GLENCORE

Glendell Mine Modification 4

RESPONSE TO SUBMISSIONS

May 2019

Appendix 2
Glendell Modification 4
Air Quality Assessment

Glendell Mine Modification 4

Mt Owen Pty Ltd

Air Quality Assessment

Final

9 May 2019

Umwelt 4052J

Glendell Mine Modification 4

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Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential air quality impacts of a proposed modification to Glendell Mine in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

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1. Introduction

Mt Owen Pty Ltd (Mount Owen) is seeking approval to modify their existing Glendell Mine development consent (DA 80/952) to provide an additional 8 months of mining and to access an additional 2.5 million tonnes (Mt) of run-of-mine (ROM) coal (the Proposed Modification).

Umwelt (Australia) Pty Ltd has been engaged by Mount Owen to manage the preparation of the Statement of Environmental Effects (SEE) and Response to Submissions (RTS) for the modification application. Jacobs Group (Australia) Pty Ltd (Jacobs) has been engaged by Umwelt, on behalf of Mount Owen, to complete an assessment of the potential air quality impacts associated with the Proposed Modification.

This air quality assessment has involved:

- Identifying the key aspects of the Proposed Modification that relate to air quality;
- Characterising the existing air quality environment; and
- Determining the likely effect of the Proposed Modification on the existing air quality environment, with regard to the existing impacts associated with the Approved Operations.

Determination of the likely effects of the Proposed Modification has been done both qualitatively and quantitatively. The qualitative assessment presented in this report and with the SEE, considered all relevant modifications to operations that have the potential to influence emissions to air and therefore, potential impacts. The quantitative assessment has been undertaken as requested by the Department of Planning and Environment (DPE) during the response to submissions, and involved modelling the dispersion of emissions and comparing the results to the originally predicted extent of impacts of the Approved Operations, with consideration of the current Environment Protection Authority (EPA) assessment criteria. This modelling was carried out using CALPUFF, and in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016).

2. Description of the Approved Operations

DA 80/952 was originally granted by the then Minister for Planning and Environment on 2 May 1983. In 1997, DA 80/952 was modified to provide for overburden emplacement in the south void and extension of the approved mining area.

DA 80/952 was then modified under section 75W of the *Environmental Planning and Assessment Act 1979* (EPA Act) on 25 February 2008. This modification was supported by an Environmental Assessment for the Modification of Glendell Mine Operations (Umwelt, 2007) (Glendell EA) and permitted mining operations to take place until the end of June 2024. The 2008 modification generally permitted the following changes to operations and infrastructure at Glendell Mine:

- Extraction of up to 4.5 million tonnes per annum (Mtpa) ROM coal using existing and approved Mt Owen Complex services and infrastructure;
- Integration of the management of Glendell Mine into the Mount Owen Complex;
- Relocation of mine infrastructure area and access road;
- Extension of the mining operations to 2024; and
- Mining in a general north to south direction.

Construction of Glendell Mine commenced in April 2008 with the first coal extracted in June 2008.

The potential air quality impacts of the existing Approved Operations, as described above, were quantified by Holmes Air Sciences (2007). This assessment identified Camberwell as an area where there may be potential cumulative air quality impacts, due to contributions from mining operations and other existing sources.

3. Description of the Proposed Modification

The Proposed Modification will involve minor changes to the mine plan along the northern and western limit to access an additional ~2.5 Mt of ROM coal and to allow for an additional approximately eight months of mining.

There will be no change to the approved ROM coal extraction limit of 4.5 Mtpa, machinery, hours of operation, total material moved or total rejects/tailings disposed. There will also be no extension of the current mine life.

Figure 1 provides an overview of the Proposed Modification. Mining will progress approximately 130 metres (m) north and 60 m to the west of the approved mining extent. Minor changes will also be implemented including hauling overburden along the western edge of the Barrett Pit at surface, providing for efficient establishment of the overburden emplacement area at the southern end of the Barrett Pit.

Haulage of overburden will occur along a western bench within the Barrett Pit (below natural ground level) during unfavourable meteorological conditions. This approach aims to assist with the management of potential off-site air quality impacts. Modifications to the haul road, existing truck parking areas and water management system structures will also be implemented to accommodate the progression of mining.

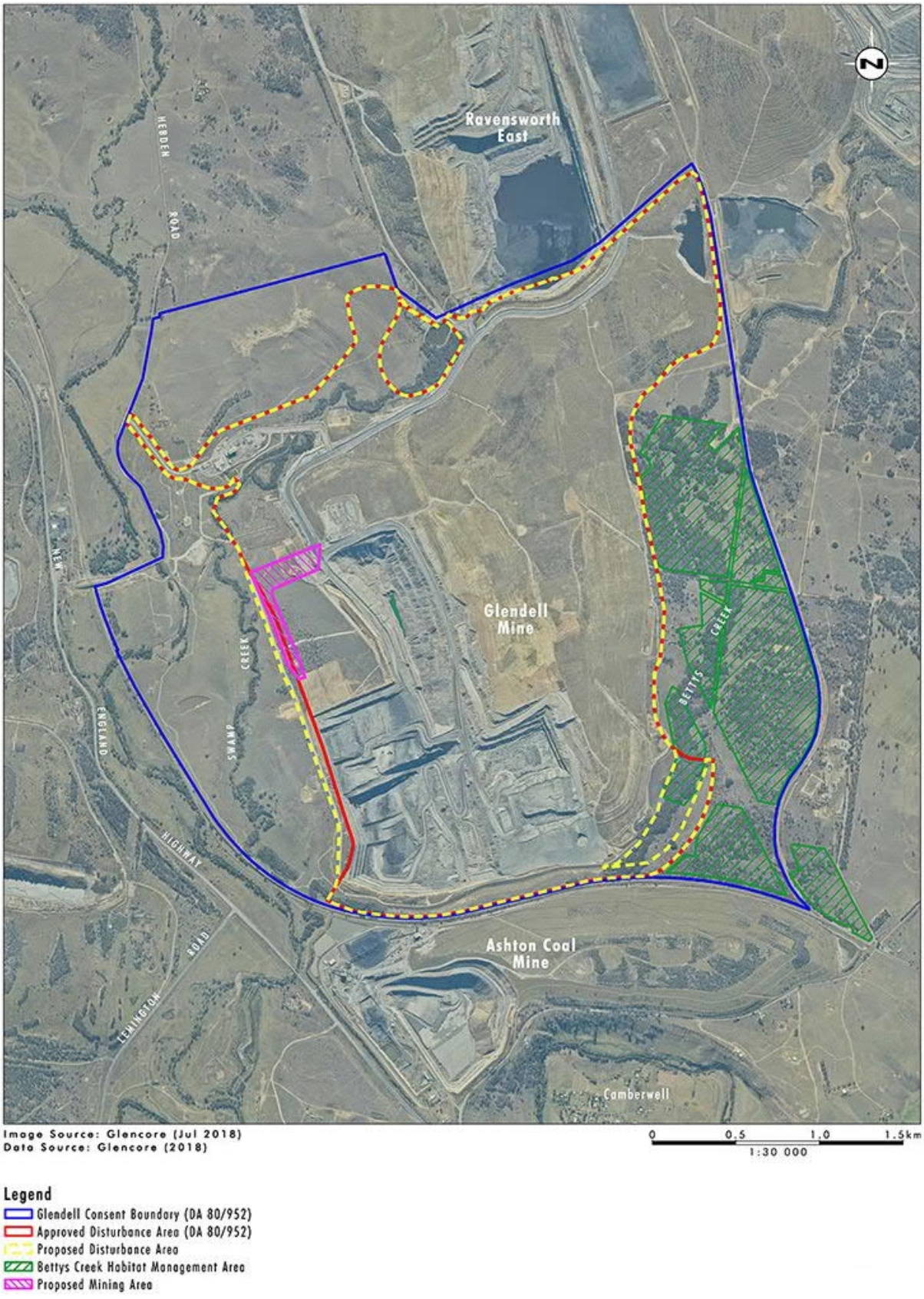


Figure 1 Proposed Modification Overview

4. Air Quality Issues

Air quality issues can arise when emissions from an industry or activity lead to deterioration in the ambient air quality. Emissions from Glendell Mine (both as approved and as modified) will occur from a variety of activities including material handling, material transport, processing, wind erosion, blasting and potentially, from the spontaneous combustion of coal. These emissions will mainly comprise of particulate matter in the form of total suspended particulates (TSP), particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10}) and particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). There would also be relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter. Spontaneous combustion of coal has historically not been an issue at Glendell Mine.

Changes to air emissions and potential impacts associated with the Proposed Modification may, most significantly, result from:

- Changes to the haul distances;
- Changes to the extent of exposed areas;
- Changes to the proximity of emission sources to sensitive receptors; and
- Changes to the duration of activities.

The Proposed Modification does not involve any activity that will change the nature of air quality issues at Glendell Mine, relative to the Approved Operations. In particular, the key air quality issues have been identified, and will remain, as:

- Dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from the general mining activities;
- Fume (that is, NO_x emissions) from blasting; and
- Emissions of substances from machinery exhausts, that is, diesel exhaust emissions.

5. Existing Environment

The existing environment can be characterised from local meteorological and ambient air quality data. Mount Owen has a network of meteorological and ambient air quality monitoring equipment that is used to collect data for supporting the management of daily operations at the Mount Owen Complex. The data are also used for determining compliance against the relevant development consent conditions. **Figure 2** shows the locations of the air quality and meteorological monitoring sites.

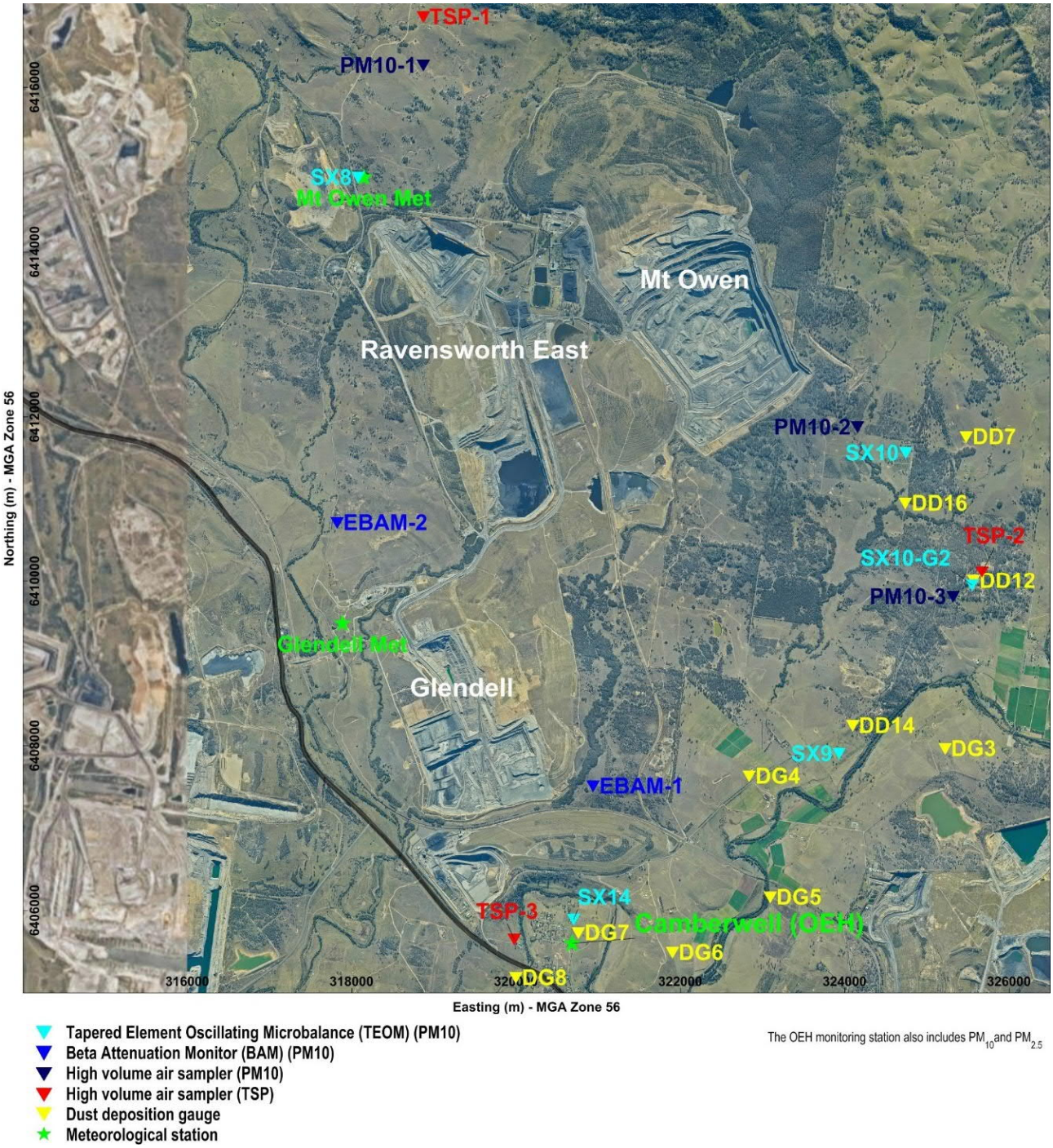


Figure 2 Location of air quality and meteorological monitoring sites

5.1 History of Compliance

Mount Owen is required to report on compliance with the conditions of DA 80/952 in their Annual Environmental Management Reports (AEMRs). DA 80/952 includes specific impact assessment criteria for air quality, as shown in **Table 1**, and compliance with these criteria is determined from analysis of the data collected at each of the monitoring sites shown in **Figure 2** (with the exception of EBAM-1, EBAM-2 and Camberwell). Data from EBAM-1 and E-BAM-2 are used for operations management and not for measuring compliance. The Camberwell monitoring station is operated by the Office of Environment and Heritage (OEH). It should be noted that, prior to 2018, a TEOM referred to as SX13 was historically operating at the location of EBAM-2.

Table 1 Air quality impact assessment criteria from development consent (DA 80/952)

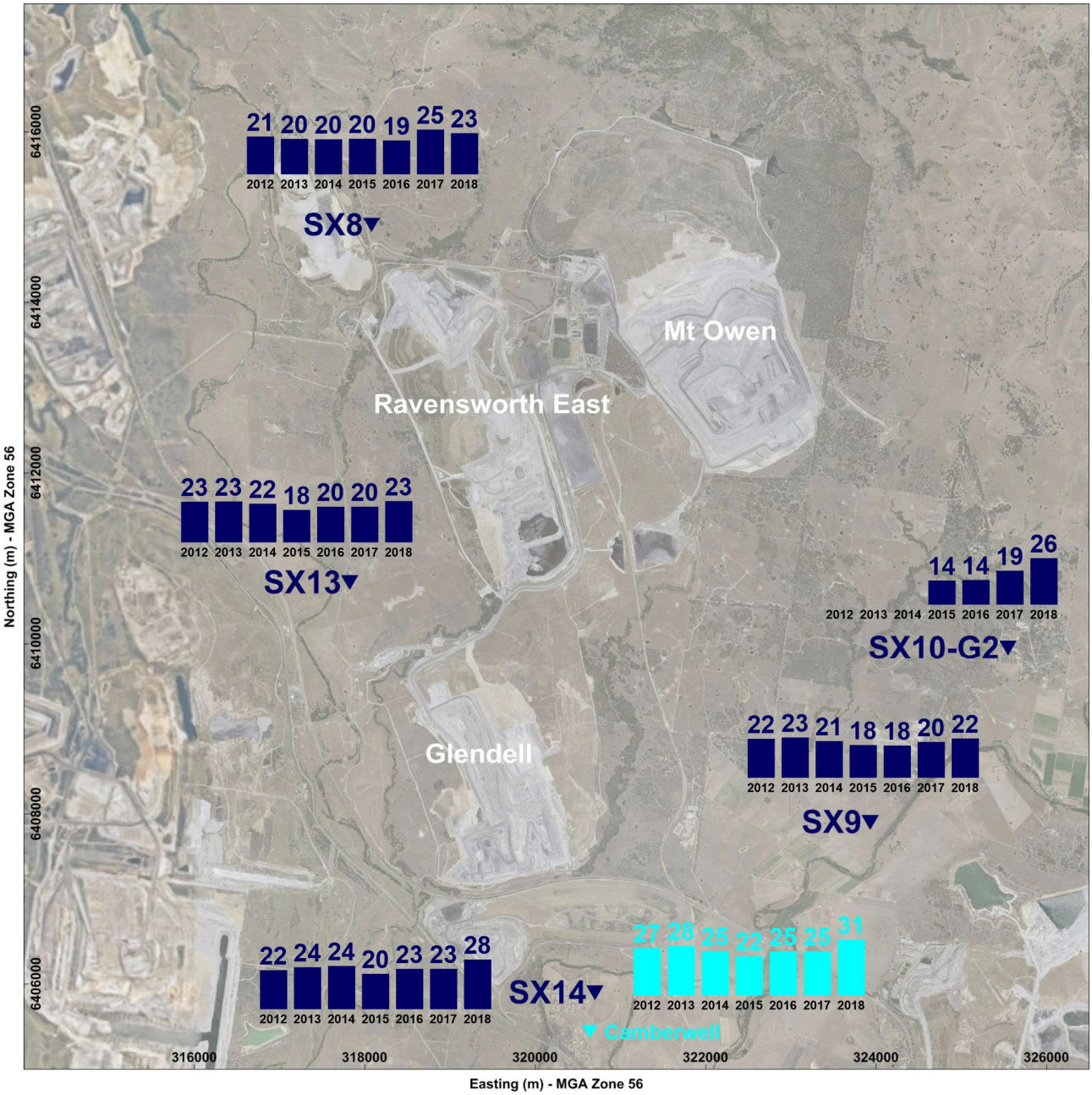
Substance	Averaging time	Criterion	Application
Particulate matter (PM_{10})	24-hour	50 µg/m^3	Incremental impact (i.e. incremental increase in concentrations due to the development on its own)
	Annual	30 µg/m^3	Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources)
Particulate matter (TSP)	Annual	90 µg/m^3	Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources)
Deposited dust	Annual (maximum increase)	2 g/m^2/month	Incremental impact (i.e. incremental increase in concentrations due to the development on its own)
	Annual (maximum total)	4 g/m^2/month	Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources)

The Mount Owen AEMRs (see references) include all relevant air quality monitoring data for determining compliance with the impact assessment criteria from DA 80/952. The AEMRs from the most recent five years, 2013 to 2017 inclusive, have been reviewed. These reports indicate that Glendell Mine has complied with the impact assessment criteria from DA 80/952.

5.2 Summary of Existing Environment

A detailed review of the existing air quality was also presented in a recent air quality assessment for the Mount Owen Continued Operations Modification 2 (Jacobs 2018). This assessment identified PM_{10} as one of the key existing air quality issues, based on measured concentrations that have historically approached the assessment criteria noted by the EPA. The current assessment provides only a brief summary of the existing air quality conditions, focussing on annual average PM_{10} concentrations, as the main objective was to determine the potential change in air quality as a result of the Proposed Modification.

Figure 3 shows the spatial variation in annual average PM_{10} concentrations around the Mount Owen Complex, for 2012 to 2018. At the time the EPA impact assessment criterion was 30 µg/m^3, however this criterion has since been revised in the “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW” to 25 µg/m^3 (EPA 2016).



Note. SX13 data in 2018 were from the site now known as EBAM-2

Figure 3 Spatial variation in annual average PM_{10} concentrations (µg/m^3)

Figure 3 shows that PM_{10} concentrations have complied with the 30 µg/m^3 criterion (DA 80/952) at all Mount Owen monitoring sites. Levels in Camberwell have typically been higher than at other locations and exceeded 25 µg/m^3 in three years (2012, 2013 and 2018). The data for 2018 also reflected drought conditions that were experienced across many parts of NSW and it can be seen from **Figure 3** that there were some increases in annual average PM_{10} concentrations in 2018, most notably at SX14, SX10-G2 and Camberwell. The measurements will have included all sources which were at some stage upwind of the monitor. Also, it should be noted that the data from Camberwell have been represented in a different colour as this monitor is operated by the OEH.

6. Review of Impacts

The emissions and existing extent of air quality impacts due to the Approved Operations have been quantified in the Environmental Assessment (Umwelt 2007) and by Holmes Air Sciences (2007). Changes to air emissions and potential impacts (i.e. ambient concentrations) associated with the Proposed Modification can result from:

- Changes to haul distances;
- Changes to the extent of exposed areas;
- Changes to the proximity of emission sources to sensitive receptors; and
- Changes to the duration of activities.

Each of these elements has been considered in order to determine whether the Proposed Modification will lead to an increased potential for air quality impacts, over the potential that is currently approved. **Table 2** provides the discussion of potential effects. From this information it has been concluded that the changes due to the Proposed Modification are unlikely to result in an increase in the currently approved air quality impacts of Glendell Mine. Air dispersion modelling, carried out in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", has also been carried out to confirm this outcome. This modelling is described in **Section 7**.

Table 2 Proposed Modification and potential air quality effects

Element	Proposed Modification	Effects on emissions and potential air quality impacts
Haul distances	Mining will progress in a northerly direction, closer to the main haul road which leads from the Glendell Mine Pit to the ROM pad. This progression of mining will result in a shorter haul distance than for the current Approved Operations. Haul distances from pit to emplacement areas will remain unchanged. There will be no change to the machinery used for transporting coal and overburden on haul roads. There will be no change to the hours when machinery transport coal and overburden on haul roads. There will be no change to the quantities of coal and overburden transported on haul roads.	Mining activities and equipment related emissions from vehicles on haul roads will most likely decrease as a result of the shorter haul distance. A reduction in emissions will typically result in a lower potential for off-site air quality impacts.
Exposed areas	The extent of exposed areas will not increase under the Proposed Modification. There will be progressive rehabilitation of mined areas, as is the case for the Approved Operations.	No change to overall site emissions relating to wind erosion from exposed areas.
Proximity of mining to sensitive receptors	Mining will progress in a northerly direction, away from the key sensitive receptor area of Camberwell.	The contribution of emissions from Glendell Mine to air quality in Camberwell is expected to decrease, due to the increasing distance between the mine and village.
Duration of changes	The Proposed Modification will represent an additional approximately eight months of mining.	Emissions from Glendell Mine will be present for an additional eight months, however while mining is currently approved to 2024, the current approved mining operations are expected to cease in 2022 and the proposed modification will provide for mining operations until Quarter 1, 2023. Therefore, there will not be an extension to the approved mine life.

7. Modelling of Impacts

7.1 Overview

The qualitative review (**Section 6**) indicated that the changes due to the Proposed Modification are unlikely to result in an increase in the currently approved air quality impacts of Glendell Mine. A quantitative assessment has also been carried out. This quantitative assessment has been prepared in response to a request from the Department of Planning and Environment for an updated air quality impact assessment in accordance with the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016).

The modelling for this quantitative assessment has followed the "Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales" (EPA, 2016). The "Approved Methods" specifies how assessments based on the use of air dispersion models should be undertaken and includes guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of dispersion model predictions.

In summary, this updated air quality impact assessment has been carried out by:

- Estimating emissions from Glendell mine for the one year period that is relevant to the Proposed Modification;
- Running the air dispersion model, CALPUFF, to predict the contribution of the Proposed Modification to local air quality; and
- Comparing the results of the modelling for the Proposed Modification to the extent of air quality impacts for the Approved Operations.

Details of the emission estimation techniques, model setup and input data are fully described in Jacobs (2018), prepared for the Mount Owen Continued Operations Project Modification 2. A summary of the key modelling aspects is provided below.

7.2 Assessment Criteria

Air quality is quantified by the concentrations of air pollutants in the ambient air, where an air pollutant is a substance that is known to cause health, nuisance and/or environmental effects. The EPA has set air quality criteria for many air pollutants including particulate matter in the form of TSP, PM_{10}, $PM_{2.5}$ and deposited dust. With regard to human health and nuisance effects, the air pollutant most relevant to the Project would be particulate matter, and in particular, PM_{10} because measured levels of this particulate matter classification are typically closest to the impact assessment criteria.

The air quality assessment criteria for the Approved Operations, and applicable to the current development consent, are from the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (DEC 2005). The relevant air quality criteria for the Approved Operations, in accordance with Schedule 3, Condition 20 of the current development consent (DA 80/952), are provided in **Table 3**.

Table 3 Air quality criteria for particulate matter and deposited dust (Approved Operations)

Air quality indicator	Averaging time	Criterion
Particulate matter (PM_{10})	24-hour	[b]50 µg/m^3
	Annual	[a]30 µg/m^3
Total suspended particulate (TSP) matter	24-hour	[a]90 µg/m^3
[c]Deposited dust	Annual – maximum increase in deposited dust level	[b]2 g/m^2/month
	Annual – maximum total deposited dust level	[a]2 g/m^2/month

[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).

[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).

[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.

[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed to by the Secretary.

The extent of air quality impact of the Approved Operations was most significantly defined (Holmes Air Sciences 2007) by annual average PM_{10} concentrations as the predictions at the time consumed the highest fraction of the then applicable assessment criterion. As the qualitative review (**Section 6**) highlighted that the Proposed Modification will be minor in nature, this quantitative assessment has focussed on comparisons between the contributions of the Approved Operations and Proposed Modification for PM_{10}, although $PM_{2.5}$ is also presented.

As noted above, the air quality impact assessment undertaken to support the Approved Operations was based on the earlier version of the "Approved Methods" (DEC 2005), refer to **Table 3**. The 2016 version of the "Approved Methods" introduced a revised, more stringent impact assessment criterion for PM_{10} as well as new criteria for 24-hour and annual average $PM_{2.5}$. The impact assessment criteria applicable to the Approved Operations for annual average PM_{10} was 30 µg/m^3 and additionally there was no impact assessment criteria for $PM_{2.5}$ at the time of the assessment. Potential air quality impacts associated with the Proposed Modification have now been assessed against the revised air quality impact assessment criteria identified in the Approved Methods (EPA 2016). These impact assessment criteria are outlined in **Table 4**, including TSP and dust deposition criteria for completeness.

Table 4 Air quality impact assessment criteria from the current Approved Methods (EPA 2016)

Air quality indicator	Averaging time	Criterion	Notes
Particulate matter (PM_{10})	24-hour	50 µg/m^3	Cumulative. Applies to sensitive receptors
	Annual	25 µg/m^3	Cumulative. Applies to sensitive receptors
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3	Cumulative. Applies to sensitive receptors
	Annual	8 µg/m^3	Cumulative. Applies to sensitive receptors
Total Suspended Particulates (TSP)	24-hour	90 µg/m^3	Cumulative
Deposited Dust	Annual	2 g/m^2/month incremental 4 g/m^2/month total	Incremental and cumulative criteria. Applies to sensitive receivers

7.3 Emissions

The most significant emission to air from Glendell mine is dust (particulate matter) due to material handling, material transport, processing, wind erosion, and blasting. Estimates of these emissions are required for the dispersion modelling. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and mine plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for this assessment have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012); and
- AP 42 (US EPA, 1985 and updates).

Table 5 shows the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions due to the Proposed Modification. These estimates reflect a one year period in the proposed final stages of mining, that is, from 2022 to 2023. Estimates were based on production and material handling quantities provided by Mount Owen. For comparison the Approved Operations were based on annual TSP emissions that were estimated (Holmes Air Sciences 2007) to be up to 3,713,715 kg/y in the worst case year. The estimated emissions for the Proposed Modification are 2,026,746 kg/y TSP and are below the original estimates from Holmes Air Sciences (2007). This reduction primarily reflects a shorter pit to ROM pad haul distance in the later stage of mining and improved management controls introduced at Glendell since the 2007 assessment.

It should be noted that the main intent of the inventories is to capture the most significant emission sources that may affect off-site air quality. Not every source will be captured. However, the contribution of emissions from sources not identified will be captured in the air quality monitoring data and these data have been added to the predicted site contributions. **Appendix A** provides details of the dust emission calculations, including assumptions, emission controls and allocation of emissions to modelled locations.

Table 5 Estimated TSP, PM_{10} and $PM_{2.5}$ emissions due to the Proposed Modification

Activity	Annual emissions (kg/y)		
	TSP	PM_{10}	$PM_{2.5}$
Stripping topsoil by scraper	783	197	39
Drilling overburden	3,490	1,815	105
Blasting overburden	24,781	12,886	743
Excavators loading overburden to trucks	59,889	28,326	4,289
Hauling overburden from pit to dump	404,808	119,624	12,144
Unloading overburden to dump	59,889	28,326	4,289
Dozers shaping overburden	439,805	107,069	46,179
Dozers working on overburden for rehabilitation	219,902	53,534	23,090
Dozers working on coal	262,928	83,815	5,784
Loading ROM coal to trucks	211,609	30,433	4,021
Hauling ROM coal from pit to hopper / ROM pad	143,697	42,464	4,311
Wind erosion from active pits	78,686	39,343	5,901
Wind erosion from active dumps	107,246	53,623	8,043
Grading roads	9,232	3,264	101
Total	**2,026,746**	**604,718**	**119,041**

7.4 Meteorological Modelling

The air dispersion model used for this assessment, CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radio-sondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

Key model settings for TAPM are shown below in **Table 6**.

Table 6 Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2014, with one “spin-up” day.
Centre of analysis	Mount Owen Mine (32°24.5’ S, 151°5.5’ E)
Terrain data source	Shuttle Research Topography Mission (SRTM)
Land use data source	Default
Meteorological data assimilation	Glendell mine meteorological station. Radius of influence = 15 km. Number of vertical levels for assimilation = 4

Table 7 lists the model settings and input data for CALMET.

Table 7 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	SRTM and Project Digital Elevation Model (DEM)
Land-use data source(s)	Digitized from aerial imagery
Meteorological grid domain	20 km x 20 km
Meteorological grid resolution	0.2 km
Meteorological grid dimensions	100 x 100 x 9
Meteorological grid origin	310000 mE, 6400000 mN. MGA Zone 56
Surface meteorological stations	Glendell (Observations of wind speed and wind direction. TAPM for ceiling height, cloud cover and air pressure) Mount Owen (Observations of wind speed and wind direction) Camberwell (Observations of wind speed, wind direction, temperature and humidity)
Upper air meteorological stations	Upper air data file for the location of Glendell met station derived by TAPM Biased towards surface observations (-1, -0.8, -0.6, -0.4, -0.2, 0, 0, 0, 0)
Simulation length	8760 hours (1 Jan 2014 to 31 Dec 2014)
R1, R2	0.5, 1
RMAX1, RMAX2	5, 20
TERRAD	5

Terrain information was extracted from the NASA Shuttle Research Topography Mission database which has global coverage at approximately 30 metre resolution. Land use data were extracted from aerial imagery. **Figure 4** shows the model grid, land-use and terrain information, as used by CALMET. It is noted that the extent of some land-uses will change over time, such as mining areas, however the model sensitivity has been tested and changes from grassland to barren land (i.e. mining areas) were found to have very little influence on the dispersion modelling results.

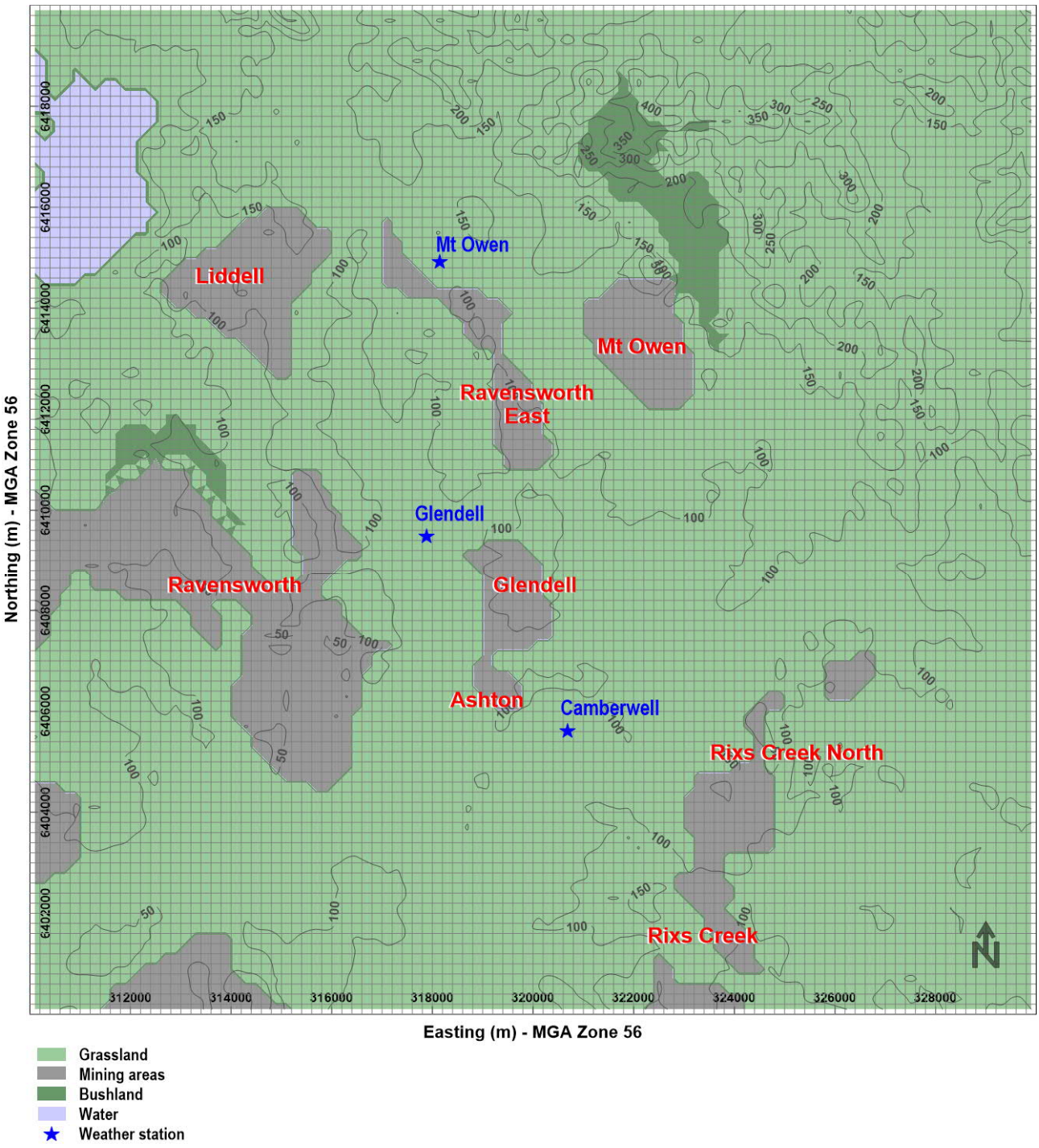


Figure 4 Model grid, land-use and terrain information

Figure 5 shows a snapshot of winds at 10 metres above ground-level as simulated by the CALMET model under stable conditions. This plot shows the effect of the topography on local winds (for this particular hour), and highlights the non-uniform wind patterns in the area, which further supports the use of a non-steady-state model such as CALPUFF.

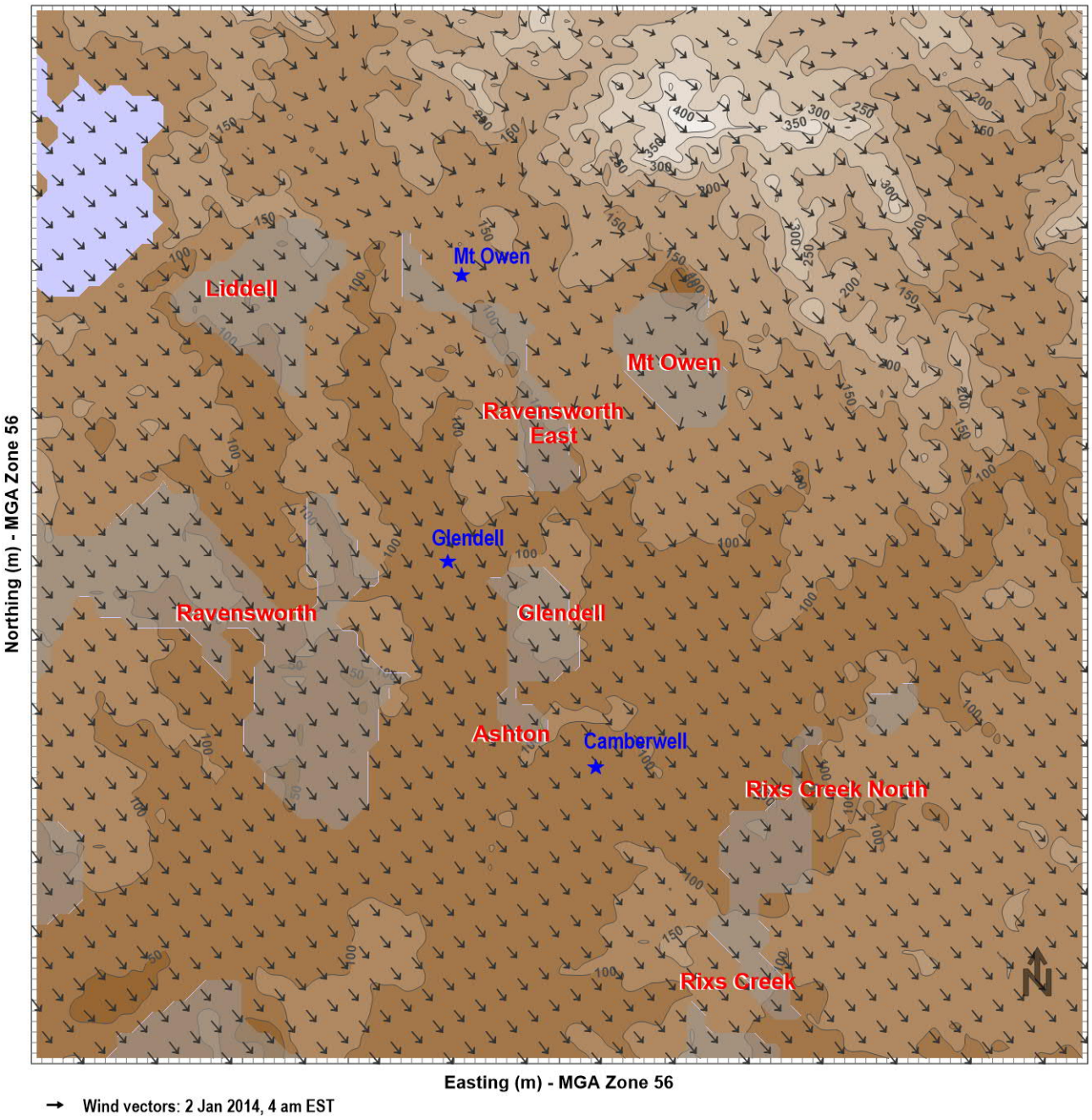


Figure 5 Example of CALMET simulated ground-level wind flows

7.5 Dispersion Modelling

Dust concentrations due to emissions from the Proposed Modification (and other sources) have been predicted using CALPUFF Version 6.42. The modelling was performed using emission estimates as described in **Section 7.3** and using the meteorological information provided by the CALMET model, described in **Section 7.4**. Predictions were made at 986 receptors at sufficient resolution to allow for contouring of results.

Mining operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. **Figure 6** shows the location of the modelled sources, where the emissions from each dust generating activity were assigned to one or more of these source locations.

Dust emissions for all modelled mine-related sources have been characterised to fit in one of three categories, as follows:

- Wind insensitive sources, where emissions do not vary with wind speed (for example, dozers).
- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3, a generic relationship published by the US EPA (1987). This relationship has been applied to sources such as loading and unloading of waste to/from trucks and results in increased emissions with increased wind speed.
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3, a generic relationship published by Skidmore (1998). This relationship has been applied to sources including wind erosion from stockpiles, overburden dumps or active pits, and results in increased emissions with increased wind speed.

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation.

Blasting activities and associated emissions were assumed to take place only during daylight hours (9 am to 5 pm for the purposes of the modelling) while all other activities have been modelled for 24 hours per day.

Pit retention (that is, retention of dust particles within the open pits) has been included in the model simulations. The pit retention calculation determines the fraction of dust emitted in the pit that may escape the pit. The "escaped fraction" is a function of the gravitational settling velocity of the particles and the wind speed and is shown by the following relationship (US EPA, 1995).

Equation 1:

$$\varepsilon = \frac{1}{\left(1 + \frac{v_g}{(\alpha U_r)}\right)}$$

where:

ε = escaped fraction for the particle size category

V_g = gravitational settling velocity (m/s)

U_r = approach wind speed at 10 m (m/s)

α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit (0.029)

To model the effect of pit retention, the emissions from mining sources within the open pits have been reduced as per the calculation above for each hour of the simulation depending on the wind speed. This approach means that much of the coarser dust would remain trapped in the pits. Typically five per cent of the PM_{10} emissions are trapped in the pit using this calculation.

Figure 6 Location of modelled sources for 2023

Key model settings and inputs for CALPUFF are provided in **Table 8**.

Table 8 Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
Computational grid domain	100 x 100
Chemical transformation	None
Dry deposition	Yes
Wind speed profile	ISC rural
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Number of volume sources	39 (see **Figure 6**). Height = 5m, SY = 20 m, SZ = 10 m
Number of discrete receptors	986.

Finally, the model predictions for the Proposed Modification were compared to the original, maximum extent of model predictions for the Approved Operations, as per Holmes Air Sciences (2007). Predictions have also been presented for Camberwell for comparison with the key EPA air quality criteria, previously discussed in **Section 7.2**.

7.6 Model Results

7.6.1 Particulate Matter (PM_{10})

Figure 7 shows the predicted maximum 24-hour average PM_{10} concentrations due to activities at Glendell Mine alone (i.e. incremental impacts from Glendell Mine), including the maximum extent of 50 µg/m^3 for Approved Operations, as well as the 50 µg/m^3 contour under the Proposed Modification. These results show a reduced contribution from Glendell Mine to maximum PM_{10} concentrations in the Camberwell area, relative to the Approved Operations. There is a potential increase in maximum contributions to the north of Glendell, attributed to the progression of mining to the north, however the changes are predicted in an area where there are no private sensitive receptors. The differences between contours would also reflect the differences in the models used for each scenario; that is, ISCMOD for the Approved Operations and CALPUFF for the Proposed Modification.

Figure 8 shows the predicted annual average PM_{10} concentrations due to activities at Glendell Mine. The extent of the 25 µg/m^3 contour in the Camberwell area is almost identical for the Approved Operations and Proposed Modification scenarios and, from an air quality perspective, these results would suggest a negligible change in air quality.

Figure 9 shows the predicted annual average PM_{10} concentrations due to Glendell Mine and other sources where the other sources include background levels and other existing and approved mining operations. In this case the cumulative PM_{10} concentrations under the Proposed Modification have been compared to the predicted cumulative PM_{10} concentrations for the most recent models available for the Mount Owen Complex and neighbouring operations, that is, the models developed for Mount Owen Continued Operations Modification 2 (Jacobs 2018). The Modification 2 model outputs are for the worst case modelled cumulative year for that project being 2020. The cumulative models prepared at the time of the assessment for Modification 2 included the contribution from Glendell Mine (as currently scheduled to cease in 2021) and did not reflect the status of the proposed modified operations in and around 2023. These results again highlight that the Proposed

Modification will not lead to an increase in PM_{10} concentrations in Camberwell or at other sensitive receptor locations relative to the Approved Operations.

The modelling results indicate that the cumulative annual average PM_{10} concentrations are predicted to exceed the 25 µg/m^3 "Approved Methods" assessment criterion and the current 30 µg/m^3 cumulative PM_{10} annual average impact criteria in the Glendell consent (DA 80/952) in Camberwell in the modelled year. This is based on the inclusion of all current and approved mining operations at the maximum production rates for all operations (including the Ashton South East Open Cut (SEOC) Project) so the predictions for the future cumulative operational scenarios should therefore be considered as conservative estimates of potential impacts.

Contributions for the worst case year (2020) for the Mount Owen Modification 2 were presented in order of significance and the contributions were predicted to be ranked as follows:

- Background (39%)
- Ashton including South East Open Cut (SEOC) Project (15%)
- Rix's Creek North (11%)
- Ravensworth Surface Operations (10%)
- Glendell (as approved) (9%)
- Rix's Creek including Rix's Creek Extension (6%)
- Mount Owen Continued Operations (as modified) (4%)
- Liddell Coal Operations (3%)
- Hunter Valley Operations (2%)
- Integra Underground (1%).

Based on the breakdown above, Glendell Mine is estimated to contribute in the order of 9% to the future PM_{10} concentrations in Camberwell and is not be the main contributor.

Table 9 provides the predicted contribution of Glendell Mine to PM_{10} levels in Camberwell under the Approved Operations and Proposed Modification scenarios. These results indicate that the Proposed Modification is unlikely to result in an increase in the currently approved contribution of Glendell Mine to air quality levels in Camberwell.

Table 9 Model predictions of PM_{10} in Camberwell

Parameter	Scenario	Predicted contribution of Glendell Mine
Annual average PM_{10} (µg/m^3)	Approved Operations	5.2
	Proposed Modification	3.1

The PM_{10} predictions, both 24-hour and annual average, provide additional confirmation that the changes due to the Proposed Modification are unlikely to result in an increase in the currently approved air quality impacts of Glendell Mine.

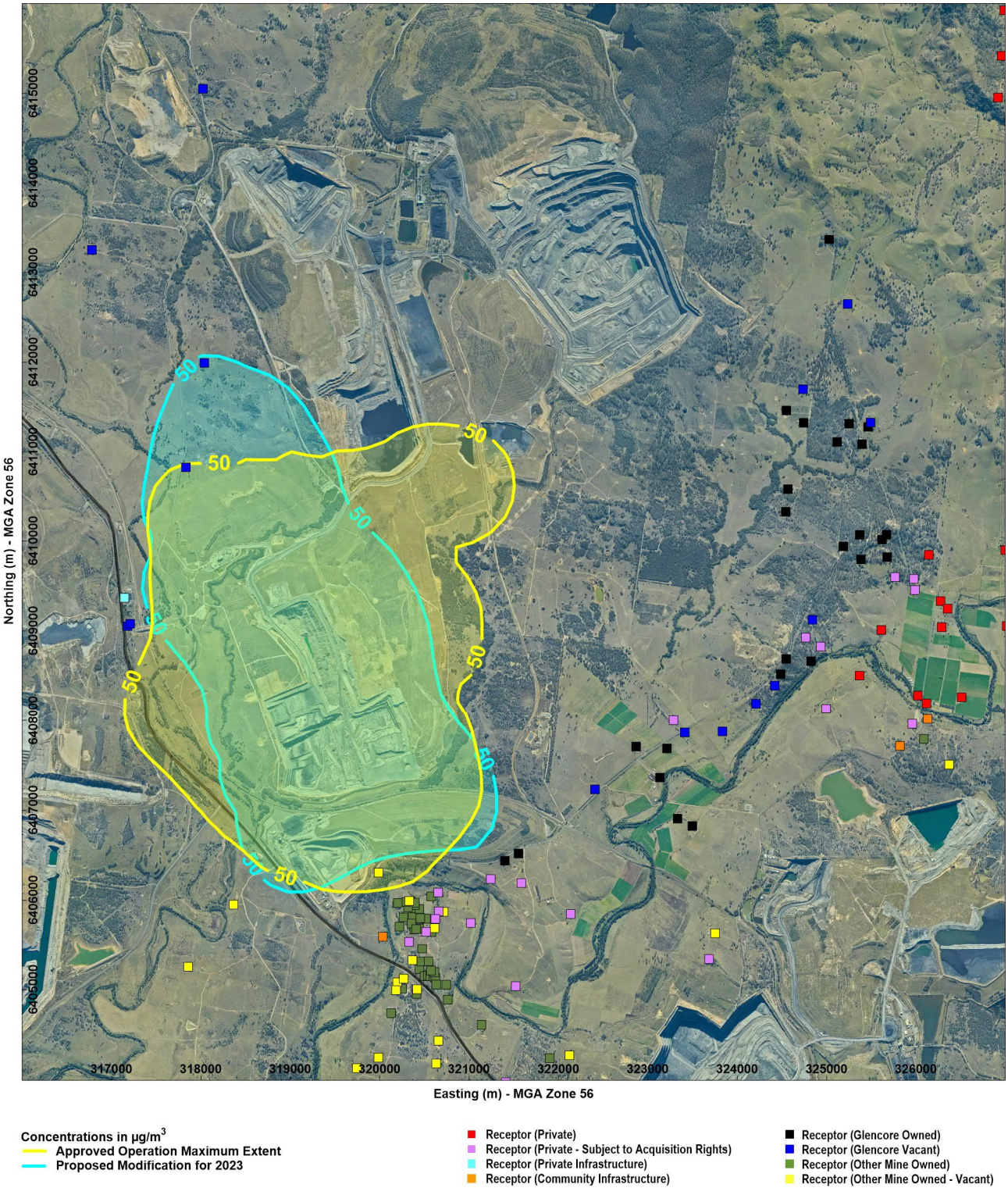


Figure 7 Predicted maximum 24-hour average PM_{10} concentrations due to Glendell Mine

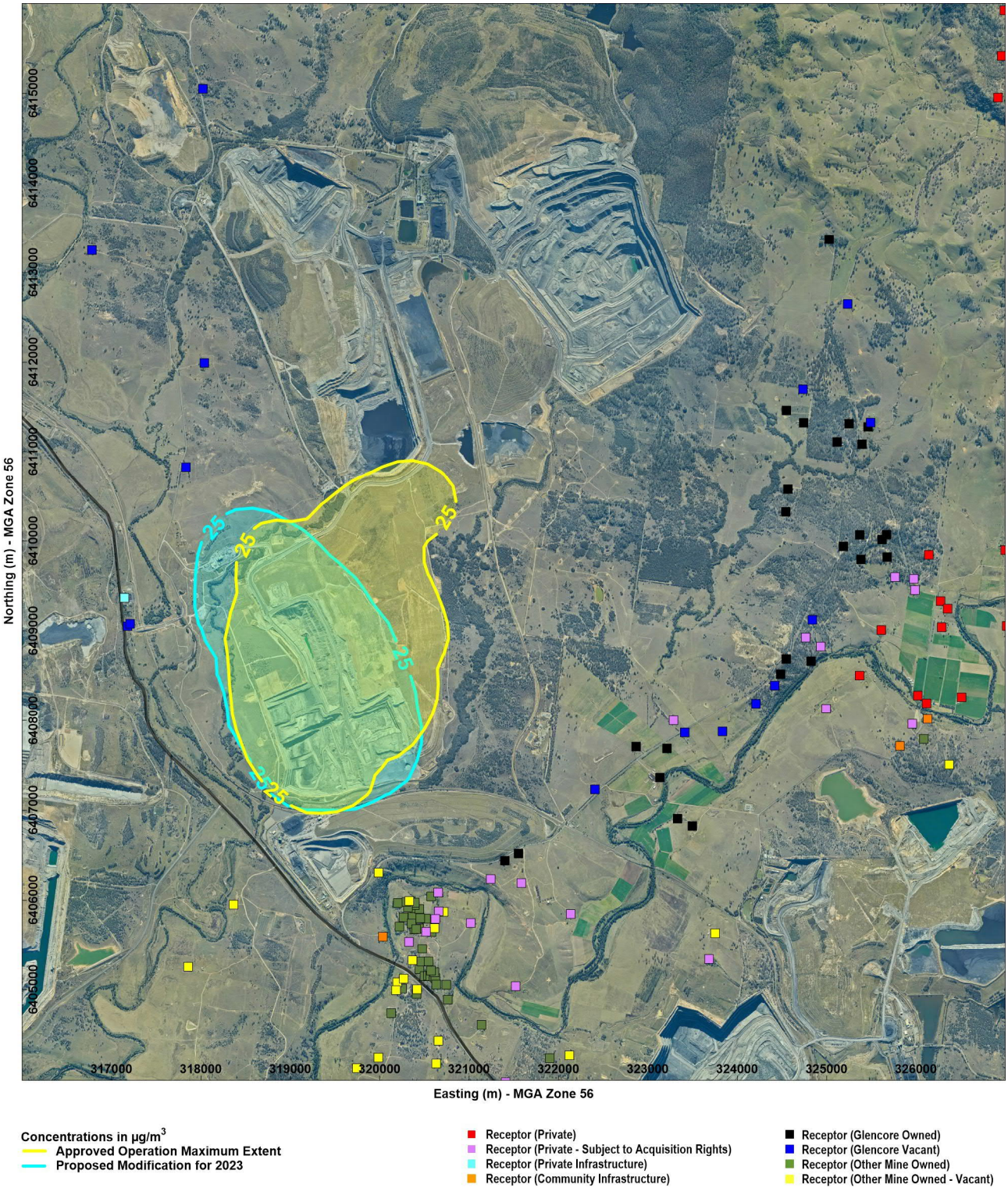


Figure 8 Predicted annual average PM_{10} concentrations due to Glendell Mine

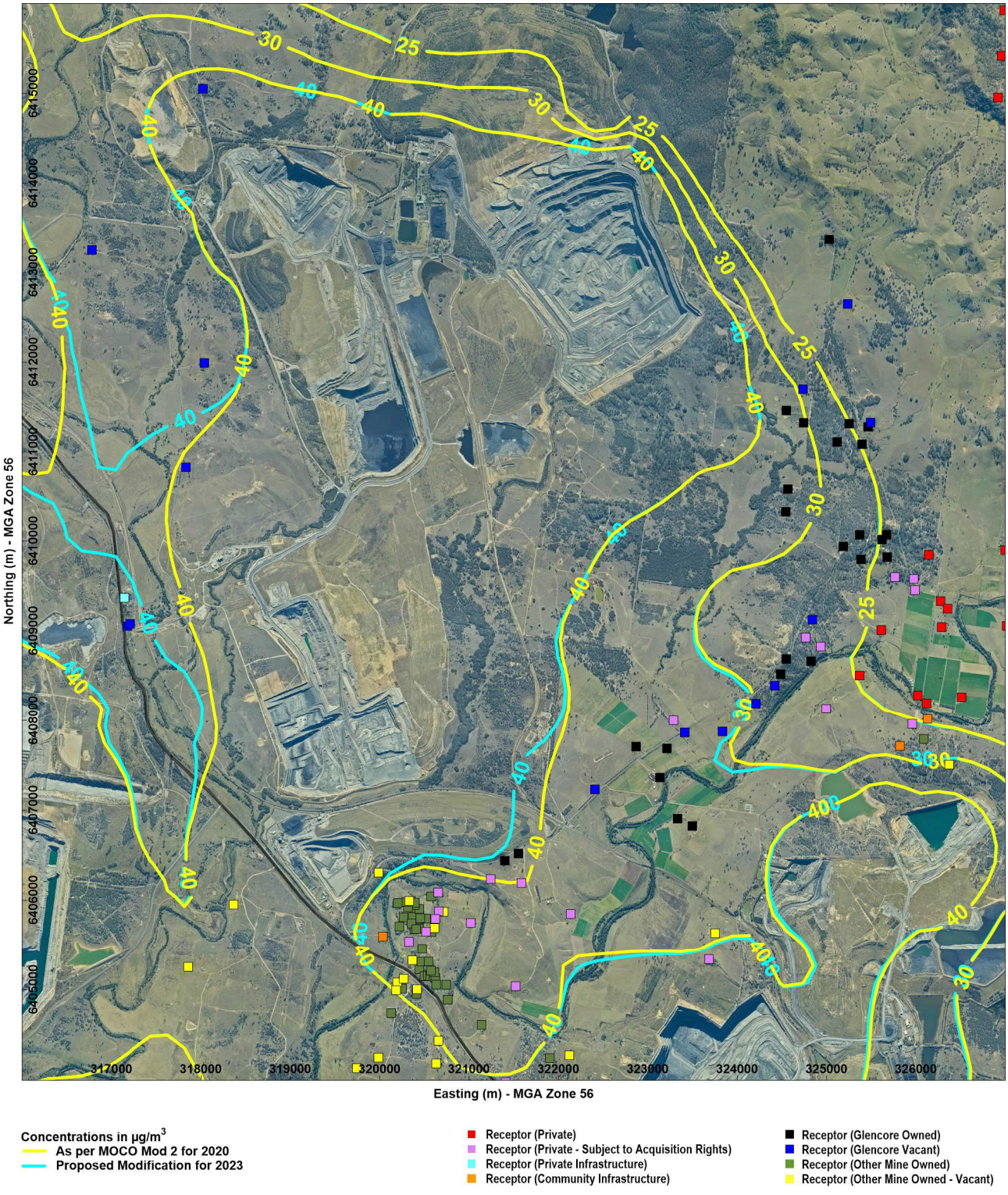


Figure 9 Predicted annual average PM_{10} concentrations due to Glendell Mine (proposed modification year 2023) and other sources

7.6.2 Particulate Matter ($PM_{2.5}$)

Figure 10 and **Figure 11** show the predicted maximum 24-hour average and annual average $PM_{2.5}$ concentrations due to the Proposed Modification respectively. There are no $PM_{2.5}$ predictions for the Approved Operations available for comparison as the Environmental Assessment (Umwelt 2007) did not provide predictions of $PM_{2.5}$ concentrations since there were no applicable criteria at the time.

Figure 12 shows the predicted annual average $PM_{2.5}$ concentrations due to Glendell Mine and other sources. As for PM_{10}, the cumulative $PM_{2.5}$ concentrations under the Proposed Modification have been compared to the predicted cumulative $PM_{2.5}$ concentrations for the most recent modelling for Mount Owen Modification 2 (Jacobs 2018) (2020 modelled year). These results highlight that the Proposed Modification will not lead to an increase in $PM_{2.5}$ concentrations in Camberwell or at other sensitive receptor locations relative to the Approved Operations.

Table 10 shows the predicted contribution of Glendell Mine to $PM_{2.5}$ levels in Camberwell for the Proposed Modification scenario. Predictions of $PM_{2.5}$ were not available for the Approved Operations however it can be inferred that the relative $PM_{2.5}$ comparison will be similar to the PM_{10} comparison (**Table 9**) and that the Proposed Modification is unlikely to result in an increase in the currently approved contribution of Glendell Mine to air quality levels in Camberwell.

Table 10 Model predictions of $PM_{2.5}$ in Camberwell

Parameter	Scenario	Predicted contribution of Glendell Mine
Annual average $PM_{2.5}$ ($\mu g/m^3$)	Approved Operations	Not available
	Approved Operations as predicted in Mount Owen Modification 2 for 2020	1.0
	Proposed Modification	1.0

The $PM_{2.5}$ predictions, both 24-hour and annual average, provide additional confirmation that the changes due to the Proposed Modification are unlikely to result in an increase in the currently approved air quality impacts of Glendell Mine.

The Voluntary Land Acquisition and Mitigation Polity (VLAMP) 2018 was gazetted on 21 September 2018, supersedes an earlier version of the VLAMP, and provides for updates to the Mining SEPP to bring the air quality criteria in line with the NEPM standards and current EPA criteria.

In relation to the application of the VLAMP to modifications of consent, the VLAMP states:

> *The policy commences from the date that it is gazetted, and applies to:*
>
> - *Modification applications that involve increases in the approved dust or noise impacts of a development.*

The air quality impact assessment demonstrates that the Proposed Modification is not predicted to result in an increase to air quality impact on sensitive receptors relative to the Approved Operations. No additional (current) private receptors will be impacted than that identified under DA 80/952 for the Approved Operations and the duration of approved operations at Glendell Mine (currently approved to 2024). Accordingly, the VLAMP 2018 does not apply to the assessment of the Proposed Modification.

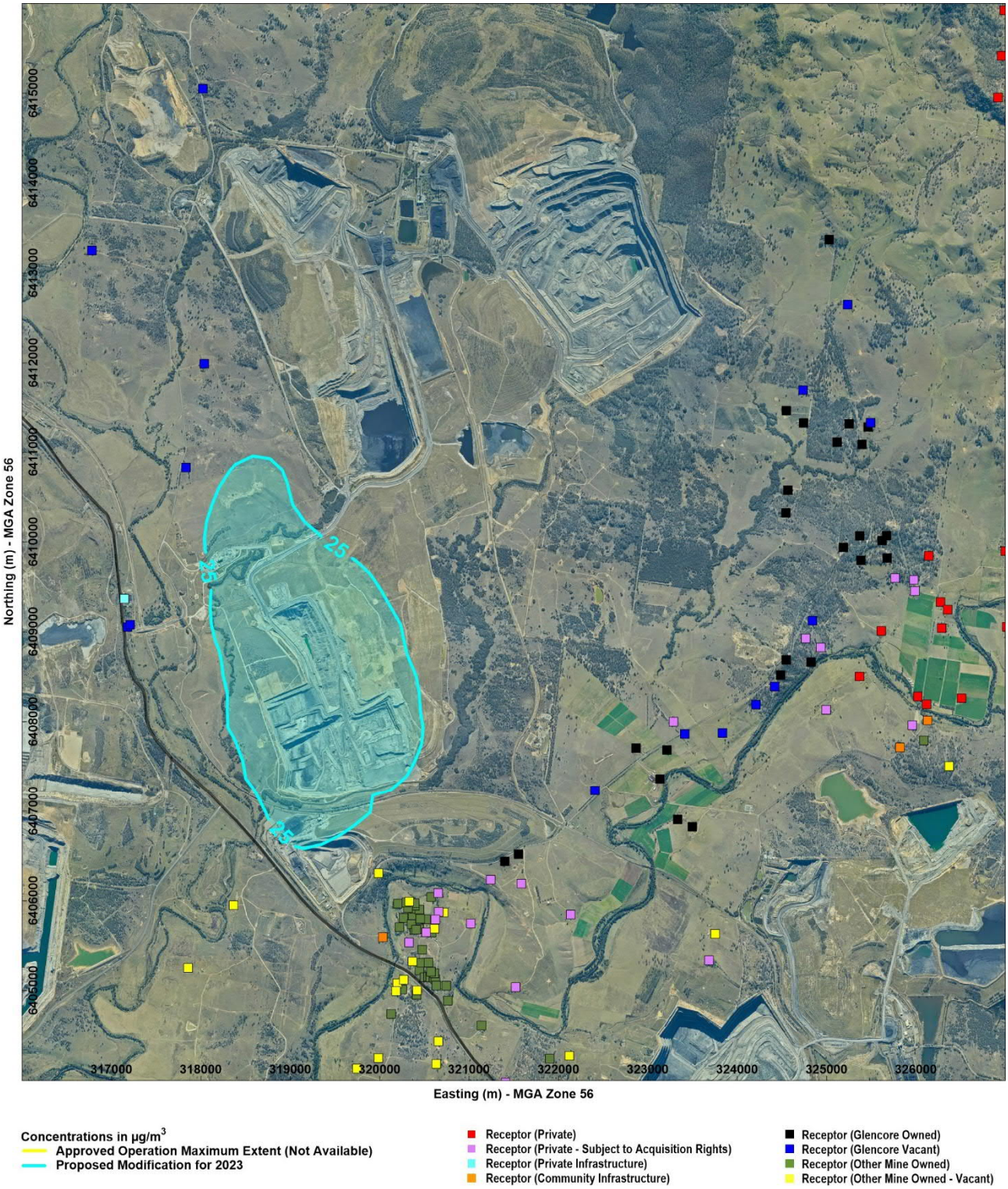


Figure 10 Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to Glendell Mine

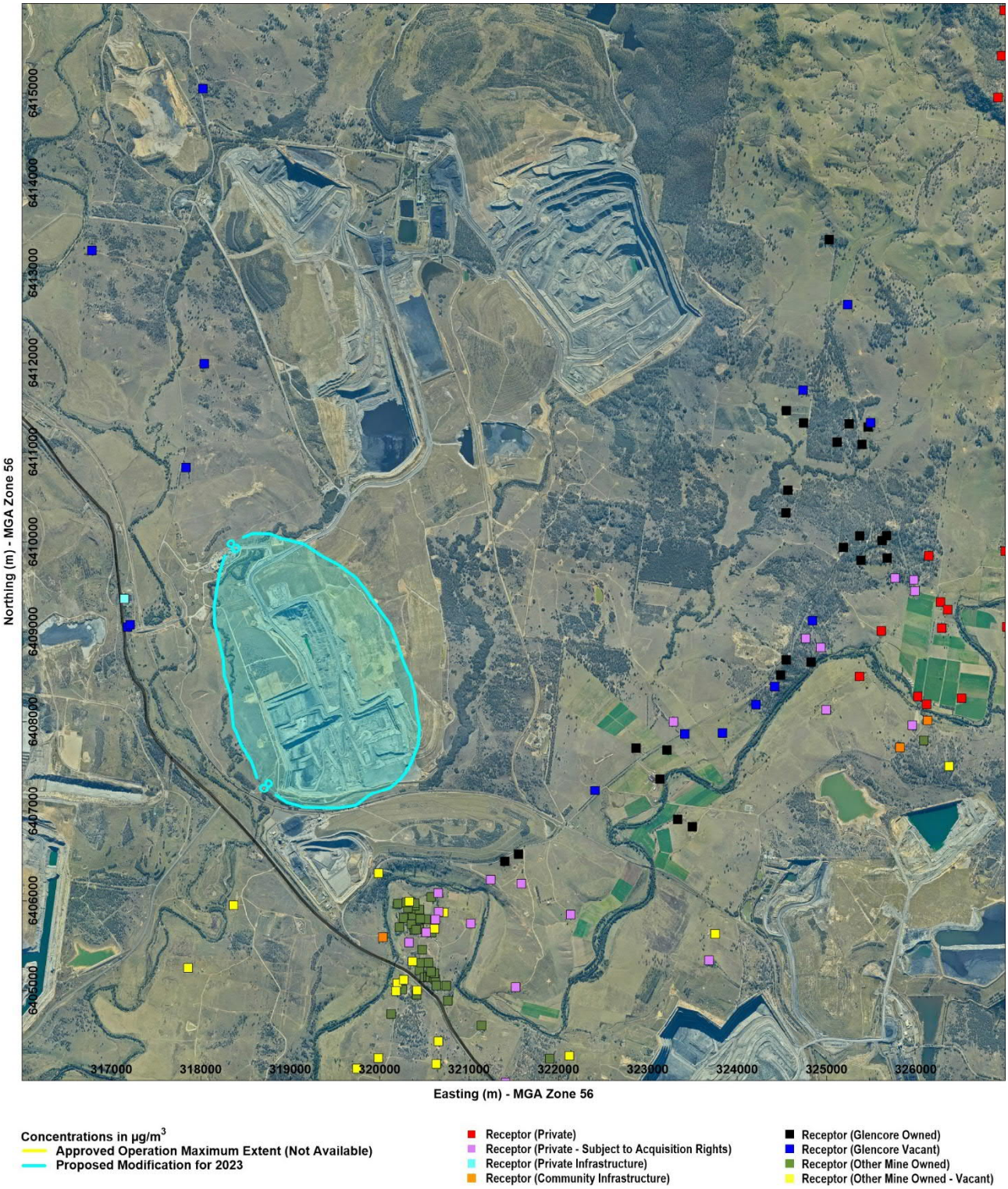


Figure 11 Predicted annual average $PM_{2.5}$ concentrations due to Glendell Mine

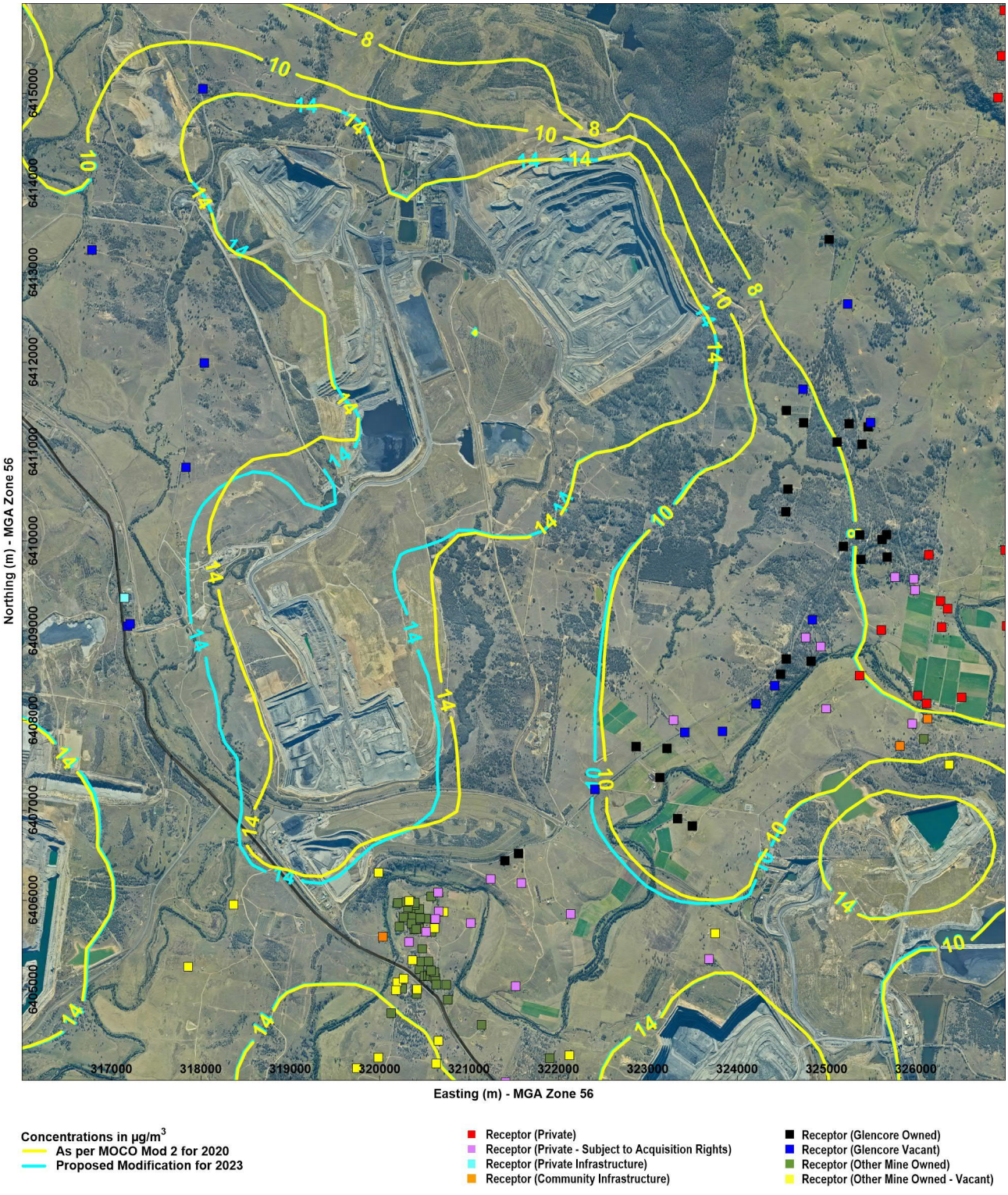


Figure 12 Predicted annual average $PM_{2.5}$ concentrations due to Glendell Mine and other sources

8. Air Quality Management

Table 11 summarises the standard emission management measures, currently implemented as part of the existing Air Quality Management Plan, that will continue to be adopted as part of the Proposed Modification. The dust management measures as outlined in **Table 11** have been compared to the measures outlined in the "NSW Coal Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining" (Donnelly et al, 2011). This comparison shows that the majority of proposed measures are consistent with best practice dust mitigation measures. Exceptions are noted in instances where no mines were using the stated practice from Donnelly et al (2011).

Table 11 Emission management measures

Activity	Emission management measures	Measures identified from Donnelly et al (2011)	Consistent with best practice
Stripping topsoil by scraper	Watering of haul routes Restricting vehicle speeds	Control measures for this activity are not specifically identified but can be inferred from the bulldozers information below.	Y
Drilling overburden	Water injection and application of water to drill cuttings upon removal Dust curtains Ceasing operations if dust suppression systems are inoperable or if dust is visible above the drill deck level for a sustained period	*"Best practice control measures include air extraction to a bag filter. No mines were found to use this practice."*	N (bag filters are not best practice in NSW)
Blasting overburden	Pre-blast checks including review of meteorological conditions	*"Best practice control measures include delaying shot to avoid unfavourable weather conditions and minimising the area blasted"*	Y
Hauling overburden and coal on unsealed roads	Watering of haul routes Gravel compaction and maintenance of haul routes Restricting vehicle speeds Clearly marked haul routes Fleet optimisation to reduce vehicle kilometres travelled Prompt clean-up of any material spillage	*"Control measures include watering, grading, well-defined haul routes, speed limits to 40 km/h and/or the use of suppressants."*	Y
Loading and unloading of overburden	Minimisation of fall distances during unloading and loading Planning of dump locations based on weather conditions Ceasing operations during adverse dust conditions	*"Current practices adopted to control emissions from loading and dumping overburden were found to be water application, minimisation of drop heights and suspension or modification of activities during adverse weather conditions. Best practice control measures were identified as minimising drop heights and / or the application of water".*	Y
Grading roads	Watering of haul routes Restricting vehicle speeds Clearly marked routes	Control measures for this activity are not specifically identified. This activity forms part of the control measures for haul roads.	N/A

Activity	Emission management measures	Measures identified from Donnelly et al (2011)	Consistent with best practice
Machinery exhausts and plant and equipment	Servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance. Targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle. Defining failure modes, effects and criticality. Constructing timelines for downtimes.	Control measures for this activity are not specifically identified.	N/A

In addition to the measures listed above Mount Owen implements both proactive and reactive dust control strategies. Reactive air quality management include the modification or suspension of activities in response to the visual, meteorological or ambient air quality triggers. These triggers are defined in the Mount Owen Complex Air Quality Management Plan and are linked to specific actions for managing dust at both private and mine owned residences.

The meteorological and air quality monitoring network currently operated by Mount Owen (refer to **Section 5**) is suitably setup with upwind and downwind monitors to measure the key air quality parameters, compliance with air quality criteria, and to allow for the contribution of mining activities to be determined. This monitoring network will continue to be operated as part of the Proposed Modification.

9. Conclusions

This report has provided an assessment of the potential air quality impacts of a proposed modification of the Glendell Mine development consent to provide an additional 8 months of mining and to access an additional 2.5 Mt of ROM coal. The Proposed Modification was assessed by qualitative and quantitative approaches.

The assessment led to the following conclusions:

- Emissions for the Proposed Modification are expected to be within maximum levels estimated for the Approved Operations.
- From an air quality perspective, the Proposed Modification will be minor in nature and there will not be an increase in the potential air quality impacts, over and above that currently approved.
- The predicted maximum contributions of the Proposed Modification to air quality are less than the predicted maximum contributions of the Approved Operations at all private sensitive receivers.
- The relevant cumulative criteria in assessing PM_{10} and $PM_{2.5}$ have been revised since DA 80/952 was determined and exceedances of the current criteria is attributed to the change in neighbouring mining operations and to the relevant criteria rather than an increase in emissions associated with the Proposed Modification. It is also noted that when Glendell Mine was originally approved in 1983 and modified in 2008, Hunter Valley Operations was the only operation approved at the time that would have remained operational in 2023. All other existing approved operations currently impacting on Camberwell have been approved following the approval and modification of the current Glendell Mine consent DA 80/952.
- The modelling does not include the simulation of reactive management measures that can be undertaken by Mount Owen in the event that elevated dust levels are identified.

The above findings are consistent with the findings of the qualitative assessment contained in the Statement of Environmental Effects for the Proposed Modification.

The potential air quality impacts predicted by the modelling will continue to be managed in accordance with relevant approval conditions and with the existing proactive and reactive management processes currently implemented at the Mount Owen Complex as outlined in the approved Air Quality Management Plan.

10. References

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Appendix A. Emission Calculations

Emission calculations

Glendell Mod 4 year ending 2023

	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables								
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil by scraper	783	197	39	50	54000	t/y	0.029	kg/t	0.0073	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-
Drilling overburden	3490	1815	105	70	19720	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Blasting overburden	24781	12886	743	0	68	blasts/y	364.4	kg/blast	189.5	kg/blast	10.9	kg/blast	14000	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	69037	32653	4945	0	42386700	t/y	0.00163	kg/t	0.00077	kg/t	0.0001	kg/t	-	1.38	2	-	-	-	-	-	-
Hauling overburden from pit to dump	466643	137897	13999	85	42386700	t/y	0.07339	kg/t	0.02169	kg/t	0.002	kg/t	-	-	-	-	4	218	4	-	-
Unloading overburden to dump	69037	32653	4945	0	42386700	t/y	0.00163	kg/t	0.00077	kg/t	0.0001	kg/t	-	1.38	2	-	-	-	-	-	-
Dozers shaping overburden	439805	107069	46179	0	26280	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Dozers working on overburden for rehabilitation	219902	53534	23090	0	13140	h/y	16.7	kg/h	4.07415	kg/h	1.757	kg/h	-	-	2	-	-	-	-	10	-
Drilling coal	0	0	0	70	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.018	kg/hole	-	-	-	-	-	-	-	-	-
Blasting coal	0	0	0	0	0	blasts/y	364.4	kg/blast	189.5	kg/blast	10.9	kg/blast	14000	-	-	-	-	-	-	-	-
Dozers working on coal	262928	83815	5784	0	13140	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Loading ROM coal to trucks	266521	38330	5064	0	5572000	t/y	0.04783	kg/t	0.00688	kg/t	0.001	kg/t	-	-	8	-	-	-	-	-	-
Hauling ROM coal from pit to hopper / ROM pad	180985	53483	5430	85	5572000	t/y	0.21654	kg/t	0.06399	kg/t	0.006	kg/t	-	-	-	-	4	133	7.2	-	-
Unloading ROM coal to ROM pad	0	0	0	70	0	t/y	0.01	kg/t	0.0042	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-
ROM coal rehandle to hopper	0	0	0	0	0	t/y	0.01	kg/t	0.0042	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-
Transferring ROM coal by conveyor to CHPP	0	0	0	70	0	t/y	0.00023	kg/t	0.00011	kg/t	0.0000	kg/t	-	1.38	8	-	-	-	-	-	-
Handling coal at CHPP	0	0	0	70	0	t/y	0.00117	kg/t	0.00055	kg/t	0.0000	kg/t	-	1.38	8	-	-	-	-	-	-
Dozers on ROM coal stockpiles	0	0	0	50	0	h/y	20.0	kg/h	6.4	kg/h	0.440	kg/h	-	-	8	-	-	-	-	7	-
Dozers on product coal stockpiles	0	0	0	50	0	h/y	8.6	kg/h	2.5	kg/h	0.188	kg/h	-	-	11	-	-	-	-	5	-
Conveyer to product stockpiles	0	0	0	70	0	t/y	0.00015	kg/t	0.00007	kg/t	0.0000	kg/t	-	1.38	11	-	-	-	-	-	-
Loading product coal to trains	0	0	0	0	0	t/y	0.00040	kg/t	0.00017	kg/t	0.0000	kg/t	-	-	-	-	-	-	-	-	-
Wind erosion from active pits	78686	39343	5901	0	90	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from active dumps	107246	53623	8043	0	122	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from partially rehabilitated dumps	0	0	0	30	0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	0	0	0	50	0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpile	0	0	0	50	0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-	-	-
Grading roads	9232	3264	101	50	30000	km	0.61547	kg/VKT	0.2176	kg/VKT	0.007	kg/VKT	-	-	-	-	-	-	-	-	8
Dragline working on overburden	0	0	0	0	0	t/bcm	0.03	kg/bcm	0.01	kg/bcm	0.002	kg/bcm	-	-	2	7	-	-	-	-	-
	2199076	650560	124369																		

Source allocations

```
  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil by scraper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 783 kg/y TSP  197 kg/y PM10  39 kg/y PM2.5
 FROM SOURCES  : 2
10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3490 kg/y TSP  1815 kg/y PM10  105 kg/y PM2.5
 FROM SOURCES  : 10
2 3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 24781 kg/y TSP  12886 kg/y PM10  743 kg/y PM2.5
 FROM SOURCES  : 10
2 3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 59889 kg/y TSP  28326 kg/y PM10  4289 kg/y PM2.5
 FROM SOURCES  : 10
2 3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden from pit to dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 404808 kg/y TSP  119624 kg/y PM10  12144 kg/y PM2.5
 FROM SOURCES  : 19
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 59889 kg/y TSP  28326 kg/y PM10  4289 kg/y PM2.5
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers shaping overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 439805 kg/y TSP  107069 kg/y PM10  46179 kg/y PM2.5
 FROM SOURCES  : 10
11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden for rehabilitation
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 219902 kg/y TSP  53534 kg/y PM10  23090 kg/y PM2.5
 FROM SOURCES  : 4
17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 262928 kg/y TSP  83815 kg/y PM10  5784 kg/y PM2.5
 FROM SOURCES  : 10
2 3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading ROM coal to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 211609 kg/y TSP  30433 kg/y PM10  4021 kg/y PM2.5
 FROM SOURCES  : 10
2 3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal from pit to hopper / ROM pad
 ACTIVITY TYPE : Wind insensitive
```

```
 DUST EMISSION : 143697 kg/y TSP  42464 kg/y PM10  4311 kg/y PM2.5
 FROM SOURCES  : 30
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 21 22 23 24 25 26 27 28 29 30 31 32 33 34
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Wind erosion from active pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 78686 kg/y TSP  39343 kg/y PM10  5901 kg/y PM2.5
 FROM SOURCES  : 10
2 3 4 5 6 7 8 9 10 11
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from active dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 107246 kg/y TSP  53623 kg/y PM10  8043 kg/y PM2.5
 FROM SOURCES  : 9
12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9232 kg/y TSP  3264 kg/y PM10  101 kg/y PM2.5
 FROM SOURCES  : 33
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1


 Pit retention sources:
2 3 4 5 6 7 8 9 10 11
```