydraulic fill or some other form of cemented fill via up-holes drilled from the access underground; and/or
- backfill with cemented hydraulic fill or some other form of cemented fill via down-holes from the surface.

iii New Cobar/Jubilee

It is generally advised not to mine stopes in or close to weak cover layers such as the oxidised zone at New Cobar due to the potential for stope chimneying. It is noted that stopes at other mines (not within the New Cobar or Peak Complexes) have chimneyed along faults and through the weak cover units to surface. Although the likelihood is low, these stopes have the potential to chimney to surface. PGM will undertake a detailed geotechnical assessment during the stope design stage, prior to mining these stopes. PGM will also undertake:

- crown pillar stability assessment;
- confirmation of the top of fresh rock boundary; and
- backfilling of the stopes. The stopes in the current design are up-hole stopes, which makes tight filling from underground difficult. Downhole drilling from surface for backfilling with cemented hydraulic fill will be performed as required.

iv Chesney

During detailed design PGM will review the design and dimensions of rib pillars and sill pillars in the current mine design. Some rib pillars in the Chesney mine design are very narrow and likely to fail during stope production.

9.6 Conclusion

The project involves the development of new underground workings of Great Cobar and Gladstone deposits, within and close to existing mining operations. Accordingly, the geotechnical and subsidence characteristics of the project area are already well understood and associated risk managed through the existing management plan framework.

The geotechnical and subsidence assessment conducted by Beck Engineering for the New Cobar Complex deposits found:

- Surface subsidence forecasts are less than 15 mm and are considered negligible.
- Negligible subsidence is expected for the proposed underground mining due to:
  - small footprint of future underground mining;
  - relatively strong rockmass conditions;
  - small (narrow) stopes with a small footprint;
  - low extraction ratio due to the narrow stopes and small amount of rock planned to be mined (compared to other larger stoping mines); and
  - use of backfill.
- Planned underground mining is not close to the New Cobar Complex open cut and there is no significant stress interaction and minimal subsidence in the vicinity of the open cut. Proposed underground mining does not result in instability in the open cut in the model forecasts.
- Minor to moderate levels of rockmass damage is forecast close to some stopes. This increases with depth. Forecast levels of damage would generally be associated with minor dilution and stope overbreak. This is normal in most stoping mines. Moderate level of rockmass damage with potential for increased levels of stope overbreak are forecast along the Great Chesney and Great Cobar faults which bounds the hangingwall of some future stopes.

- Damaging levels of seismicity are not anticipated at the New Cobar Complex and dynamic support is not anticipated to be required due to the rockmass properties, low extraction ratio and mining depth.

- There are stopes at New Cobar (Jubilee) and Gladstone which are close to or intersect the weathered/oxidised layers near surface. The rockmass in the oxidised layers is weaker and more susceptible to instability and chimneying. The stopes assessed by the geotechnical and subsidence assessment are conceptual only and were designed based on the Inferred Mineral Resource and may not be economic or become part of the Ore Reserve and executable mine design.

- Diminishing pillars are formed at Great Cobar and Gladstone mines due to the mining sequence. These diminishing pillars form as stopes are retreated to a central access. These stopes will likely have elevated levels of stope overbreak and dilution compared to nearby stopes due to the stress concentration that occurs as the pillar diminishes. However, due to the rockmass conditions, depth and small number of stopes with this sequence, this is not considered to be a significant problem for the mine.

To reduce subsidence, stability and deformation risk the following mitigation and management measures are proposed and reflect the findings of the geotechnical and subsidence assessment conducted by Beck Engineering:

- Rigorous subsidence monitoring such as regular surveying, laser scanning or InSAR is not required given the model forecasts and negligible amount of subsidence expected. Low levels of monitoring such as annual survey pick-ups of key locations will be undertaken by PGM.

- Reviewing mining of any stopes near the top of fresh rock boundary. Any stopes planned close to the oxidised layers will be risk assessed and have a stable crown pillar.

- Ongoing stope stability assessment and observation of stope performance. The mine will adjust the stope design, including stope dimensions should instability and overbreak be excessive.

- Backfilling of stopes in a timely manner and minimise the total mine void at each mine as far as practical.

- Reviewing the design and dimensions of rib pillars and sill pillars in the current mine design.

- An observational approach with continuous evaluation of rockmass response to mining and iterative adjustment of the mine plan, if required, as mining continues, and as additional geotechnical information becomes available.

10 Groundwater

10.1 Introduction

A groundwater impact assessment (GIA) was completed by EMM to assess the predicted impacts of the project on groundwater. The GIA was prepared in accordance with the policies and guidelines set out in the SEARs. The GIA report is provided in full in Appendix I.

10.2 Assessment requirements

The SEARs require an assessment of the likely groundwater impacts of the project. The specific requirements relating to groundwater are provided in Table 10.1.

Table 10.1 Groundwater related assessment requirements

Authority comments	EMM responses
Assessment of the likely impacts of the development on the quantity and quality of surface and groundwater resources having regard to the NSW Aquifer Interference Policy.	Section 10.8.1
Assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users.	Section 10.8.
Detailed site water balance, including a description of site water demands, water disposal methods (including the location, volume and frequency of any water discharges and management of discharge water quality), water supply arrangements, water supply and transfer infrastructure and water storage structures, including: • an assessment of the reliability of water supply, including consideration of climate change; and • demonstration that water can be obtained from an appropriately authorised supply in accordance with the operating rules of any relevant WSP;	The site water balance is described in detail in the New Cobar Complex Project: surface water assessment (Appendix J). Project water supply sourced from groundwater (mine inflows) is discussed in Section 10.11.
Identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*, including a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Section 10.11.
Detailed description of the proposed water management system (including sewerage), water monitoring program and other measures to mitigate surface water and groundwater impacts.	The water management system is described in detail in the New Cobar Complex Project: surface water assessment in Chapter 11 (Surface water) of this EIS and (Appendix J). Existing groundwater monitoring is described in Sections 10.4.1. Groundwater-related mitigation, monitoring and management is discussed in Section 10.9.

In addition to above SEARs, the following agencies have raised additional comments:

- DPIE BCSD – letter dated 29 January 2020;

- DPIE Water and NRAR – letter dated 22 January 2020; and
- NSW EPA – letter dated 23 January 2020.

Agency comments and EMM responses are provided below (Table 10.2).

Table 10.2 Additional agency requirements and EMM responses

Authority comments	EMM responses
DPIE Biodiversity and Conservation Division	
The EIS must map the following features relevant to water and soils including: d. Groundwater. e. Groundwater dependent ecosystems.	The New Cobar Complex and its surrounds are located within the regional fractured rock groundwater system of the Lachlan Fold Belt Murray-Darling Basin Groundwater Source. Potential groundwater dependent ecosystems are mapped within Section 10.3.1.
The EIS must describe background conditions for any water resource likely to be affected by the development, including: a. Existing surface and groundwater c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters. d. Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the (ANZG, 2018) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government . . .	Background groundwater conditions are described in Section 10.4. Water Quality Objectives, in terms of environmental values are described in Chapter 11 of this EIS and Appendix J.
The EIS must assess the impacts of the development on water quality, including: a. The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved… b. Identification of proposed monitoring of water quality…	Minimal discharge is proposed to occur from the New Cobar Complex. Potential impacts on receiving waters are described in Chapter 11 of this EIS and Appendix J. Groundwater-related monitoring is discussed in Section 10.9.3.
DPIE Water and NRAR	
The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.	Water supply security is described in Chapter 11 and Appendix J. Project water supply sourced from groundwater (mine inflows) is discussed in Section 10.4.
A detailed and consolidated site water balance.	The site water balance is described in detail Chapter 11 of this EIS and Appendix J.
Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	Groundwater-related impacts are discussed in Section 10.8. Groundwater-related mitigation, monitoring and management is discussed in Section 10.9.3.

Table 10.2 Additional agency requirements and EMM responses

Authority comments	EMM responses
Proposed surface and groundwater monitoring activities and methodologies.	Groundwater-related monitoring is discussed in Section 10.9.3.
Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans.	Sections 10.2, 10.8.1, and 10.11.
NSW EPA	
If the proposed development intends to discharge waters to the environment, the EIS must demonstrate how the discharge(s) will be managed in terms of water quantity, quality and frequency of discharge and include an impact assessment of the discharge on the receiving environment. This should include: Description of the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges. Description of the receiving waters including upstream and downstream groundwater and surface water quality, as well as any other water users. Demonstration that all practical options to avoid discharge have been implemented and environmental impacted minimised where discharge is necessary.	Minimal discharge is proposed to occur from the New Cobar Complex. Potential impacts on receiving waters are described in Chapter 11 of this EIS and Appendix J.
The EA must describe any water quality monitoring programs to be carried out at the project site. Water quality monitoring should be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales (EPA, 2004).	Groundwater-related monitoring is discussed in Section 10.9.3.

10.2.1 Methodology

The groundwater assessment was prepared with consideration of the following legislation, policies, guidelines and plans:

- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (Australian and New Zealand Environment and Conservation Council, 1995);
- *Water Management Act 2000*;
- *Protection of the Environment Operations Act 1997*;
- NSW State Groundwater Policy Framework Document (NSW Department of Land and Water Conservation [DLWC], 1997);
- NSW State Groundwater Quality Protection Policy (DLWC 1998);
- NSW Groundwater Dependent Ecosystem Policy (DLWC 2002);
- NSW Aquifer Interference Policy (DPI 2012);
- Australian Groundwater Modelling Guidelines (Barnett et al. 2012);

- Guidelines for the Assessment and Management of Groundwater Contamination (Department of Environment and Conservation NSW, 2007); and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).

The method and a detailed summary of assessment for the projects against key policy requirements, is contained in the GIA (Appendix I).

10.3 Existing Environment

10.3.1 Sensitive receivers

i Private water use

There is one water supply work (GW803422.1.1) within a 5 km of the New Cobar Complex located at the Cobar District Rugby Club. The supply is used by the club for back-up irrigation of the playing field (during drought or interruption only). Figure 10.1 shows the location of the water supply work and other environmental sensitive receivers in relation to the New Cobar Complex. PGM has established access to bore GW803422 and has incorporated this bore into the regular groundwater monitoring schedule as part of the PGM WMP (PGM 2020a).

ii Groundwater dependent ecosystems

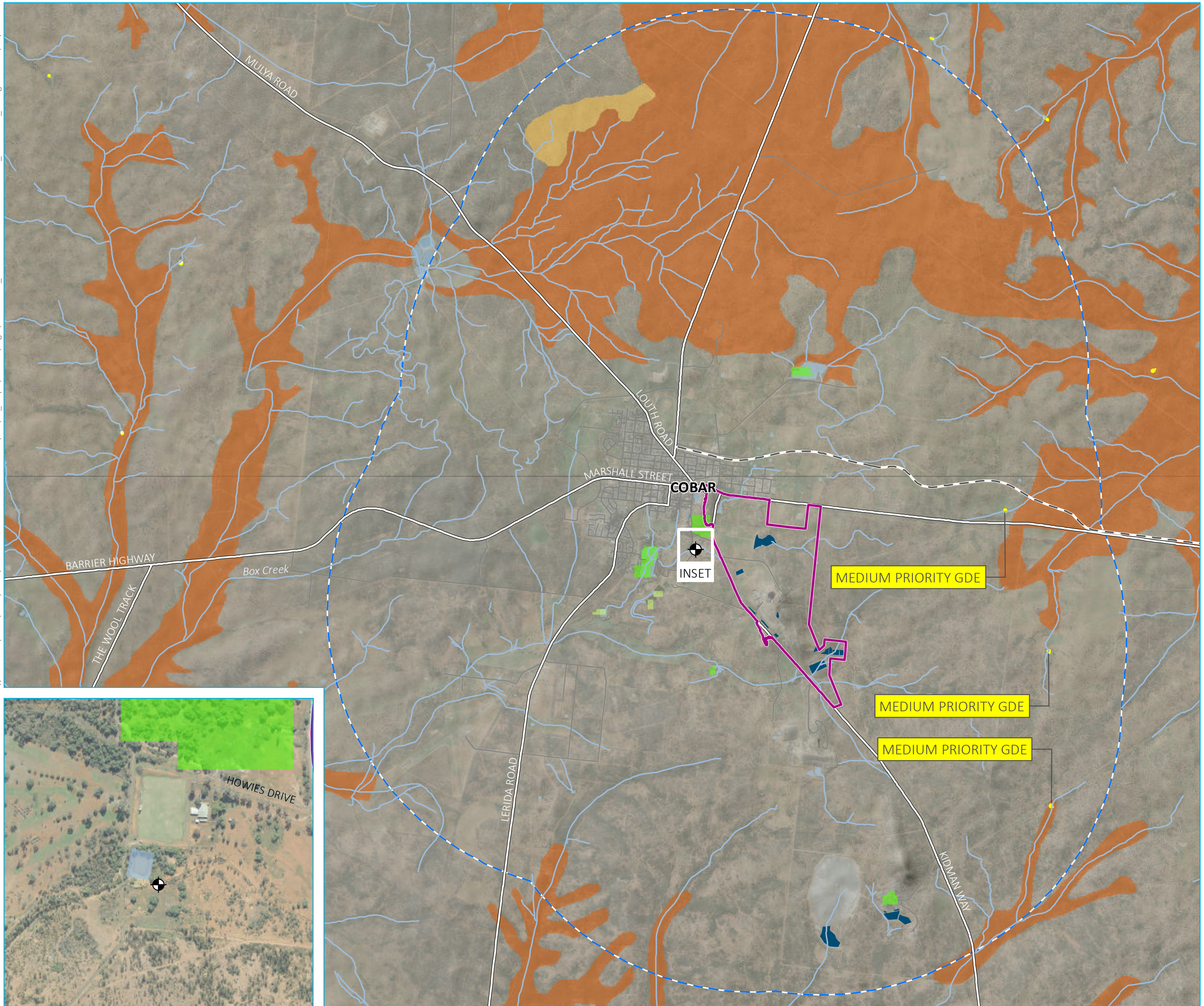
While regional groundwater systems can provide water sources for livestock and other anthropogenic uses, groundwater also supports surface (above ground) and subsurface (below ground) ecosystems that are assessed as beneficial users of groundwater. These are known as groundwater dependent ecosystems (GDEs).

GDE mapping provided in the Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020 (NSW Government 2020), based on the HEVAE Vegetation Groundwater Dependent Ecosystems Value – Western Division dataset (DPIE 2018b) shows no high priority GDEs, three medium priority GDEs, and no low priority GDEs located within 5 km of the New Cobar Complex. The medium priority GDEs comprise small GDEs located more than 2 km to the east of the New Cobar Complex (shown in Figure 10.1) that are categorised as having medium ecological value under the GDE High Ecological Value Aquatic Ecosystems (HEVAE) method.

A review of the BoM GDE Atlas also mapped the presence of seven GDEs within 5 km of the New Cobar Complex, of which three are high potential GDEs, one is a moderate potential GDE and three are low potential GDEs.

Despite the mapping of GDEs near the project area, the depth to groundwater modelling shows that depth to groundwater at the location of all potential GDEs precludes any level of groundwater dependency of streams, rivers and springs, or terrestrial vegetation at these locations. Therefore, it is highly unlikely that there are GDEs present at these mapped locations.

GDEs are discussed in greater detail in Chapter 12: Biodiversity.



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

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KEY

- Project area
- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody
- Mine water management storage
- Private landholder bore (GW803422.1.1)
- New Cobar Complex buffer (5 km)

Groundwater Dependent Ecosystem Atlas (BoM 2017)

Aquatic GDE potential

- High
- Low

Terrestrial GDE potential

- Moderate
- Low

High Ecological Value Aquatic Ecosystems (DPIE 2020)

Aquatic GDE potential

- Medium
- Low

Sensitive receivers within 5 km of the project area

Peak Gold Mines
New Cobar Complex Project
Environmental impact assessment
Figure 10.1

10.4 Existing groundwater environment

The existing groundwater environment is summarised in the following sections. For a detailed analysis, please refer to the GIA in Appendix I.

10.4.1 Groundwater monitoring network

PGM has an extensive groundwater monitoring program consisting of six monitoring locations at the New Cobar Complex and 17 monitoring locations at the Peak Complex. The network comprises standpipe piezometers with nested monitoring sites which are designed to aid in aquifer characterisation around the site operations and were selected for use in this assessment based on proximity to potentially sensitive features such as local groundwater works and the proposed mining locations.

The New Cobar Complex monitoring network was installed specifically for this project, and groundwater data is available from April 2020 onwards. Monitoring data from the Peak Complex monitoring network was used to prepare the groundwater model and to explore regional groundwater trends given the long time series of observations available. The Peak Complex does not form part of this project approval or assessment and information is provided as context for the regional hydrogeological conceptualisation and modelling inputs only. The groundwater monitoring network is shown on Figure 10.2.

10.4.2 Groundwater levels and flow regimes

i Temporal trends

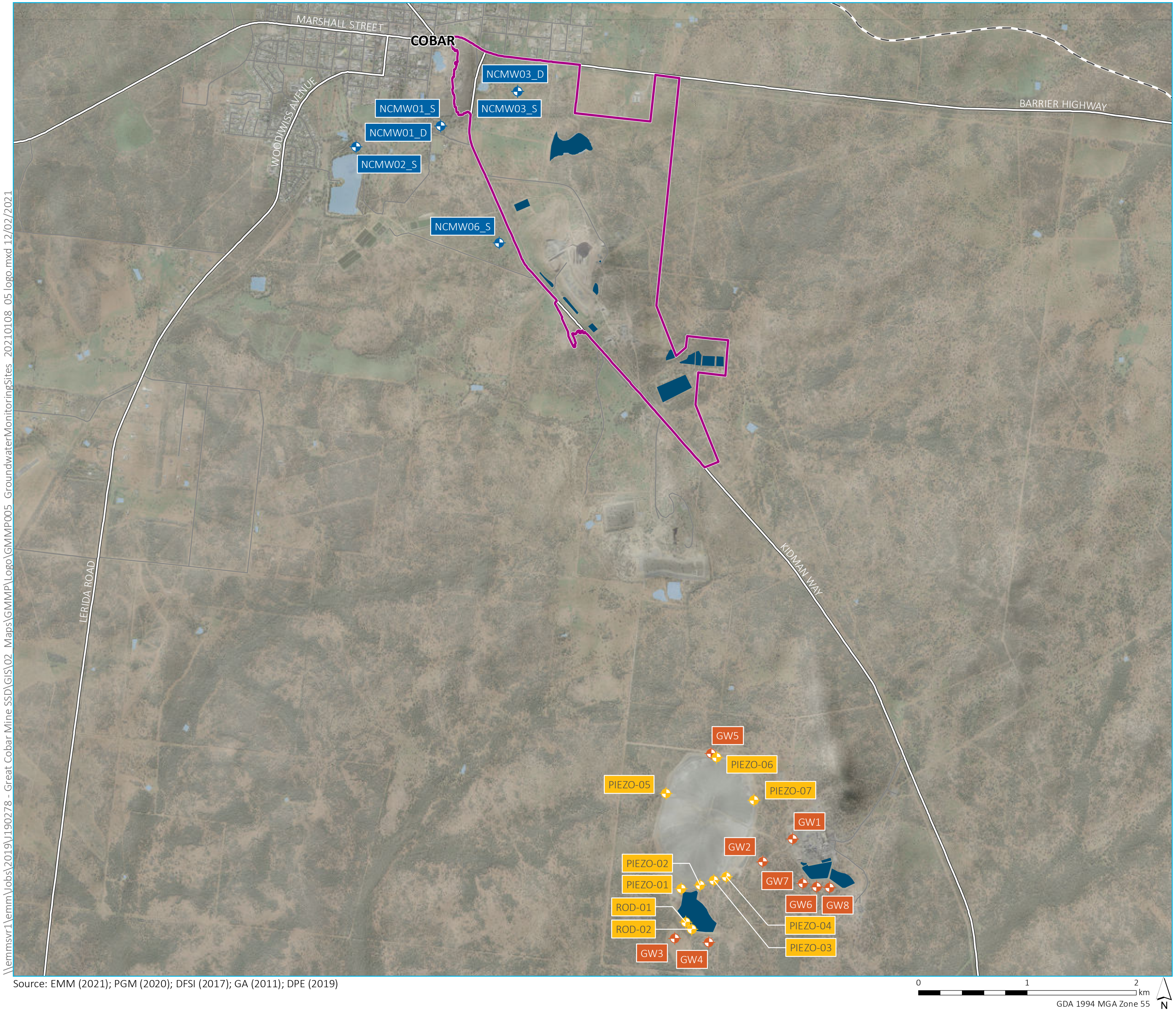
Groundwater levels at both the New Cobar and Peak complexes are generally stable with only minor fluctuations recorded. Seasonal trends were not evident at most of the New Cobar Complex groundwater monitoring sites during the limited baseline monitoring period. Groundwater level fluctuations observed at GW803422 (Cobar District Rugby Club) show evidence of groundwater drawdown as a result of water being used for irrigation of the rugby club playing field during the drought in late 2019 and early 2020.

ii Vertical gradients

The vertical gradient (ie the difference of groundwater pressure elevations) measured at the New Cobar Complex is negligible, suggesting minimal vertical groundwater leakage occurs under the current conditions, and that groundwater flow is predominantly horizontal. At the Peak Complex however, groundwater drawdown is observed, caused by underground mining activities occurring at several hundred metres below the bore screens, suggesting a high component of vertical flow exists here.

iii Spatial trends

Water table elevations are generally higher around the New Cobar Complex than the Peak Complex, and groundwater flows towards the Peak Complex to the south. Local drawdown is evident around the underground mining areas at Peak Complex, which causes a cone of depression to develop, however this drawdown is localised. Groundwater levels are relatively shallow to the north and west of the New Cobar Complex indicating minimal widespread drawdown has occurred since mining began in the Cobar region in 1880.



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KEY
- Project area
- Rail line
- Major road
- Minor road
- Waterbody
- Mine water management storage

Groundwater monitoring location
- New Cobar monitoring bore
- Peak monitoring bore
- Peak piezometer

Groundwater monitoring network

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

Peak Gold Mines
New Cobar Complex Project
Environmental impact assessment
Figure 10.2

aurelia METALS Ltd.
EMM creating opportunities

10.4.3 Groundwater quality

Groundwater quality from New Cobar Complex monitoring bores is brackish to saline with electrical conductivity (EC – an indicator of salinity) increasing with depth. Shallow groundwater receives recharge from rainfall hence has a lower EC while increasing EC with depth is attributed to water-rock interactions and the increase in dissolved mineral concentrations as water moves along the flow path. Groundwater pH is slightly acidic to neutral. Major ions are dominated by chloride (Cl) and sodium (Na) with similar major ion ratios for all groundwater in the Cobar area.

Dissolved metals were found in low concentrations and were generally below the laboratory detection limit. Detected dissolved metals include arsenic, boron, cadmium, chromium, copper, lead, manganese, molybdenum, nickel, selenium and zinc and is representative of the local geology.

10.4.4 Hydraulic testing

Hydraulic slug tests were conducted on the six groundwater monitoring bores at New Cobar Complex to determine site-specific information on the hydraulic properties of the surrounding aquifer. The tests found that hydraulic conductivity (the ease and speed at which groundwater flows through the aquifer) decreases with depth and ranges from 25.1−0.09 m/day. Groundwater flow is predominantly through cracks and fractures in the rock and can be highly variable depending on whether a fracture is intersected or not. Increased groundwater flow at shallow depths is generally higher due to weathered rock having more fractures.

10.4.5 Groundwater recharge and discharge

i Recharge

Recharge to groundwater systems occurs primarily via rainfall infiltration and is expected to be very low, given the low rainfall and high evapotranspiration in the region. Water enters the aquifer by infiltration through the weathered fractured rock in the upper sections of the GCS and superficial deposits of alluvium in the area. Rainfall recharge in the project area was determined to be approximately 0.5 mm/year, which is around 0.15% of annual average rainfall.

ii Discharge

There is limited natural groundwater discharge to surface water bodies (eg discharge to creeks or springs) as the depth to groundwater is generally greater than 15 mbgl. The main groundwater discharge in the area is mine dewatering at the Peak and New Cobar complexes, where water is pumped to the surface to access underground mining deposits. This water is then used within mining and processing operations.

10.4.6 Mine dewatering

Groundwater from the New Cobar Complex underground workings is managed by pumping from development headings to various underground pump stations. The water is then pumped to the New Cobar Complex settlement ponds at the surface, where the sediment is removed. The water from these settlement ponds is preferentially returned underground for use in mining operations or pumped to the Peak Complex for reuse in the processing circuit.

Groundwater inflow to mine workings at the New Cobar Complex has varied from 15 L/s to less than 1 L/s over the period 2018 to 2019. Changes of inflow volumes reflects the variable aquifer conditions, with the amount of groundwater inflow dependent on the density of fractures intercepted during mining progression.

10.5 Conceptual hydrogeological model

The conceptual hydrogeological model sets out the known existing groundwater environment described in Section 10.4 with historical data from the surrounding area to develop an understanding of the broader hydrogeological system, and how it may respond to project activities.

Figure 10.3 and Figure 10.4 visually display the conceptual model of the area from east to west and north to south respectively.

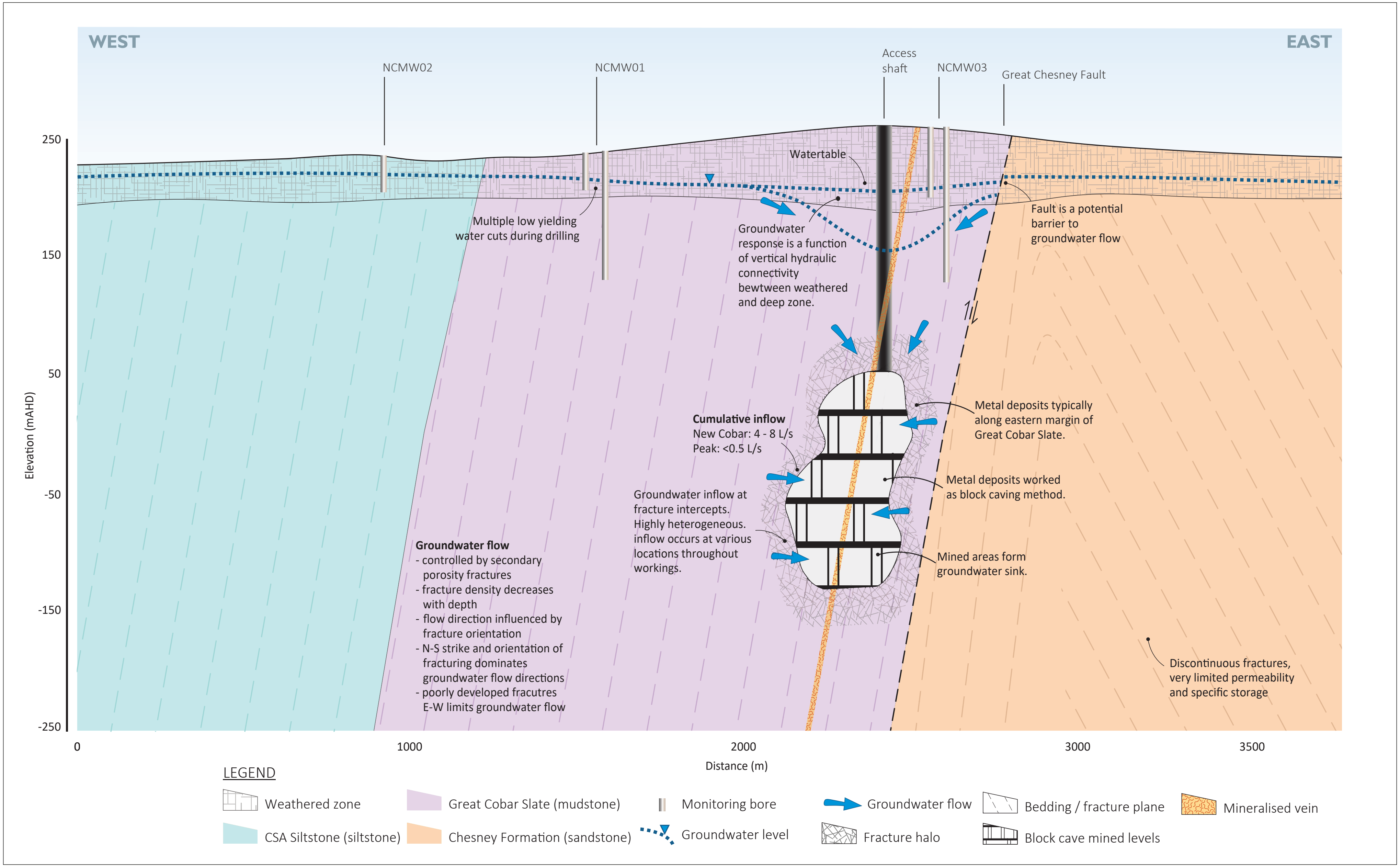
10.6 Assessment approach

The National Water Commission (NWC) mining risk framework was adopted for the groundwater risk assessment. Risks are characterised by making an informed decision as to the potential for adverse effects to impact sensitive groundwater receivers as a result of mine-related activities. Table 10.3 and Table 10.4 document project-related activities which may cause direct or indirect groundwater impacts.

The framework uses a source-pathway-analysis that describes how water-affecting activities might impact on sensitive groundwater receivers. For an effect to occur to a sensitive water receiver, an exposure pathway must exist between a water-affecting activity and a sensitive receiver. Risks are characterised by making an informed decision as to the potential for adverse effects to impact sensitive groundwater receivers as a result of mine-related activities.

The impact assessment quantifies the risk from water-affecting activities and involves assessing the potential consequences arising from the water-affecting activities in terms of direct effects (altered water resource condition) and in terms of possible sensitive receiver response (such as reduced water access for other users).

The risk assessment provides a basis for communicating risks and identifying the management approach strategies that may be necessary. The groundwater monitoring program will continue to collect data and be evaluated. Results of monitoring may be used to review the management measures and approach.

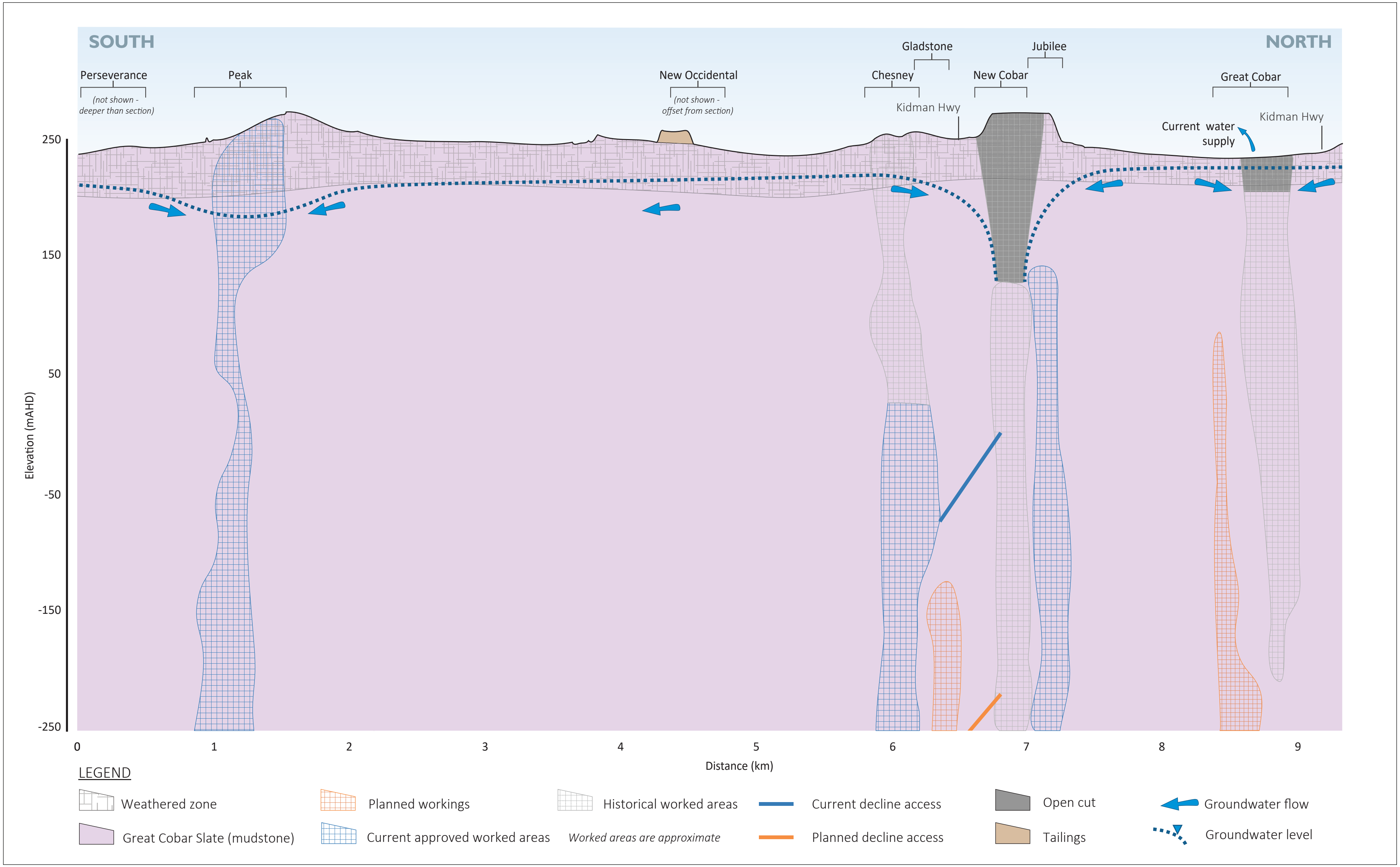


Conceptual cross section through the planned Great Cobar underground complex (east to west)

Peak Gold Mines

Environmental impact assessment

Figure 10.3



aurelia METALS Ltd.

Conceptual regional long-section (north to south)

Peak Gold Mines

Environmental impact assessment

Figure 10.4

10.6.1 Direct impacts

Direct impacts encompass changes to physical and/or quality aspects of groundwater, or the changes to the physical characteristics of aquifers as a result of an activity or change to the existing environment. Examples include changes in groundwater levels, changes in groundwater chemistry or changes in hydraulic properties of aquifers. Project activities with the potential to have direct impacts to groundwater are detailed in Table 10.3.

Table 10.3 Project activities with potential direct impacts to groundwater

Direct effect	Water affecting activity	Potential risk/effect
Quantity	Mine dewatering	Watertable drawdown, aquifer depressurisation.
	Groundwater supply development (mine inflows used as major water supply for the project)	Insufficient water supply source for project Drawdown in landholder bores is significantly larger than predicted
	Stockpiling	Altered recharge
	Backfilling	Altered hydraulic properties
	Wastewater ponds and water storage	Perched watertable, seepage, watertable mounding, overtopping of dams
Quality	Mine dewatering	Mobilisation of salts and heavy metals
	Stockpiling	Acid mine drainage, leaching of solutes
	Backfilling	Introducing solutes
	Wastewater ponds and water storage	Leaching of solutes
	Dust suppression	Salt retention in landscape
	Built infrastructure (roads, buildings, plant)	Solutes in runoff
	Hazardous goods storage (containment failure)	Solutes in runoff, short-term release of contaminants
Aquifer interception	Excavation / mining	Removal of part or whole of aquifer
	Backfilling	Altered hydraulic properties
	Stockpiling	Hydraulic loading of aquifers
	Great Cobar development intercepting old underground workings	In-rush of water from Great Cobar open cut, safety concerns for employees working underground
	Great Cobar development causing increased leakage from Great Cobar historical underground workings and shaft	Reduction in water security

10.6.2 Indirect impacts

Indirect impacts are those that occur as a response to direct impacts and typically relate to the potential consequential impacts of direct impacts on sensitive receivers. Potential indirect impacts associated with project activities are detailed in Table 10.4.

The assessment of potential receiver exposure to adverse changes in the groundwater regime (quantity, quality, groundwater and surface water interactions and physical disruption of aquifers) requires the following:

- knowledge of the location of sensitive receivers within the landscape, particularly in relation to the location and area of influence of water affecting activities;
- an understanding of the sensitive receiver's reliance on groundwater (eg depth to water table, groundwater quality to meet beneficial purposes); and
- an understanding of the spatial and temporal scale of direct groundwater effects at the location of sensitive receivers.

Table 10.4 Potential indirect groundwater impacts as a result of the project

Indirect effect	Impacted environmental value	Potential effect (source-pathway-receiver)
Quantity	Aquatic ecosystems	Mapped GDEs may be indirectly impacted by groundwater drawdown impacts, however the existing depth to groundwater indicates that there are unlikely to be GDEs in mapped locations.
	Terrestrial ecosystems (with potential groundwater dependency)	Possible riparian vegetation associated with ephemeral watercourses to the north, east and south of the New Cobar Complex. Effect unlikely due to existing depth to groundwater, distance (over 2 km away) and will only be impacted if large and widespread impacts occur within the shallower groundwater system, which is not expected.
	Recreational water supply (GW803422)	Potential failure of irrigation bore if drawdown exceeds aquifer thickness or screen sections.
	Historical Great Cobar open cut / old workings	The water within the historical Great Cobar open cut (located on PGM owned land) and adjacent historical underground workings are currently licensed to PGM for operations via an existing shaft. Underground mining could reduce water availability from the void if connected to dewatered groundwater.
Quality	Aquatic ecosystems	Mapped GDEs may be indirectly impacted by groundwater quality impacts, however the existing depth to groundwater indicates that there are unlikely to be GDEs in mapped locations.
	Terrestrial ecosystems (with potential groundwater dependency)	Possible riparian vegetation associated with ephemeral watercourses to the north, east and south of the New Cobar Complex. Effect unlikely due to existing depth to groundwater, distance from project and disconnection from deeper aquifer systems being targeted for dewatering.
	Recreational water supply (rugby club irrigation bore)	Effect unlikely due to possible disconnect between deeper system and shallow weathered regolith.
	Historical Great Cobar open cut / old workings	Dewatering of new underground declines and stopes may induce local depressurisation/ drawdown cones that could promote the movement of poor-quality groundwater into the Great Cobar open cut and historical workings. However, the risk of water quality reducing below the limit of PGM's currently requirements for processing/mining is small.

Table 10.4 Potential indirect groundwater impacts as a result of the project

Indirect effect	Impacted environmental value	Potential effect (source-pathway-receiver)
Groundwater-surface water interaction	Aquatic ecosystems	Mapped GDEs may be indirectly impacted by groundwater drawdown impacts, however the existing depth to groundwater indicates that there are unlikely to be GDEs in mapped locations.
	Terrestrial ecosystems (with potential groundwater dependency)	Possible riparian vegetation associated with ephemeral watercourses to the north, east and south of the New Cobar Complex. Effect unlikely due to existing depth to groundwater, distance (over 2 km away) and will only be impacted if large and widespread impacts occur within the shallower groundwater system, which is not expected.
Aquifer disruption	Historical Great Cobar open cut / old workings	Lowering of water level in Great Cobar open cut (located on PGM owned land). The site is a tourist attraction in the town.

10.7 Groundwater numerical model

A complex 3D numerical flow model was developed using all available data to make predictions about future changes to groundwater as a result of the project. The outputs of the groundwater model were designed to specifically address the SEARs as well as the identified project risks. The model will guide the development of management approaches to mitigate and manage any potential groundwater impacts.

The model was developed using MODFLOW-USG and Groundwater Vistas 7 (ESI 2017) graphical user interface (GUI) to build and run the model as well as to conduct some aspects of post-processing of model results. The model domain covers a rectangular area of 20 km E-W by 20 km N-S and is centred on the southern part of the project area. The maximum predicted groundwater drawdown contours in the context of the project area and sensitive receivers are presented in Figure 10.5.

Further details regarding the numerical model development is provided in the GIA in Appendix I.

10.8 Impact assessment

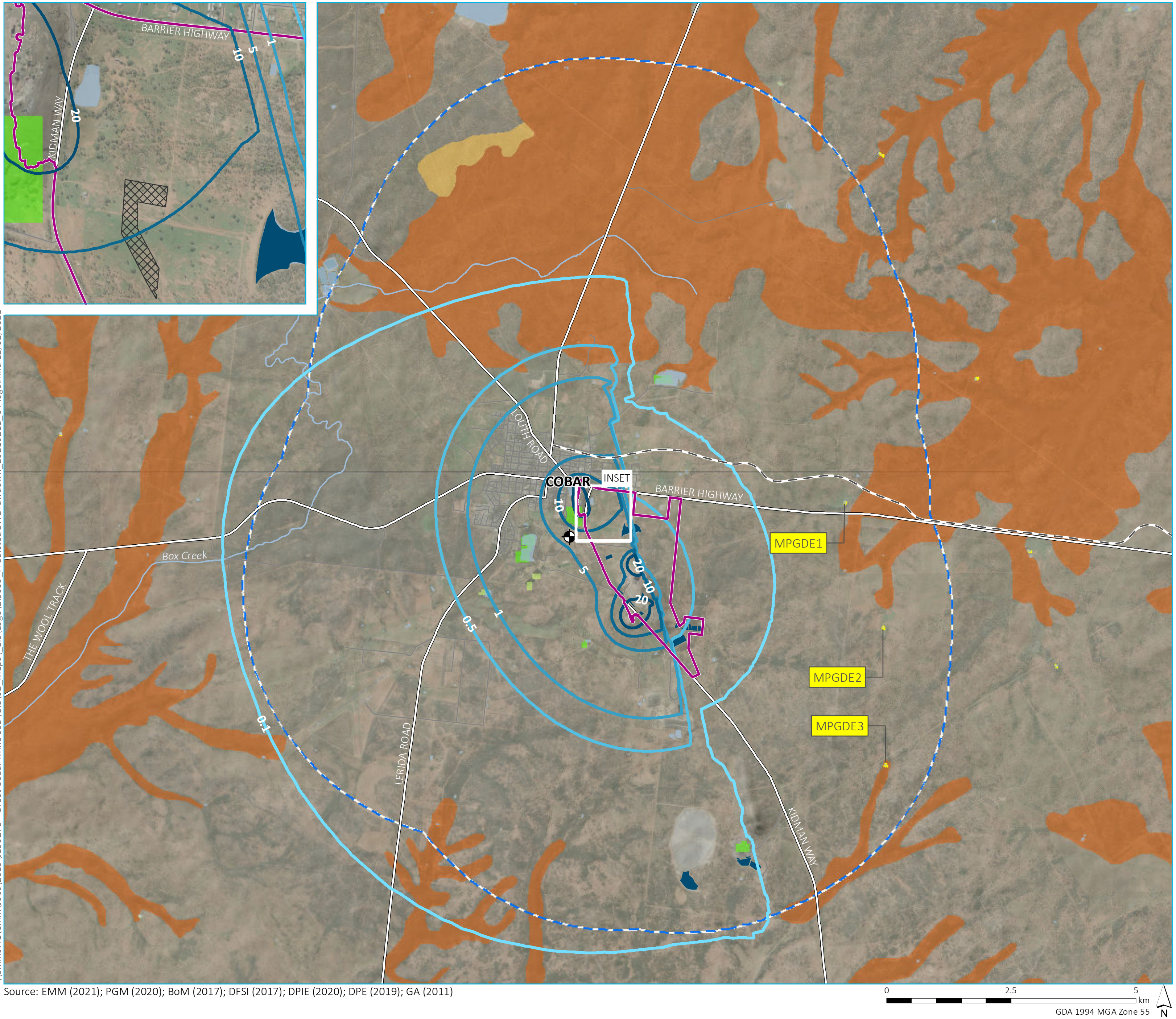
10.8.1 Aquifer interference and groundwater level changes

The Aquifer Interference Policy (AIP) (DPI 2012) outlines the minimal impacts considerations for assessing potential groundwater impacts in NSW, as well as requirements for obtaining water licences for aquifer interference activities such as groundwater abstraction. If impact thresholds are exceeded, PGM will be required to apply make good provisions to affected users.

i Private water users

Predictive simulations were used to quantify the potential impact for active registered water supply bores. Impacts were assessed using the AIP minimal impact requirements of a maximum 2 m decline cumulatively at any water supply work.

The predictive modelling shows maximum drawdown of around 12.5 m is predicted to occur around 2050 at GW803422. As this drawdown may reduce the pumping capacity and extractable yield from the water supply bore, PGM has committed to make good arrangements to supply supplementary water to replace any reduction in pumping capacity that may occur.



KEY

- Project area
- Private landholder bore (GW803422.1.1)
- Rail line
- Major road
- Minor road
- Named watercourse
- Waterbody
- Mine water management storage
- New Cobar Complex buffer (5 km)
- Proposed power line corridor

Groundwater Dependent Ecosystem Atlas (BoM 2017)

Aquatic GDE potential

- High
- Low

Terrestrial GDE potential

- Moderate
- Low

High Ecological Value Aquatic Ecosystems (DPIE 2020)

Aquatic GDE potential

- Medium
- Low

Maximum predicted groundwater drawdown (mBGL)

- 0.1
- 0.5
- 1
- 5
- 10
- 20

Predicted groundwater drawdown

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Figure 10.5

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

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ii Groundwater dependent ecosystems

As discussed in Section 10.3.1, there are no designated high priority GDEs located within 5 km of the New Cobar Complex. Therefore, the AIP minimal impact consideration is not applicable to GDEs.

Despite this, further review and assessment of GDEs listed under the BoM GDE Atlas and other relevant literature was conducted by EMM as part of the groundwater impact assessment for the project. In summary, regional groundwater levels in this area are known to be deep (>15 m) and the maximum groundwater drawdown due to the project is not expected to have an impact on any potential GDEs.

10.8.2 Groundwater quality changes

i Water quality protection framework

Six environmental value categories are described in Australian and New Zealand fresh and marine water quality guidelines (ANZG 2018). Of these, two environmental value categories are considered relevant to the groundwater resources in the vicinity of the New Cobar Complex – recreation and aesthetics (sporting field irrigation during times of drought); and industrial water (mine water).

ii Source pollution

A review of studies undertaken in the project area which investigated the geochemical properties of waste material and seepage water quality as a result of existing operations and the project, demonstrated the groundwater quality impacts of the project will be low (see section 16.4 for more details). The beneficial use category (industrial and recreational) of the regional fractured rock aquifer will not change.

iii Seepage from stockpiles and water storages

Most waste rock samples analysed to date are classified as PAF or NAF, albeit with a low capacity to generate acidic drainage (PAF-LC), and seepage derived from these waste rock types is expected to present a low risk to groundwater quality.

iv Discharge waters to environment

The water quality of waterbodies that receive runoff from dirty water or rehabilitated catchments is generally within water quality objective (WQO) ranges. This is also the case for the Salty Dam (this dam is not related to mining operations) which is located downstream of Spain's Dam and receives runoff from both a natural catchment and the Cobar town industrial area stormwater network. Discharge of water to the environment is not expected to occur, however if it does occur, it is expected to present a low risk to groundwater quality.

v Water quality changes due to increased drawdown

Based on previous geochemical investigations, a large proportion of the lithologies affected by drawdown are anticipated to be NAF and is not expected to adversely affect groundwater quality. Exposed PAF rock may present an increased risk of adverse effects on groundwater. However, mine dewatering followed by a slow recovery of heads as the voids slowly fill with groundwater, will result in inward draining of groundwater into the New Cobar Complex voids and will prevent outward seepage of acidic and metalliferous water. In addition, this water will be utilised for mining operations and will be managed accordingly. Therefore, groundwater drawdown is expected to present a low risk to groundwater quality.

vi Water quality changes due to exposure/rewetting of backfill material

PAF backfill that is exposed on excavation and rewetting may mobilise acidity and metals. However, since the groundwater gradient will be towards the New Cobar Complex voids following cessation of mining (both underground and open cut), pathways to sensitive receivers and/or to the regional aquifer will be limited. Furthermore, the one water supply work GW803422 located at the Cobar District Rugby Club and used by the club for irrigation of the playing field during drought has a total depth of 22 m which is well above the proposed project mining area. Groundwater quality impacts of the project will be negligible with groundwater flow being maintained towards the existing New Cobar open cut. Therefore, exposure of backfill material as a result of groundwater drawdown is expected to present a low risk to groundwater quality.

10.8.3 Cumulative impacts

The GIA considered the potential cumulative impacts for all stages of the development. The surrounding operating mines nearby are the Peak Complex located around 10 km to the south (incorporated into the project's numerical model) and CSA mine, located around 15 km to the north. The predicted drawdown from this project was assessed and was shown to be localised, extending around 2 km from the active mining area. The location of the sensitive receivers in the vicinity of the mine and the distance to the other mining operations that may affect groundwater will result in no cumulative impacts on sensitive receivers.

10.8.4 Mine recovery

Due to the low transmissivity, low storage and low recharge environment, water table contours at the end of mining and post mining indicate that residual drawdown will exist at the New Cobar Complex underground mine voids for a period of time, but the New Cobar Complex open cut will remain a sink within the groundwater system in the longer term. Groundwater levels will slowly recover over time and become mostly stable within about 270 years post mining cessation.

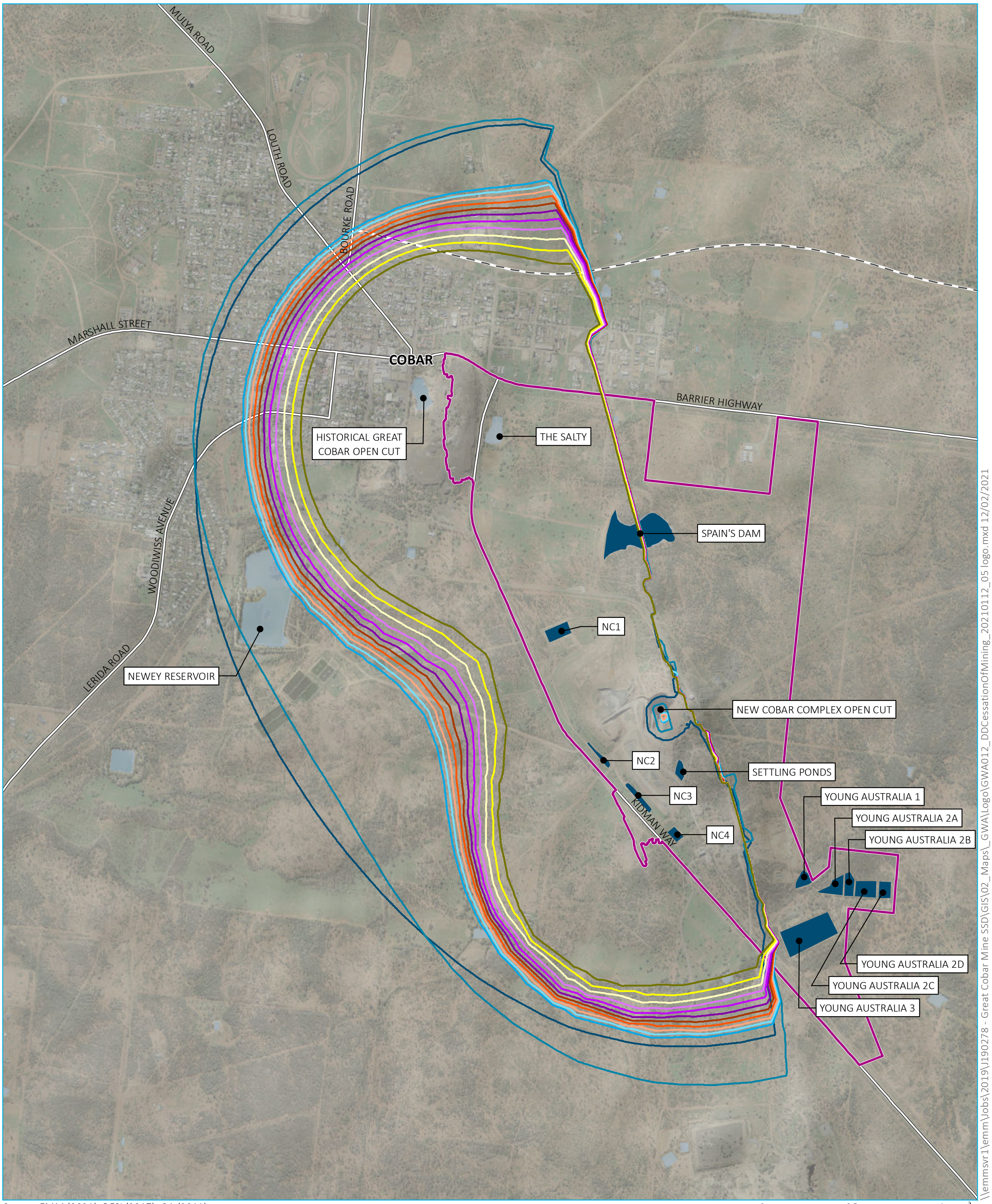
Figure 10.6 shows the modelled two metre drawdown contour post mining cessation over time between end of mining and up to 100 years post mining.

10.9 Commitments and management measures

10.9.1 Mitigation measures

i Groundwater level changes

PGM has committed to make good arrangements to supply supplementary water to replace any reduction in pumping capacity that may occur at the Cobar District Rugby Club bore (GW803422). This bore is part of the New Cobar Complex groundwater monitoring network with monitoring frequency and parameters outlined in the PGM WMP (PGM 2020a). A Trigger Action Response Plan (TARP) is included in the WMP outlining corrective actions if greater than 2 m drawdown occurs.



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

KEY

- Project area
- Modelled 2 m watertable drawdown contour
  - End of mining
  - Recovery year 1
  - Recovery year 2
  - Recovery year 3
  - Recovery year 4
  - Recovery year 5
  - Recovery year 6
  - Recovery year 7
  - Recovery year 8
  - Recovery year 9
  - Recovery year 10
  - Recovery year 50
  - Recovery year 100
- Rail line
- Major road
- Mine water management storage
- Waterbody

Modelled 2 m drawdown extent following cessation of mining

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Figure 10.6

ii Groundwater quality changes

PGM's management of waste rock and tailings is designed to prevent adverse groundwater quality impacts by:

- maintaining an inward groundwater gradient towards the Great Cobar void and limiting the pathways to the regional aquifer and any potential GDEs;
- appropriately managing seepage from surface waste stockpiles, including the New Cobar WRE and the Peak Complex TSF; and
- appropriately managing mine-impacted ('contact') water.

To prevent adverse impacts on groundwater quality from the New Cobar Complex WRE and other waste stockpile seepage, PGM will implement the following management measures:

- preferential usage of PAF waste rock as backfill in underground voids. If voids are unavailable, transportation of PAF waste rock to the surface and storage in New Cobar Complex WRE will be undertaken. PAF material may also be used in the construction of the TSF dam raises (on internal TSF walls only); and
- lower reactivity NAF material will be used for capping and construction.

10.9.2 Water management

i Water management strategy

The overarching PGM water management strategy is to maintain a zero-discharge site, and to maximise the capture and reuse of site rainfall runoff. This strategy assists in maintaining a consistent supply of water to the operation and reduces reliance on other external water sources. The water management strategy is described further in the surface water assessment in Appendix J.

ii Water management plan

A WMP was developed for the PGM operations and covers existing operations at both the New Cobar and Peak complexes. It was revised in May 2020 by EMM for PGM and submitted to NRAR for comment. No comment has been received to date but will be updated in consultation with DPIE Water, NRAR and NSW EPA, and will incorporate any conditional approval requirements arising from this project. The WMP will provide a program for reviewing and updating the numerical groundwater model as more data and information becomes available during the operation of the mine and will outline the reporting requirements against each of the project approvals.

10.9.3 Monitoring

The groundwater monitoring network currently includes 23 monitoring locations across the New Cobar and Peak complexes and one existing third-party bore. Details of monitoring analysis and frequency are outlined in the WMP (PGM 2020a). All water quality monitoring will be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutant in NSW (EPA 2004). The suite of water quality analytes (ie constituents) to be sampled and the frequency of sampling will be reviewed and updated in the existing PGM WMP.

10.9.4 Groundwater model verification and review

Future improvements to the numerical groundwater flow model will be undertaken as and when new data becomes available, particularly where there is a divergence of observed groundwater system response from the predicted. Groundwater monitoring data (including groundwater abstraction (sump pumping rates) and groundwater level observations), will be used to verify and validate the groundwater model predictions, with updated predictions re-forecasted if required.

10.10 Residual impacts

Section 10.6 identifies water affecting activities with the potential for both direct and indirect impacts to groundwater. For each water affecting activity, Table 10.5 (direct) and Table 10.6 (indirect):

- identifies the water affecting activity and potential risk/impact;
- lists the existing and proposed mitigation controls and actions; and
- provides an assessment of the residual risk.

10.11 Groundwater licensing

10.11.1 NSW Water legislation and policies for licensing water

PGM is required to hold a water access licence (WAL) for each affected water source to account for all water extracted and intercepted. In accordance with the AIP, the project is required to licence both the direct and indirect groundwater take from adjacent and overlying water sources. For this project the volume of water to be licensed was determined to be the groundwater inflow to the underground mine that will be physically handled by the mine water management system. The results from the groundwater model were used to estimate the required groundwater licence entitlements for the project, based on the predicted total groundwater inflow rates to the operational mining areas.

10.11.2 Predicted take from the Lachlan Fold Belt MBD Groundwater Source

The project will have a direct take of water from the Lachlan Fold Belt MDB Groundwater Source comprising groundwater inflow to the underground mine. The predicted mine inflow rates were modelled conservatively and are summarised below:

- the predicted mine inflow rate in 2020 ranged between 365 ML/year and 679 ML/year, compared to an average measured inflow of 252 ML/year;
- the peak predicted inflow rate in 2026 is 854 ML/year;
- the inflow rate at the end of mining is predicted to be 11 ML/year; and
- the Great Cobar mined stopes are predicted to become a throughflow system within 10 years following mine closure.

Table 10.5 Direct groundwater-affecting activities risk assessment

Direct effect	Water affecting activity	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual risk
Quantity	Mine dewatering	Water table drawdown, aquifer depressurisation. Drawdown in landholder bores is significantly larger than predicted.	• Groundwater level change will continue to be monitored by the site monitoring network. • WMP and TARP are implemented. • Make good arrangements will be implemented to replace water supply work (GW803422), if required. Make good arrangements may include measures such as: – provision of supplementary water to offset loss in water supply; – provision of a new submersible pump to sustain a lost yield; – lowering pumping infrastructure within the bore to increase available drawdown; or – drilling a new bore for the landowner.	**Medium** – Some drawdown is likely to occur
	Groundwater supply development (mine inflows used as major water supply for the project)	Insufficient water supply source for project.	• Metering and monitoring will be in place to record the volume of water removed from the underground mine. • Use of mine inflow water as a priority over external water supply. • Great Cobar underground has approximately 4 years of supply volume (1,600 ML) available for use as water security. This assumes a constant pumping rate of ~13 L/s, 24 hours a day, and assumes no other water is harvested from surface water sources which is unlikely and is therefore a conservative estimate.	**Low** – Secondary storage in Great Cobar underground and mine inflow is available should Macquarie and Cudgegong Regulated Rivers Source be unavailable
	Stockpiling	Altered recharge.	• Soil stockpiles will continue to be placed in bunded areas.	**Low** – minimal changes to existing recharge pathways

Table 10.5 Direct groundwater-affecting activities risk assessment

Direct effect	Water affecting activity	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual risk
	Backfilling	Altered hydraulic properties.	• Backfill of worked stopes will be predominantly undertaken with crushed waste rock. Cemented aggregate fill is proposed in some less-deep stopes in the weathered rock zone. • Worked areas will have a higher storage and hydraulic conductivity than the surrounding rock matrix.	**Low** – No change in the regional flow dynamics
	Wastewater ponds and water storage	Perched water table, seepage, water table mounding, overtopping of dams.	• Sediment is regularly removed from water storage structures as part of maintenance operations. • Maximise the reuse of water from onsite storages – stored water is preferentially and regularly used onsite and water storage levels maintained to prevent overtopping.	**Low** – Ongoing maintenance is used to maintain water ponds
Quality	Mine dewatering	Mobilisation of salts and heavy metals.	• Mine operations will remove groundwater for safe working conditions. • Groundwater quality change will continue to be monitored by site monitoring network. • WMP and TARP are implemented. • Make good arrangements will be implemented to replace water supply work (GW803422), if required.	**Low** – existing groundwater is saline and of poor quality
	Stockpiling	Acid mine drainage, leaching of solutes.	• PAF material is preferentially used as stope backfill underground and is not brought to the surface. • If it is unavoidable to bring material to the surface, PAF will be stored in the existing WRE.	**Low** – no change to existing waste rock management.
	Backfilling	Introducing solutes.	• Backfill of worked stopes will be predominantly undertaken with crushed waste rock. Cemented aggregate fill is proposed in some less-deep steps in the weathered rock zone. • New Cobar Complex open cut will be retained post mining (unfilled) and therefore will act as a terminal groundwater sink directing groundwater flow (and any potential solutes) towards it until a new equilibrium is reached.	**Low** – Backfilled areas are well below the level of the existing groundwater user extraction level

Table 10.5 Direct groundwater-affecting activities risk assessment

Direct effect	Water affecting activity	Potential risk/effect	Mitigation actions/controls (existing and proposed)	Residual risk
	Wastewater ponds and water storage	Leaching of solutes	• Sediment is regularly removed from water ponds. • Stored water is regularly used onsite and water storage levels maintained to prevent overtopping.	**Low** – Ongoing maintenance is used to maintain water ponds
	Built infrastructure (roads, buildings, plant)	Solutes in runoff.	• The mine development will include runoff containment systems and other features to restrict surface water runoff within the project disturbance area. Drainage will continue to report to water management dams and reused in process water within a contained system.	**Low** – Runoff and drainage management plan in place
	Hazardous goods storage (containment failure)	Solutes in runoff, short-term release of contaminants.	• Existing dedicated and bunded storage areas for fuel and reagents, and runoff containment systems for ore stockpiles will be maintained over the operational period while potential pollutants remain on site.	**Low** – Dedicated bunded and managed area
Aquifer interception	Excavation/mining	Removal of part or whole of aquifer.	• Groundwater inflows into underground workings will occur and be managed as part of the mine water management system.	**Low –** 20 years of current operational experience
	Great Cobar development intercepting old underground workings	In-rush of water from Great Cobar open cut, safety concerns for employees working underground.	• Mine operations plan and safety plans will continue to be implemented to maintain safe working conditions.	**Low** – Historical mining areas are well known
	Great Cobar development causing increased leakage from Great Cobar historical underground workings and shaft	Reduction in water security.	• Licenced raw water may be sourced from the Macquarie and Cudgegong Regulated Rivers Source in the event of mine inflows and shaft pumping not meeting site water requirements. • Great Cobar levels will be monitored, and water balance updated as required.	**Low** – Water balance is updated regularly. Bore field developed if required

Table 10.6 Indirect groundwater effects

Indirect effect	Impacted environmental value	Potential risk/effect	Mitigation actions/controls	Residual risk
Quantity	Aquatic ecosystems	GDE mapping provided in the Groundwater WSP details no high priority GDEs located within 5 kms of the New Cobar Complex. High potential aquatic GDEs were mapped in the vicinity of the township in the BoM Atlas, including associated with the slag dump at the Great Cobar open cut and at the Newey Reservoir to the immediate west of the New Cobar Complex. Possible effect (although unlikely due to disconnect from deeper aquifer systems being targeted for dewatering) where baseflow is altered within the potential zone of drawdown impact.	• None – impact assessment identified areas as being outside of the drawdown area and modelled groundwater depths indicate that mapped ecosystems are unlikely to be groundwater-dependent.	**Low** – Outside area of drawdown and deep modelled groundwater elevations
	Terrestrial ecosystems (with potential groundwater dependency)	Possible riparian vegetation associated with drainage lines to the north, east and south of the New Cobar Complex. Over 2 km away and will only be impacted if large impacts occur within the shallower groundwater system.	• None – an analysis of the distribution of PCTs in relation to the simulated regional groundwater levels identified that none of the PCTs mapped are associated with shallow groundwater systems, indicating that none of the vegetation within the groundwater drawdown area is considered groundwater dependent.	**None**.

Table 10.6 Indirect groundwater effects

Indirect effect	Impacted environmental value	Potential risk/effect	Mitigation actions/controls	Residual risk
	Recreational water supply (rugby club irrigation bore)	Potential failure of irrigation bore if drawdown exceed aquifer thickness or screen sections.	• Groundwater level change will continue to be monitored by the site monitoring network. • WMP and TARP are implemented. • Make good arrangements will be implemented to replace water supply work (GW803422), if required. Make good arrangements may include measures such as: – provision of supplementary water to offset loss in water supply; – provision of a new submersible pump to sustain a lost yield; – lowering pumping infrastructure within the bore to increase available drawdown; or – drilling a new bore for the landowner.	**Medium** – Some drawdown at the bore is likely to occur.
	Historical Great Cobar open cut / old workings	Currently, there is water in the historical Great Cobar open cut (located on PGM owned land). The area may receive inflow from surface water. The water within the adjacent historical workings is also currently licensed to PGM for operations via an existing shaft. Dewatering and underground mining could reduce water availability from the void if connected to groundwater.	• Licenced raw water may be sourced from the Macquarie and Cudgegong Regulated Rivers Source in the event of mine inflows and shaft pumping not meeting site water requirements. • Great Cobar levels will be monitored, and water balance updated as required.	**Low** – Water balance is updated regularly.

Table 10.6 Indirect groundwater effects

Indirect effect	Impacted environmental value	Potential risk/effect	Mitigation actions/controls	Residual risk
Quality	Aquatic ecosystems	GDE mapping provided in the Groundwater WSP details no high priority GDEs located within 5 km of the New Cobar Complex. High potential aquatic GDEs were mapped in the vicinity of the township in the BoM Atlas, including associated with the slag dump at the Great Cobar open cut and at the Newey Reservoir to the immediate west of the New Cobar Complex. Possible effect (although unlikely due to disconnect from deeper aquifer systems being targeted for dewatering) where baseflow is altered within the potential zone of drawdown impact.	• None – impact assessment identified areas as being outside of the drawdown area and modelled groundwater depths indicate that mapped ecosystems are unlikely to be groundwater-dependent.	**Low** – Outside area of drawdown and deep modelled groundwater elevations
	Terrestrial ecosystems (with potential groundwater dependency)	Possible riparian vegetation associated with drainage lines to the north, east and south of the New Cobar Complex. Effect unlikely due to distance from project and disconnection from deeper aquifer systems being targeted for dewatering.	• None – an analysis of the distribution of PCTs in relation to the simulated regional groundwater levels identified that none of the PCTs mapped are associated with shallow groundwater systems, indicating that none of the vegetation within the groundwater drawdown area is considered groundwater dependent.	**None**.

Table 10.6 Indirect groundwater effects

Indirect effect	Impacted environmental value	Potential risk/effect	Mitigation actions/controls	Residual risk
	Recreational water supply (rugby club irrigation bore)	Effect unlikely due to possible disconnect between deeper system and shallow weathered regolith.	• Groundwater level change will continue to be monitored by the site monitoring network. • WMP plan and TARP are implemented. • Make good arrangements will be implemented to replace water supply work (GW803422), if required. Make good arrangements may include measures such as: – provision of supplementary water to offset loss in water supply; – provision of a new submersible pump to sustain a lost yield; – lowering pumping infrastructure within the bore to increase available drawdown; or – drilling a new bore for the landowner.	**Low** – Project unlikely to change shallow groundwater quality
	Historical Great Cobar open cut/old workings	Dewatering of new underground declines and stopes may induce local depressurisation/ drawdown cones that could promote the movement of poor-quality groundwater into the Great Cobar open cut and historical workings.	• Water treatment as required.	**Low** – Treat water if needed
Groundwater-surface water interaction	Aquatic ecosystems	GDE mapping provided in the Groundwater WSP details no high priority GDEs located within 5 km of the New Cobar Complex. High potential aquatic GDEs were mapped in the vicinity of the township in the BoM Atlas, including associated with the slag dump at the Great Cobar open cut and at the Newey Reservoir to the immediate west of the New Cobar Complex.	• None – impact assessment identified areas as being outside of the drawdown area and modelled groundwater depths indicate that mapped ecosystems are unlikely to be groundwater-dependent.	**Low** – Outside area of drawdown and deep modelled groundwater elevations

Table 10.6 Indirect groundwater effects

Indirect effect	Impacted environmental value	Potential risk/effect	Mitigation actions/controls	Residual risk
	Terrestrial ecosystems (with potential groundwater dependency)	Possible riparian vegetation associated with drainage lines to the north, east and south of the New Cobar Complex. Effect unlikely due to distance from project and disconnection from deeper aquifer systems being targeted for dewatering.	• None – an analysis of the distribution of PCTs in relation to the simulated regional groundwater levels identified that none of the PCTs mapped are associated with shallow groundwater systems, indicating that none of the vegetation within the groundwater drawdown area is considered groundwater dependent.	**None**.
Aquifer disruption	Historical Great Cobar open cut / old workings	Lowering of water level in Great Cobar open cut (located on PGM owned land).	• Great Cobar levels will be monitored.	**Low** – Great Cobar open cut not used by mine

10.11.3 Required groundwater licence entitlements

PGM currently holds a WAL (WAL31045) for 880 unit shares from the Lachlan Fold Belt Murray Darling Basin Groundwater Source. Based on the results of the numerical groundwater model, the maximum volume required for licensing in the Lachlan Fold Belt MDB Groundwater Source is conservatively estimated to be 854 ML/year in 2026. If it is considered necessary for PGM to purchase additional water shares for the project, there are sufficient licence entitlements available in the Lachlan Fold Belt Murray Darling Basin Groundwater Source for this take. The mechanisms available for PGM to purchase these licence entitlements are:

- purchase of unassigned water during a controlled allocation order, which occur approximately every 18 months; or
- trading of existing water allocations on a temporary or permanent basis (water allocation assignment or share assignment).

10.12 Conclusion

A numerical groundwater model was built using all available data to simulate historical and predicted groundwater effects associated with the expansion of the New Cobar Complex.

The project has the potential to impact on local and regional groundwater sources and nearby sensitive receivers. Potential impacts were assessed in accordance with the AIP and project related SEARs and include:

- Drawdown of greater than 2 m is expected at bore GW803422, the only water supply works identified within 5 km of the New Cobar Complex. Under the AIP, make good arrangements will be put in place in consultation with the water supply work owner.
- There are no designated high priority GDEs located within 5 km of the New Cobar Complex. Therefore, the AIP minimal impact consideration is not applicable.
- The potential aquatic GDEs mapped by the BoM GDE Atlas near the project area are unlikely to be GDEs due to depth to groundwater (>15 m).
- Identified medium potential terrestrial GDEs are outside the area of expected drawdown of the project and therefore will not to be impacted by the project.
- The existing New Cobar Complex open cut will act as a regional groundwater terminal sink post mining, maintaining groundwater flow towards it. Any change in groundwater quality will be localised, therefore the beneficial use category of the aquifer will not change because of the project. The groundwater quality impacts of the project are consequently anticipated to be negligible.
- The residual impacts, following management measure implementation are generally low and will be managed by updates to the existing WMP and the TARP to ensure any impacts are identified and managed accordingly.

Monitoring of the PGM groundwater network will continue, and the network has been expanded to target the identification of potential impacts from mining activities. Monitoring each component of the water management system underpins if, how, and when management responses are required. Triggers and thresholds will be reviewed and updated to provide context on if, how, and when management measures are required as part of the revised WMP.

The numerical groundwater model has also been used to assess water license requirements in accordance with the WMA 2000, the AIP and the relevant statutory WSPs. The peak predicted inflow rate was modelled at 854 ML/year at 2026, which is below PGM’s current allocation of 880 unit shares. Predictive uncertainty analysis has identified that although there may be short periods where the allocation may be exceeded, the probability remains low.

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