BHP

Olympic Dam Smelter and Refinery Expansion Project

Environmental Impact Statement

Appendix C3 to Appendix C5

October 2026

BHP

Olympic Dam Smelter and Refinery Expansion Project

Environmental Impact Statement

Appendix C3 to Appendix C5

October 2026

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BHP

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BHP

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Air Quality Impact Assessment

Olympic Dam Smelter and Refinery Expansion Project

Prepared for BHP Olympic Dam Corporation Pty Ltd

May 2026

Air Quality Impact Assessment

Olympic Dam Smelter and Refinery Expansion Project

BHP Olympic Dam Corporation Pty Ltd

May 2026

Approved by

Scott Fishwick
Associate Director | National Technical Lead – Air Quality and Climate
22 May 2026

Level 10 201 Pacific Highway
St Leonards NSW 2065
ABN: 28 141 736 558

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ABN: 28 141 736 558

Executive summary

BHP Olympic Dam Corporation Pty Ltd (BHP) is proposing to develop the Smelter and Refinery Expansion Project (SRE Project) at the Olympic Dam mining operations, in the far north of South Australia (SA) (Figure 1.1).

EMM Consulting Pty Ltd and Lathwida Environmental Pty Ltd (EMM-Lathwida) are preparing an Environmental Impact Statement (EIS) for the SRE Project in accordance with EIS assessment requirements and Practice Direction 17 Impact Assessed Development under the *Planning, Development and Infrastructure Act 2016* (PDI Act) (SA).

EMM was commissioned by BHP to undertake an air quality impact assessment (AQIA) of the proposed air quality-related SRE Project activities to:

- determine if the activities have the potential to result in changes to the baseline air quality environment (baseline condition assessment in Chapter 2 of this report)
- determine the likely magnitude of the change to baseline air quality values as a result of the SRE Project (effects assessment in Chapter 3 of this report)
- quantify the likely impacts resulting from the predicted change to baseline air quality values on identified receptors (impact assessment in Chapter 4 of this report).

An analysis of existing air quality and dispersion meteorological conditions in the study area was undertaken.

Meteorological input data to the dispersion modelling for the SRE Project was sourced from the Bureau of Meteorology (BoM) Olympic Dam Aerodrome for the 2024 calendar year.

Baseline air quality concentrations for the study area were derived primarily from BHP air quality monitoring data in the Olympic Dam region (two sensitive receptor stations [Olympic Dam Village and Roxby Downs] and one background station [Northern Background]).

In order to assess the significance of emissions and impacts from the SRE Project relative to existing operations at Olympic Dam, the following emission scenarios have been developed for this AQIA:

- existing business as usual (BAU) operations, hereafter referred to as BAU operations
- three future operations scenarios, comprising BAU and SRE Project emissions:
  - Stage 1a SRE operations
  - Stage 1b SRE operations
  - Stage 2 SRE operations.

Air pollutant emissions were quantified for all four scenarios listed above. Through the analysis, it was determined that Stage 2 SRE operations represented the highest emission potential for the entire SRE phase. Therefore, focus is given to Stage 2 SRE emissions and impacts in this report.

Emissions were quantified for the following air pollutants:

- particulate matter, specifically:
  - total suspended particulate (TSP)
  - particulate matter less than 10 micrometres in aerodynamic equivalent diameter (PM_{10})
  - particulate matter less than 2.5 micrometres in aerodynamic equivalent diameter ($PM_{2.5}$)

- sulphur dioxide (SO_2)
- sulphur trioxide (SO_3)
- hydrogen sulphide (H_2S)
- oxides of nitrogen (NO_x)[1], including nitrogen dioxide (NO_2)
- carbon monoxide (VOC)
- hydrogen chloride (HCl)
- fluoride compounds
- metals and metalloids.

Emissions were quantified for a range of stack sources and fugitive emission processes associated with the BAU operations (using the FY25 NPI reporting totals) and the SRE Project. The emission totals derived from the calculations show that the introduction of the SRE Project will increase annual air pollutant emissions relative to BAU operations; however, the magnitude of increase varies by pollutant. Compliance with all relevant stack emission concentration limits, consistent with Schedule 4 of the *Environment Protection (Air Quality) Policy 2016* (Air Quality EPP), is expected for all SRE Stage 2 emission sources.

Dispersion modelling was undertaken for both BAU operations and SRE Stage 2 + existing operations. The atmospheric dispersion modelling completed for the air quality impact assessment used the AERMOD dispersion model (version v24142).

Modelling for BAU operational emissions returned predicted concentrations for all pollutants and averaging periods that are below the applicable ground level concentration limits listed in Schedule 2 of the Air Quality EPP at all modelled receptor locations.

The SRE Project is predicted to increase air quality impacts at neighbouring sensitive receptor locations relative to BAU operations. The most significant increase in predicted concentrations as a result of the SRE Project Stage 2 occurs for SO_2, copper, manganese and particulate matter (PM_{10}, $PM_{2.5}$).

Despite the predicted increase in air quality emissions, the predicted concentrations for all pollutants and averaging periods are below the applicable ground level concentration limits listed in Schedule 2 of the Air Quality EPP at all receptor locations for SRE Project Stage 2 operations.

Following completion of the assessment of effects investigation, it was determined that there were no confirmed air quality impact events assessed as having the potential for a significant impact against BHP's environmental impact assessment framework (EIAF) impact significance criteria.

Irrespective of this outcome, mitigation and management measures are proposed to reduce the impact significance to as low as reasonably achievable (ALARA).

The following fugitive particulate matter emission mitigation measures are incorporated into the design of the SRE Project:

- All RC transported to the SRE Project area in sealed rotainers to eliminate fugitive emission loss during transport.
- The rotainers will be emptied within an enclosure, with dust extraction system if required.

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

- All conveyors and conveyor transfer points moving RC will be fitted with a cover and side wall cladding for wind protection.
- With the exception of the slag haul road, all SRE Project roads will be sealed. Water spraying will occur along all unsealed and sealed roads as required.
- Slag pot trucks will have a reduced travel speed.
- All other material handling and transfer operations (e.g. silo and day bin loading, bedding plant, slag/revert shed, etc) will occur within full enclosures with dust extraction.

Other mitigation measures incorporated into the SRE Project, and accounted for in the dispersion modelling through engineering calculations where relevant, include the following:

- Concentrate retention proposed in ponds (wet), in storage bins, shed, dome, to prevent losses.
- Matte to be stored as a granulate and damp preventing losses.
- Crushing and breaking operations to be in a dedicated area, where possible completed with wet techniques (i.e. slag milling).
- The concentrate material will feature a high moisture content, reducing dust generation potential.
- Venturi scrubbers and off-gas capture are in place at the acid plant to convert to sulphuric acid.
- Primary processes are operated under negative pressure which contains all process emissions within the primary processing equipment and buildings
- Anode furnaces and primary smelting emissions are scrubbed prior to ventilation to atmosphere.
- Optimised stack heights and release characteristics (exhaust flow rate and temperature, exit diameter) to enhance dispersion performance.
- Continuous and periodic emissions monitoring of all significant existing and SRE emission stack sources.

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1 Introduction

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- determine if the activities have the potential to result in changes to the baseline air quality environment (baseline condition assessment in Chapter 2 of this report)
- determine the likely magnitude of the change to baseline air quality values as a result of the SRE Project (effects assessment in Chapter 3 of this report)
- quantify the likely impacts resulting from the predicted change to baseline air quality values on identified receptors (impact assessment in Chapter 4 of this report).

This report supports the EIS, which will be submitted to the Government of South Australia's Minister for Energy and Mining as the relevant Minister for the SRE Project under the *Roxby Downs (Indenture Ratification) Act 1982* (SA).

1.1 Project area definitions

To maintain consistency throughout the EIS and supporting technical assessments, the following terminology related to project infrastructure have been defined for the SRE Project where the **SRE Project Area** is defined at the boundary around the SRE Project for which BHP is seeking approval, including:

- **Special Mining Lease (SML) Area**, located within the SML (Figure 1.2), which is further delineated by the following areas:
  - **SRE Area**: the extent of the proposed SRE Project infrastructure required for construction and operation of the SRE Project within the SML. Includes the existing brownfield plant area, proposed facility relocation(s), proposed plant and laydown areas.
  - **General Infrastructure Area**: the extent of the proposed ancillary infrastructure and ancillary activities required for construction and operation within the SML. Includes the proposed infrastructure laydown areas, proposed stormwater dam location, proposed topsoil and subsoil storage areas.
  - **Water Infrastructure Area**: the extent of the proposed water infrastructure and ancillary activities required for construction and operation within the SML. Includes the proposed water pipeline and water storage dam locations.
- **Electricity Infrastructure Ground Re-Profiling Area (EIGR Area)**: the extent of the isolated proposed vegetation disturbance required to maintain regulatory clearance distances between the 275 kilovolt (kV) transmission line and the ground surface within Clause 28 land. It is noted that the transmission line and infrastructure are already in place, but additional electricity loads required for the SRE Project will result in increased transmission line temperature and more pronounced line sagging and, therefore, changes to existing clearance distances to enable safe operation (Figure 1.3).

1.2 Regulatory context

The SRE Project was declared an Impact Assessed development pursuant to section 108(1)(c) and 108(7) of the PDI Act on 29 August 2024. The declaration reflects the nature, scale and significance of the SRE Project to SA.

Impact Assessed Development is the most rigorous level of development assessment prescribed under the PDI Act.

Specifically, the Minister made the following declaration:

> Pursuant to Section 108(1)(c) and Section 108(7) of the *Planning Development and Infrastructure Act 2016*, having taken into account those principles prescribed under Regulation 27(2) of the Planning, Development and Infrastructure (General) Regulations 2017 (the Regulations) and having given consideration to the matters under Regulation 27(3) of the Regulations, I declare that all development of a kind specified in the Schedule to this Notice, to the extent that it is undertaken on land identified in Clause 28(1) of the Indenture as impact assessed development and that references to "development" include a project.

The majority of the SRE Project activities, with the exception of ground re-profiling within the Electricity Infrastructure Area, would be located wholly within the existing SML but does not include business-as-usual (BAU) operations (operations which enable existing approved production of up to approximately 200,000 tonnes per annum (tpa) total copper production) or activities associated with scheduled campaign maintenance 2027 (SCM27) works. These activities are subject to separate regulation (e.g. Environment Protection Authority (EPA) licensing) and approval. The SRE Project may also be supported by low impact development outside the SML, which could include, for example, minor road works and upgrades to accommodation infrastructure. It is proposed that any approvals required for these activities would be sought on an as-needs basis under applicable legislation and guidelines.

1.2.1 *Planning Development and Infrastructure Act 2016 (SA)*

Development approval is required for the SRE Project under the PDI Act. The PDI Act established a new development assessment system in SA to streamline the assessment process. The PDI Act is supported by subordinate regulations, as well as practice directions and guidelines which are issued by the State Planning Commission, the state's independent principal planning body.

A key feature of the new planning system is the Planning and Design Code (the Code) which contains a single set of planning policy, rules and classifications for SA, which is applied spatially via mapping. The Code establishes a performance-based approach to planning and development assessment by including policies that address the scale, form and design of built structures and the contextual setting of the development.

The planning system established by the PDI Act includes five assessment pathways; accepted development, code assessed development (deemed-to-satisfy or performance assessed) and impact assessed development (restricted and impact assessed). As previously stated, impact assessed development is the most rigorous level of development assessment prescribed under the PDI Act.

i Ministerial declaration – impact assessed development

The declaration subjects the SRE Project to an EIS process requiring detailed environmental, social and economic assessment.

A Scoping Application was prepared by BHP to inform the development of EIS Assessment Requirements by the State Planning Commission (SPC). The EIS Assessment Requirements issued by the SPC summarise all potential issues needing to be addressed by BHP and highlight any further information required by the Minister to enable a proper assessment of the proposed SRE Project.

Due to the operation of the *Roxby Downs (Indenture Ratification) Act 1982*, the Minister for Energy and Mining is the relevant Minister for the SRE Project.

Specific Assessment Requirements for air quality are as follows:

- Provide an air quality impact assessment prepared by an appropriately qualified specialist for all potential sources of dust/particles and gaseous pollutants associated with the construction and ongoing operation of the proposed development and the facility as a whole, to identify any known or potential human health and amenity effects of air emissions (including point source and diffuse sources) on the local residential population (including workers) and describe how these would be mitigated, minimised, managed and monitored.

- Provide a review and identify any proposed upgrades of the point sources and ambient air quality monitoring systems.

- The impact assessment must include modelling undertaken in accordance with the *Environment Protection (Air Quality) Policy 2016* and the EPA's *Ambient Air Quality Assessment 2016* guidance document. Techniques used to obtain the predictions should be referenced and key assumptions and data sets explained.

- The impact assessment must consider the current level of emissions (baseline) and the cumulative impacts of increased emissions.

1.2.2 Air quality assessment

Policy and guidance relevant to the assessment of air quality and the planning and delivery of the SRE Project is summarised below.

- South Australia Environment Protection Authority (SA EPA) *Environment Protection (Air Quality) Policy 2016* (Air Quality EPP), as amended in May 2023

- *Ambient air quality assessment*, a document developed by SA EPA to support assessment of ambient air quality under the *Environment Protection Act 1993* (EP Act), for which the EPA is the primary regulatory body, and the *Planning, Development and Infrastructure Act 2016*, for which the EPA is a referral body for certain categories of developments.

1.3 Project description

The objective of the SRE Project is to expand BHP's smelter and refinery capacity, enabling the Copper South Australia growth plan by:

- increasing copper production capacity up to 650,000 tpa of total copper plus associated products from the current average production of approximately 200,000 tpa

- delivering a sustainable, highly productive, and more resilient smelting and refining flowsheet

- ensuring the Cu:S ratio is resolved at Olympic Dam for copper concentrate production

- delivering reliable and predictable production outcomes following the 2023 acquisition of OZ Minerals' Carrapateena and Prominent Hill mining operations to realise Copper SA province opportunities.

Key elements of the SRE Project are:

- expansion of, and additions to, the existing smelter and refinery to enable total production of up to 650,000 tpa copper plus associated products
- introduction of two-stage smelting involving the installation of a new primary flash smelting furnace (FSF) to produce copper matte, adding material smelting capacity
- conversion of the existing direct-to-blister flash furnace (DBF) to a flash converting furnace (FCF), which would process the matte into blister
- addition of an acid plant of similar nature and scale to the existing acid plant and subsequent upgrade of the existing acid plant
- expansion of the electrorefinery and precious metals recovery facilities to produce cathode copper, gold, and silver.

Associated with these key elements, the SRE Project would require new supporting facilities, infrastructure and services and the upgrade, removal and/or relocation of existing facilities and services within the SML Area (Figure 1.2).

External to the SML Area, electricity would be supplied to the SRE Project through the existing 275 kV line from Davenport substation (near Port Augusta) to Olympic Dam mine, located within Clause 28 land[2] (EIGR Areas). Whilst the transmission line and infrastructure are already in place, additional electricity loads required for the SRE Project will result in increased transmission line temperature and more pronounced line sagging, reducing the existing electrical clearances that are required to enable safe operation. The maintenance of the required electrical clearances between the 275 kV line and the ground surface would necessitate isolated areas of land disturbance and associated vegetation clearance (Figure 1.3).

The SRE Project would be constructed and operated in a staged manner to enable production capacity up to 650,000 tpa of total copper and associated products, with stages detailed in Table 1.1.

This technical assessment has been prepared based upon the maximum potential impacts associated with Stage 2 (i.e. the greatest impact scenario) to ensure that the full extent of all potential impacts is identified and assessed.

The indicative location of key infrastructure is shown in Figure 1.2 and Figure 1.3, while the key project characteristics are outlined in Table 1.2.

2 Clause 28 land as defined under the Roxby Downs (Indenture Ratification) Act 1982 (SA)

Table 1.1 Project stages and timing

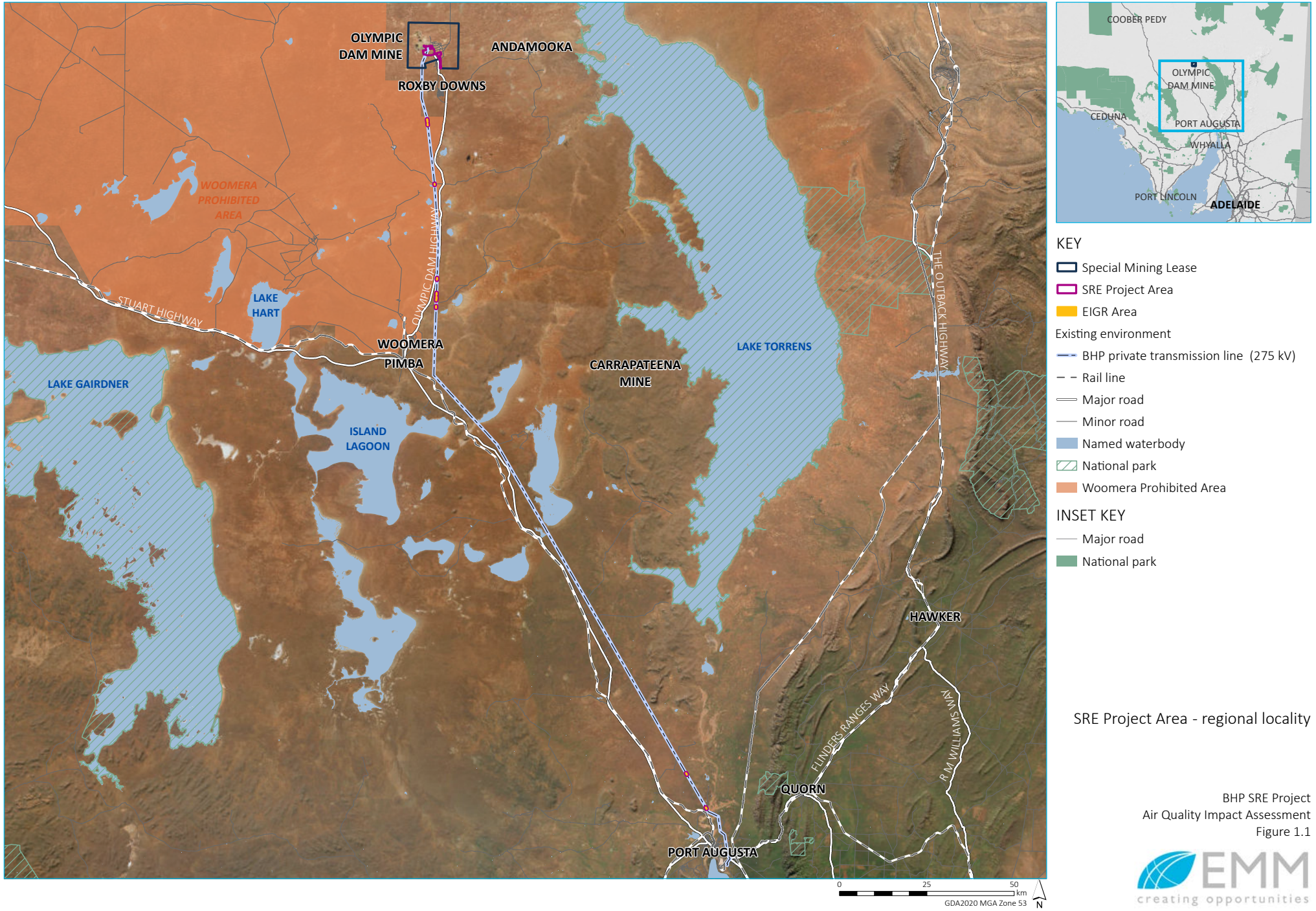
Stage	Smelter concentrate throughput (tpa)	Description	Anticipated timing
Stage 1a	1,100,000	Stage 1a includes: • an increase of smelter throughput to approximately 1,100,000 tpa of concentrate producing an output of approximately 390,000 tpa of total copper • a new regional concentrate receiving, handling and blending facility • additional concentrate leach capacity • upgrade and expansion of the existing smelter feed preparation, including additional concentrate storage, blending and a new steam dryer • installation of a new primary FSF to produce copper matte and conversion of the existing DBF to an FCF to convert matte to blister, including additional anode furnace and anode casting infrastructure and decommissioning of the existing electric slag reduction furnace (EF) if required • expansion of the brownfield slag concentrator supported by FSF slag cooling pits, a new interim slag stockpile and associated environmental management infrastructure • new off-gas management infrastructure, including additional gas and dust handling equipment • a new acid plant, additional acid storage and an associated acid loading station to allow the export of acid • a new electrorefinery and associated anode preparation infrastructure • a new slimes treatment plant • expansion of the precious-metals refinery (PMR) facility.	2028 to 2032
Stage 1b	1,400,000	Stage 1b includes: • an increase in smelter throughput to approximately 1,400,000 tpa of concentrate producing an output of approximately 500,000 tpa of total copper • installation of additional concentrate leach thickening and filtration infrastructure • development of greenfield slag concentrator and associated stockpile, and decommissioning of brownfield slag concentrator • incremental expansion of Stage 1a infrastructure and services, including: – the installation of additional electrorefinery modules – expansion of feed preparation, FCF feed system (including lime addition), off-gas management, acid plant, slimes treatment and PMR capacities.	2032 to 2036
Stage 2	2,000,000	Stage 2 includes: • an increase in smelter throughput to approximately 2,000,000 tpa of concentrate producing an output of approximately 650,000 tpa of total copper • installation of new concentrate leach circuit for treatment of imported concentrate • incremental expansion of Stage 1b infrastructure and services, including: – the installation of additional electrorefinery modules – the installation of an additional anode furnace and associated off-gas management infrastructure – expansion of feed preparation, FSF and FCF feed systems, off-gas and slag management, acid plant, slimes treatment and PMR capacities.	2038 to closure

Table 1.2 Key characteristics of the SRE Project

Project element	Summary
Smelter and refinery expansion and additions	Expansion of, and additions to, the existing smelter and refinery to enable production of up to 650,000 tpa copper plus associated products (gold, silver and acid). This would include: • a new concentrate handling and blending facility • additional concentrate leach capacity • upgrade and expansion of existing smelter feed preparation • installation of a new primary FSF to produce copper matte and conversion of the existing DBF to a FCF to convert matte to blister, including additional anode furnace and anode casting infrastructure • upgrade the existing slag concentrator circuit and subsequent development of a new slag concentrator circuit • new off-gas management infrastructure, including additional gas and dust handling equipment • a new acid plant and upgrade of the existing acid plants • a new electro-refinery and associated infrastructure • a new slimes treatment plant • expansion of the PMR facility • slag stockpile and treatment.
Electricity demand, supply and distribution	An electricity demand of up to 68 Mega Volt-Amperes (MVA) net load increase would be required for the SRE Project. The additional electrical demand due to the SRE Project would be met by capacity from the national grid via the existing 275 kV transmission line (noting potential for below line land disturbance and associated vegetation clearance outside of the SML). Minor augmentation of existing onsite electricity supply infrastructure at Olympic Dam within the SML would be to ensure the additional capacity could be achieved and maintained. New high and low voltage power supply and reticulation infrastructure would be required to all smelter infrastructure.
Water demand	Water demand of between 2 and 16 megalitres per day (ML/day) required for the SRE Project in addition to the existing supply for current operations.
Water supply and distribution	The SRE Project proposes no additional water extraction from the Great Artesian Basin (GAB) above daily average BAU volumes. Water supply for the SRE Project would nominally be provided from the Department for Infrastructure and Transport (DIT) Northern Water Project (NWP) infrastructure, following commissioning of the initial 90 ML/d capacity of the NWP. This would require new water storage and distribution infrastructure to connect the SRE Project to the NWP connection point at the SML boundary. The NWP water supply may be supplemented or offset by the provision of local groundwater supply (subject to further approvals). This water supply would occur via existing process storage dams, the desalination plant at the Olympic Dam site, and/or through the distribution of the existing water supply within daily average BAU volumes. The additional water supplies are likely to require augmentation of the existing desalination water treatment plant and water distribution network, and a demineralised water plant will be required to support the SRE Project operations.

<table>
<tr><th>Project element</th><th>Summary</th></tr>
<tr><td>Supporting infrastructure</td><td>Supporting infrastructure includes:
civil infrastructure works, such as roads and stormwater infrastructure
new offices and crib rooms
new workshops
new laydown areas
process control system upgrades
concrete batching
other supporting infrastructure as required to facilitate the implementation and operation of the SRE Project.</td></tr>
<tr><td>Waste management</td><td>Development of the SRE Project may require decommissioning of existing processing plant components including dryers, the electric furnace and the existing concentrate storage and transfer system. Some of the decommissioned infrastructure would be retained in situ to preserve operational flexibility or for future management under the site Closure Management and Rehabilitation Plan; however, some elements may require disposal as a component of the SRE Project.
Waste generated during construction would be managed as follows:
where practicable, demolition materials would be removed from site and recycled
materials not suitable for removal from site would be managed on the SML via existing waste management facilities.
All waste generated from construction of the SRE Project would be managed in accordance with existing site procedures and approved management plans.
Operational wastes associated with the SRE Project consist of processing and non-processing wastes where:
processing wastes are limited to low-copper slags generated from the smelting and slag concentrator operations that are not suitable for reprocessing and effluent streams from various process operations that are directed to tailings, including from the PMR and smelter off-gas systems
non-processing wastes including reagent packaging wastes and operational consumables.</td></tr>
<tr><td>Workforce</td><td>100% fly in fly out (FIFO) workforce is assumed for construction and the SRE Project operational workforce. Estimated peak construction workforce numbers (in full time equivalents (FTE)) are summarised below.
<table>
<tr><th>Construction stage</th><th>Average FTE</th><th>Peak FTE</th></tr>
<tr><td>Stage 1a</td><td>~708</td><td>~1,313</td></tr>
<tr><td>Stage 1b</td><td>~260</td><td>~515</td></tr>
<tr><td>Stage 2</td><td>~519</td><td>~978</td></tr>
</table>
Following construction, the SRE Project would require the permanent operational workforce summarised below:
<table>
<tr><th>Operational stage</th><th>Additional SRE Project operational workforce</th><th>Total Olympic Dam Smelter and Refinery workforce</th></tr>
<tr><td>Stage 1a</td><td>~207</td><td>766</td></tr>
<tr><td>Stage 1b</td><td>~57 (additional Stage 1a)</td><td>823</td></tr>
<tr><td>Stage 2</td><td>~244 (additional Stage 1b)</td><td>1,067</td></tr>
</table>
SRE Project construction and operational workforce is proposed to utilise existing and new accommodation to be established by BHP for the scheduled campaign maintenance 2027 (SCM27) shutdown, Olympic Dam future campaign maintenance accommodation, and/or greenfield accommodation (subject to separate approvals).</td></tr>
</table>

Project element	Summary
Concentrate import	Import of copper concentrate from Prominent Hill and Carrapateena mining operations, as well as possible future mining operations (e.g. Oak Dam), and maintain the ability to receive copper concentrate from other third-party suppliers. Prominent Hill concentrate may be passed through concentrate leach to remove fluorides prior to smelter feed preparation. Carrapateena concentrate to pass directly to smelter feed preparation. Other, third-party concentrates may be passed through concentrate leach to remove deleterious elements (e.g. fluorides) prior to smelter feed preparation as required.
Production and export	Total production volumes of up to: • ~650,000 tpa of cathode copper • ~893,000 ounces per annum of gold • ~3,950,000 ounces per annum of silver • ~4,900 tpa of uranium oxide concentrate; note that the SRE Project does not materially change existing uranium production, with an increase of approximately 1% expected as a result of the leaching of Prominent Hill concentrate to remove fluoride. No upgrade or modification of uranium production facilities is proposed as a part of the SRE Project. • ~1,700,000–1,900,000 tpa of 98% sulphuric acid (H_2SO_4), of which up to approximately 810,000 tpa may be exported from Olympic Dam (i.e. operations become 'net' sulphuric acid producer).



KEY

- Special Mining Lease
- SRE Project Area
- EIGR Area

Existing environment

- BHP private transmission line (275 kV)
- Rail line
- Major road
- Minor road
- Named waterbody
- National park
- Woomera Prohibited Area

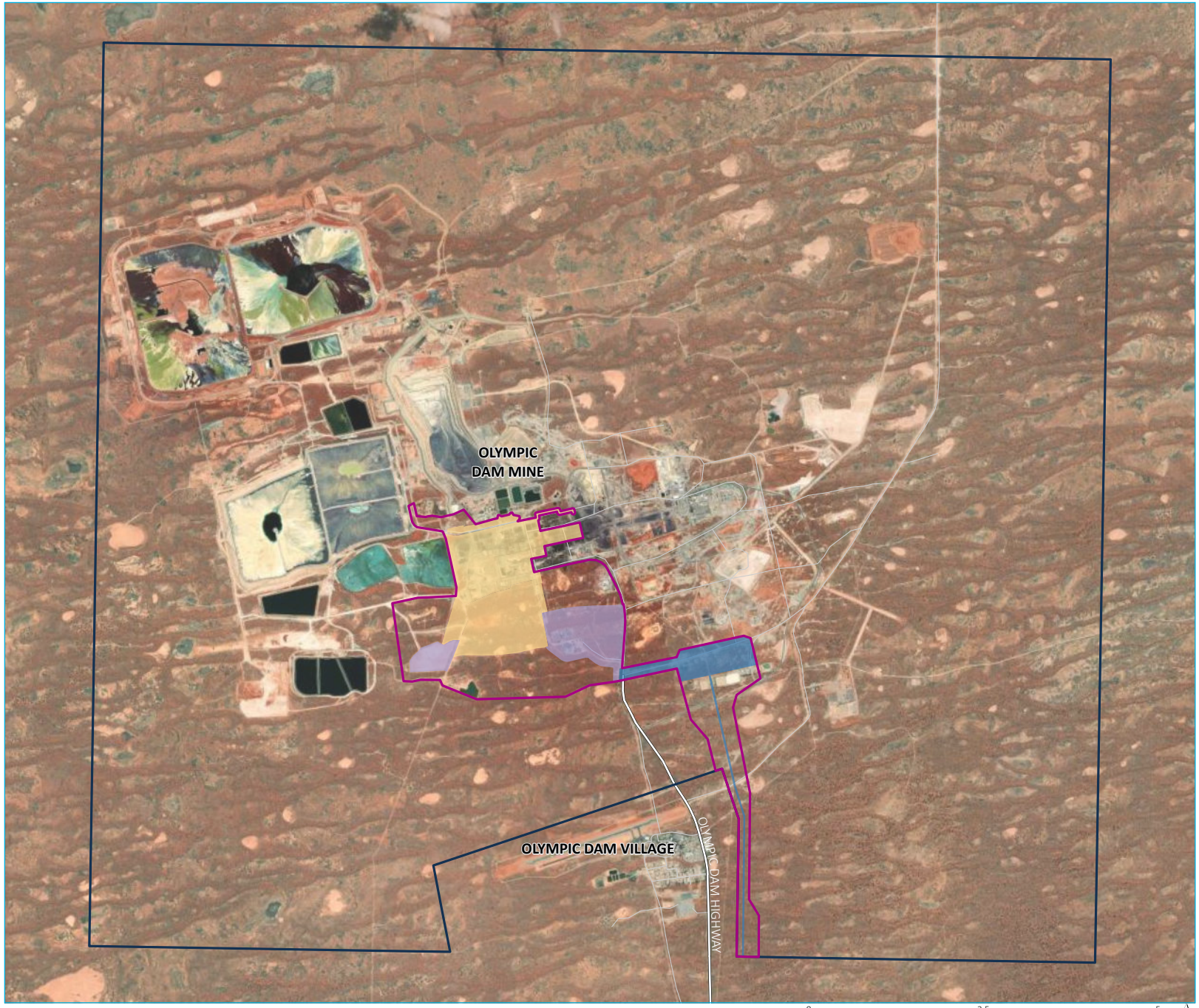
INSET KEY

- Major road
- National park

SRE Project Area - regional locality

BHP SRE Project
Air Quality Impact Assessment
Figure 1.1

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KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area

Existing environment

- Major road
- Minor road

0 2.5 5 km

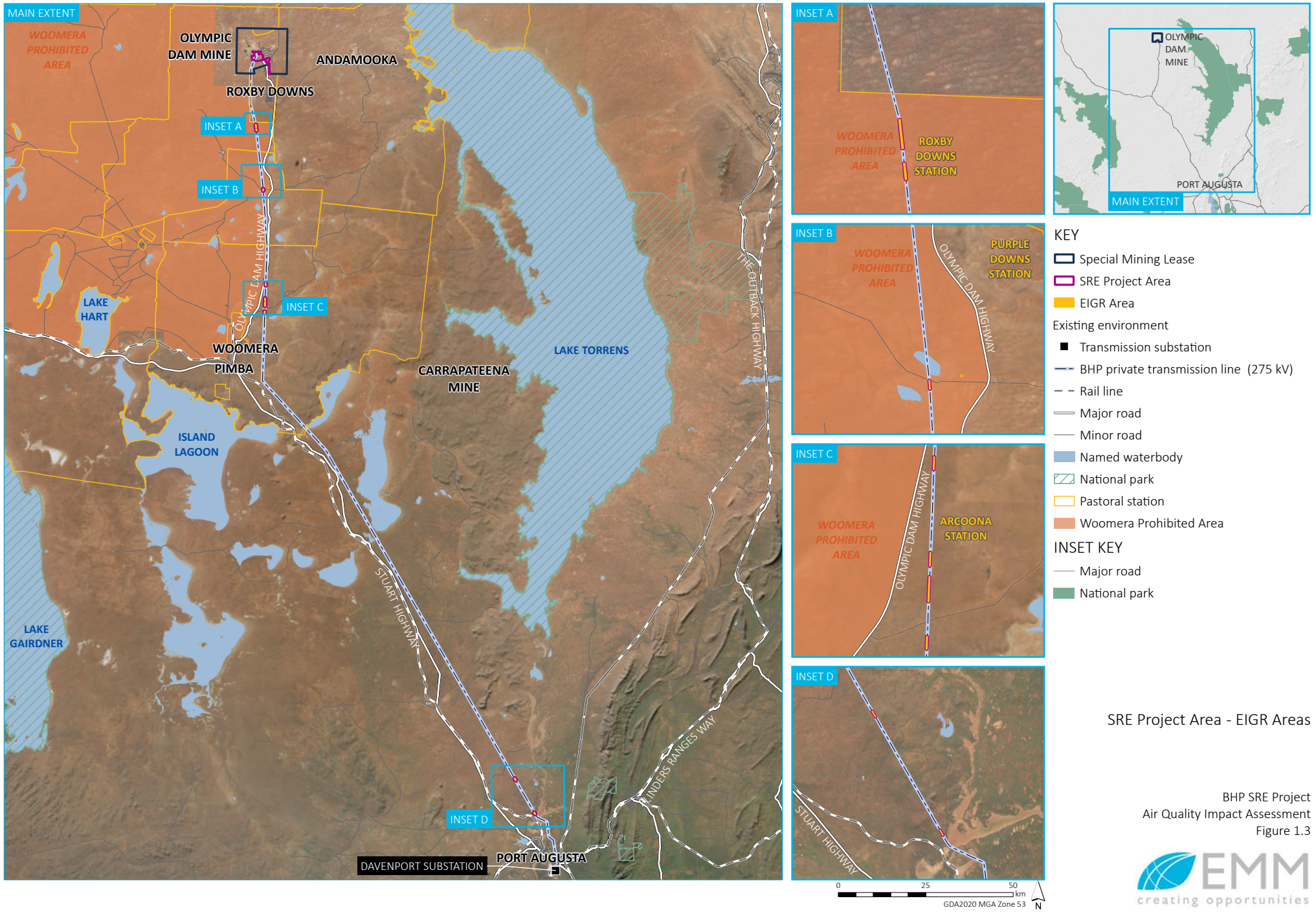
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SRE Project Area - SML Area

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Air Quality Impact Assessment
Figure 1.2

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SRE Project Area - EIGR Areas

BHP SRE Project
Air Quality Impact Assessment
Figure 1.3

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2 Baseline condition assessment

In order to quantify the potential effects of the SRE Project on air quality values and the subsequent impacts to receptors, it is necessary to understand the existing baseline environment, and specifically:

- to classify and describe the existing air quality environment prior to the development of the SRE Project (baseline assessment)
- to provide a basis for project activities aimed at describing the likely change in the baseline environment as a result of the development of the SRE Project and quantifying the significance of resultant impacts to receptors (impact assessment).

2.1 Environmental context

2.1.1 Site location

The SRE Project is located at the Olympic Dam mining operations, approximately, 580 kilometres (km) north of Adelaide in the far north of South Australia (Figure 1.1).

The existing BHP Olympic Dam includes a mining concentrator, smelter and refinery, with the smelter treating high grade copper concentrates through a single-stage DBF smelter, with an average output of approximately 200,000 tpa of total copper (and associated products).

Site access is via Olympic Dam Highway to the existing Olympic Dam mine site. The SRE Project is serviced by internal (and proposed new) access road, with public access restricted at the main entrance to the mine site.

Olympic Dam airport is located approximately 6 km south of the existing Olympic Dam mine. The closest township is Roxby Downs which is approximately 15 km south of the mine site.

2.1.2 Study area

The study area for the baseline AQIA is illustrated in Figure 2.6. The study area covers the SRE Area, General Infrastructure Area and Water Infrastructure Area within the SML, as well as Olympic Dam Village and Roxby Downs.

2.1.3 Terrain and land cover

The SRE Project Area is located within the Gawler Interim Biogeographic Regionalisation of Australia (IBRA) Bioregion which spans approximately 123,605 km^2.

The Gawler Bioregion is characterised by semi-arid to arid flat to rounded landscapes, rocky hills, plains and salt-encrusted lake beds. The native vegetation across the area is generally relatively intact, but highly disturbed in some areas particularly near stock watering points or infrastructure.

The surrounding landscape of the SRE Project includes the Olympic Dam operations, Olympic Dam Aerodrome, and Olympic Dam Village and the nearby township of Roxby Downs, which is connected by a network of established roads. Beyond this, there are large areas of native vegetation to which are subject to pastoral leasing.

The study area sits within the Olympic Dam area where the landscape consists of small undulating plains covered with intermittent native vegetation, sand dunes and claypans. The topography is generally flat with slight undulations.

2.1.4 Meteorology

i Monitoring data resources

Meteorology is one of the most important considerations when assessing the impacts of air pollutant emissions from a new or modified project to the surrounding environment.

BHP maintains three air quality monitoring stations (AQMS) as part of the air quality monitoring network for the operations of the Olympic Dam site (see Section 2.2.3 for further discussion on the monitoring network):

- Olympic Dam Village, located approximately 700 metres (m) to the south of the Olympic Dam Special Mining Lease (SML) boundary
- Roxby Downs, located approximately 6.5 km to the south of the Olympic Dam SML boundary
- Northern Background, located approximately 11.0 km to the north of the Olympic Dam SML boundary.

The Olympic Dam Village and Roxby Downs AQMS are classed as sensitive receptor monitoring locations. The Northern Background AQMS is a background monitoring location. Each of these AQMS locations are co-located with a weather station to record meteorological parameters.

In addition to the three BHP AQMS locations, the Bureau of Meteorology (BoM) maintain the Roxby Downs (Olympic Dam Aerodrome) automatic weather station (AWS) (station 016096), located approximately 300 m to the south of the Olympic Dam SML boundary. The BoM Olympic Dam Aerodrome AWS records measurements of wind speed, wind direction, standard deviation of wind direction, temperature, relative humidity, station-level barometric pressure and cloud observations.

ii Selection of a representative year

The meteorological data from all four meteorological monitoring stations (one BoM, three BHP) were analysed for the nine-year period between 2016 and 2024. At the time of commencement for this AQIA, 2024 represented the most recent and complete calendar year with regards to available hourly varying measurements.

The analysis, which is presented in Appendix A, demonstrated the following:

- In terms of data completeness during the 2024 calendar year, all stations feature excellent data completeness across measured parameters. The BoM Olympic Dam Aerodrome dataset featured the highest percentage for data completeness at 99.9% for the majority of parameters, relative to 93% for the BHP Northern Background dataset, 95% for the BHP Olympic Dam Village dataset and 99% for the Roxby Downs dataset.
- At each monitoring location, the annual wind roses show close agreement across the nine-year period reviewed, both in terms of the range of wind speed and distribution of recorded wind direction. It is considered that any of the individual years reviewed could be adopted as representative of the wind conditions experienced at the four monitoring locations.
- Across the nine-year period of data analysed, the BoM Olympic Dam Aerodrome and BHP Northern Background datasets show a strong agreement in both recorded wind speed and wind direction (prevailing alignment along the north-south axis). By comparison, the BHP Olympic Village and BHP Roxby Downs datasets feature a typically lower wind speed. It is likely that the difference in recorded wind speed is attributable to differences in the local land cover between the stations (e.g. built structures in the vicinity of the BHP Olympic Village and BHP Roxby Downs stations versus sparser land coverage at the BoM Olympic Dam Aerodrome and BHP Northern Background sites). It is considered that the BoM Olympic Dam Aerodrome and Northern Background datasets are more appropriate datasets for adoption in this assessment.

The BoM Olympic Dam Aerodrome AWS dataset for 2024 has been selected as the primary reference point for meteorological conditions in the study area over the BHP Northern Background dataset on the basis that the dataset features a higher data completeness rate in 2024 and records more of the meteorological parameters that are required for dispersion modelling inputs.

The BoM Olympic Dam Aerodrome AWS dataset showed a similarity across the analysed years in terms of the most important parameters for pollutant dispersion, such as wind speed, wind direction and the frequency of calm conditions (wind speed less than 0.5 metres per second (m/s))[3]. The annual average wind speed recorded by the BoM Olympic Dam Aerodrome AWS ranged from 4.2 m/s to 4.5 m/s. The frequency of calm conditions ranged from 1.6% to 4.2%; however, it is noted that the anemometer was upgraded in 2020[4] which may have influenced instrument sensitivity to low wind conditions (e.g. anemometer stall speed).

The inter-annual profiles for air temperature and relative humidity were also generally comparable between 2016 and 2024.

On the basis of similarities in inter-annual trends of wind speed and direction, air temperature and relative humidity, the BoM Olympic Dam Aerodrome AWS dataset for 2024 was considered to be suitably representative for use in this AQIA.

iii Prevailing winds

An annual wind rose – showing the wind speed and wind direction recorded at the BoM Olympic Dam Aerodrome AWS in 2024 – is presented in Figure 2.1. The wind rose shows that the prevailing winds were from the southern quadrant (south-east to south-west), with a lower frequency northern component. The annual average wind speed in 2024 was 4.3 m/s, with a frequency of calm conditions of 1.7%.

[3] Calm winds are typically associated with stable atmospheric conditions, which have a lower potential for the dispersion of air pollutant emissions.

[4] BoM 2025 - http://www.bom.gov.au/clim_data/cdio/metadata/pdf/siteinfo/IDCJMD0040.016096.SiteInfo.pdf

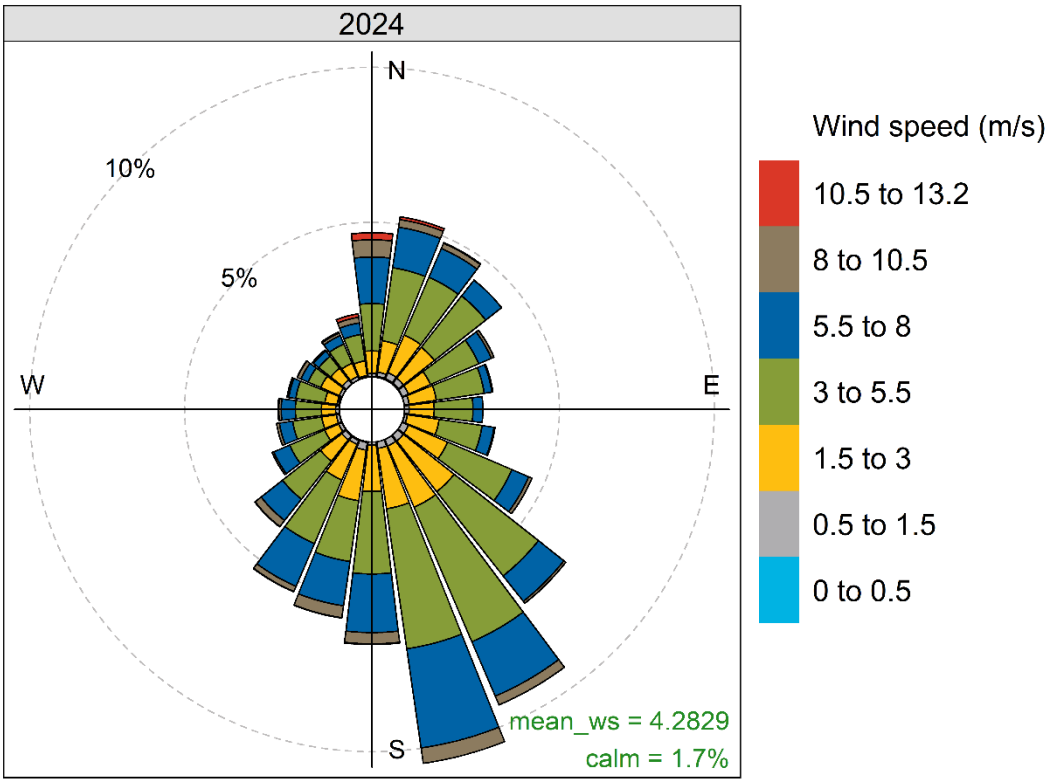


Figure 2.1 Recorded wind speed and direction – BoM Olympic Dam Aerodrome AWS – 2024

Seasonal wind roses from the BoM Olympic Dam Aerodrome AWS 2024 dataset are shown in Figure 2.2. The mean wind speed ranged from 3.7 m/s in autumn to 4.9 m/s in summer.

The frequency of calm conditions ranged from 0.8% in summer to 3.2% in winter. The spring, summer and autumn months featured a higher proportion of wind from the southern quadrant, while winds from the north-east were more common in winter.

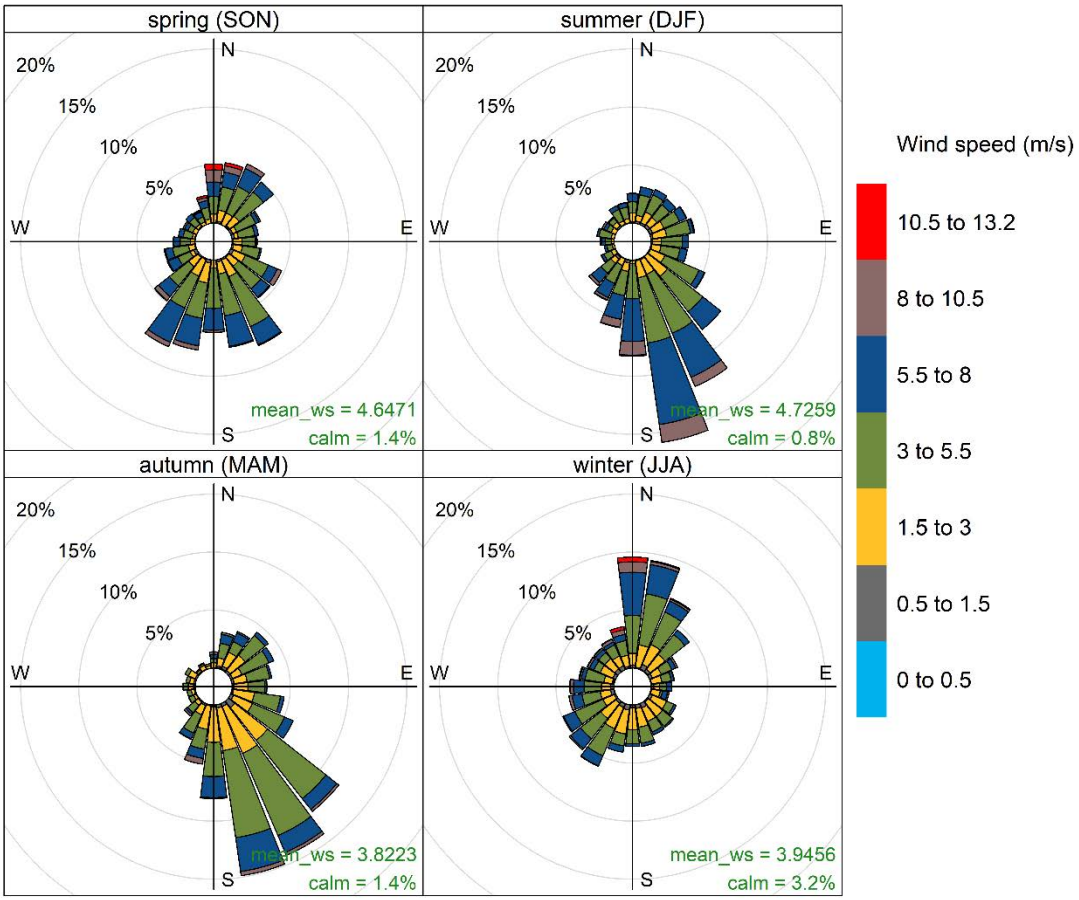


Figure 2.2 Seasonal wind speed and direction – BoM Olympic Dam Aerodrome AWS – 2024

Average wind roses for the daytime and night-time periods are shown in Figure 2.3. The wind patterns during the night-time hours were dominated by air flow from the south, while a more even distribution between southerly and northerly air flow is experienced during the day. Average wind speeds and frequency of calm conditions are comparable between day and night periods.

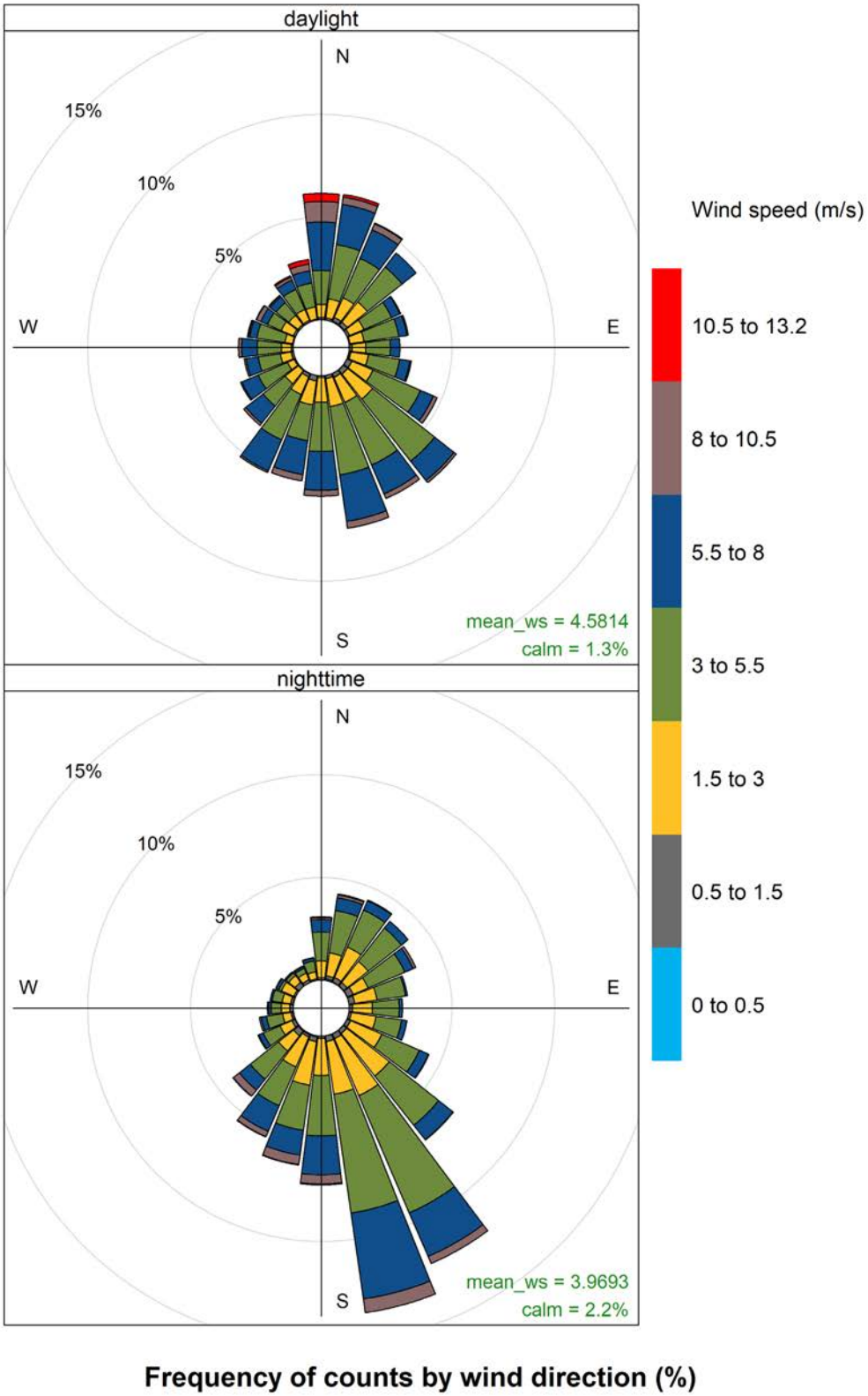


Figure 2.3 **Diurnal wind speed and direction – BoM Olympic Dam Aerodrome AWS – 2024**

iv Atmospheric stability and mixing depth

Atmospheric stability refers to the degree of turbulence or mixing that occurs within the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically, about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 2.4 illustrates the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by AERMET based on observation data collected from the BoM Olympic Dam Aerodrome AWS in 2023.

The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

Hourly-varying atmospheric boundary layer depths were calculated by AERMET and refers to the height of the atmosphere above ground level within which the dispersion of air pollution occurs. The variation in boundary layer depth by hour of the day is illustrated in Figure 2.5. The profile presented in Figure 2.5 shows that greater boundary layer depths are experienced during the daytime hours between mid-morning and late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increase the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.

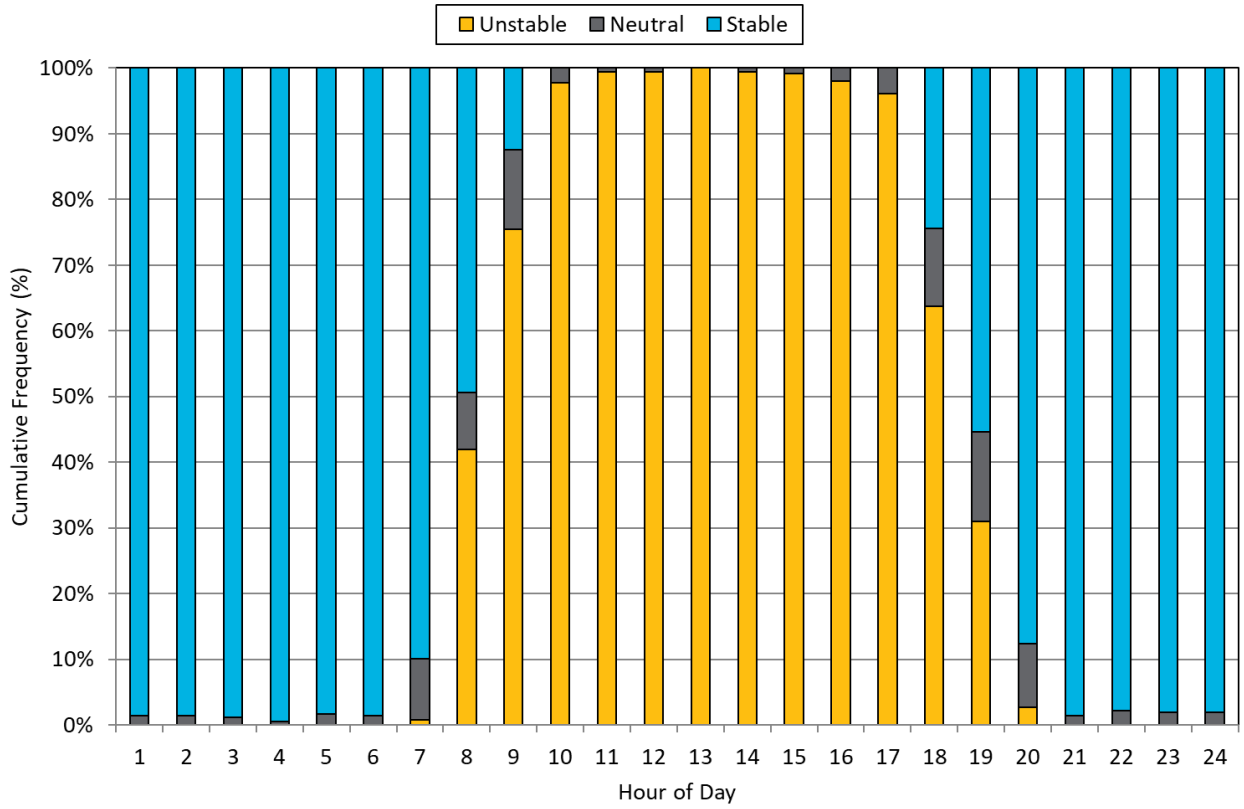


Figure 2.4 AERMET generated diurnal variation in atmospheric stability – BoM Olympic Dam Aerodrome AWS – 2024

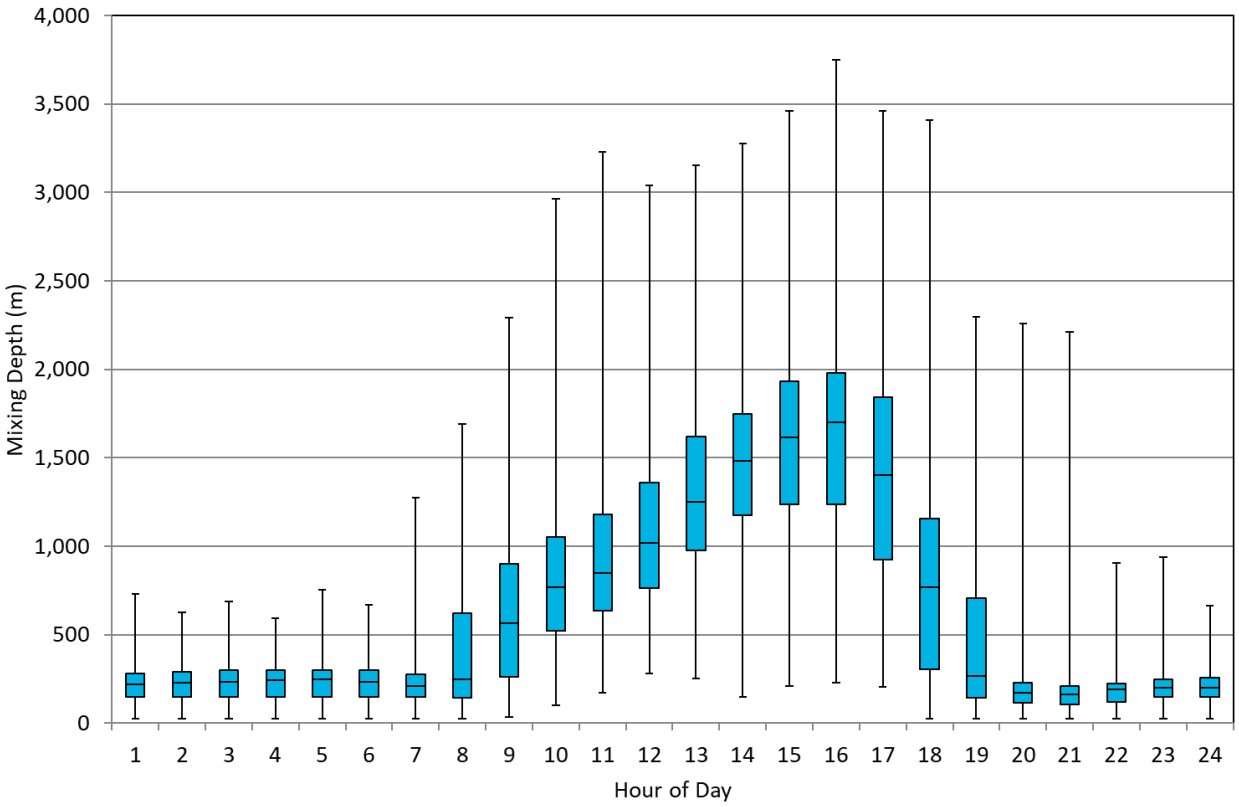


Figure 2.5 **AERMET generated diurnal variation in atmospheric boundary layer depth – BoM Olympic Dam Aerodrome AWS – 2024**

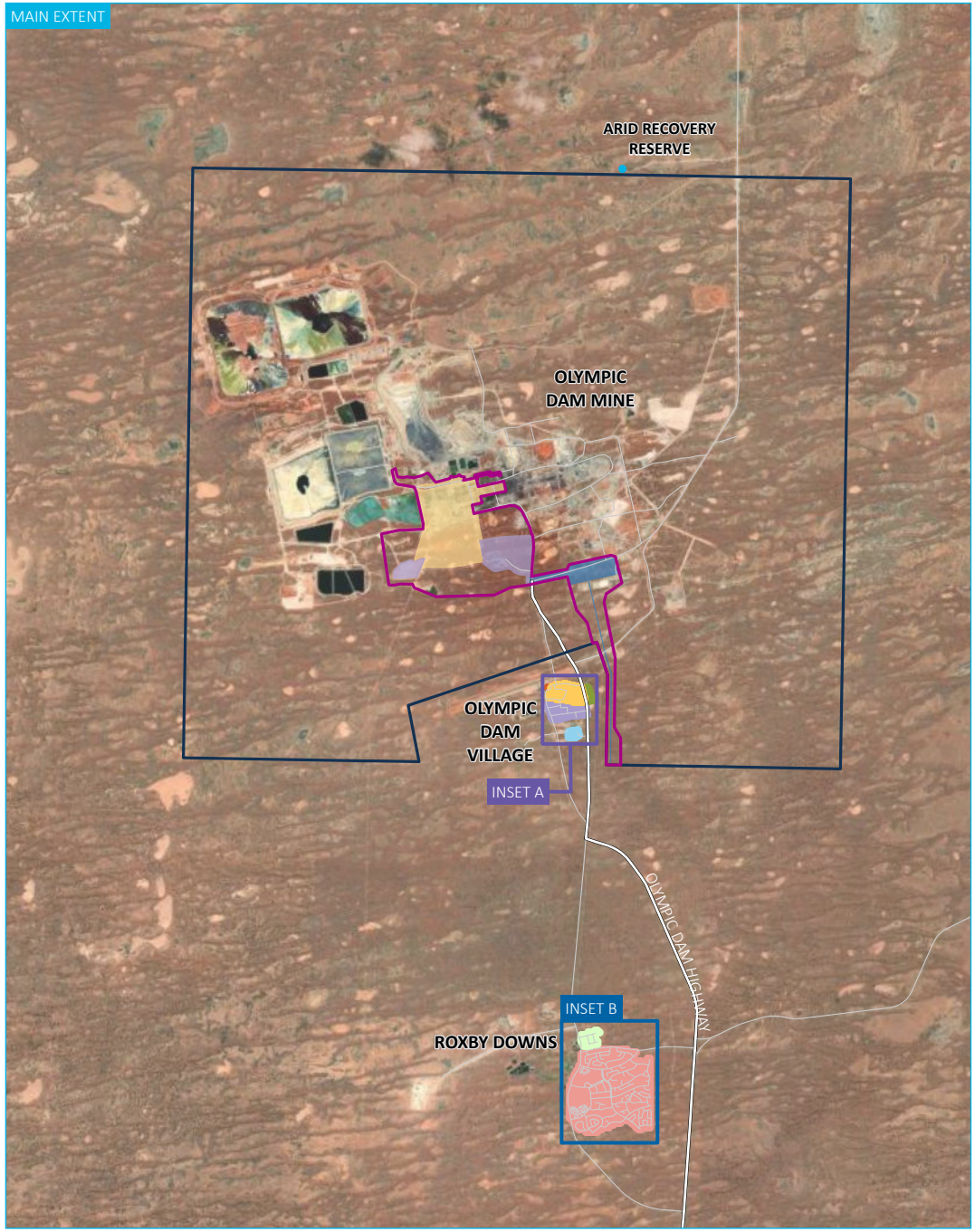
2.1.5 Assessment locations

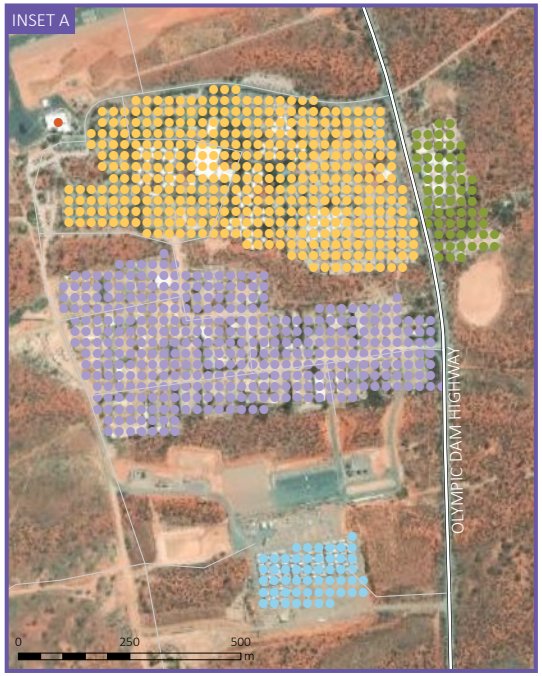
Assessment locations representative of human-receptor locations have been selected from the study area, which include a mixture of workers accommodation camps, residential dwellings, industrial and commercial properties and an airport. Rather than select individual dwellings or buildings, each identified area of receptor developments has been allocated a 25 m resolution receptor point grid for the purpose of assessing potential air quality impacts over entire populated areas.

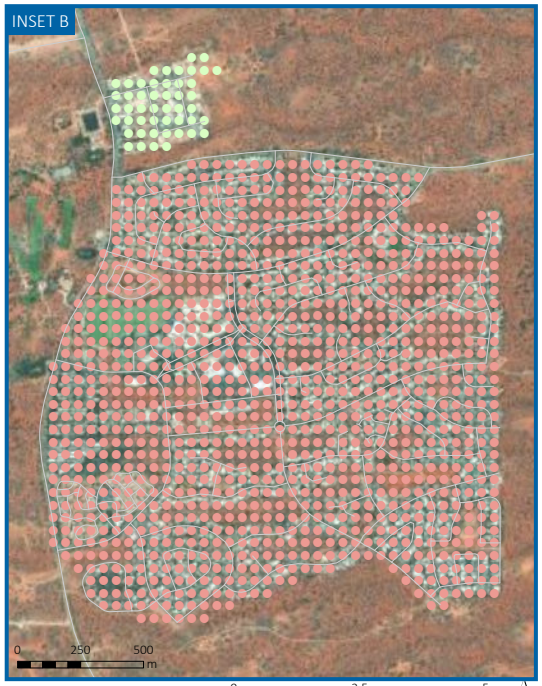
As documented in Section 2.1.4, the Olympic Dam Village and Roxby Downs are classed as sensitive receptor locations for air quality monitoring purposes. Details of the assessment location areas and the gridded receptor points allocated in the model are provided in Table 2.1 and Figure 2.6.

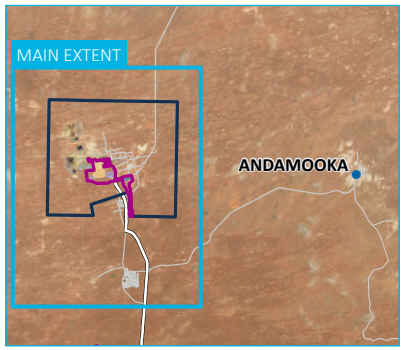
Table 2.1 Assessment locations

Assessment area	Receptor type	Number of gridded receptor points in model
BHP Industrial Estate	Industrial	372
Olympic Dam Aerodrome	Transport	1
Olympic Dam Commercial	Commercial	63
Olympic Dam Village	Worker's accommodation	394
Olympic Dam Village South	Worker's accommodation	52
Roxby Downs	Residential/Commercial/Education	1,145
Roxby Downs Industrial Estate	Industrial	48
Andamooka	Residential	1
Arid Recovery Reserve	Commercial/Education	1









KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area

Model assessment location

- Andamooka
- Arid Recovery Reserve
- BHP Industrial Estate
- Olympic Dam Aerodrome
- Olympic Dam Commercial
- Olympic Dam Village
- Olympic Dam Village South
- Roxby Downs
- Roxby Downs Industrial

Existing environment

- Major road
- Minor road

0 2.5 5 km

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N

Model assessment locations

BHP SRE Project
Air Quality Impact Assessment
Figure 2.6

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2.2 Baseline air quality environment

2.2.1 Potential air pollutants

The BHP Olympic Dam operations, and the proposed SRE Project, have the potential to generate emissions of various air pollutants. Further discussion regarding SRE Project emission sources is provided in Section 3.2.2.

The air pollutants that are of most relevance to assessment of effects, in terms of emission sources, health effects and the potential to exceed air quality criteria, are:

- particulate matter, specifically:
  - total suspended particulate (TSP)
  - particulate matter less than 10 micrometres in aerodynamic equivalent diameter (PM_{10})
  - particulate matter less than 2.5 micrometres in aerodynamic equivalent diameter ($PM_{2.5}$)
- sulphur dioxide (SO_2)
- sulphur trioxide (SO_3)
- oxides of nitrogen (NO_X), including nitrogen dioxide (NO_2)
- carbon monoxide (CO)
- hydrogen chloride (HCl)
- fluoride compounds
- metals and metalloids
- volatile organic compounds (VOCs).

2.2.2 Existing emission sources

The primary existing air pollutant emission source in the study area are considered to be the existing operations at the Olympic Dam site. BHP currently report annual emissions to air from point sources (i.e. stack releases) and fugitive sources (e.g. mining operations, truck movements, material handling and processing, wind-blown dust). To characterise the current contribution from existing sources to air quality impacts for all air pollutants at the adopted model assessment locations (Section 2.1.5), the reported NPI emissions data for the FY24 period has been adopted to best align with the adopted 2024 modelling period. Further discussion on existing emissions is presented in Section 3.2.2.

Beyond the existing operational emissions at the Olympic Dam site, the study area is located in remote South Australia, with the predominant surrounding land being outback and desert. Baseline air quality in the local airshed will be influenced by:

- dust entrainment due to vehicle movements along unsealed and paved town and rural roads with high silt loadings
- minor industrial operations in the BHP and Roxby Downs industrial precincts
- fuel combustion-related emissions from on-road and non-road engines

- long-range transport of fine particles into the region
- wind-generated dust from exposed areas within the surrounding region
- more remote sources which contribute episodically to suspended particles in the region include dust storms and bushfires.

For the purpose of the AQIA, it has been assumed that these emissions sources are accounted for in the monitoring data that has been used to characterise baseline air quality, as described in the following sections of this report.

2.2.3 Air quality monitoring stations

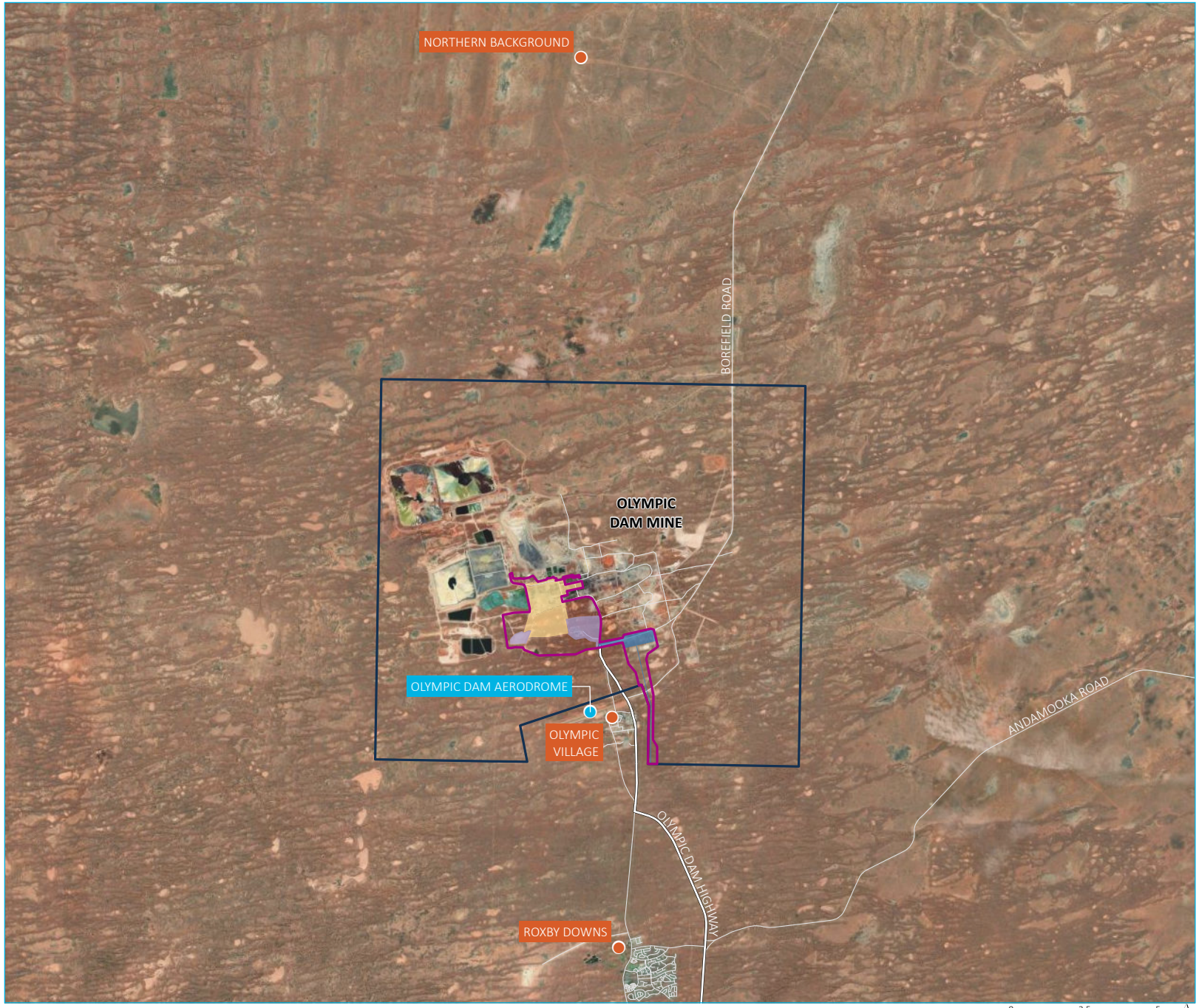
As detailed in Section 2.1.4, BHP maintains three AQMS as a part of the air quality network for Olympic Dam.

For the purpose of the AQIA, the data from the air quality monitoring network at the BHP Olympic Dam mine (Figure 2.7) have been used to represent background concentrations for PM_{10}, and are located as follows:

- Olympic Dam Village, located approximately 700 m to the south of the Olympic Dam SML boundary, records continuous measurements of PM_{10} and SO_2. This station is classed as a sensitive receptor AQMS location.
- Roxby Downs, located approximately 6.5 km to the south of the Olympic Dam SML boundary, records continuous measurements of PM_{10} and SO_2. This station is classed as a sensitive receptor AQMS location.
- Northern Background, located approximately 11.0 km to the north of the Olympic Dam SML boundary, records continuous measurements of PM_{10} only. This station is classed as a background AQMS location.

The existing Olympic Dam monitoring stations do not measure ambient $PM_{2.5}$ concentrations. Data for this metric were, therefore, derived using concurrent measurements of PM_{10} and $PM_{2.5}$ from the now decommissioned BHP Olympic Dam Western Background and Hiltaba Village monitoring stations, which were located approximately 8 km south-west and 14 km south-east of the SML area, respectively. The relationship between PM_{10} and $PM_{2.5}$ from these two sites were applied to the PM_{10} concentration measurements from the three operational BHP Olympic Dam AQMS sites.

In the absence of local monitoring data for NO_x and NO_2, historical SA EPA ambient NO_x/NO_2 monitoring results from Whyalla, located approximately 290 km south-south-east of the SML area, recorded between March 2004 and June 2006 have been adopted to represent background at the study area. It is considered that the use of the historical Whyalla data to represent background NO_2 concentrations in the current report is highly conservative.



Regional air quality monitoring network

BHP SRE Project
Air Quality Impact Assessment
Figure 2.7

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2.2.4 Baseline air quality

i PM_{10}

Summary statistics for PM_{10} for the period between January 2016 and December 2024 at the three BHP AQMS locations are presented in Table 2.2. The corresponding time series plots of 24-hour average PM_{10} concentrations are presented in Figure 2.8. The concentrations presented correspond to total PM_{10} concentrations recorded, rather than the contribution from Olympic Dam operations only. For this AQIA, the total background concentrations (i.e. background plus operational) are utilised to represent background concentrations, which introduces a level of conservatism into the assessment of cumulative particulate matter concentrations.

Table 2.2 Summary statistics for PM_{10} measurements at BHP Olympic Dam sites

Year	Maximum 24-hour average concentration (µg/m³)	70th percentile 24-hour concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 50 µg/m³	Data recovery (%)
Northern Background					
2016	213.8	12.8	12.5	3	99
2017	63.5	10.7	10.7	3	97
2018	77.7	11.3	12.1	7	100
2019	896.0	17.9	24.5	21	93
2020	247.5	12.2	18.2	10	62
2021	139.3	11.9	12.4	8	96
2022	72.3	10.7	11.3	3	90
2023	57.3	11.0	11.2	3	97
2024	61.4	10.3	9.8	2	92
Olympic Village					
2016	145.3	16.9	15.7	4	92
2017	87.9	17.0	16.1	5	97
2018	107.8	17.4	17.3	9	98
2019	672.3	28.3	32.3	30	100
2020	342.3	28.9	31.2	33	92
2021	198.0	25.7	27.3	22	83
2022	218.3	16.5	19.1	7	78
2023	314.1	20.8	21.8	18	90
2024	105.2	18.2	18.4	8	82

Year	Maximum 24-hour average concentration (µg/m³)	70th percentile 24-hour concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 50 µg/m³	Data recovery (%)
Roxby Downs					
2016	98.1	11.5	11.3	3	96
2017	113.1	11.5	11.4	2	99
2018	278.2	18.2	21.5	22	99
2019	372.0	21.8	30.4	38	95
2020	388.4	17.5	23.3	19	93
2021	66.5	15.2	14.6	1	87
2022	45.8	13.7	13.7	0	85
2023	52.3	13.8	12.9	2	94
2024	61.0	11.5	10.5	2	95

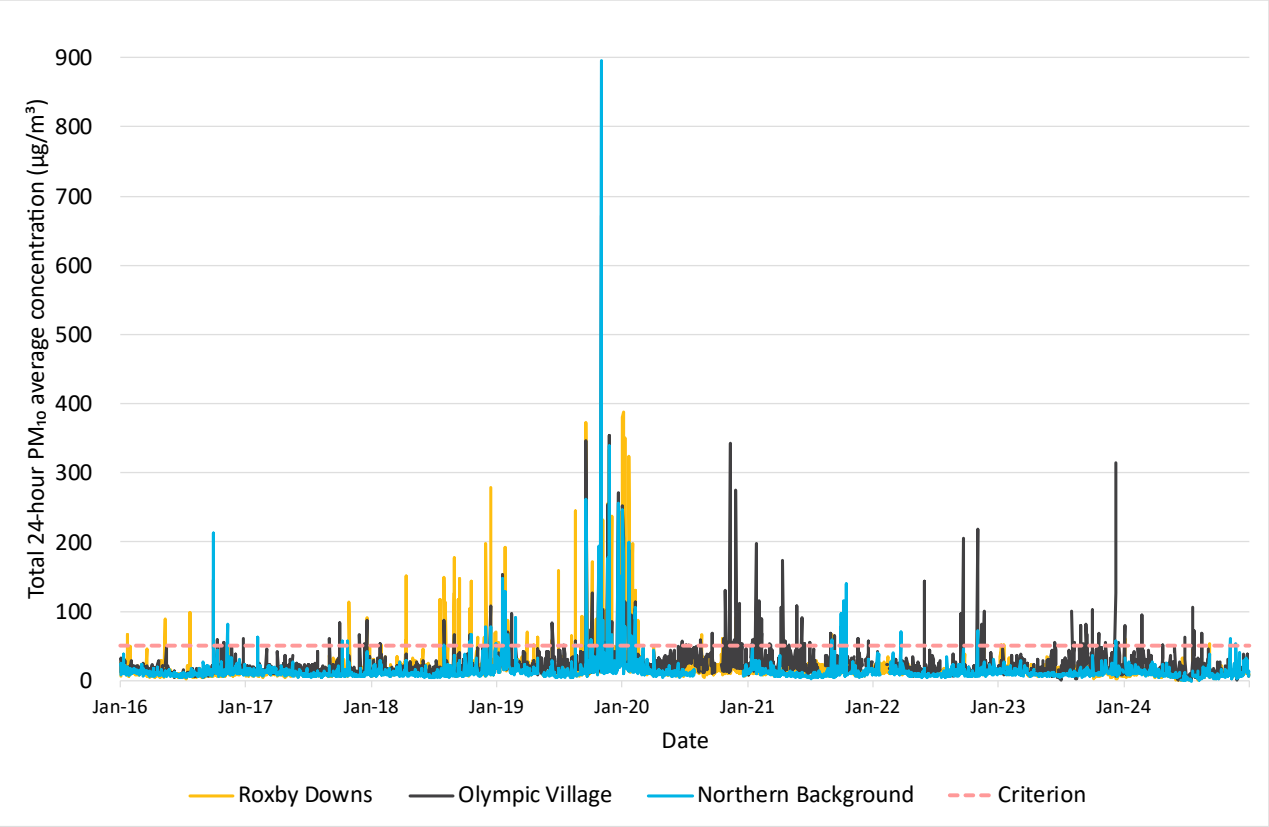


Figure 2.8 **Timeseries plot for 24-hour PM_{10} – BHP Olympic Dam AQMS – January 2016 to December 2024 – total (background and operations)**

It is noted that the *Dust & Emission Management Plan* (BHP 2025) outlines the approach for determining the potential operational component of total PM_{10} concentrations recorded by the Olympic Dam Village and Roxby Downs AQMS locations. If the concurrent wind direction measurement places the relevant AQMS station downwind of Olympic Dam operations (e.g. between 298° and 45° for Olympic Dam Village, or between 330° and 16° for Roxby Downs), the recorded PM_{10} background concentration at the Northern Background AQMS is subtracted from the concurrent PM_{10} background concentration at the relevant AQMS.

It is considered that this approach is highly conservative for the estimation of the operational component, due to the significant area of naturally occurring wind-erodible surfaces situated between the Northern Background AQMS and the two sensitive receptor AQMS locations.

For illustrative purposes, the derived operational component concentrations at the Olympic Dam Village and Roxby Downs AQMS locations are illustrated in Figure 2.9.

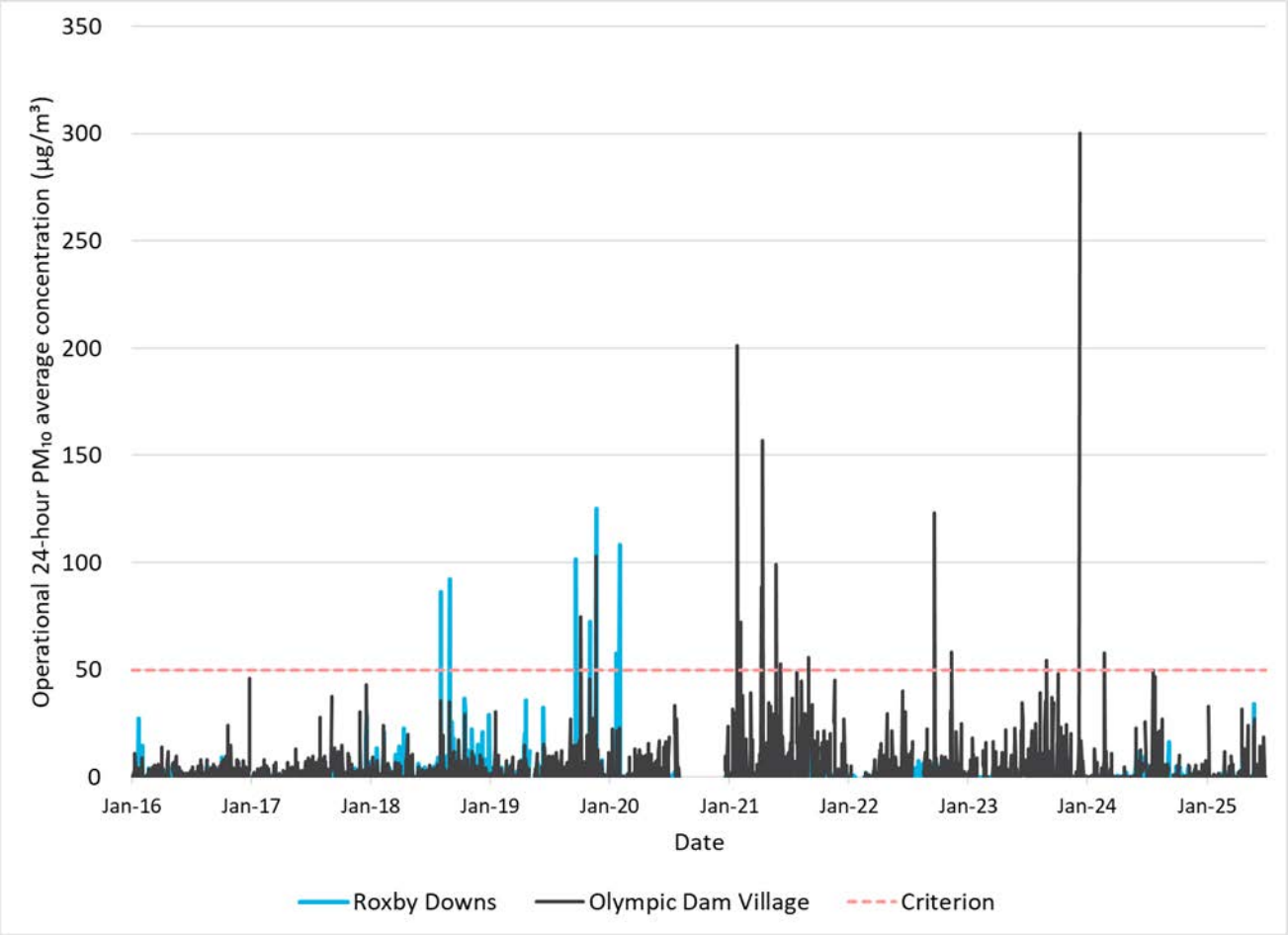


Figure 2.9 Timeseries plot for operational 24-hour PM_{10} – BHP Olympic Dam AQMS – January 2016 to December 2024 – total (operations only)

It can be seen from the presented data that the total 24-hour average PM_{10} concentrations varied significantly over the analysed period, with concentrations above the 24-hour average criterion of 50 µg/m^3 occurring across all years and stations. Substantially more days above criterion were recorded during 2018, 2019 and 2020 than during other years as a result of the extensive 'Black Summer' bushfires that occurred between November 2019 and February 2020.

To illustrate the relationship between recorded PM_{10} concentrations and wind conditions, bivariate polar plots have been generated for each of the three BHP AMQS sites (Figure 2.10 for Northern Background, Figure 2.11 for Olympic Village and Figure 2.12 for Roxby Downs). The figures highlight that the highest PM_{10} concentrations coincide with wind speeds higher than 10 m/s and can occur from all directions, which is reflective of the significant contribution of regional particulate matter emission sources, such as wind-blown dust from exposed surfaces, to local particulate matter concentrations.

The Olympic Village AQMS plots (Figure 2.11) show a pattern of elevated PM_{10} concentrations when winds are blowing at lower speeds than 10 m/s and from the north-north-west (i.e. blowing from the direction of the SML Area). Comparatively, this same pattern is not evident in the polar plots for the other two AQMS stations. It is, therefore, considered that this pattern is reflective of the contribution of emissions from BHP operations.

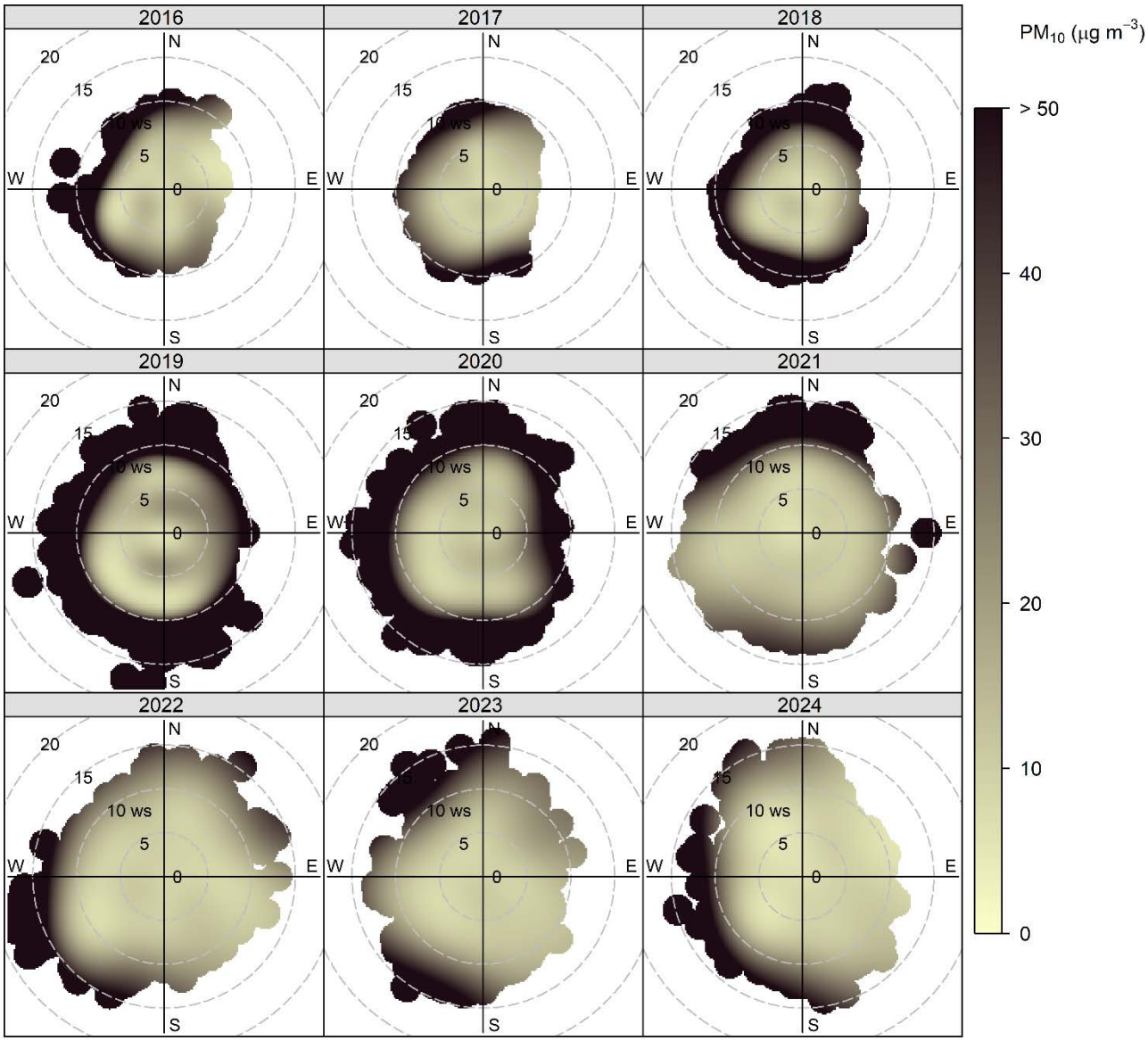


Figure 2.10 **Bivariate polar plot (PM_{10} concentration relative to wind speed and wind direction) – BHP Northern Background AQMS – 2016 to 2024**

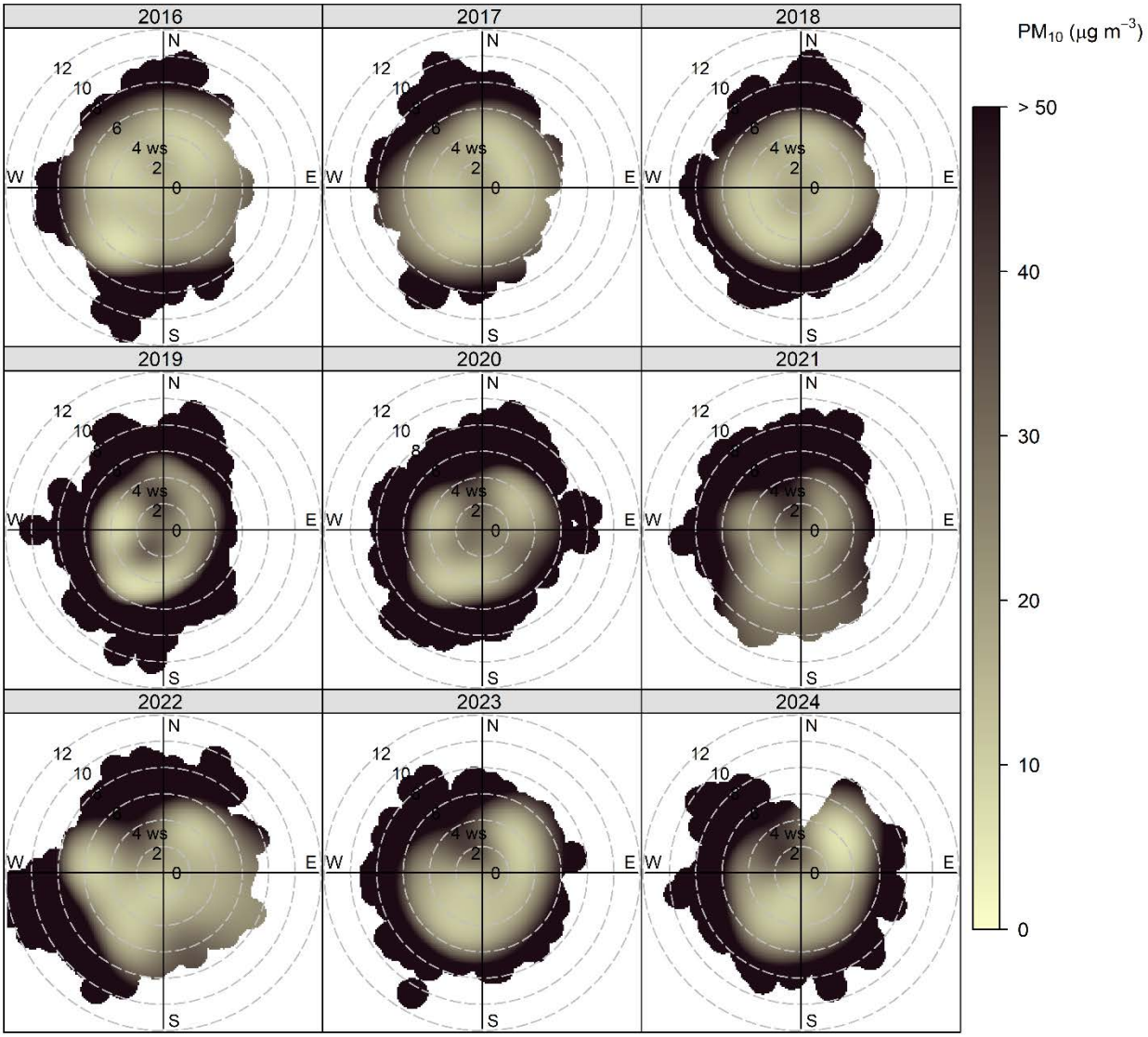


Figure 2.11 **Bivariate polar plot (PM_{10} concentration relative to wind speed and wind direction) – BHP Olympic Village AQMS – 2016 to 2024**

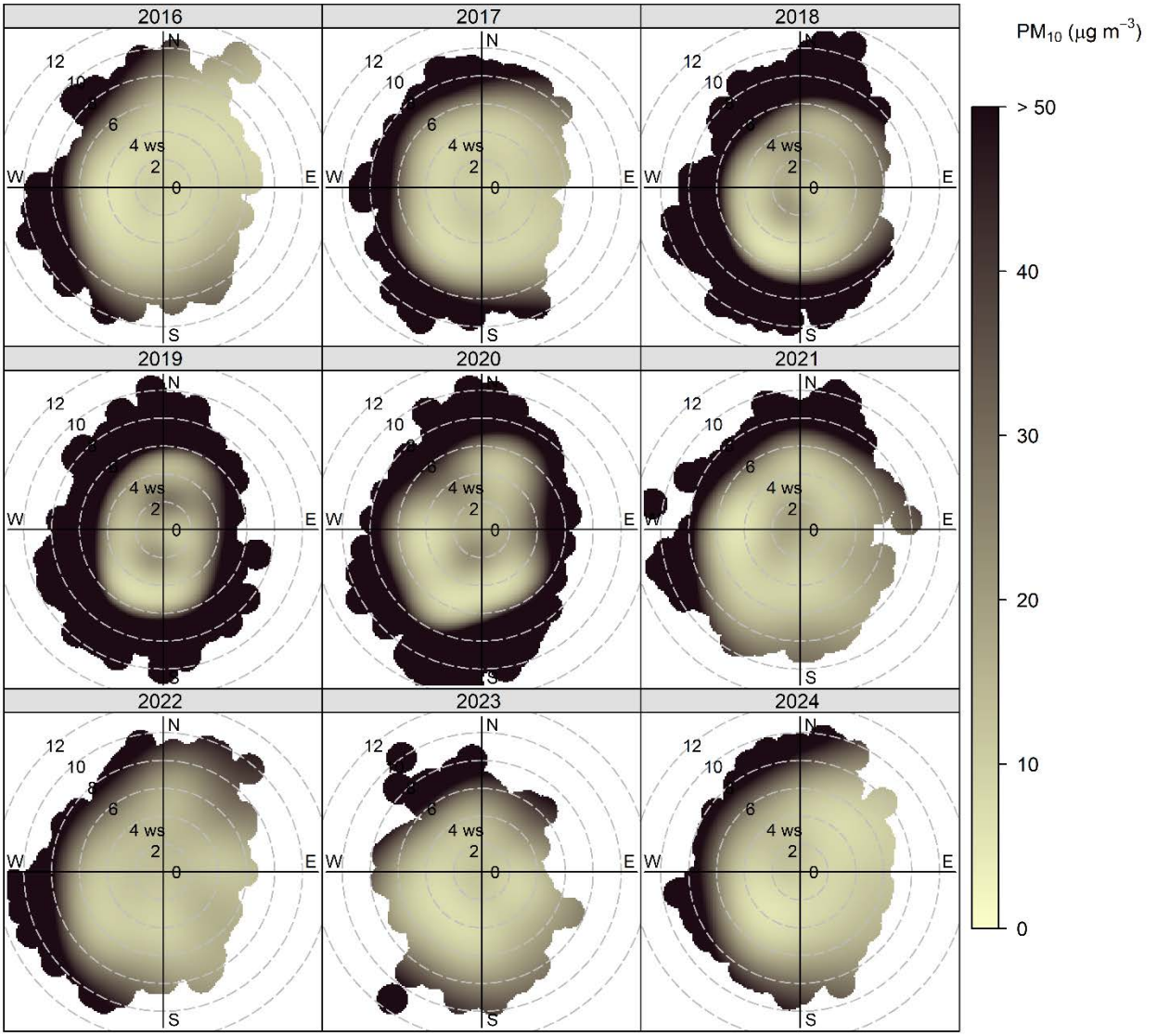


Figure 2.12 Bivariate polar plot (PM_{10} concentration relative to wind speed and wind direction) – BHP Roxby Downs AQMS – 2016 to 2024

The Northern Background AQMS is currently used by BHP as a control site for ambient PM_{10} concentrations for comparison with the other two monitoring stations. For the purpose of this assessment, the Northern Background AQMS was chosen to represent background air quality.

For the purpose of the AQIA, the 2024 calendar year monitoring dataset has been selected to characterise local background PM_{10} concentrations, consistent with the adopted 2024 calendar year from the BoM Olympic Dam Aerodrome AWS meteorological dataset (see Section 2.1.4).

Table 2.3 Summary statistics for total PM_{10} (background plus operations) – Northern Background station

Year	Maximum 24-hour average concentration (µg/m³)	70th percentile 24-hour concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 50 (µg/m³)
2016	213.8	12.8	12.5	3
2017	63.5	10.9	10.8	3
2018	77.7	11.3	12.1	7
2019	896.0	18.4	24.2	22
2020	342.3	18.5	21.3	23
2021	139.3	12.5	12.7	8
2022	96.7	11.4	11.1	4
2023	57.3	11.2	11.4	3
2024	105.2	10.9	10.3	4

ii $PM_{2.5}$

There is no monitoring for $PM_{2.5}$ at any of the BHP AQMS locations. Data for this metric were derived using concurrent measurements of PM_{10} and $PM_{2.5}$ from the now decommissioned BHP Olympic Dam Western Background and Hiltaba Village monitoring stations, which were located approximately 8 km south-west and 14 km south-east of the SML area, respectively. The relationship between PM_{10} and $PM_{2.5}$ recorded from these two stations was calculated to be 0.5. This ratio was applied to the adopted baseline PM_{10} to obtain an estimate of local $PM_{2.5}$ concentrations in the absence of actual measurements. Summary statistics for the baseline $PM_{2.5}$ concentrations are presented in Table 2.4.

Table 2.4 Summary statistics for baseline $PM_{2.5}$

Year	Maximum 24-hour average concentration (µg/m³)	70th percentile 24-hour concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 25 (µg/m³)
2016	109.8	6.6	6.4	3
2017	32.6	5.6	5.5	3
2018	39.9	5.8	6.2	8
2019	460.0	9.5	12.4	22
2020	175.7	9.5	10.9	24
2021	71.5	6.4	6.5	8
2022	49.6	5.9	5.7	4
2023	29.4	5.8	5.8	3
2024	54.0	5.6	5.3	4

Consistent with PM_{10} the 2024 calendar year $PM_{2.5}$ dataset has been adopted to represent background conditions.

iii SO_2

Summary statistics for SO_2 for the period between January 2016 and December 2024 at the Olympic Village and Roxby Downs AQMS locations are presented in Table 2.5. The corresponding time series plots of 1-hour average SO_2 concentrations are presented in Figure 2.13. It is reiterated that the concentrations presented correspond to total SO_2 concentrations recorded, rather than the contribution from Olympic Dam operations.

Table 2.5 Summary statistics for SO_2 measurements at BHP Olympic Dam sites

Year	Maximum 1-hour average concentration (ppm)	70th percentile 1 hour concentration (ppm)	Maximum 24-hour concentration (ppm)	Annual average concentration (ppm)	Data recovery (%)
Olympic Village					
2016	0.013	<0.001	0.003	<0.0001	28
2017	0.017	0.001	0.005	0.0002	43
2018	0.010	0.001	0.003	0.0005	53
2019	0.043	<0.001	0.004	<0.0001	25
2020	0.034	0.001	0.003	0.0006	55
2021	0.004	0.002	0.003	0.0012	77
2022	0.006	0.001	0.003	0.0011	94
2023	0.002	0.001	0.001	0.0004	77
2024	0.002	0.001	0.002	0.0007	90
Roxby Downs					
2016	0.007	<0.001	0.001	<0.0001	17
2017	0.007	<0.001	0.002	<0.0001	22
2018	0.007	0.001	0.004	0.0002	35
2019	0.007	0.001	0.005	0.0008	52
2020	0.005	0.001	0.002	0.0003	33
2021	0.004	0.001	0.003	0.0009	77
2022	0.004	0.001	0.002	0.0007	65
2023	0.008	0.001	0.003	0.0009	71
2024	0.005	0.001	0.003	0.0009	85

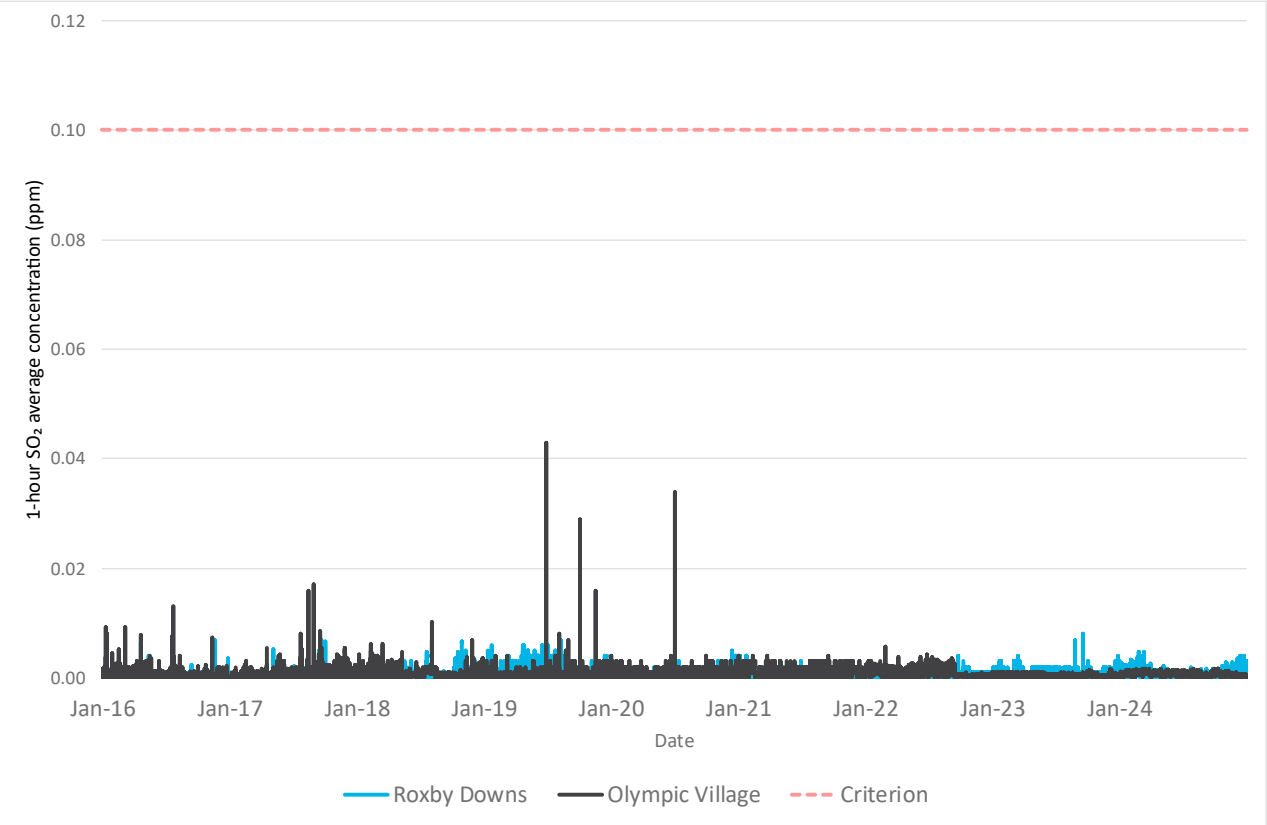


Figure 2.13 Timeseries plot for 1-hour SO_2 – BHP Olympic Dam AQMS – January 2016 to December 2024 – total (background and operations)

Throughout the analysed period, 1-hour SO_2 concentrations are well below the applicable assessment criterion of 0.1 ppm at both monitoring locations and across all years of data.

To illustrate the relationship between recorded SO_2 concentrations and wind conditions, bivariate polar plots have been generated for each of the two BHP AMQS sites (Figure 2.14 for Olympic Village and Figure 2.15 for Roxby Downs).

The bivariate polar plots show a clear SO_2 concentration pattern when winds are blowing from the north-east at the Olympic Village AQMS during 2018, 2019 and 2021, which is indicative of emissions from Olympic Dam operations; however, this same directional pattern is not evident for the other years presented. There is considered to be no clear or consistent directional pattern for SO_2 concentrations in the Roxby Downs AQMS dataset, suggesting that the direct influence of Olympic Dam operational emissions is not evident.

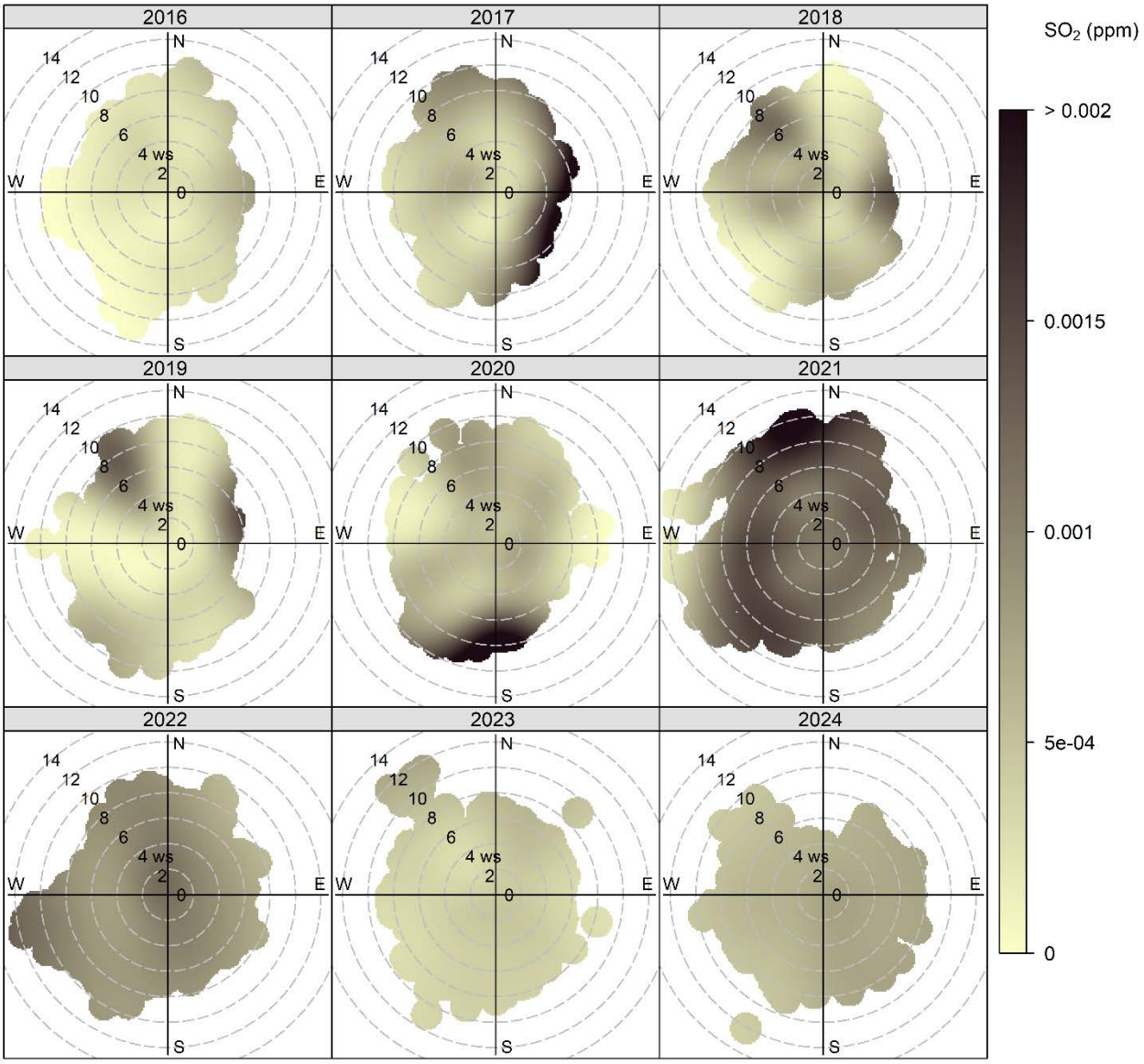


Figure 2.14 **Bivariate polar plot (SO_2) concentration relative to wind speed and wind direction) – BHP Olympic Village AQMS – 2016 to 2024**

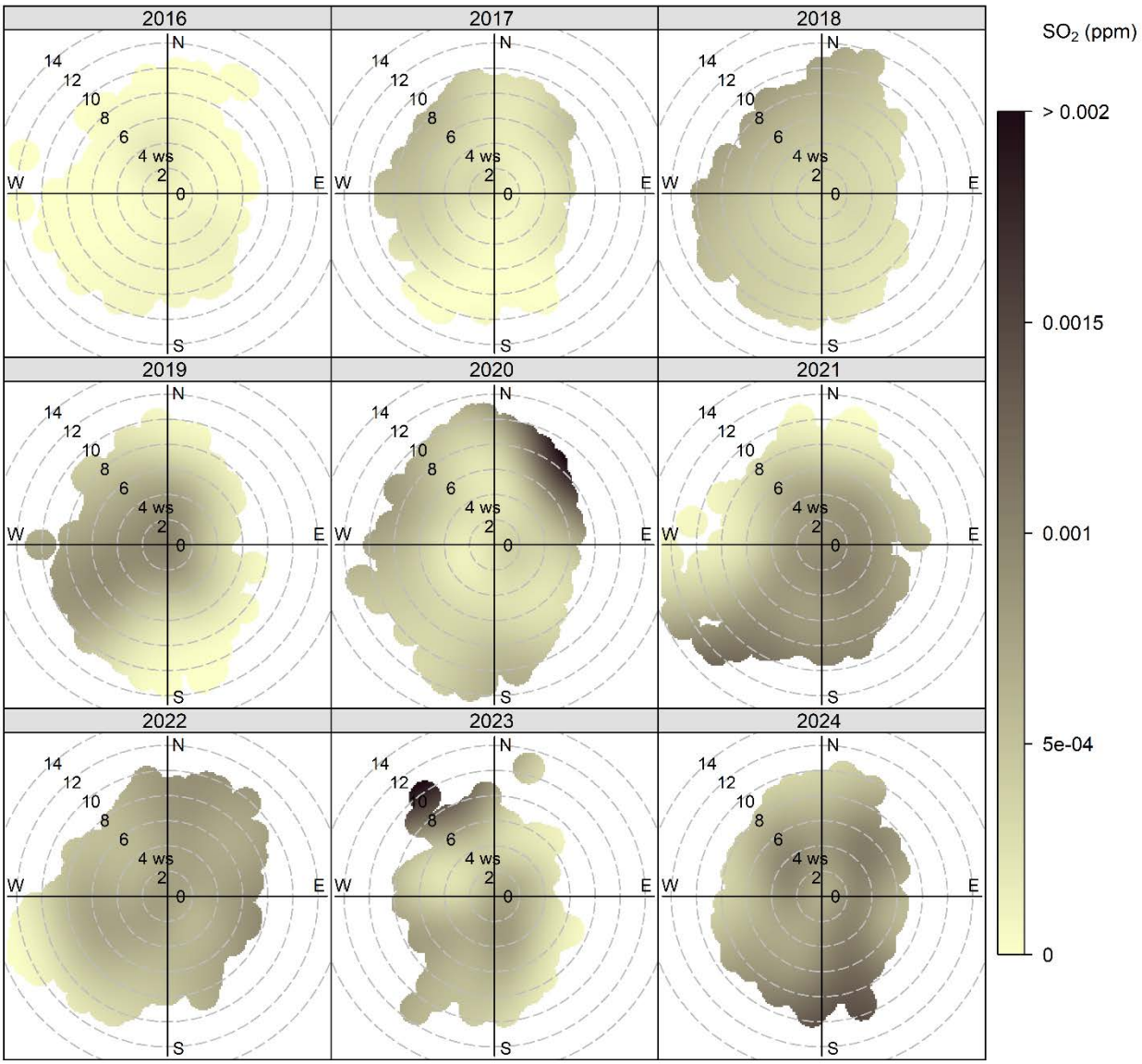


Figure 2.15 **Bivariate polar plot (SO_2 concentration relative to wind speed and wind direction) – BHP Roxby Downs AQMS – 2016 to 2024**

For the purpose of this AQIA, the 2024 calendar year monitoring dataset has been selected to characterise local background SO_2 concentrations, consistent with the adopted 2024 calendar year from the BoM Olympic Dam Aerodrome AWS meteorological dataset (see Section 2.1.4).

Summary statistics for the baseline SO_2 concentrations, derived from the BHP Olympic Dam monitoring locations, are presented in Table 2.6.

Table 2.6 Summary statistics for baseline SO_2

Year	Maximum 1-hour average concentration (ppm)	70th percentile 1 hour concentration (ppm)	Maximum 24-hour concentration (ppm)	Annual average concentration (ppm)
2016	0.013	<0.001	0.003	<0.0001
2017	0.017	0.001	0.005	0.0002
2018	0.010	0.001	0.003	0.0004
2019	0.043	<0.001	0.004	0.0001
2020	0.034	0.001	0.003	0.0006
2021	0.004	0.002	0.003	0.0012
2022	0.006	0.001	0.003	0.0011
2023	0.003	0.001	0.003	0.0005
2024	0.004	0.001	0.002	0.0007

iv NO_2

No ambient monitoring of NO_x or NO_2 is conducted at the BHP Olympic Dam mine. The closest current SA EPA NO_2 monitoring location is in Adelaide. Historically, the SA EPA completed an ambient air quality monitoring campaign at Whyalla between March 2004 and June 2006 which included measurements of NO_2. During this campaign, the recorded average NO_2 concentration was 6.2 µg/m³. In the absence of site-specific NO_2 measurements, this concentration from Whyalla was used to represent background NO_2 concentrations for the baseline AQIA.

2.3 Conclusion

An analysis of existing air quality and dispersion meteorological conditions in the study area has been undertaken.

Meteorological input data to the dispersion modelling for the SRE Project has been sourced from the BoM Olympic Dam Aerodrome for the 2024 calendar year.

Background air quality concentrations for the study area were derived from historical BHP and SA EPA air quality monitoring data as follows:

- 24-hour PM_{10} concentration – 70th percentile of ~10.9 µg/m³
- 24-hour $PM_{2.5}$ concentration – 70th percentile of ~5.6 µg/m³
- annual average $PM_{2.5}$ concentration – ~5.3 µg/m³
- annual average NO_2 – ~6.2 µg/m³
- annual average SO_2 – ~0.0007 ppm.

For all other pollutants to be considered in this AQIA, the baseline air quality concentrations are considered to be accounted for by the modelling of existing operational emissions (see Section 3.2.2).

3 Assessment of effects

An assessment of effects was undertaken to determine the change in the existing pathway environment as a result of the proposed SRE Project activities. The assessment of effects included the following works:

- Obtain input data (i.e. baseline environment) as required for the development of an atmospheric dispersion model for the SRE Project.
- Review the SRE Project activities and the identified potential impact events to determine representative scenarios for emission calculation and dispersion modelling.
- Complete atmospheric dispersion modelling based on the emission calculations and assess air quality effects.

3.1 Potential impact events

BHP has identified potential impact events associated with likely changes to the baseline air quality environment as a result of the implementation of the SRE Project. These events represent scenarios for which there is, or is likely to be, a linkage between SRE Project activities (sources), ambient air (pathways) and the identified receptors (Table 2.1).

To ensure a consistent approach to impact assessment for the SRE Project, sources, pathways, and receptors (SPR) are defined and applied in this assessment as follows:

- Source – the SRE Project activities (i.e. potential impact event) which, alone or in combination, has the potential to impact a receptor.
- Pathway – the pathway, means or route (with consideration of any natural barriers) by which the receptor can be exposed to, or may reasonably be expected to be impacted by, the source.
- Receptor – the receptor that may be impacted by the source via the pathway.

The detailed list of potential impact events is provided in the Environmental Impact Assessment Tables Appendix to the EIS and are summarised for the air quality pathways in Table 3.1. The scope of this assessment of effects presented herein has considered these identified potential impact events.

Table 3.1 Preliminary SPR assessment – potential impact events

SPR ID No.	Potential impact event	Source	Pathway	Receptor	Linkage
A6	Operational activities release emissions of off-gases and fugitive gases from smelting, acid plant and refinery operations affect air quality, resulting in impacts to the health and safety of the local community	Emission of off-gases and fugitive gases	Air (air quality)	Local community (health and safety)	Uncertain
A7	Operational activities release emissions of off-gases and fugitive gases from smelting, acid plant and refinery operations affect air quality, resulting in impacts to the amenity of the local community	Emission of off-gases and fugitive gases	Air (air quality)	Local community (amenity)	Uncertain
A8	Operational activities release emission of off-gases and fugitive gases that affects air quality, resulting in impacts to flora and vegetation	Emission of off-gases and fugitive gases	Air (air quality)	Ecology (flora and vegetation)	Refer Ecological Impact Assessment
A9	Operational activities release emissions of off-gases and fugitive gases that affect air quality, resulting in impacts to fauna and habitat	Emission of off-gases and fugitive gases	Air (air quality)	Ecology (fauna and habitat)	Refer Ecological Impact Assessment
A10	Operational activities release emissions of off-gases and fugitive gases that affect air quality, resulting in impacts to State and Commonwealth listed threatened species	Emission of off-gases and fugitive gases	Air (air quality)	Ecology (state and Commonwealth threatened species)	Refer Ecological Impact Assessment
A11	Operational activities release emission of off-gases and fugitive gases from smelting, acid plant and refinery operations that generates odour, resulting in impacts to the amenity of the local community	Emission of off-gases and fugitive gases	Air (air quality)	Local community (health and safety)	Uncertain
A12	Operational activities release emission of off-gases and fugitive gases from smelting, acid plant and refinery operations that generates odour, resulting in impacts to the health and safety of the local community	Emission of off-gases and fugitive gases	Air (air quality)	Local community (amenity)	Uncertain
A13	Project-related construction activities (e.g. land clearing) release emissions of particulate matter that affect air quality, resulting in impacts to the health and safety of the local community	Emission of particulate matter	Air (air quality)	Local community (health and safety)	Uncertain
A14	Project-related construction activities (e.g. land clearing) release emissions of particulate matter that affect air quality, resulting in impacts to the amenity of the local community	Emission of particulate matter	Air (air quality)	Local community (amenity)	Uncertain

SPR ID No.	Potential impact event	Source	Pathway	Receptor	Linkage
A15	Project-related construction activities release emissions of particulate matter that affect air quality, resulting in impacts to flora and vegetation	Emission of off-gases and fugitive gases	Air (air quality)	Ecology (flora and vegetation)	Refer Ecological Impact Assessment
A16	Project-related construction activities release emissions of particulate matter that affect air quality, resulting in impacts to fauna and habitat	Emission of off-gases and fugitive gases	Air (air quality)	Ecology (fauna and habitat)	Refer Ecological Impact Assessment
A17	Project-related construction activities release emissions of particulate matter that affect air quality, resulting in impacts to State and Commonwealth listed threatened species	Emission of off-gases and fugitive gases	Air (air quality)	Ecology (state and Commonwealth threatened species)	Refer Ecological Impact Assessment
A18	Project-related operational activities (e.g. stacks or materials handling activities) release emissions of particulate matter that affect air quality, resulting in impacts to the health and safety of the local community	Emission of particulate matter	Air (air quality)	Local community (health and safety)	Uncertain
A19	Project-related operational activities (e.g. stacks or materials handling activities) release emissions of particulate matter that affect air quality, resulting in impacts to the amenity of the local community	Emission of particulate matter	Air (air quality)	Local community (amenity)	Uncertain
A20	Project-related operational activities release emissions of particulate matter that affect air quality, resulting in impacts to flora and vegetation	Emission of particulate matter	Air (air quality)	Ecology (flora and vegetation)	Refer Ecological Impact Assessment
A21	Project-related operational activities release emissions of particulate matter that affect air quality, resulting in impacts to fauna and habitat	Emission of particulate matter	Air (air quality)	Ecology (fauna and habitat)	Refer Ecological Impact Assessment
A22	Project-related operational activities release emissions of particulate matter that affect air quality, resulting in impacts to State and Commonwealth listed threatened species	Emission of particulate matter	Air (air quality)	Ecology (state and Commonwealth threatened species)	Refer Ecological Impact Assessment

3.2 Assessment of effects

This section describes the methods, assumptions, scenario configurations and assessment criteria prepared for the AQIA.

3.2.1 Assessment emission scenarios

In order to assess the significance of emissions and impacts from the SRE Project relative to existing operations at Olympic Dam, the following emission scenarios have been developed for this AQIA:

- existing BAU operations, hereafter referred to as BAU operations
- three future operations scenarios, comprising BAU and SRE Project emissions:
    - Stage 1a SRE operations
    - Stage 1b SRE operations
    - Stage 2 SRE operations.

Air pollutant emissions were quantified for all four scenarios listed above. Through the analysis, it was determined that Stage 2 SRE operations represented the highest emission potential for the entire SRE phase. Therefore, focus is given to Stage 2 SRE emissions and impacts in this report.

3.2.2 Air pollution emissions inventory – BAU operations

BHP report annual estimates of air pollutant emissions generated by the Olympic Dam operations to the National Pollution Inventory (NPI). The air pollutant emission sources reported include:

- point sources (emissions from stacks associated with existing smelter and refinery processes)
- diesel and other fuel combustion (smelter, underground mining fleet, permanent gensets, quarrying fleet, etc.)
- explosives detonation (surface and underground)
- fugitive emissions from surface mining and quarrying operations
- fugitive emissions from material handling and processing operations
- fugitive emissions from the movement of trucks along paved and unpaved roads
- fugitive emissions from wind generated erosion of open surfaces such as stockpiles, cleared areas and tailings storage facilities (TSFs).

In order to assess impacts from BAU operations for comparison against impacts under the SRE Project, a combination of resources have been adopted:

- Stack emissions – emissions for existing stack sources have been quantified using recent stack test emissions data provided by BHP, and engineering assumptions from Hatch (2025). A summary of emission parameters, adopted in-stack emission concentrations and derived emission rates for modelling are presented in Table 3.2, Table 3.3 and Table 3.4, respectively.

- Fugitive emissions – annual NPI reported fugitive emissions for FY25 have been sourced from BHP. The annual reported emissions by pollutant for FY25 are presented in Table 3.5.

- Temporary rock storage facility (RSF) emissions – sourced from the 2025 report prepared by Lathwida Environmental for the construction of a temporary rock storage facility at Olympic Dam.

For stack emissions, the monitoring results are expressed as concentrations of total particulate matter. In order to derive PM_{10} and $PM_{2.5}$ emissions from the sampled total particulate matter emission concentrations, a particle size distribution of 92% as PM_{10} and 82% as $PM_{2.5}$ has been applied to all sources, aligned with the AP-42 (1995) general particle size distribution for melting, smelting and refining of metals.

In order to derive TSP and $PM_{2.5}$ emissions from fugitive sources (not required to be reported under NPI) from reported PM_{10} emissions, relevant particle size distribution scaling factors from the NPI (2012) literature have been adopted:

- wind erosion – TSP = 2 times PM_{10}, $PM_{2.5}$ = 0.15 times PM_{10}

- wheel generated dust - TSP = 2.98 times PM_{10}, $PM_{2.5}$ = 0.1 times PM_{10}

- materials handling/mining - TSP = 2.11 times PM_{10}, $PM_{2.5}$ = 0.1514 times PM_{10}.

All stack sources have been represented in the model using point sources. Emissions from the tankhouse sources have been represented using a buoyant line source positioned along the ridgeline of the tankhouse buildings.

Fugitive emission totals have been distributed evenly across the Olympic Dam site, using a BHP-provided shapefile for open areas as the reference point. Emissions have been represented by a series of volume sources, as shown in Figure 3.1. It is acknowledged this approach simplifies the spatial distribution of fugitive emissions about the Olympic Dam site, given the separation distance from the closest sensitive receptors to the south (approximately 2.4 km to the Olympic Dam Village receptors), it is considered sufficient for the purposes of accounting for BAU operations emissions in the model.

Emissions from wind erosion have been scaled proportional to the cube of the wind in order to allocate higher emissions to periods of elevated wind conditions. Emissions from other fugitive emission sources have been modelled on a continuous hourly-average basis.

For emissions from the Cyanidation and Zinc Precipitation Area Stack, no relevant stack emissions monitoring data was available for use in the assessment. In order to estimate the emissions from the stack, the reported cyanide emissions from the NPI FY25 were adopted. An annual emission of 16.03 kg/year of cyanide was reported from point emissions, and 1,213.9 kg/year of cyanide was reported from fugitive sources. The annual cyanide emission rate was assumed to be released entirely from the Cyanidation and Zinc Precipitation Area Stack on a continuous basis. Fugitive cyanide emissions were distributed evenly across the Olympic Dam site, as detailed above.

To derive emissions of H_2SO_4, it is assumed that all emissions of SO_3 are converted to H_2SO_4 upon release into the atmosphere. To make this adjustment, the SO3 emissions were adjusted by the molecular weight relationship, specifically 98.08/80.06 = 1.225.

Table 3.2 Olympic Dam – BAU operations - stack source emission parameters

Stack name	Easting	Northing	Exit diameter (mm)	Temperature (deg C)	Release height (m)	Flow Normal (Nm^3/hr dry)	Exit velocity (m/s)
Dryer Stack 1	679,069	6,630,407	1,200	110	22	20,000	7.3
Calciner A stack	679,483	6,630,533	500	67	29	3,400.0	7.1
Calciner B stack	679,463	6,630,550	500	90	29	2,000.0	11.2
Tails leach hygiene stack	679,697	6,630,354	1,620	39	35	86,400.0	13.9
Anode Furnace 3 and 4 Casting Wheel Vent	678,912	6,630,241	1,260	40	25	73,700.8	19.2
Main Smelter Stack (FCF and AF Hygiene + AF)	678,875	6,630,397	3,800	80	90	503,586.6	16.3
Acid Plant 2 - Stack	678,875	6,630,403	1,600	80	90	91,170.8	16.4
PMR - Roaster Scrubber (Hydrosonic Scrubber) Stack	679,073	6,629,966	1,000	41	20	57,802.8	25.9
Slimes Treatment NOx Scrubber	679,144	6,629,986	400.0	25	20	6,000.0	15.2
Brown Field - Cyanidation and Zinc Precipitation Area Stack	679,045	6,629,976	300.0	26	17	4,800.0	21.3
Brown Field ER Tankhouse A	n/a – ridgeline vent		n/a	62	20	398,924.6	n/a
Brown Field ER Tankhouse B	n/a – ridgeline vent		n/a	62	20	398,924.6	n/a

Table 3.3 Adopted in-stack emission concentrations – BAU operations

Pollutant	Emission concentration (mg/Nm³) by stack source											
	Dryer Stack 1	Calciner A stack	Calciner B stack	Tails leach hygiene stack	Anode Furnace 3 and 4 Casting Wheel Vent	Main Smelter Stack (FCF and AF Hygiene + AF)	Acid Plant 2 - Stack	PMR - Roaster Scrubber (Hydrosonic Scrubber) Stack	PMR - Slimes Treatment NOx Scrubber	Brown Field - Cyanidation and Zinc Precipitation Area Stack	Brown Field ER Tankhouse A	Brown Field ER Tankhouse B
Total PM	50	60	140	1.5	20	22.1	1	42	15	-	-	-
SO_2	0.15	-	-	-	-	258.9	522.2	-	-	-	-	-
SO_3	4.9	-	-	25	-	35	8	-	-	-	0.1	0.1
H2S	-	-	-	5.85	-	-	-	0.05	0.05	-	-	-
CO	-	-	-	25	-	-	-	-	-	-	-	-
NO_x	33.5	-	-	100	-	14	72	221	317	-	-	-
HCL	0.05	-	-	2.7	-	0.3	1	-	-	-	-	-
HF	0.38	-	-	0.4	-	0.057	0.038	-	-	-	-	-
Antimony	0.08	-	-	0.1	-	0.02	-	0.005	0.005	-	-	-
Arsenic	0.09	-	-	0.02	-	0.09	-	0.005	0.005	-	-	-
Beryllium	0.02	-	-	0.02	-	0	-	0.005	0.005	-	-	-
Cadmium	0.003	-	-	0.7	-	0.01	-	0.03	0.005	-	-	-
Chromium 3	0.03	-	-	0.1	-	0.2	-	0.005	0.005	-	-	-
Cobalt	0.29	-	-	0.02	-	0.01	-	0.005	0.005	-	-	-
Copper	134.5	-	-	0.09	-	1	-	0.01	0.47	-	-	-
Lead	0.47	-	-	0.03	-	0.7	-	0.005	0.005	-	-	-

Pollutant	Emission concentration (mg/Nm^3) by stack source											
	Dryer Stack 1	Calciner A stack	Calciner B stack	Tails leach hygiene stack	Anode Furnace 3 and 4 Casting Wheel Vent	Main Smelter Stack (FCF and AF Hygiene + AF)	Acid Plant 2 - Stack	PMR - Roaster Scrubber (Hydrosonic Scrubber) Stack	PMR - Slimes Treatment NOx Scrubber	Brown Field - Cyanidation and Zinc Precipitation Area Stack	Brown Field ER Tankhouse A	Brown Field ER Tankhouse B
Manganese	0.26	-	-	0.1	-	0.02	-	0.005	0.005	-	-	-
Mercury	-	-	-	0.002	-	0	-	0	0	-	-	-
Nickel	0.16	-	-	0.05	-	0.1	-	0.005	0.01	-	-	-
Selenium	0.08	-	-	0.02	-	0.03	-	0.07	0.13	-	-	-
Zinc	0.4	-	-	0.1	-	0.08	-	0.01	0.05	-	-	-

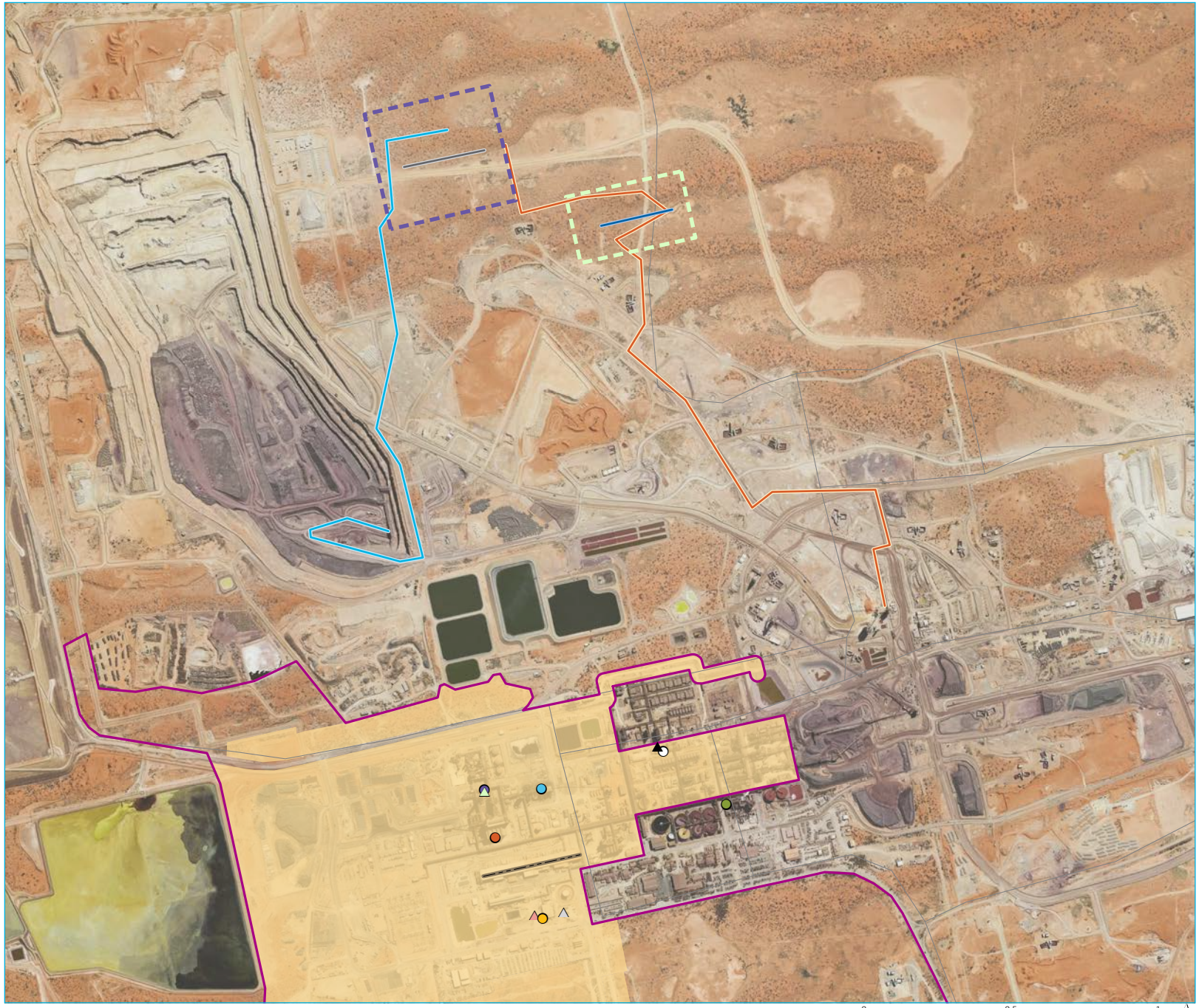
Table 3.4 Calculated stack emission rates - BAU operations

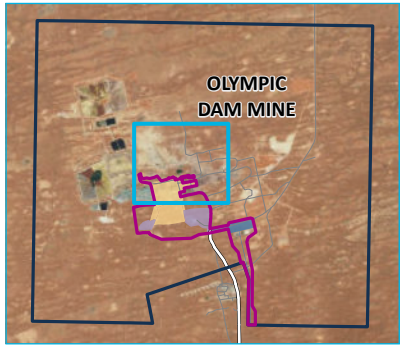
Pollutant	Emission rates (g/s) by stack source											
	Dryer Stack 1	Calciner A stack	Calciner B stack	Tails leach hygiene stack	Anode Furnace 3 and 4 Casting Wheel Vent	Main Smelter Stack (FCF and AF Hygiene + AF)	Acid Plant 2 - Stack	PMR - Roaster Scrubber (Hydrosonic Scrubber) Stack	Slimes Treatment NOx Scrubber	Brown Field - Cyanidation and Zinc Precipitation Area Stack	Brown Field ER Tankhouse A	Brown Field ER Tankhouse B
TSP (g/s)	2.78E-01	5.67E-02	7.78E-02	3.60E-02	4.09E-01	3.09E+00	2.53E-02	6.74E-01	2.50E-02	-	-	-
PM_{10} (g/s)	2.56E-01	5.21E-02	7.16E-02	3.31E-02	3.77E-01	2.85E+00	2.33E-02	6.20E-01	2.30E-02	-	-	-
$PM_{2.5}$ (g/s)	2.28E-01	4.65E-02	6.38E-02	2.95E-02	3.36E-01	2.54E+00	2.08E-02	5.53E-01	2.05E-02	-	-	-
SO_2 (g/s)	8.33E-04	-	-	-	-	3.62E+01	1.32E+01	-	-	-	-	-
SO_3 (g/s)	2.72E-02	-	-	6.00E-01	-	4.90E+00	2.03E-01	-	-	-	1.11E-02	1.11E-02
H_2S (g/s)	-	-	-	1.40E-01	-	-	-	8.03E-04	8.33E-05	-	-	-
CO (g/s)	-	-	-	6.00E-01	-	-	-	-	-	-	-	-
NO_x (g/s)	1.86E-01	-	-	2.40E+00	-	1.96E+00	1.82E+00	1.12E+01	1.65E+00	-	-	-
HCL (g/s)	2.78E-04	-	-	6.48E-02	-	4.20E-02	2.53E-02	-	-	-	-	-
HF (g/s)	2.11E-03	-	-	9.60E-03	-	7.97E-03	9.62E-04	-	-	-	-	-
Antimony (g/s)	4.44E-04	-	-	2.40E-03	-	2.80E-03	-	8.03E-05	8.33E-06	-	-	-
Arsenic (g/s)	5.00E-04	-	-	4.80E-04	-	1.26E-02	-	8.03E-05	8.33E-06	-	-	-
Beryllium (g/s)	1.11E-04	-	-	4.80E-04	-	-	-	8.03E-05	8.33E-06	-	-	-
Cadmium (g/s)	1.67E-05	-	-	1.68E-02	-	1.40E-03	-	4.82E-04	8.33E-06	-	-	-

Pollutant	Emission rates (g/s) by stack source											
	Dryer Stack 1	Calciner A stack	Calciner B stack	Tails leach hygiene stack	Anode Furnace 3 and 4 Casting Wheel Vent	Main Smelter Stack (FCF and AF Hygiene + AF)	Acid Plant 2 - Stack	PMR - Roaster Scrubber (Hydrosonic Scrubber) Stack	Slimes Treatment NOx Scrubber	Brown Field - Cyanidation and Zinc Precipitation Area Stack	Brown Field ER Tankhouse A	Brown Field ER Tankhouse B
Chromium 3 (g/s)	1.67E-04	-	-	2.40E-03	-	2.80E-02	-	8.03E-05	8.33E-06	-	-	-
Cobalt (g/s)	1.61E-03	-	-	4.80E-04	-	1.40E-03	-	8.03E-05	8.33E-06	-	-	-
Copper (g/s)	7.47E-01	-	-	2.16E-03	-	1.40E-01	-	1.61E-04	7.83E-04	-	-	-
Lead (g/s)	2.61E-03	-	-	7.20E-04	-	9.79E-02	-	8.03E-05	8.33E-06	-	-	-
Manganese (g/s)	1.44E-03	-	-	2.40E-03	-	2.80E-03	-	8.03E-05	8.33E-06	-	-	-
Mercury (g/s)	-	-	-	4.80E-05	-	-	-	-	-	-	-	-
Nickel (g/s)	8.89E-04	-	-	1.20E-03	-	1.40E-02	-	8.03E-05	1.67E-05	-	-	-
Selenium (g/s)	4.44E-04	-	-	4.80E-04	-	4.20E-03	-	1.12E-03	2.17E-04	-	-	-
Zinc (g/s)	2.22E-03	-	-	2.40E-03	-	1.12E-02	-	1.61E-04	8.33E-05	-	-	-
Cyanide (g/s)	-	-	-	-	-	-	-	-	-	5.08E-04	-	-

Table 3.5 Olympic Dam annual FY25 NPI reported emissions – fugitive emissions – BAU operations

Air pollutant	Annual emissions (kg/year)	
	Wind erosion	Other fugitive (fuel combustion, mining, processing, etc)
TSP	5,685,945.7	1,151,068.6
PM_{10}	2,842,972.9	457,347.1
$PM_{2.5}$	426,445.9	124,482.0
NO_x	-	1,012,521.5
SO_2	-	1,190.3
CO	-	631,433.9
HCl	-	0.0
Fluoride compounds	712.4	542.4
Lead & compounds	5.1	0.2
Antimony & compounds	29.4	3.6
Arsenic & compounds	1.8	0.3
Benzene	0.4	1.3
Beryllium & compounds	341.6	14.0
Cadmium & compounds	43.8	0.6
Chromium (III) compounds	709.0	1.7
Cobalt & compounds	73.0	108.1
Copper & compounds	5,626.7	228.2
Cyanide (inorganic) compounds	-	1,229.9
Lead & compounds	0.2	0.3
Manganese & compounds	254.7	8.8
Mercury & compounds	33.9	7.9
Nickel & compounds	77.8	917.0
Selenium & compounds	5,685,945.7	1,151,068.6
Zinc and compounds	2,842,972.9	457,347.1





KEY

Special Mining Lease
SRE Project Area - SML Area
SRE Area
General Infrastructure Area
Water Infrastructure Area

Model source location

Acid plant 2 - stack
Anode furnace 3 and 4 casting wheel vent
Calciner A stack
Calciner B stack
Dryer stack 1
Main smelter stack (FCF and AF hygiene + AF)
PMR Brown field - cyanidation and zinc precipitation area stack
PMR - Roaster scrubber (hydrosonic scrubber) stack
PMR - Slimes treatment NOx scrubber
Tails leach hygiene stack

Area source

Low grade stockpile
Waste rock stockpile

Buoyant line source

ER - Brown field ER tankhouse A and B

Line volume source

Pit to WR stockpile
Reclaimed WR haul to CAF plant
RSF5
WR stockpile ops

Existing environment

Major road
Minor road

0 0.5 1 km

GDA2020 MGA Zone 53

N

Model source locations - BAU model sources

BHP SRE Project
Air Quality Impact Assessment
Figure 3.1

EMM
creating opportunities

3.2.3 SRE Project construction phase emissions

The construction of the SRE Project is expected to be undertaken progressively during Stage 1a, Stage 1b and Stage 2.

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

Throughout each construction period, it is considered that the assorted earthworks phases progressively staged in 4 to 6 month campaigns will have the greatest potential for air pollutant emission generation.

However, the emissions intensity during this phase is expected to be lower than BAU operations or future operations involving the operation of the SRE Project. Furthermore, any construction-related air pollution emissions will be generated well within the SML and distant from sensitive receptor locations to the south. Consequently, air quality impacts from the construction phase are expected to be lower than the BAU or future SRE operations.

Construction phase air pollutant emissions and impacts are not considered further in this AQIA.

3.2.4 Air pollution emissions inventory – SRE Project operations

As documented in Section 1.3, the SRE Project involves the following aspects:

- expansion of, and additions to, the existing smelter and refinery to enable total production of up to 650,000 tpa copper plus associated products
- the introduction of TSS involving the installation of a new primary FSF to produce copper matte, adding material smelting capacity
- conversion of the existing DBF to a FCF, that will process the matte into blister
- an additional acid plant of similar nature and scale to the existing acid plant and subsequent upgrade of the existing acid plant
- expanded electro-refinery and precious metals recovery facilities to produce cathode copper and gold, and silver.

Associated with the change in smelter configuration and additional refinery and acid plant infrastructure, the SRE Project would require new supporting facilities, infrastructure and services and the upgrade, removal and/or relocation of existing facilities and services within the existing Olympic Dam SML.

Similar to BAU operations, the SRE Project will involve a combination of fugitive and stack air pollutant emission sources. Emissions from proposed SRE Project stack sources have been quantified using a combination of representative stack test emissions data provided by BHP, and engineering assumptions from Hatch (2025). A summary of emission parameters, adopted in-stack emission concentrations and derived emission rates for the SRE Project stack sources adopted in the modelling are presented in Table 3.7 and Table 3.8, respectively.

It is noted that all BAU operations stack sources listed in Section 3.2.2 will remain for the SRE Project, with the exception of BAU operations Dryer 1, which will be decommissioned and replaced by a new concentrate Dryer for the SRE Project.

Consistent with the BAU operations emission calculations, in order to derive PM_{10} and $PM_{2.5}$ emissions from the SRE stack total particulate matter emissions, a particle size distribution of 92% as PM_{10} and 82% as $PM_{2.5}$ has been applied to all sources, aligned with the AP-42 (1995) general particle size distribution for melting, smelting and refining of metals.

For emissions from the SRE Cyanidation and Zinc Precipitation Area Stack, no relevant stack emissions monitoring data was available for use in the assessment. In order to estimate the cyanide emissions for Stage 2 from both point and fugitive sources, the reported annual cyanide emissions from the NPI FY25 were upscaled relative to the difference in total smelter concentrate throughput (i.e. from 500 ktpa to 2,400 ktpa for Stage 2). This approach is expected to be highly conservative.

For emissions from the Slimes Autoclave Scrubber and Circulation Area Scrubber, limited emission parameters were available to estimate emissions for modelling. Based on guidance from HFJV, these stacks are expected to release SO_3/H_2SO_4 mist emissions. For conservative purposes, the stack emission limit for SO_3 of 100 mg/Nm^3 was adopted for both stacks.

Table 3.6 Olympic Dam –stack source emission parameters – SRE Project operations Stage 2

Stack name	Existing or new	Easting	Northing	Exit diameter (mm)	Temperature (deg C)	Release height (m)	Flow Normal (Nm^3/hr dry)	Exit velocity (m/s)
Calciner A stack	Existing	679,483	6,630,533	500.0	67.0	29.000	3,400.0	7.100
Calciner B stack	Existing	679,463	6,630,550	500.0	90.0	29.000	2,000.0	11.200
Tails leach hygiene stack	Existing	679,697	6,630,354	1,620.0	39.0	34.500	86,400.0	13.900
Anode Furnace 3 and 4 Casting Wheel Vent	Existing	678,912	6,630,241	1,260.0	40.0	25.000	73,700.8	19.243
Main Smelter Stack (FCF and AF Hygiene + AF)	Existing	678,875	6,630,397	3,800.0	80.0	90.000	503,586.6	16.303
Acid Plant 2 - Stack	Existing	678,875	6,630,403	1,600.0	80.0	90.000	150,417.4	27.139
PMR - Roaster Scrubber (Hydrosonic Scrubber) Stack	Existing	679,073	6,629,966	1,000.0	41.0	20.000	57,802.8	25.870
Slimes Treatment NOx Scrubber	Existing	679,144	6,629,986	400.0	25.0	20.000	6,000.0	15.240
Brown Field - Cyanidation and Zinc Precipitation Area Stack	Existing	679,045	6,629,976	300.0	25.9	17.000	4,800.0	21.300
Brown Field ER Tankhouse A	Existing	678,950	6,630,131	-	62.000	-	398,924.6	-
Brown Field ER Tankhouse B	Existing	679,118	6,630,169	-	62.000	-	398,924.6	-
Smelter 3 - Dryer Stack	New	678,466	6,630,333	1,420.0	95.0	53.000	61,328.4	20.898
Smelter 3 - Hygiene Stack	New	678,398	6,630,263	2,500.0	61.2	90.000	269,181.3	24.711
Smelter 3 - Matte Grinding Mill Stack	New	678,744	6,630,408	2,200.0	96.3	43.000	226,501.5	23.771

Stack name	Existing or new	Easting	Northing	Exit diameter (mm)	Temperature (deg C)	Release height (m)	Flow Normal (Nm^3/hr dry)	Exit velocity (m/s)
Anode Furnace 5 and 6 Casting Wheel Vent	New	678,970	6,630,254	1,260.0	40.0	25.000	73,700.8	19.243
Acid Plant 3 - Stack	New	678,628	6,630,399	2,400.0	80.0	90.000	252,548.8	20.251
Cupel Furnace Scrubber Stack	New	679,100	6,629,939	300.0	60.0	30.000	2,423.4	15.492
Green Field - Cyanidation and Zinc Precipitation Area Stack	New	679,068	6,630,012	300.0	25.9	17.000	4,800.0	21.300
ER - Slimes Autoclave Scrubber	New	679,110	6,629,705	400.0	25.0	20.0	6,000	15.24
ER - Circulation Area Scrubber	New	679,132	6,629,644	400.0	25.0	20.0	6,000	15.24
Green Field ER Tankhouse A	New	679,150	6,629,622	-	62.000	-	398,924.6	-
Green Field ER Tankhouse B	New	678,979	6,629,584	-	62.000	-	398,924.6	-

Table 3.7 Adopted in-stack emission concentrations – SRE Project operations (Stage 2)

Pollutant	Emission concentration (mg/Nm^3) by stack source																				
	Calciner A stack	Calciner B stack	Tails leach hygiene stack	Anode Furnace 3 and 4 Casting Wheel Vent	Main Smelter Stack (FCF and AF Hygiene + AF)	Acid Plant 2 - Stack	Roaster Scrubber (Hydrosonic Scrubber) Stack	Slimes Treatment NOx Scrubber	Cyanidation and Zinc Precipitation Area Stack	ER Tankhouse A	ER Tankhouse B	Smelter 3 - Dryer Stack	Smelter 3 - Hygiene Stack	Smelter 3 - Matte Grinding Mill Stack	Anode Furnace 5 and 6 Casting Wheel Vent	Acid Plant 3 - Stack	Cupel Furnace Scrubber Stack	Cyanidation and Zinc Precipitation Area Stack	Slimes Autoclave Scrubber	Circulation Area Scrubber	Green Field ER Tankhouse A	Green Field ER Tankhouse B
Total PM	58	45	1.5	20	22.1	1.5	78	7	-	-	-	140	100	10	20	1.5	7	-	-	-	-	-
SO_2	-	-		-	258.9	1,254.70	-	-	-	-	-	0.15	1,200	-	-	1,254.7	-	-	-	-	-	-
SO_3	-	-	25.000	-	35.	25	-	-	-	0.1	0.1	4.9	-	-	-	25	-	-	100	100	0.1	0.1
H_2S	-	-	5.850	-	-	-	5.850	0.03	-	-	-	-	-	-	-	-	0.030	-	-	-	-	-
CO	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO_x	-	-	100	-	14	72	221	317	-	-	-	33.5	14	-	-	72	317	-	-	-	-	-
HCL	-	-	2.700	-	0.3	1.0	-	-	-	-	-	0.050	0.300	-	-	1	-	-	-	-	-	-
HF	-	-	0.400	-	0.057	0.04	-	-	-	-	-	0.380	0.060	-	-	0.040	-	-	-	-	-	-
Antimony	-	-	0.100	-	0.020	-	0.005	0.005	-	-	-	0.080	0.020	-	-	-	0.005	-	-	-	-	-
Arsenic	-	-	0.020	-	0.090	-	0.005	0.005	-	-	-	0.090	0.090	-	-	-	0.005	-	-	-	-	-
Beryllium	-	-	0.020	-	-	-	0.005	0.005	-	-	-	0.020	-	-	-	-	0.005	-	-	-	-	-
Cadmium	-	-	0.700	-	0.010	-	0.030	0.005	-	-	-	0.003	0.010	-	-	-	0.005	-	-	-	-	-
Chromium 3	-	-	0.100	-	0.200	-	0.005	0.005	-	-	-	0.030	0.200	-	-	-	0.005	-	-	-	-	-
Cobalt	-	-	0.020	-	0.010	-	0.005	0.005	-	-	-	0.290	0.010	-	-	-	0.005	-	-	-	-	-
Copper	-	-	0.090	-	1.000	-	0.010	0.470	-	-	-	134.5	1.000	-	-	-	0.470	-	-	-	-	-
Lead	-	-	0.030	-	0.700	-	0.005	0.005	-	-	-	0.470	0.700	-	-	-	0.005	-	-	-	-	-
Manganese	-	-	0.100	-	0.020	-	0.005	0.005	-	-	-	0.260	0.020	-	-	-	0.005	-	-	-	-	-
Mercury	-	-	0.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	0.050	-	0.100	-	0.005	0.010	-	-	-	0.160	0.100	-	-	-	0.010	-	-	-	-	-
Selenium	-	-	0.020	-	0.030	-	0.070	0.130	-	-	-	0.080	0.030	-	-	-	0.130	-	-	-	-	-
Zinc	-	-	0.100	-	0.080	-	0.010	0.050	-	-	-	0.400	0.080	-	-	-	0.050	-	-	-	-	-

Table 3.8 Calculated emission rates – SRE Project operations (Stage 2)

Pollutant	Emission rates by stack source (g/s)																				
	Calciner A stack	Calciner B stack	Tails leach hygiene stack	Anode Furnace 3 and 4 Casting Wheel Vent	Main Smelter Stack (FCF and AF Hygiene + AF)	Acid Plant 2 - Stack	Roaster Scrubber (Hydrosonic Scrubber) Stack	Slimes Treatment NOx Scrubber	Cyanidation and Zinc Precipitation Area Stack	Tankhouse A	Tankhouse B	Smelter 3 - Dryer Stack	Smelter 3 - Hygiene Stack	Smelter 3 - Matte Grinding Mill Stack	Anode Furnace 5 and 6 Casting Wheel Vent	Acid Plant 3 - Stack	Cupel Furnace Scrubber Stack	Cyanidation and Zinc Precipitation Area Stack	Slimes Autoclave Scrubber	Circulation Area Scrubber	Green Field ER Tankhouse A	Green Field ER Tankhouse B
TSP	5.48E-02	2.50E-02	3.60E-02	4.09E-01	3.09E+00	6.27E-02	1.25E+00	1.17E-02	-	-	-	2.38E+00	7.48E+00	6.29E-01	4.09E-01	1.05E-01	4.71E-03	-	-	-	-	-
PM_{10}	5.04E-02	2.30E-02	3.31E-02	3.77E-01	2.85E+00	5.77E-02	1.15E+00	1.07E-02	-	-	-	2.19E+00	6.88E+00	5.79E-01	3.77E-01	9.68E-02	4.34E-03	-	-	-	-	-
$PM_{2.5}$	4.49E-02	2.05E-02	2.95E-02	3.36E-01	2.54E+00	5.14E-02	1.03E+00	9.57E-03	-	-	-	1.96E+00	6.13E+00	5.16E-01	3.36E-01	8.63E-02	3.86E-03	-	-	-	-	-
SO_2	-	-	-	-	3.62E+01	5.24E+01	-	-	-	-	-	2.56E-03	8.97E+01	-	-	8.80E+01	-	-	-	-	-	-
SO_3	-	-	6.00E-01	-	4.90E+00	1.04E+00	-	-	-	1.11E-02	1.11E-02	8.35E-02	-	-	-	1.75E+00	-	-	1.17E-01	1.17E-01	1.11E-02	1.11E-02
H_2S	-	-	1.40E-01	-	-	-	9.39E-02	5.00E-05	-	-	-	-	-	-	-	-	2.02E-05	-	-	-	-	-
CO	-	-	6.00E-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NO_x	-	-	2.40E+00	-	1.96E+00	3.01E+00	3.55E+00	5.28E-01	-	-	-	5.71E-01	1.05E+00	-	-	5.05E+00	2.13E-01	-	-	-	-	-
HCL	-	-	6.48E-02	-	4.20E-02	4.18E-02	-	-	-	-	-	8.52E-04	2.24E-02	-	-	7.02E-02	-	-	-	-	-	-
HF	-	-	9.60E-03	-	7.97E-03	1.67E-03	-	-	-	-	-	6.47E-03	4.49E-03	-	-	2.81E-03	-	-	-	-	-	-
Antimony	-	-	2.40E-03	-	2.80E-03	-	8.03E-05	8.33E-06	-	-	-	1.36E-03	1.50E-03	-	-	-	3.37E-06	-	-	-	-	-
Arsenic	-	-	4.80E-04	-	1.26E-02	-	8.03E-05	8.33E-06	-	-	-	1.53E-03	6.73E-03	-	-	-	3.37E-06	-	-	-	-	-
Beryllium	-	-	4.80E-04	-	-	-	8.03E-05	8.33E-06	-	-	-	3.41E-04	-	-	-	-	3.37E-06	-	-	-	-	-
Cadmium	-	-	1.68E-02	-	1.40E-03	-	4.82E-04	8.33E-06	-	-	-	5.11E-05	7.48E-04	-	-	-	3.37E-06	-	-	-	-	-
Chromium 3	-	-	2.40E-03	-	2.80E-02	-	8.03E-05	8.33E-06	-	-	-	5.11E-04	1.50E-02	-	-	-	3.37E-06	-	-	-	-	-
Cobalt	-	-	4.80E-04	-	1.40E-03	-	8.03E-05	8.33E-06	-	-	-	4.94E-03	7.48E-04	-	-	-	3.37E-06	-	-	-	-	-
Copper	-	-	2.16E-03	-	1.40E-01	-	1.61E-04	7.83E-04	-	-	-	2.29E+00	7.48E-02	-	-	-	3.16E-04	-	-	-	-	-
Lead	-	-	7.20E-04	-	9.79E-02	-	8.03E-05	8.33E-06	-	-	-	8.01E-03	5.23E-02	-	-	-	3.37E-06	-	-	-	-	-
Manganese	-	-	2.40E-03	-	2.80E-03	-	8.03E-05	8.33E-06	-	-	-	4.43E-03	1.50E-03	-	-	-	3.37E-06	-	-	-	-	-
Mercury	-	-	4.80E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	1.20E-03	-	1.40E-02	-	8.03E-05	1.67E-05	-	-	-	2.73E-03	7.48E-03	-	-	-	6.73E-06	-	-	-	-	-
Selenium	-	-	4.80E-04	-	4.20E-03	-	1.12E-03	2.17E-04	-	-	-	1.36E-03	2.24E-03	-	-	-	8.75E-05	-	-	-	-	-
Zinc	-	-	2.40E-03	-	1.12E-02	-	1.61E-04	8.33E-05	-	-	-	6.81E-03	5.98E-03	-	-	-	3.37E-05	-	-	-	-	-

Fugitive dust and diesel combustion emission sources associated with the SRE Project were quantified through the application of USEPA AP-42 emission factor equations. Particulate matter emissions were quantified for the three size fractions – TSP, PM_{10} and $PM_{2.5}$. Emission rates for PM_{10} and $PM_{2.5}$ were estimated using ratios for the different particle size fractions available in the literature (principally the USEPA AP-42).

The following key assumptions underpin the SRE Stage 2 fugitive emissions inventory developed:

- Material throughputs have been adopted from the estimated annual solid mass, matte, silica and slag material rates provided by BHP, as follows:
  - Regional concentrate (RC) unloading to storage – 1,125,200 tpa
  - FSF matte production – 975,600 tpa
  - FSF slag production – 1,332,800 tpa
  - Slag concentrate to concentrate thickening – 152,600 tpa
  - Silica flux – 349,100 tpa.
- All RC transported to the SRE area is assumed to be delivered by trucks in rotainers to the unloading zone to the north of the SRE area.
- Emissions from truck movements correlate to projected Stage 2 traffic movements, less the existing truck movement totals (assumed to be accounted for in the BAU operations fugitive emissions).
- Truck movements not associated with the SRE Project, are assumed to extend from the SRE Project road junction into the central weighbridge of the Olympic Dam site.

The following particulate matter emission mitigation measures are incorporated into the design of the SRE Project:

- All RC transported to the SRE Project area in sealed rotainers to eliminate fugitive emission loss during transport.
- The rotainers will be emptied within an enclosure (99% reduction).
- All conveyors and conveyor transfer points moving RC will be fitted with a cover and side wall cladding for wind protection (75% reduction).
- With the exception of the slag haul road, all primary SRE Project roads for the transportation of RC will be sealed. Water spraying will occur along all unsealed and sealed roads (75% reduction).
- Slag pot trucks will have a reduced travel speed (44% reduction for travel < 40 km/hr).
- All other material handling and transfer operations (e.g. silo and day bin loading, bedding plant, slag/revert shed) will occur within full enclosures with dust extraction (99% reduction).

The quoted emission reduction factors have been applied to individual sources in the fugitive emissions inventory for the SRE Project.

Further details regarding emission estimation factors and assumptions are provided in Appendix B.

The calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for the SRE Project by emission release or activity are listed in Table 3.9. Activities were assumed to occur for 24 hours of the day.

Fugitive emission totals have been distributed across the proposed layout SRE project area, using a combination of line-volume sources, volume sources and area sources. Emissions from wind erosion have been scaled proportional to the cube of the wind in order to allocate higher emissions to periods of elevated wind conditions. Emissions from other fugitive emission sources have been modelled on a continuous hourly-average basis.

Emissions of metals and metalloids from the SRE project have been derived by adopting the relationship between the annual emission totals for PM_{10} and each individual element from the BAU operations scenario (Table 3.5) and combining with the calculated fugitive PM_{10} emissions for the SRE Project.

Table 3.9 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – fugitive emission sources associated with SRE Project Stage 2

Emission source type and activity	Calculated annual emissions (kg/year) by source		
	TSP	PM_{10}	$PM_{2.5}$
Site entrance to SRE road junction	106,289.4	20,402.3	4,936.0
SRE junction to main internal weighbridge	110,746.2	21,257.8	5,143.0
SRE junction to RC storage shed	36,284.3	6,964.8	1,685.0
OD concentrate unloading	85.3	40.3	6.1
OD concentrate conveyor transfer 1	85.3	40.3	6.1
OD concentrate conveyor transfer 2	85.3	40.3	6.1
OD concentrate conveyor transfer 3	85.3	40.3	6.1
OD concentrate conveyor transfer 4	85.3	40.3	6.1
Unloading RC to storage shed	3.3	1.6	0.2
OD/RC concentrate conveyor transfer 1	141.9	67.1	10.2
OD/RC concentrate conveyor transfer 2	141.9	67.1	10.2
Bedding Plant dome loading	141.9	67.1	10.2
Conc/Silica/Revert day bins loading	136.9	64.7	9.8
Revert/silica transfer	136.9	64.7	9.8
Day bins to dryer conveying transfer 1	7.9	3.7	0.6
Day bins to dryer conveying transfer 2	7.9	3.7	0.6
Matte conveyor transfer 1	1,232.7	583.1	88.3
Matte conveyor transfer 2	1,232.7	583.1	88.3
Molten slag tipping trucks to Slag cooling area	29,304.9	9,834.4	983.4
Slag transportation to Slag Concentrator	56,973.8	19,119.9	1,912.0
Slag unloading to Slag Concentrator hopper	9,906.4	4,685.4	709.5
Transfer to Slag Concentrator stockpile	9,906.4	4,685.4	709.5

Emission source type and activity	Calculated annual emissions (kg/year) by source		
	TSP	PM_{10}	$PM_{2.5}$
Slag concentrator (crushing)	266,560.0	26,656.0	2,665.6
Slag concentrator stockpile wind erosion	2,986.3	1,493.1	224.0
Slag conveyor transfer 1	1,684.1	796.5	120.6
Slag conveyor transfer 2	1,684.1	796.5	120.6
SRE diesel combustion - vehicle movements	337.8	337.8	323.3
Total	**636,274.2**	**118,737.7**	**19,791.3**

Note: Totals may not sum due to rounding.



KEY

- Special Mining Lease
- SRE Project Area - SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Area source
- Volume source

Model source location

- Acid plant 2- stack
- Acid plant 3- stack
- Anode furnace 3 and 4 casting wheel vent
- Anode furnace 5 and 6 casting wheel vent
- Calciner A stack
- Calciner B stack
- ER- Circulation area scrubber
- ER- Slimes autoclave scrubber
- Main smelter stack (FCF and AF hygiene + AF)
- PMR Brown field- cyanidation and zinc precipitation area stack
- PMR- Cupel furnace scrubber stack
- PMR Green field- cyanidation and zinc precipitation area stack
- PMR- Roaster scrubber (hydrosonic scrubber) stack
- PMR- Slimes treatment NOx scrubber
- Smelter 3- Dryer stack
- Smelter 3- Hygiene stack
- Smelter 3- Matte grinding mill stack
- Tails leach hygiene stack

Buoyant line source

- ER- Brown field ER tankhouse A and B
- ER- Green field ER tankhouse A and B

Line volume source

- Molten slag tipping trucks to slag cooling area
- Site entrance to SRE road junction
- Slag concentrator
- Slag transportation to slag concentrator
- SRE junction to main internal weightbridge
- SRE junction to RC storage shed

Existing environment

- Major road
- Minor road

SRE Project emission source locations

BHP SRE Project
Air Quality Impact Assessment
Figure 3.2

EMM
creating opportunities

3.2.5 Change in annual emissions

The total annual emissions by pollutant from BAU operations and SRE Stage 2 operations existing sources are presented in Table 3.10. All pollutants are estimated to have an increase relative to BAU operations under Stage 2 operations; however, the magnitude of increase varies by pollutant.

Table 3.10 Annual emission totals (fugitive + stack sources) – BAU operations vs SRE Project Stage 2 + existing sources

Air pollutant	Annual emissions (tonnes/year)	
	BAU operations	SRE Project Stage 2 + existing
TSP	7,003.31	7,995.32
PM_{10}	3,443.43	3,889.45
$PM_{2.5}$	672.95	984.45
SO_2	1,560.36	8,402.05
SO_3	181.27	265.60
H_2S	4.46	7.39
CO	650.36	652.81
NO_X	1,341.91	1,596.87
HCl	4.17	7.63
Fluoride	1.91	2.32
Antimony	0.19	0.26
Arsenic	0.46	0.71
Beryllium	0.02	0.03
Cadmium	0.59	0.62
Chromium III	1.32	1.82
Cobalt	0.16	0.29
Copper	28.78	79.87
Lead	3.38	5.20
Manganese	6.07	6.42
Mercury	0.00	0.00
Nickel	0.77	1.08
Selenium	0.25	0.35
Zinc	1.50	1.85
Cyanide	1.23	4.92

3.2.6 Excluded emission sources

The existing site and proposed SRE include a range of bypass emission stacks that are used infrequently for emergency releases, principally comprising SO_2. Table 3.11 provides details of the bypass stacks associated with existing and SRE plant, including the expected frequency and duration of emission releases. Due to uncertainty around the exact timing of bypass releases and the nature of the dispersion modelling undertaken for continuous processes, it is not practical to include the bypass emissions in the dispersion modelling presented in this report.

Table 3.11 Details relating to bypass stacks

Existing or new stack	Stack name	Operating conditions
Existing	Acid Plant 2 - Bypass Stack	Assume 54 times per year, 20 minutes per event. After 20 minutes, SO_2 will be less than 1% of initial concentrations and other emissions significantly reduced.
Existing	Anode Furnace 3 - Bypass Stack	Assume 88 times per year, 120 mins per event. Assuming in oxidation mode at time of bypass to be conservative
Existing	Anode Furnace 4 - Bypass Stack	Assume 88 times per year, 120 mins per event. Assuming in oxidation mode at time of bypass to be conservative
Existing	Smelter 2 - FCF Emergency - Self-suction Chimney	Assume 6 times per year, 4 hours per event
New	Acid Plant 3 - Bypass Stack	Assume 54 times per year, 20 minutes per event. After 20 minutes, SO_2 will be less than 1% of initial concentrations and other emissions significantly reduced.
New	Anode Furnace 5 - Bypass Stack	Assume 88 times per year, 120 mins per event. Assuming in oxidation mode at time of bypass to be conservative
New	Anode Furnace 6 - Bypass Stack	Assume 88 times per year, 120 mins per event. Assuming in oxidation mode at time of bypass to be conservative
New	Smelter 3 - FSF Emergency - Self-suction Chimney	Assume 6 times per year, 4 hours per event

It is noted that consistent with EPA Licence 1301, the reporting of bypass stack emission releases is conducted in accordance with *Development of the Quarterly Notification of Emissions Events Report to the EPA, Document No.48955*. The reporting of emissions from the proposed bypass emission stacks under the SRE Project will align with this reporting procedure.

Other excluded sources of emissions include:

- emergency power generator engines, due to infrequent operation
- underground mining ventilation shaft emissions, due to limited emissions monitoring data for existing vents by which to quantify emissions.

3.2.7 Modelling methodology

i Meteorological modelling

Atmospheric dispersion modelling for the assessment of effects was conducted using the AMS[5]/USEPA[6] regulatory model AERMOD (model version v24142). Details of the dispersion modelling are provided in Section 3.2.7ii.

The meteorological inputs for AERMOD were generated using the AERMET meteorological processor (model version v24142), using surface observations from the BoM Olympic Dam Aerodrome AWS and upper air profiles generated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) TAPM meteorological modelling module.

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

ii Atmospheric dispersion modelling

The atmospheric dispersion modelling completed for the AQIA used the AERMOD dispersion model (version v24142). AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

In addition to the 2,076 sensitive receptor gridded points (documented in Figure 2.6), air pollutant concentrations were predicted across a nested receptor grid (totalling 5,097 receptor points) with the following configuration:

- an inner 10 km x 10 km domain with receptor points at 200 m intervals
- a second-tier domain of 20 km x 20 km domain with receptor points at 500 m intervals
- a third-tier domain of 30 km x 30 km with receptor points at 1 km
- an outer domain of 60 km x 60 km with receptor points at 2 km.

Simulations were undertaken for January to December 2024 using the AERMET-generated file using the BoM Olympic Dam Aerodrome AWS data as input (see Section 2.1.4 and Appendix A for a description of input meteorology).

iii Building downwash

The influence of the existing and proposed building and structures about the Olympic Dam site, including the SRE Project area, is accounted for in the AERMOD dispersion modelling through the Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) downwash module.

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

[5] AMS – American Meteorological Society.

[6] USEPA – United States Environmental Protection Agency.

iv NO_x to NO_2 conversion

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

For this AQIA, the ozone limiting method (OLM) has been applied to convert model-predicted concentrations of NO_x to NO_2 for comparison with the applicable impact assessment criteria. The OLM approach requires the consideration of background O_3 concentrations in ambient air. In the absence of local measurements of O_3, reference has been made to the hourly-varying O_3 concentrations recorded at the closest available SA EPA AQMS (Elizabeth, in Northern Adelaide) during 2024.

The OLM assumes that all available O_3 in the atmosphere will react with nitric oxide (NO) in the plume until either all the O_3 or all the NO is used up. The approach assumes that the atmospheric reaction is instant. In reality, the reaction takes place over a number of hours. The OLM will, therefore, tend to overestimate concentrations at near-source locations. Therefore, the NO_2 predictions in this AQIA calculated using the OLM approach are considered conservative.

An in-stack ratio (ISR) value of 0.2 for primary emitted NO_2 from total NO_x has been assumed for all relevant emission sources in the OLM calculations. Based on limited NO_2 vs NO_x sampling at Olympic Dam, the ratio at site was in the order of 2.9%. Therefore, the application of 0.2 in the OLM calculations is considered conservative.

3.2.8 Air quality impact assessment criteria

Based on the emission calculations presented in the preceding sections, focus will be given to emissions of the following pollutants:

- particulate matter – TSP, PM_{10} and $PM_{2.5}$
- SO_2
- NO_x
- HCl (based on the assumption that 100% of hydrochloric acid is emitted as HCl)
- H_2SO_4 (based on the assumption that 100% of sulphur trioxide is emitted as H_2SO_4, based on molecular weight adjustment)
- H_2S
- fluoride
- cyanide
- representative metal/metalloids of arsenic, copper, lead and manganese.

The AQIA criteria relevant to these air pollutants are defined in Schedule 2 of the *Environment Protection (Air Quality) Policy 2016* (Air Quality EPP), as amended in May 2023. The criteria for the pollutants and averaging periods that are relevant to the SRE Project are given in Table 3.12. Where relevant, these are numerically consistent[7] with the national air quality standards in the *National Environment Protection (Ambient Air Quality) Measure* (AAQ NEPM).

Table 3.12 Impact assessment criteria (SA 2016)

Pollutant	Averaging time	Assessment criteria
NO_2	1 hour	0.08 ppm / 164 µg/m^3
	Annual	0.015 ppm / 30 µg/m^3
SO_2	1 hour	0.1 ppm / 290 µg/m^3
	24 hour	0.02 ppm / 60 µg/m^3
PM_{10}	24 hours	50 µg/m^3
$PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
HCl	3 minute	0.17 ppm / 270 µg/m^3
H_2S		0.0001 ppm / 0.15 µg/m^3 (odour) 0.32 ppm / 51 µg/m^3 (toxicity)
H_2SO_4	3 minute	36 µg/m^3
Arsenic	3 minute	0.19 µg/m^3
Cyanide	3 minute	190 µg/m^3
Fluoride	24 hour	3 µg/m^3
Copper	3 minute	36 µg/m^3
Lead	Annual	0.5 µg/m^3
Manganese	3 minute	36 µg/m^3

3.2.9 In-stack concentration limits

Table 3.13 presents the stack emission limits applicable to Olympic Dam operations specified in either Schedule 4 of the Air Quality EPP or documented in EPA Licence 1301.

[7] Allowing for a conversion of volumetric units to mass units, and rounding.

Table 3.13 Stack emission concentration limits - existing EPA Licence 1301 and Air Quality EPP stack emission concentration limits

Pollutant	Criteria (mg/Nm^3)		Notes
	EPA Licence 1301	Air Quality EPP	
Particulates	100	100	Processes involving the heating of metal of metals ores, including from the FF, Anode Furnace, Acid Plant, Electric Furnace Bypass Stacks (EPA 1301.37-43) and the Gold Room Roaster Scrubber
Antimony	-	10	
Arsenic	-	10	
Cadmium	-	3	
Lead	-	10	
Mercury	-	3	
NO_x	-	350	Fuel burning equipment – gaseous fuels
	-	500	Fuel burning equipment – liquid or solid fuels
	-	2,000	Sulphuric acid plants
SO_2	2,400	1,000	Acid Plant Tails Gas Stack and Main Smelter Stack
SO_3	100	100	Including from the FF, Anode Furnace, and Electric Furnace Bypass Stacks
Total acid gases (as SO_3)	100	100	Including from the Acid Plant Tail-Gas Stack and Main Smelter Stack (EPA 1301.37-43)
H_2S	-	5	
Hydrofluoric acid	-	50	Including all fluoride compounds
Chlorine	-	200	Including all chlorine compounds
CO	-	1,000	

Based on the information presented in Table 3.7 for SRE Stage 2 operations, all stacks are expected to comply with the existing stack emission concentration limits, with the exception of H_2S emissions from the Tails Leach Hygiene Stack and Roaster Scrubber (Hydrosonic Scrubber) Stack. The implications for stack emission concentrations and compliance with relevant limits is addressed by the atmospheric dispersion modelling presented in Section 3.3.

3.3 Dispersion modelling results

3.3.1 Incremental (no baseline) results

A summary of predicted incremental concentrations from the BAU operations and SRE Project Stage 2 + existing operations emission scenarios are presented in Table 3.14 and Table 3.15, respectively. It is noted that the results presented in these two tables are the highest predicted values by pollutant and averaging period across the sensitive receptor area grids.

Ground level concentrations of all pollutants are predicted to increase under SRE Project Stage 2 operations relative to BAU operations. The most significant increase in predicted concentrations as a result of the SRE Project Stage 2 occurs for SO_2, copper, manganese and particulate matter (PM_{10}, $PM_{2.5}$).

The predicted incremental concentrations for all pollutants and averaging periods are below the applicable Air Quality EPP assessment criterion at all receptor locations. Analysis of cumulative impact compliance is presented in Section 3.3.2.

As identified in Section 3.2.9, the expected in-stack emission concentration for H_2S is above the relevant Air Quality EPP stack emission concentration limit for the Tails Leach Hygiene Stack and Roaster Scrubber (Hydrosonic Scrubber) Stack. Despite this, no exceedance of the ground level concentration criteria for H_2S is predicted at any sensitive receptor.

Isopleth plots, illustrating spatial variations in project-related incremental concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 are provided in Appendix C. Isopleth plots of the maximum 1-hour and 24-hour average concentrations presented in Appendix C do not represent the dispersion pattern on any individual hour or day, but rather illustrate the maximum concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2024 modelling period.

Table 3.14 Highest predicted incremental concentrations or deposition rates by sensitive receptor type – BAU operations

Pollutant and averaging period	Criterion	Unit	Highest predicted concentration by sensitive receptor type								
			BHP Industrial Estate	Olympic Dam Aerodrome	Olympic Dam Commercial	Olympic Dam Village	Olympic Dam Village South	Roxby Downs	Roxby Downs Industrial	Andamooka	Arid Recovery
24h PM_{10}	50	µg/m³	8.8	9.5	9.5	9.6	7.4	3.3	3.4	1.7	8.9
24h $PM_{2.5}$	25	µg/m³	2.9	3.0	3.3	3.2	2.5	1.0	0.8	0.7	2.4
Annual $PM_{2.5}$	8	µg/m³	0.3	0.4	0.3	0.4	0.3	0.1	0.1	<0.1	0.5
1h NO_2	164	µg/m³	92.4	92.3	98.4	97.9	90.2	60.5	54.9	60.5	100.6
Annual NO_2	30	µg/m³	1.8	2.0	1.8	2.1	1.4	0.4	0.4	0.2	2.7
1h SO_2	0.1	ppm	0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24h SO_2	0.02	ppm	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3-min HCl	270	µg/m³	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2
24h fluoride	3	µg/m³	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3-min copper	36	µg/m³	4.5	3.6	3.5	4.6	3.9	3.2	3.3	0.8	2.9
Annual lead	0.5	µg/m³	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3-min manganese	36	µg/m³	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1
3-min cyanide	190	µg/m³	0.4	0.3	0.4	0.4	0.3	0.1	0.1	0.1	0.3
3-min H_2S	510	µg/m³	0.7	0.7	0.7	0.8	0.6	0.6	0.6	0.2	0.8
3-min H_2SO_4	36	µg/m³	3.6	3.5	3.0	3.7	3.2	2.8	2.8	1.4	3.8
3-min arsenic	0.19	µg/m³	0.07	0.06	0.08	0.08	0.05	0.03	0.02	0.03	0.06

Table 3.15 Highest predicted incremental concentrations or deposition rates by sensitive receptor type – SRE Project Stage 2 + existing operations

Pollutant and averaging period	Criterion	Unit	Highest predicted concentration by sensitive receptor type								
			BHP Industrial Estate	Olympic Dam Aerodrome	Olympic Dam Commercial	Olympic Dam Village	Olympic Dam Village South	Roxby Downs	Roxby Downs Industrial	Andamooka	Arid Recovery
24h PM_{10}	50	µg/m³	22.0	16.8	23.8	26.2	16.2	6.7	3.8	2.8	11.4
24h $PM_{2.5}$	25	µg/m³	5.4	4.9	5.9	6.4	4.6	1.7	1.2	0.8	3.0
Annual $PM_{2.5}$	8	µg/m³	0.4	0.5	0.4	0.5	0.3	0.1	0.1	<0.1	0.6
1h NO_2	164	µg/m³	94.3	93.1	100.5	101.4	90.2	63.5	54.3	60.8	100.8
Annual NO_2	30	µg/m³	1.9	2.1	1.9	2.1	1.5	0.4	0.4	0.2	2.7
1h SO_2	0.1	ppm	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.04
24h SO_2	0.02	ppm	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01
3-min HCl	270	µg/m³	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2
24h fluoride	3	µg/m³	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3-min copper	36	µg/m³	10.7	9.7	23.1	12.9	7.2	1.8	1.9	1.2	9.0
Annual lead	0.5	µg/m³	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
3-min manganese	36	µg/m³	0.5	0.3	0.5	0.6	0.2	0.2	0.1	0.1	0.2
3-min cyanide	190	µg/m³	0.4	0.3	0.4	0.4	0.3	0.2	0.1	0.2	0.3
3-min H_2S	510	µg/m³	0.7	0.7	0.7	0.8	0.6	0.6	0.6	0.2	0.8
3-min H_2SO_4	36	µg/m³	13.9	13.4	13.9	14.9	11.8	7.2	6.9	2.1	6.9
3-min arsenic	0.19	µg/m³	0.01	0.01	0.02	0.01	0.01	0.01	0.01	<0.01	0.01

3.3.2 Cumulative (Olympic Dam plus baseline) results

As summarised in Section 2.3, representative ambient baseline concentrations have been derived for TSP, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 based on reviewed air quality monitoring data. For all other pollutants modelled in this AQIA, it is assumed that the baseline beyond the contributions from BAU operational emissions are negligible (i.e. reference should be made to the increment results in Section 3.3.1).

A summary of predicted cumulative concentrations from the BAU operations and SRE Project Stage 2 + existing operations emission scenarios are presented in Table 3.16 and Table 3.17 respectively. As per the incremental results tables, is noted that the results presented in these two tables are the highest predicted values by pollutant and averaging period across the sensitive receptor area grids.

The predicted concentrations for all presented pollutants and averaging periods are below the applicable EPA assessment criterion at all sensitive receptor areas.

Table 3.16 Highest predicted cumulative concentrations by sensitive receptor type – BAU operations

Pollutant and averaging period	Criterion	Unit	Highest predicted concentration by sensitive receptor type								
			BHP Industrial Estate	Olympic Dam Aerodrome	Olympic Dam Commercial	Olympic Dam Village	Olympic Dam Village South	Roxby Downs	Roxby Downs Industrial	Andamooka	Arid Recovery
24h PM_{10}	50	µg/m³	19.7	20.4	20.4	20.5	18.3	14.2	14.3	12.6	19.8
24h $PM_{2.5}$	25	µg/m³	8.5	8.6	8.9	8.8	8.1	6.6	6.4	6.3	8.0
Annual $PM_{2.5}$	8	µg/m³	5.6	5.7	5.6	5.7	5.6	5.4	5.4	5.3	5.8
1h NO_2	164	µg/m³	98.6	98.5	104.6	104.1	96.4	66.7	61.1	66.7	106.8
Annual NO_2	30	µg/m³	8.0	8.2	8.0	8.3	7.6	6.6	6.6	6.4	8.9
1h SO_2	0.1	ppm	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	0.01
24h SO_2	0.02	ppm	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 3.17 Highest predicted cumulative concentrations by sensitive receptor type – SRE Project + BAU operations

Pollutant and averaging period	Criterion	Unit	Highest predicted concentration by sensitive receptor type								
			BHP Industrial Estate	Olympic Dam Aerodrome	Olympic Dam Commercial	Olympic Dam Village	Olympic Dam Village South	Roxby Downs	Roxby Downs Industrial	Andamooka	Arid Recovery
24h PM_{10}	50	µg/m³	32.9	27.7	34.7	37.1	27.1	17.6	14.7	13.7	22.3
24h $PM_{2.5}$	25	µg/m³	11.0	10.5	11.5	12.0	10.2	7.3	6.8	6.4	8.6
Annual $PM_{2.5}$	8	µg/m³	5.7	5.8	5.7	5.8	5.6	5.4	5.4	5.3	5.9
1h NO_2	164	µg/m³	100.5	99.3	106.7	107.6	96.4	69.7	60.5	67.0	107.0
Annual NO_2	30	µg/m³	8.1	8.3	8.1	8.3	7.7	6.6	6.6	6.4	8.9
1h SO_2	0.1	ppm	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.01
24h SO_2	0.02	ppm	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

3.3.3 Model verification

Dispersion model predictions of 1-hour SO_2 at the Olympic Dam Village AQMS under BAU operations were compared to monitored data from the baseline 2024 SO_2 dataset. It is considered that SO_2 is a useful metric to test model performance on the basis that the Olympic Dam site represents the most significant source of SO_2 emissions in the study area. By comparison, there are many additional sources of particulate matter that may influence a comparison against recorded PM_{10} concentrations.

From this SO_2 prediction vs observation comparison, the performance of the model evaluated against the following common statistical parameters:

- The index of agreement (IoA) is a metric of the differences between modelled and observed data. This metric condenses all the differences between model estimates and observations within a given analysis region and for a given time period (hourly and daily) into one statistical quantity. It is the ratio of the total RMSE to the sum of two differences – between each prediction and the observed mean, and each observation and the observed mean. An IOA of 60% or greater represents a good correlation. An IOA of one indicates a perfect correlation between predicted and observed.

- The robust highest concentration (RHC) is a metric to quantify the performance of the model in predicting the extreme end of the concentration distribution (Cox and Tikvart 1990).

- The RMSE ratio is the root mean square error normalised with the RHC, and as such is a good measure of the overall model performance.

- MaxR is the ratio of modelled to observed concentration and provides another metric for the model performance at the extreme end of the concentration range.

To provide a visualisation of the model's performance in predicting SO_2 concentrations, the AERMOD predicted 1-hour average SO_2 concentrations for BAU operations and the 1-hour average SO_2 baseline data sets were ranked in order, and then plotted against each other, in what is termed a quantile-quantile (Q-Q) plot.

A Q-Q plot for 1-hour average SO_2 concentrations at the Olympic Dam Village AQMS is presented in Figure 3.3. Perfect agreement would be indicated by the OBS vs OBS line (solid line in the graph). The Q-Q plot in Figure 3.3 indicates that the model is over-predicting the highest 1-hour average SO_2 concentrations when compared with the 2024 baseline dataset from Olympic Dam Village.

A Q-Q plot for 1-hour average SO_2 concentrations at the Roxby Downs AQMS is presented in Figure 3.4, which indicates that the model is under-predicting the highest 1-hour average SO_2 concentrations when compared with the 2024 baseline dataset from Roxby Downs AQMS.

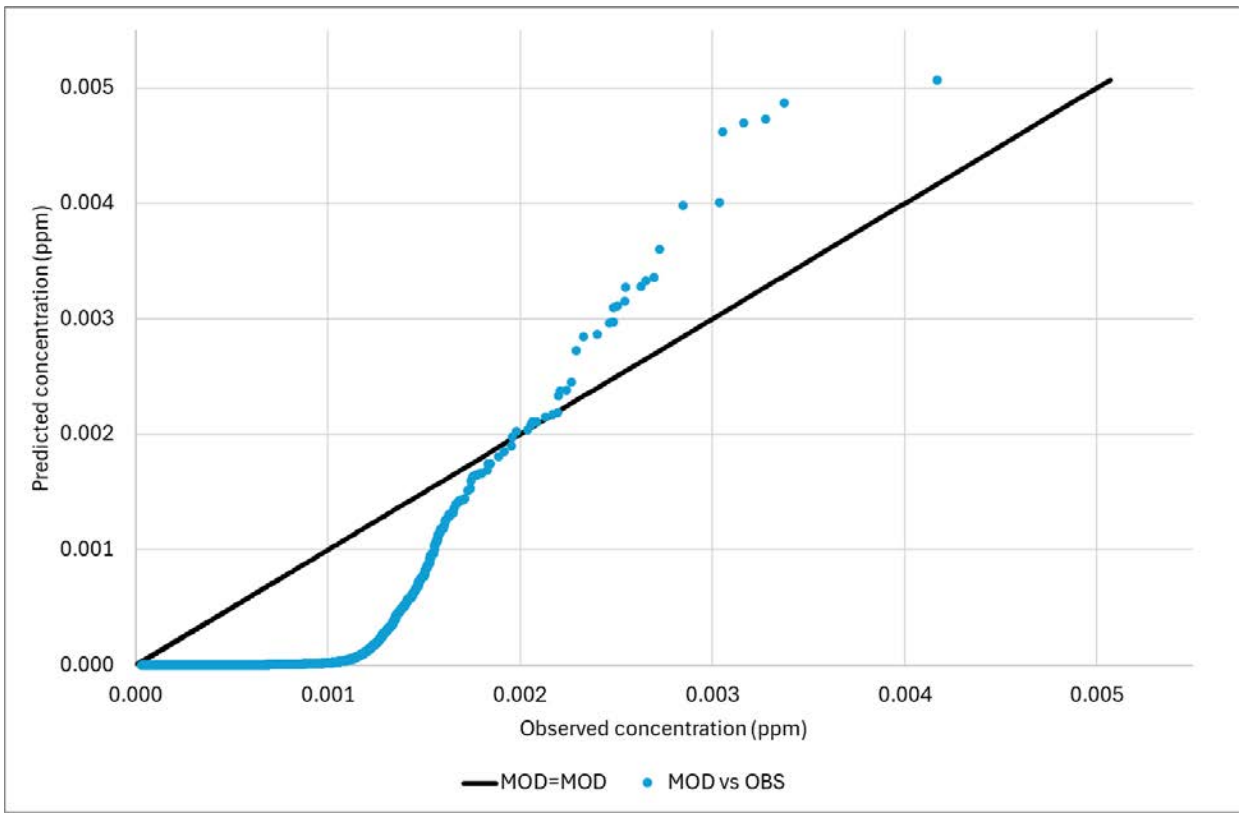


Figure 3.3 **Predicted vs. observed 1-hour average concentrations of SO_2 – Olympic Dam Village – BAU operations**

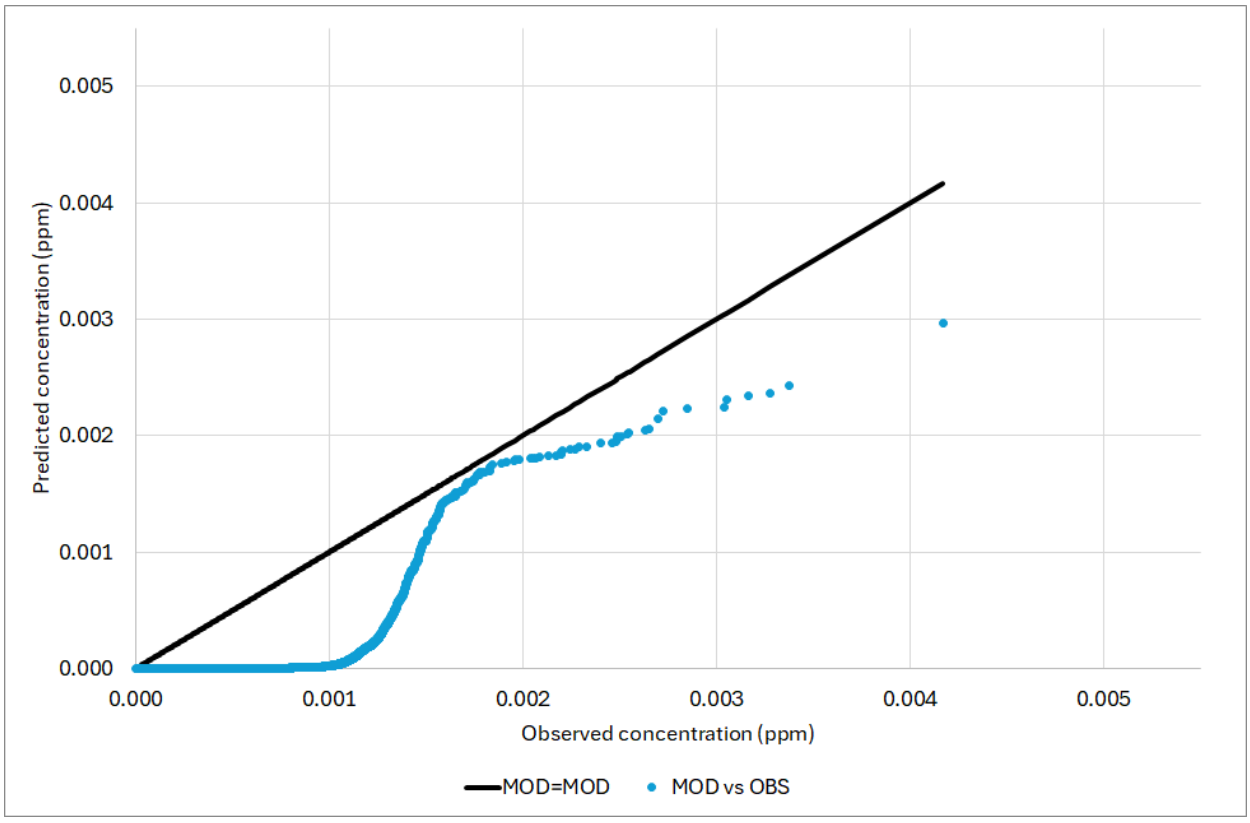


Figure 3.4 **Predicted vs. observed 1-hour average concentrations of SO_2 – Roxby Downs – BAU operations**

A summary of the model performance statistics for SO_2 is presented in Table 3.18 for Olympic Dam Village and Table 3.19 for Roxby Downs.

Table 3.18 Summary statistics of model performance for 1-hour average SO_2 predictions at Olympic Dam Village AQMS – BAU operations

Statistic	Interpretation	Scores
IoA	Perfect = 1	0.22
RMSE Ratio	Perfect = 0	0.41
RHC Ratio	Perfect = 1	3.25
MaxR	Perfect = 1	2.85

Table 3.19 Summary statistics of model performance for 1-hour average SO_2 predictions at Roxby Downs AQMS – BAU operations

Statistic	Interpretation	Scores
IoA	Perfect = 1	0.7
RMSE Ratio	Perfect = 0	0.19
RHC Ratio	Perfect = 1	0.54
MaxR	Perfect = 1	0.61

The results in Table 3.18 and Table 3.19 suggest the following:

- The IoA is below the perfect score of 1, indicating that there is limited agreement between the model and the observations dataset at either site; however, the performance is better for Roxby Downs.
- The RMSE Ratio value is low for both sites, and relative to the benchmark, indicates that the model has performed reasonably well.
- At Olympic Dam Village, the Max_R and RHC Ratio values are high relative to the respective benchmarks, which is reflective of over-prediction of the maximum recorded concentrations illustrated in Figure 3.3.
- At Roxby Downs, the Max_R and RHC Ratio values are low relative to the respective benchmarks, which is reflective of underprediction of the maximum recorded concentrations illustrated in Figure 3.4.

On the basis of these statistics, it is considered that the model is potentially overpredicting 1-hour concentrations at the Olympic Dam Village AQMS at the higher range of predicted SO_2 concentrations, and under-predicting at the Roxby Downs AQMS. The following items should be considered when reviewing this model verification exercise:

- The assumption must be made that the instrumentation is calibrated and in good working order for the measurement of ambient SO_2 concentrations.
- The BAU operations modelling scenario does not include short-term, infrequent emissions from bypass stacks at the Olympic Dam site.

3.4 Conclusion

Emissions of air pollutants have been quantified for BAU operations (using the FY25 NPI reporting totals) and the SRE Project, with a focus on Stage 2 operations. The emission totals derived from the calculations show that the introduction of the SRE Project will increase annual air pollutant emissions relative to BAU operations; however, the magnitude of increase varies by pollutant.

Dispersion modelling was undertaken for both BAU operations and SRE Project Stage 2 + existing operations.

The SRE Project is predicted to increase air quality impacts at neighbouring sensitive receptor locations relative to BAU operations. The most significant increase in predicted concentrations as a result of the SRE Project Stage 2 occurs for SO_2, copper, manganese and particulate matter (PM_{10}, $PM_{2.5}$).

Despite the predicted increase in air quality impacts, the predicted concentrations and deposition rates for all pollutants and averaging periods are below the applicable EPA assessment criterion at all receptor locations for SRE Project emissions.

Table 3.20 presents the revised SPR assessment with respect to air quality impacts following completion of the assessment of effects. Those potential impact events for which a linkage has been demonstrated have been carried forward for impact assessment (see Section 4).

Table 3.20 Final SPR assessment – confirmed impact events

Impact ID	Potential impact event	Receptor	Linkage	Linkage justification
A6	Operational activities release emissions of off-gases and fugitive gases from smelting, acid plant and refinery operations affect air quality, resulting in impacts to the health and safety of the local community	Local community (health and safety)	No	Emissions are estimated to increase as a result of the SRE Project relative to BAU operations. However, the predicted impacts are below applicable health and safety impact assessment criteria at all sensitive receptor location areas.
A7	Operational activities release emissions of off-gases and fugitive gases from smelting, acid plant and refinery operations affect air quality, resulting in impacts to the amenity of the local community	Local community (amenity)	No	Emissions are estimated to increase as a result of the SRE Project relative to BAU operations. However, the predicted impacts are below applicable amenity impact assessment criteria at all sensitive receptor location areas.
A11	Operational activities release emission of off-gases and fugitive gases from smelting, acid plant and refinery operations that generates odour, resulting in impacts to the amenity of the local community	Local community (health and safety)	No	Emissions of sulphur-related pollutants are estimated to increase as a result of the SRE Project relative to BAU operations. However, the predicted impacts are below applicable health and safety impact assessment criteria at all sensitive receptor location areas. Therefore, the likelihood of adverse odour impacts is considered low.
A12	Operational activities release emission of off-gases and fugitive gases from smelting, acid plant and refinery operations that generates odour, resulting in impacts to the health and safety of the local community	Local community (amenity)	No	Emissions of sulphur-related pollutants are estimated to increase as a result of the SRE Project relative to BAU operations. However, the predicted impacts are below applicable amenity impact assessment criteria at all sensitive receptor location areas. Therefore, the likelihood of adverse odour impacts is considered low.
A13	Project-related construction activities (e.g. land clearing) release emissions of particulate matter that affect air quality, resulting in impacts to the health and safety of the local community	Local community (health and safety)	No	While not quantified in this AQIA, emissions and associated impacts from SRE Project construction are anticipated to be lower than BAU operations or SRE Project + BAU operations.
A14	Project-related construction activities (e.g. land clearing) release emissions of particulate matter that affect air quality, resulting in impacts to the amenity of the local community	Local community (amenity)	No	While not quantified in this AQIA, emissions and associated impacts from SRE Project construction are anticipated to be lower than BAU operations or SRE Project + BAU operations.
A18	Project-related operational activities (e.g. stacks or materials handling activities) release emissions of particulate matter that affect air quality, resulting in impacts to the health and safety of the local community	Local community (health and safety)	No	Emissions are estimated to increase as a result of the SRE Project relative to BAU operations. However, the predicted impacts are below applicable health and safety impact assessment criteria at all sensitive receptor location areas.
A19	Project-related operational activities (e.g. stacks or materials handling activities) release emissions of particulate matter that affect air quality, resulting in impacts to the amenity of the local community	Local community (amenity)	No	Emissions are estimated to increase as a result of the SRE Project relative to BAU operations. However, the predicted impacts are below applicable amenity impact assessment criteria at all sensitive receptor location areas.

4 Impact assessment

The impact significance of confirmed impact events associated with the proposed SRE Project activities is described in this section.

4.1 Confirmed impact events

Following the assessment of effects, there are no confirmed air quality impact events associated with the SRE Project. While emissions are estimated to increase relative to BAU operations for all quantified air pollutants, the results of the atmospheric dispersion modelling show no exceedances of applicable impact assessment criteria at any surrounding sensitive receptor areas.

4.2 Impact significance criteria

The impact significance criteria are presented in the Environmental Impact Assessment Framework (EIAF) Appendix to the EIS. Criteria relevant to the assessment of the air quality related impact significance is repeated in Table 4.1.

4.3 Impact assessment

The air quality impact assessment, including the determination of impact significance and the understanding of uncertainties, is summarised in Table 4.2.

Table 4.1 Consequence definitions and significance determination

Severity level	1	2	3	4	5
Environmental value	**Not significant**		**Significant**		
Air quality (human health)	No exceedance of ground level concentrations (GLCs) as per Environment Protection (Air Quality) Policy 2016 (SA)	Localised exceedance of GLCs as per Environment Protection (Air Quality) Policy 2016 (SA) but no effects on off site sensitive receptors	Ongoing exceedance of GLCs as per Environment Protection (Air Quality) Policy 2016 (SA) that results in complaints or members of the public requiring medical treatment	Major or ongoing exceedance of GLCs as per Environment Protection (Air Quality) Policy 2016 (SA) resulting in persistent complaints and/or hospitalisation of members of the public	Major ongoing exceedance of GLCs as per Environment Protection (Air Quality) Policy 2016 (SA) that results in severely debilitating chronic health impacts or life threatening hazards
Air quality	No or negligible reduction in air quality at the SML boundary or at sensitive receptors (no exceedance of air quality standards)	Localised exceedance of air quality standards (annual dust deposition greater than 4 g/m^2/month) but no effects on threatened species habitat or community viability	Ongoing exceedance of air quality standards (annual dust deposition greater than 4 g/m^2/month) that results in short term loss of threatened species habitat or community viability	Major or ongoing exceedance of air quality standards (annual dust deposition greater than 4 g/m^2/month) that results in long term loss of threatened species habitat or community viability	Major ongoing exceedance of air quality standards ((annual dust deposition (total insoluble dust) is greater than 4 g/m^2/month and greater than 2 g/m^2/month above background levels at that location) that result in total extinction of threatened species habitat or community viability

Table 4.2 Air quality impact assessment

Confirmed impact event	Impact ID	Impact significance	Significance justification	Uncertainty
Air				
Air quality (human health)	A6, A11, A12, A13, A18	Level 1 (not significant)	The assessment of effects showed that no exceedances of ambient air quality impact assessment criteria were predicted at any sensitive receptor area	**Low – Moderate** The potential changes to the baseline environment are well understood. The atmospheric dispersion model used in the assessment is widely used and has been extensively tested and validated. The predicted SRE Project concentrations of air pollutants are well below the corresponding impact assessment criteria at all surrounding sensitive receptor locations. Emissions from future SRE sources are derived from monitoring data collected at comparable existing sources at the site. However, there are some uncertainties: • Emissions from Bypass Stacks, while infrequent, have been excluded from the modelling undertaken.
Air quality (environment values)	A7, A14, A19	Level 1 (not significant)	The assessment of effects showed that no exceedances of dust deposition impact assessment criteria were predicted at any sensitive receptor area	**Low – Moderate** Rationale for interpreting uncertainty is consistent with those presented above for human health impacts.

4.4 Mitigation and management

Each confirmed impact event is required to have a description of proposed management and mitigation measures applied, aimed at either breaking the SPR linkage (i.e. avoiding the impact) or otherwise reducing the impact significance to as low as reasonably achievable (ALARA). These are presented in the following sections.

There were no confirmed air quality impact events assessed as having the potential for a significant impact. Nevertheless, a range of air pollutant emission mitigation measures are incorporated into the design of the SRE Project.

The following fugitive particulate matter emission mitigation measures are incorporated into the design of the SRE Project:

- All RC transported to the SRE Project area in sealed rotainers to eliminate fugitive emission loss during transport.
- The rotainers will be emptied within an enclosure that has a dust extraction system (99% reduction).
- All conveyors and conveyor transfer points moving RC will be fitted with a cover and side wall cladding for wind protection (75% reduction).
- With the exception of the slag haul road, all SRE Project roads will be sealed. Water spraying will occur along all unsealed and sealed roads (75% reduction).
- Slag pot trucks will have a reduced travel speed (44% reduction).
- All other material handling and transfer operations (e.g. silo and day bin loading, bedding plant, slag/revert shed, etc) will occur within full enclosures with dust extraction (99% reduction).

Other mitigation measures incorporated into the SRE Project, and accounted for in the dispersion modelling through engineering calculations where relevant, include the following:

- Concentrate retention proposed in ponds (wet), in storage bins, shed, dome, to prevent losses.
- Matte to be stored as a granulate and damp preventing losses.
- Crushing and breaking operations to be in a dedicated area, where possible completed with wet techniques (i.e. slag milling).
- The concentrate material will feature a high moisture content, reducing dust generation potential.
- Venturi scrubbers and off-gas capture are in place at the acid plant to convert to sulphuric acid.
- Primary processes are operated under negative pressure which contains all process emissions within the primary processing equipment and buildings.
- Anode furnaces and primary smelting scrubber prior to emissions ventilation to atmosphere.
- Optimised stack heights and release characteristics (exhaust flow rate and temperature, exit diameter) to enhance dispersion performance.
- Continuous and periodic emissions monitoring of all significant existing and SRE emission stack sources.

4.5 Conclusion

Following completion of the assessment of effects investigation, it was determined that there were no confirmed air quality impact events assessed as having the potential for a significant impact against the EIAF impact significance criteria.

Irrespective of this outcome, mitigation and management measures are proposed to reduce the impact significance to ALARA.

Mitigation measures associated with the SRE Project include:

- control of fugitive emission releases from RC handling and storage through the use of covers, wind breaks, enclosures and dust extraction to baghouse
- application of wet suppression to paved and unpaved haul roads to control wheel generated dust emissions
- extensive flue gas treatment technology, including fume capture, scrubbers and baghouses.

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US-EPA 2006b, AP-42 Chapter 13.2.4 – *Aggregate Handling and Storage Piles.*

Abbreviations and acronyms

Acronym	Expansion
ALARA	As Low As Reasonably Achievable
AQMS	Air quality monitoring station
BAU	Business as usual
BHP	BHP Olympic Dam Corporation Pty Ltd
BoM	Bureau of Meteorology
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Copper SA	Copper South Australia
DBF	Direct to blister flash furnace
DIT	Department for Infrastructure and Transport
EIAF	Environmental Impact Assessment Framework
EIS	Environment Impact Statement
EMM	EMM Consulting Pty Ltd
EPA	Environment Protection Authority
FCF	Flash converting furnace
FIFO	Fly in/fly out
FSF	Flash smelting furnace
H2S	Hydrogen sulphide
HCl	Hydrogen chloride
HF	Hydrogen fluoride
IoA	Index of agreement
ISR	In stack ratio
NA	Not applicable
NO2	Nitrogen dioxide
NOx	Oxides of nitrogen
PDI Act	Planning, Development and Infrastructure Act 2017 (South Australia)
PM10	Particulate matter less than 10 micrometres in aerodynamic diameter
PM2.5	Particulate matter less than 2.5 micrometres in aerodynamic diameter
Q Q	Quantile quantile
RC	Regional concentrate
RHC	Robust highest concentration
RMSE	Root mean square error

Acronym	Expansion
SA	South Australia
SML	Special Mining Lease
SO2	Sulphur dioxide
SO3	Sulphur trioxide
SPC	State Planning Commission
SPR	Source pathway receptor
SRE	Smelter and Refinery Expansion
TSF	Tailings Storage Facility
TSP	Total suspended particulate
VOC	Volatile organic compound

Units of measure

Unit	Description
oC	degrees celsius
%	per cent
µg	microgram
Cu	copper
d	day
g	gram
h	hour
km	kilometre
km2	kilometre squared
kV	kilovolt
L	litre
m2	metre squared
m3	metre cubed
m	metre
ML	megalitre
mm	millimetre
ppm	parts per million
s	second
t	tonne
yr	year

Appendix A
Meteorological data analysis

EMM
creating opportunities

A.1 Meteorological data summary plots – 2016 to 2024

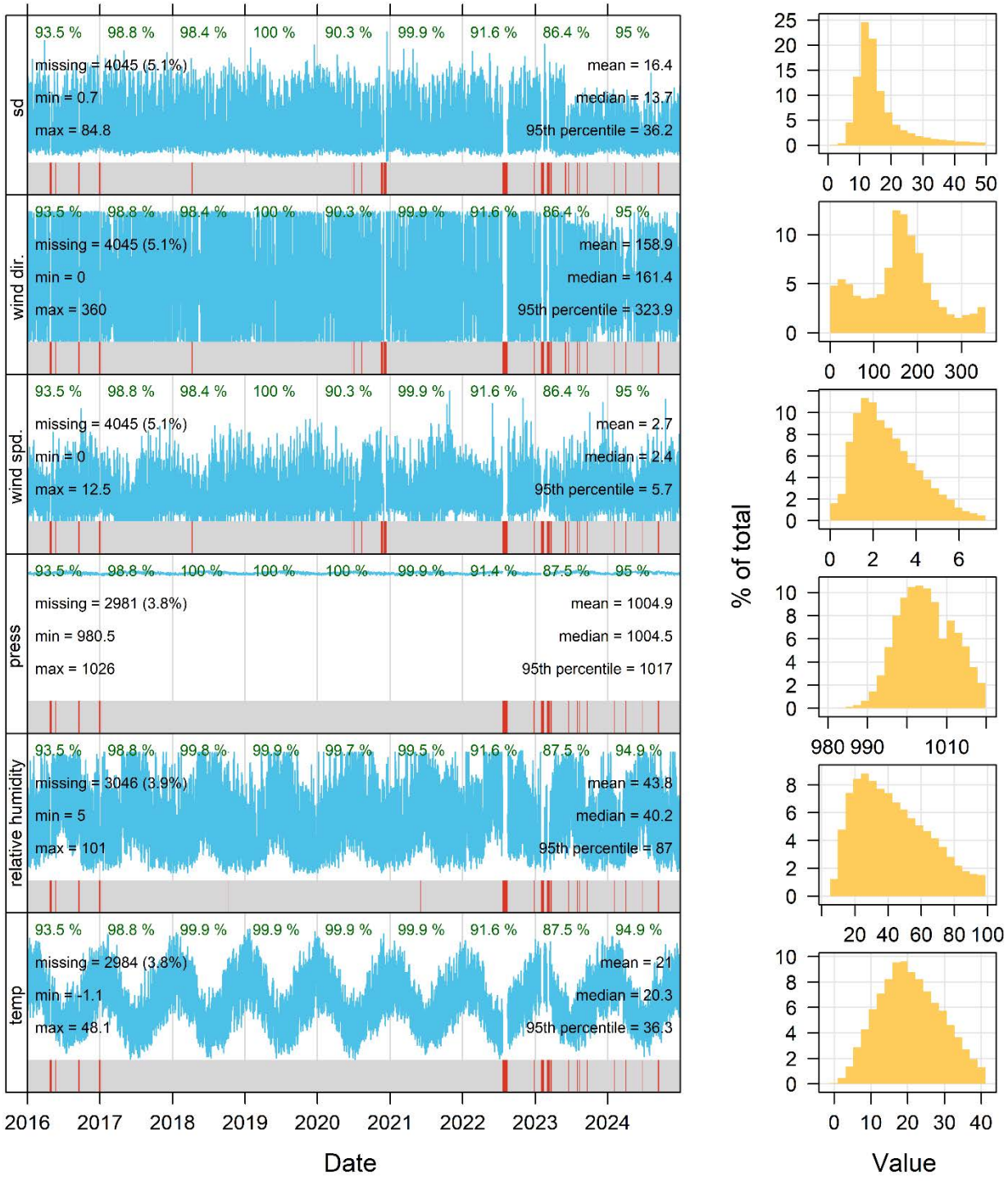


Figure A.1 Data completeness analysis plot – BHP Olympic Dam Village – 2016 to 2024

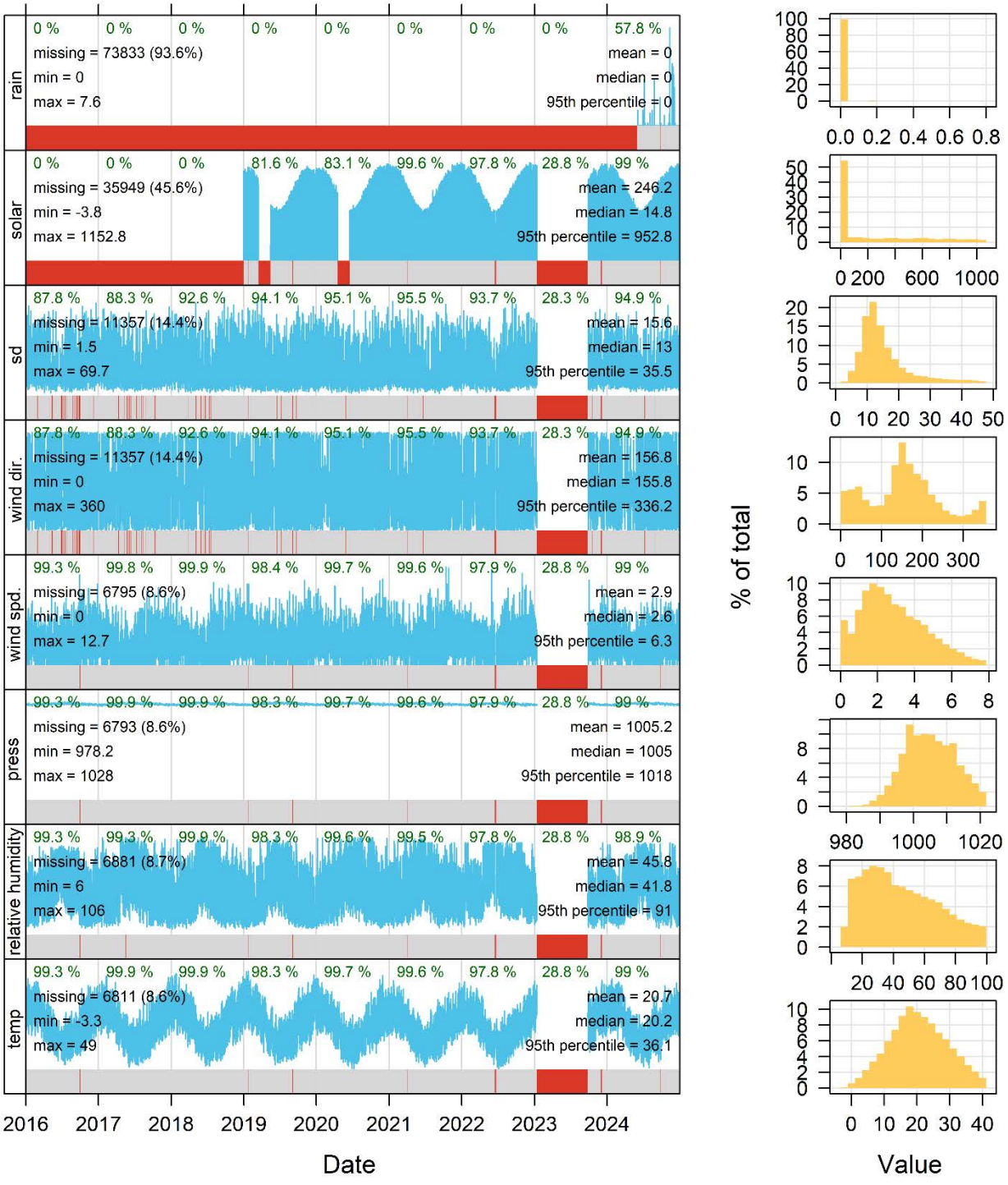


Figure A.2 Data completeness analysis plot – BHP Roxby Downs – 2016 to 2024

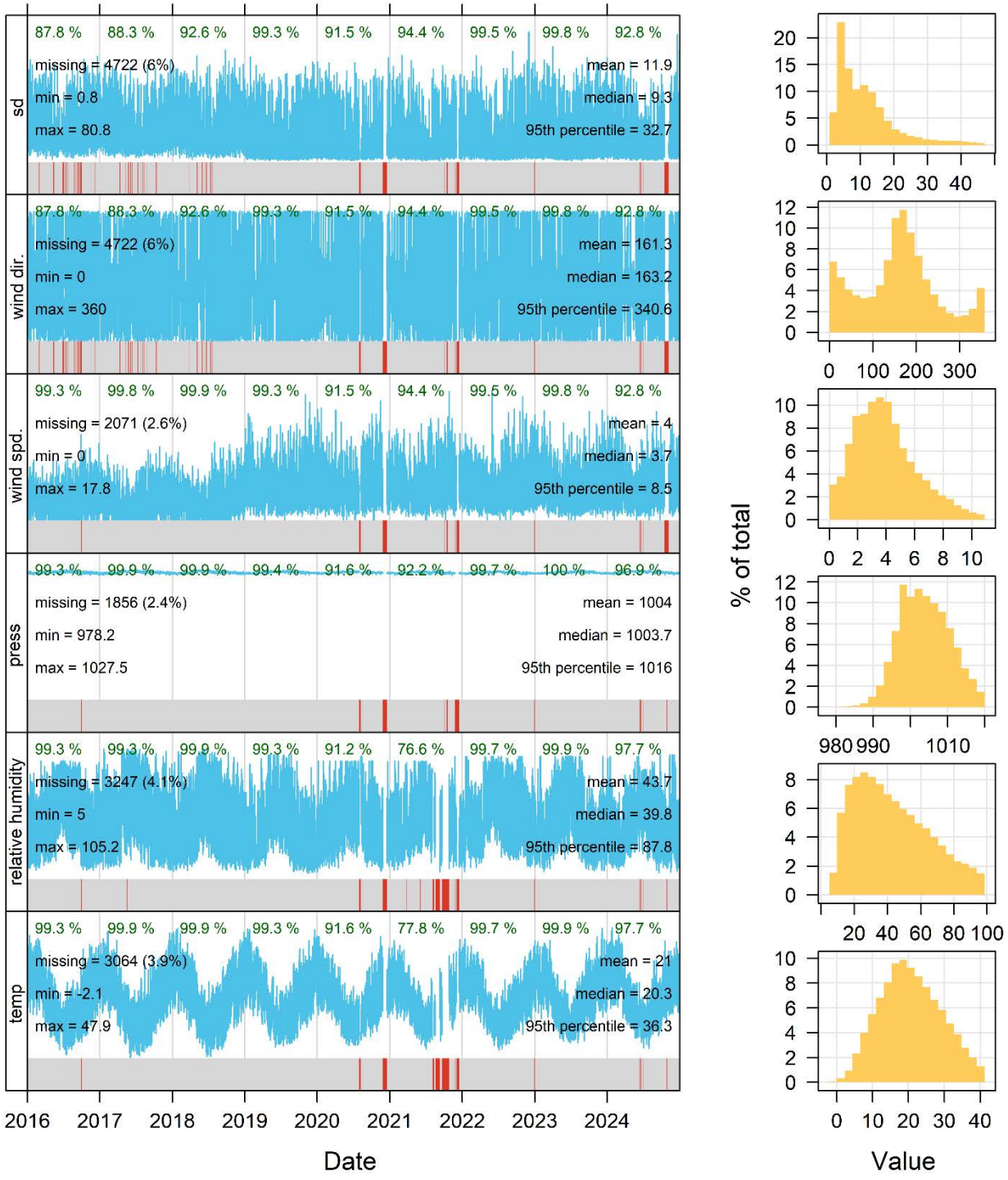


Figure A.3 **Data completeness analysis plot – BHP Northern Background – 2016 to 2024**

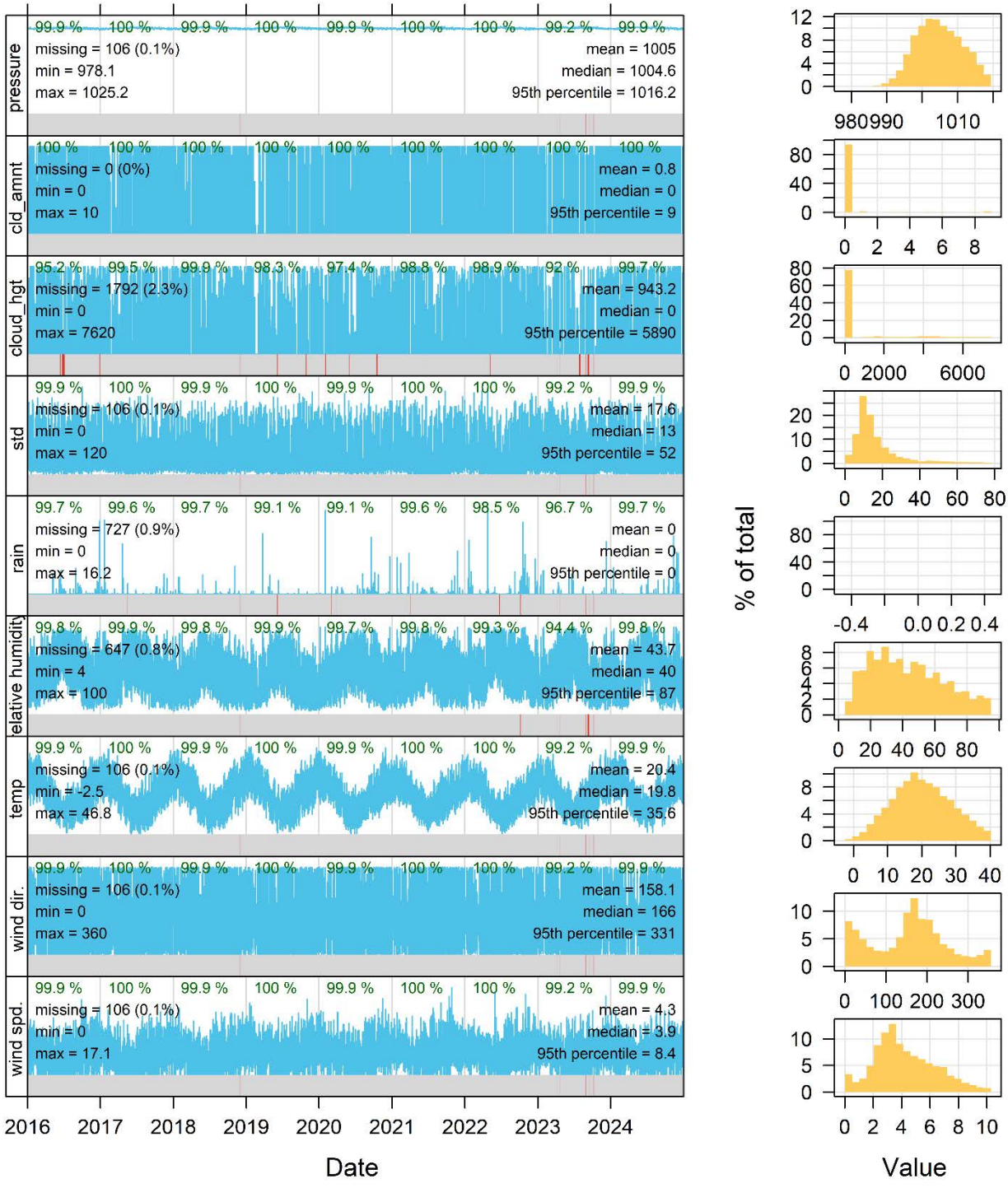


Figure A.4 **Data completeness analysis plot – BoM Olympic Dam Aerodrome AWS – 2016 to 2024**

A.2 Inter-annual wind roses – all stations – 2016 to 2024

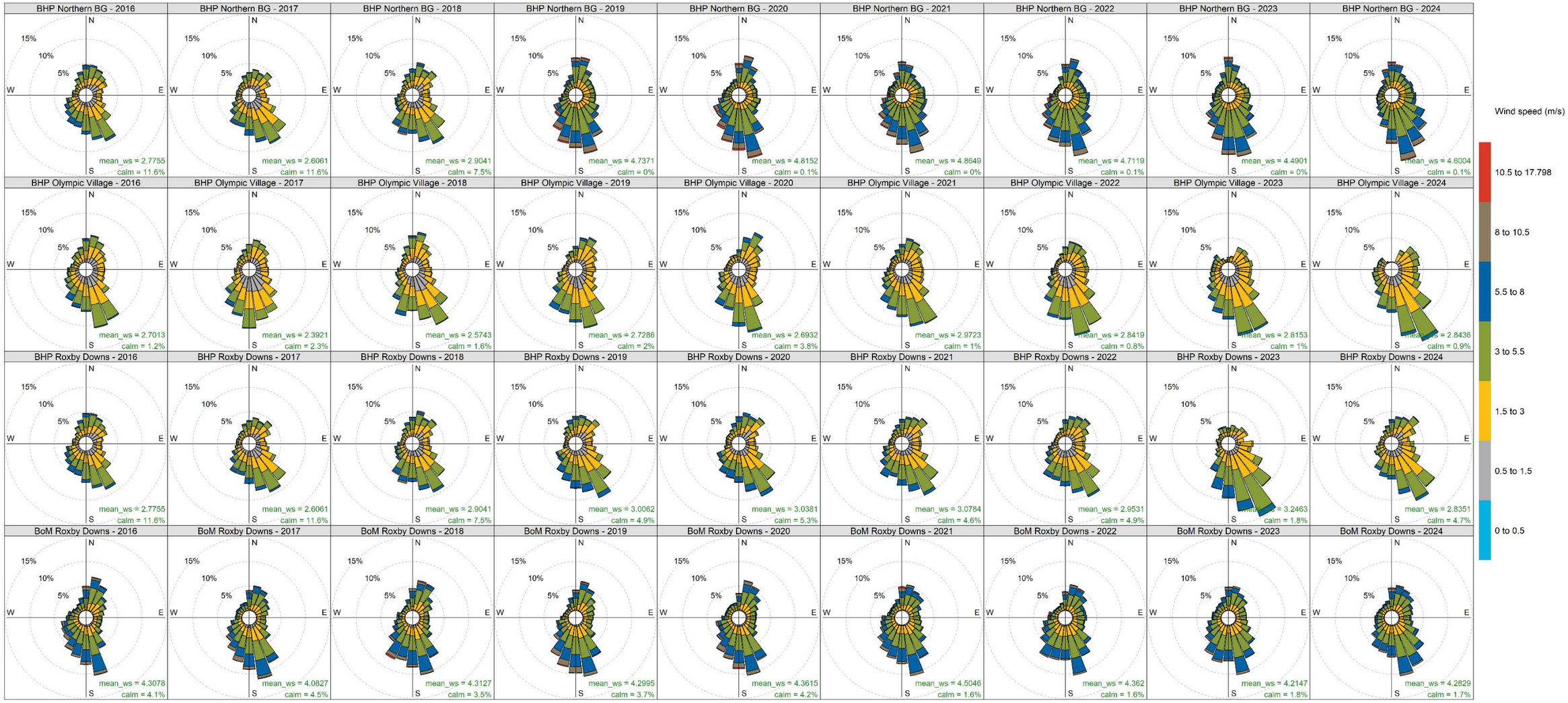


Figure A.5 Inter-annual wind roses – BHP and BoM datasets – 2016 to 2024

A.3 Inter-annual analysis – BoM Olympic Dam Aerodrome – 2016 to 2024

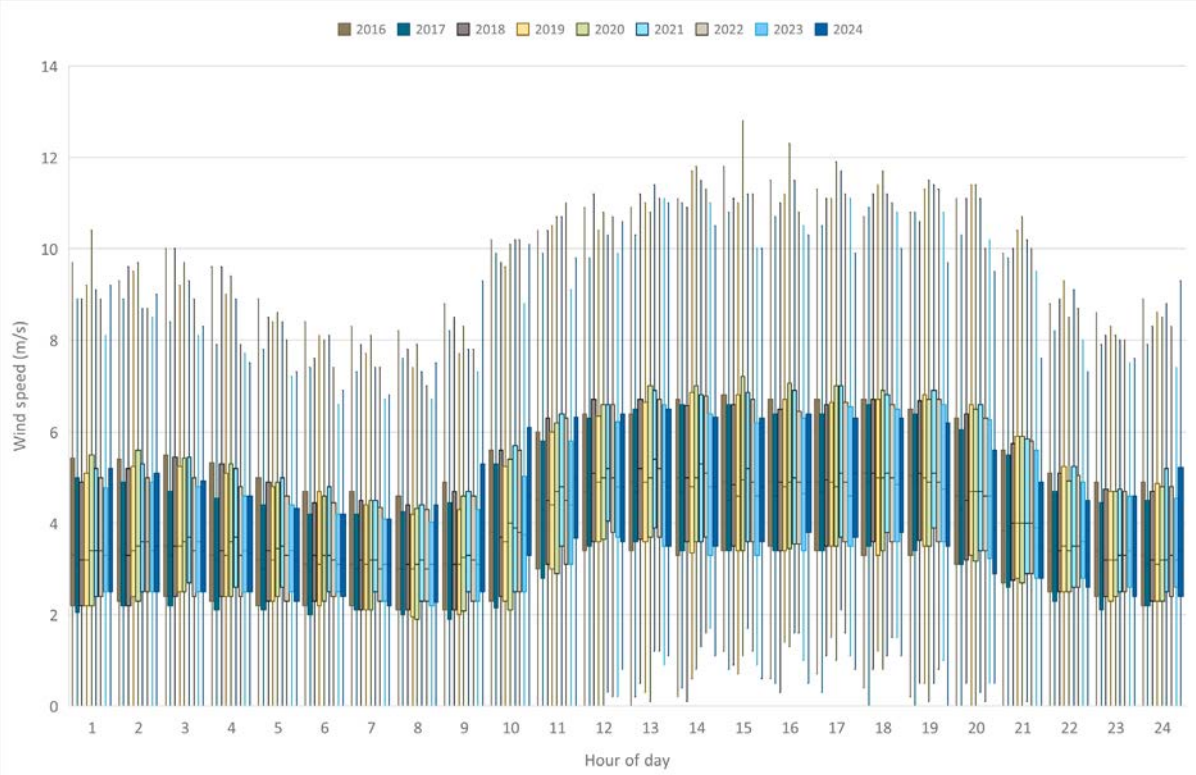


Figure A.6 **Inter-annual variability in diurnal wind speed – BoM Olympic Dam Aerodrome AWS – 2016 to 2024**

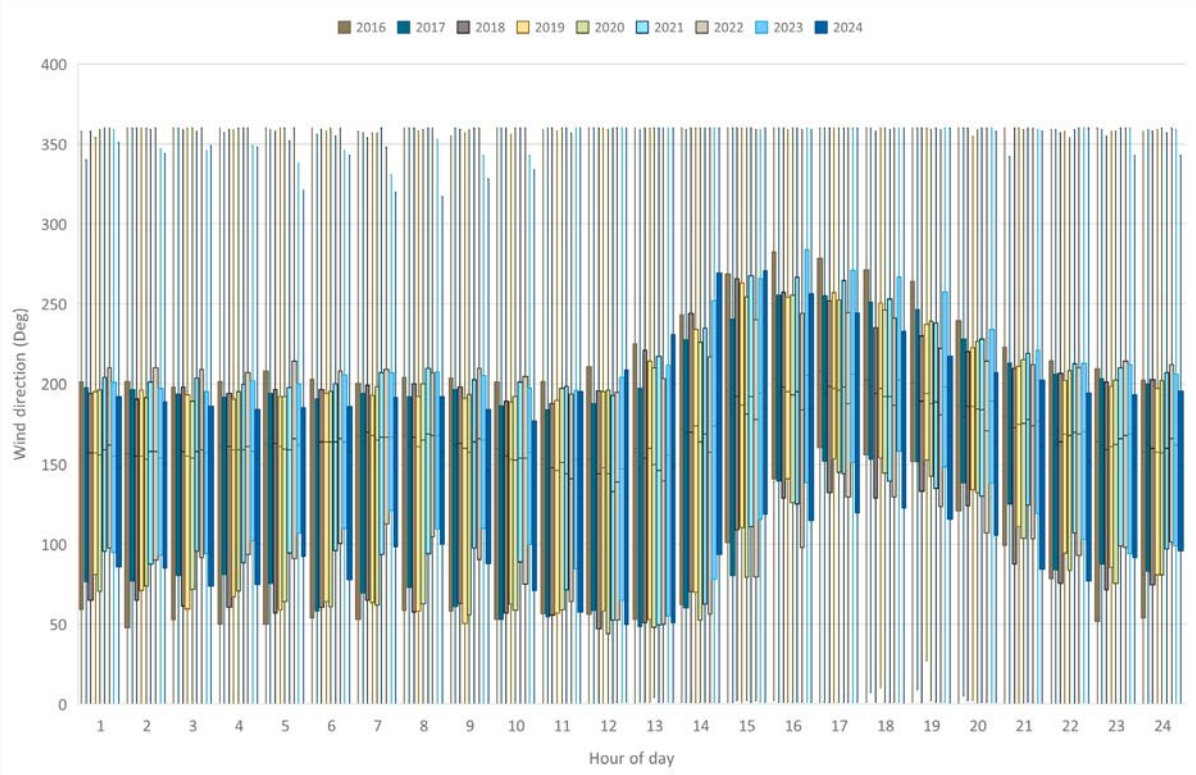


Figure A.7 **Inter-annual variability in diurnal wind direction – BoM Olympic Dam Aerodrome AWS – 2016 to 2024**

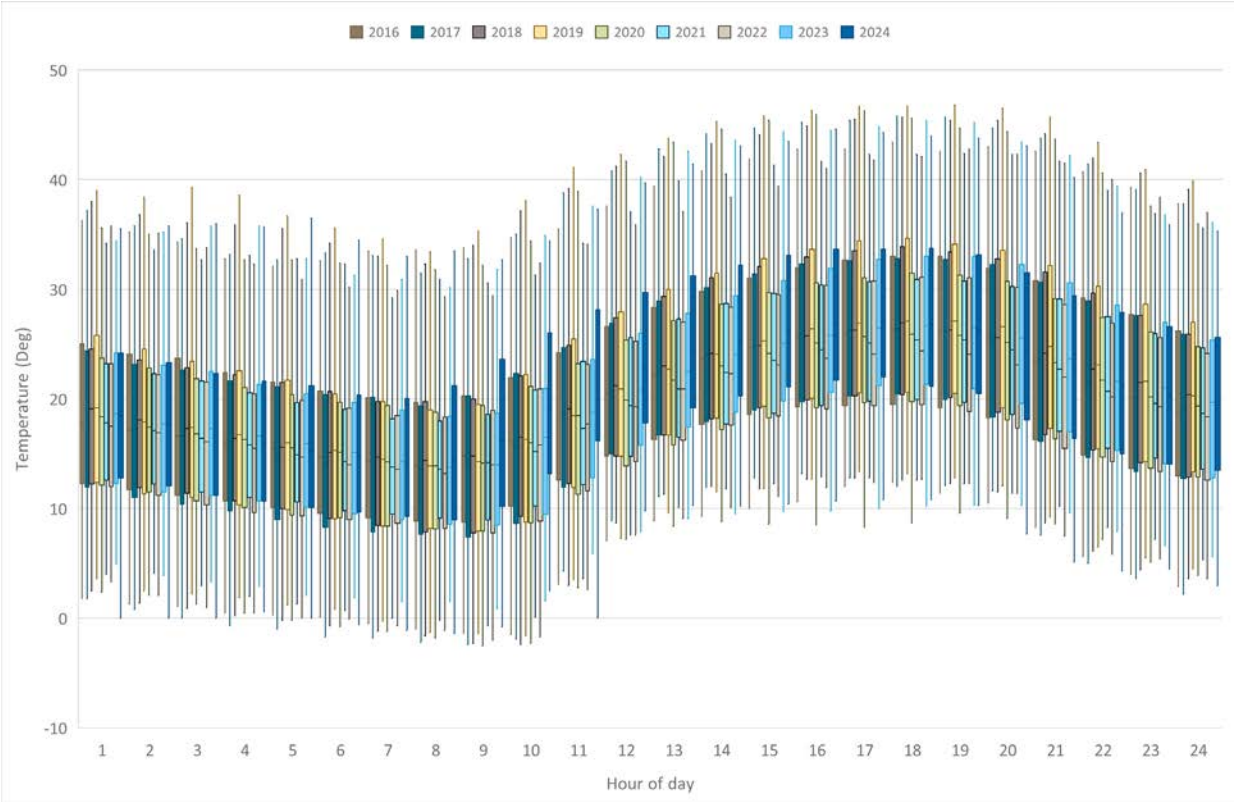


Figure A.8 **Inter- annual variability in diurnal temperature – BoM Olympic Dam Aerodrome AWS – 2016 to 2024**

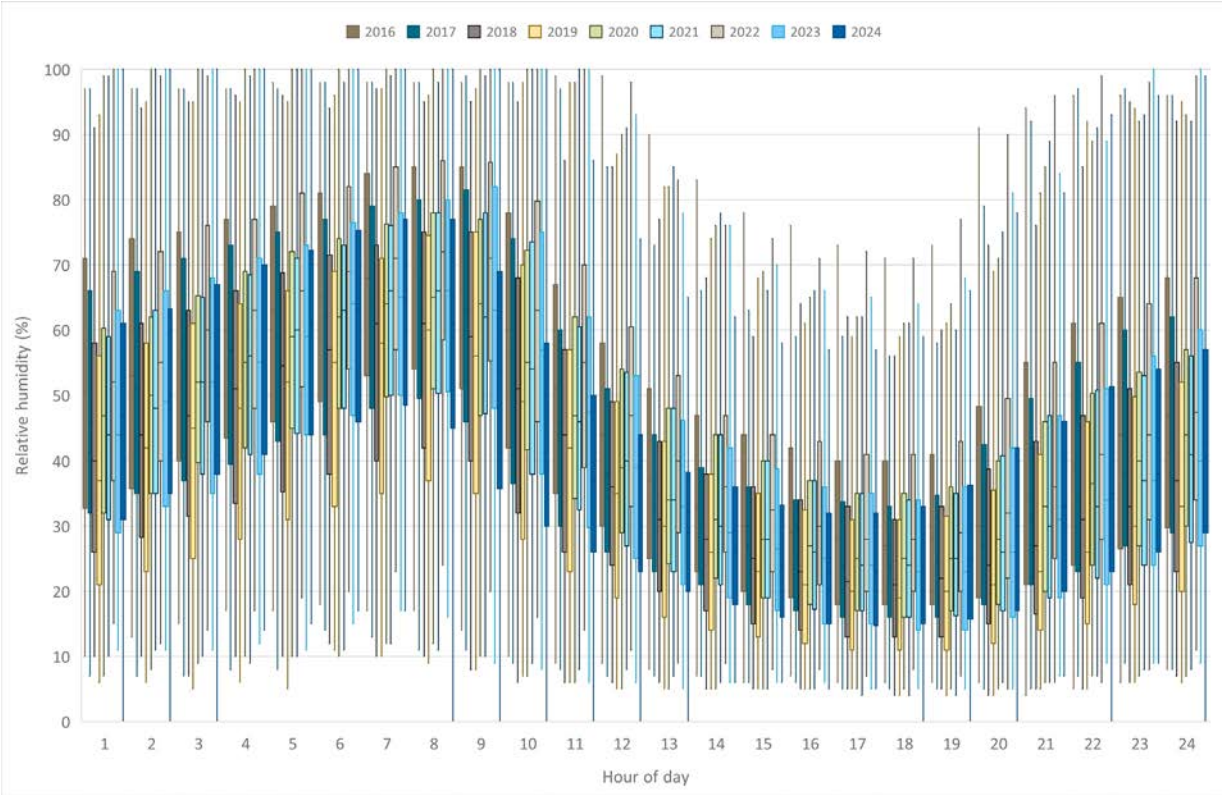


Figure A.9 **Inter-annual variability in diurnal relative humidity – BoM Olympic Dam Aerodrome AWS – 2016 to 2024**

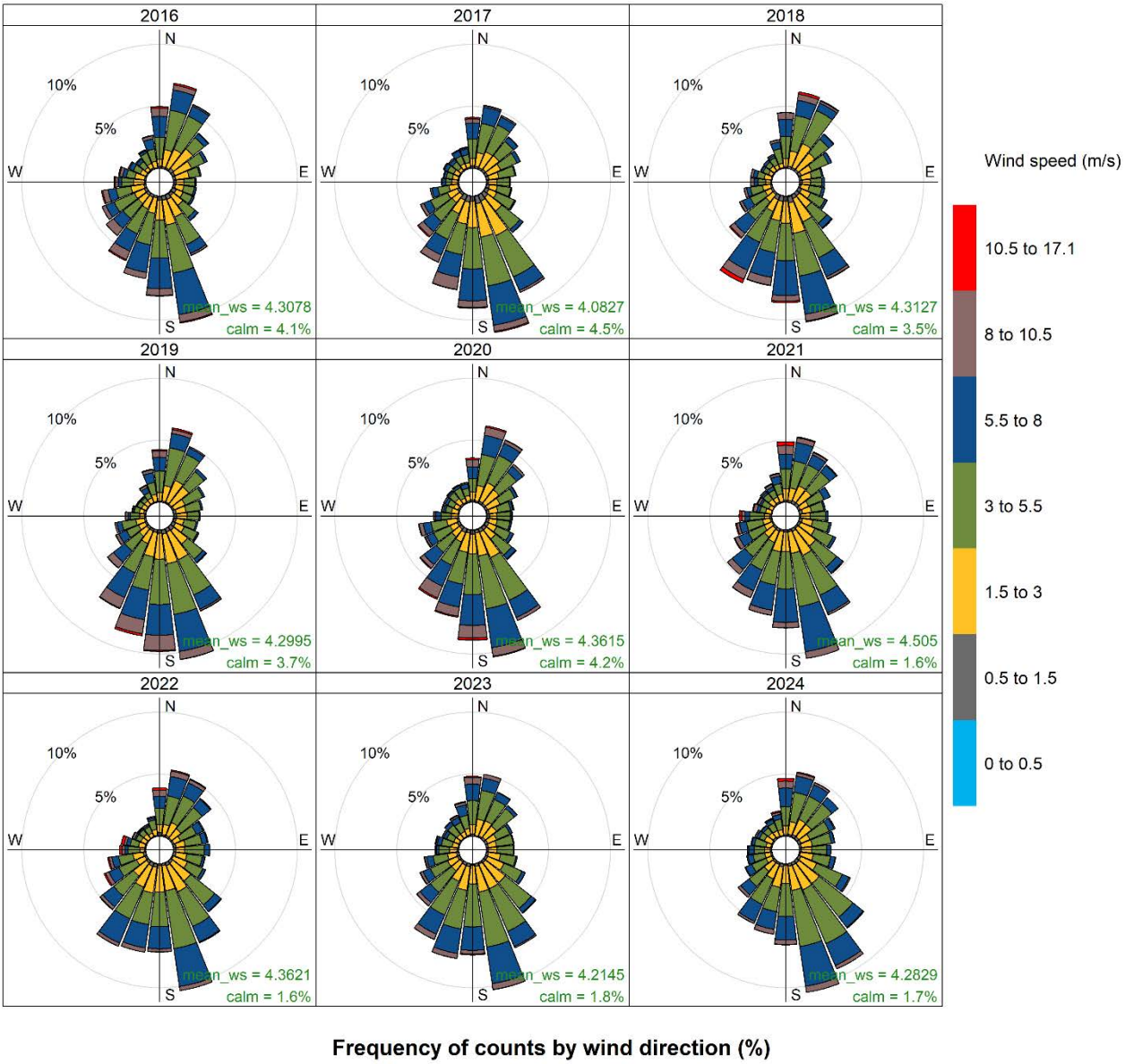


Figure A.10 Inter-annual comparison of recorded wind speed and direction – BoM Olympic Dam Aerodrome AWS – 2016 to 2024

A.4 Meteorological modelling

i TAPM modelling

To supplement the meteorological monitoring datasets adopted for this assessment, the CSIRO prognostic meteorological model TAPM was used to generate required parameters that are not routinely measured, specifically mixing height and vertical wind/temperature profile.

TAPM was configured and run as:

- TAPM version 4.0.5
- grid domains with cell resolutions of 30 km, 10 km and 3 km; each grid domain features 25 x 25 horizontal grid points and 25 vertical levels
- TAPM default databases for land use, synoptic analyses and sea surface temperature
- TAPM defaults for advanced meteorological inputs
- two 'spin-up' days allowed at the beginning and end of the run.

ii AERMET meteorology processing

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

iii Surface characteristics

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

- surface roughness length
- albedo
- Bowen ratio.

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

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

Monthly-varying values for surface roughness, Bowen ratio and albedo were allocated to each sector based on the values prescribed by USEPA (2013).

Surface moisture characteristics for the 2023 modelling period was determined by comparing the period rainfall total to the previous 30-year rainfall records from the following BoM long term rainfall stations:

- Olympic Dam Aerodrome (016069)
- Andamooka (016065), 28 km to the east of the Olympic Dam Aerodrome site.

Annual rainfall total for 2024 was 212 millimetres (mm), which places the 12-month period above the 70th percentile rainfall totals for the previous 30 years and, therefore, a 'wet' surface moisture classification was allocated. It is noted that the rainfall records are not incorporated into dispersion model predictions (i.e. no wet deposition of air pollutants is modelled).

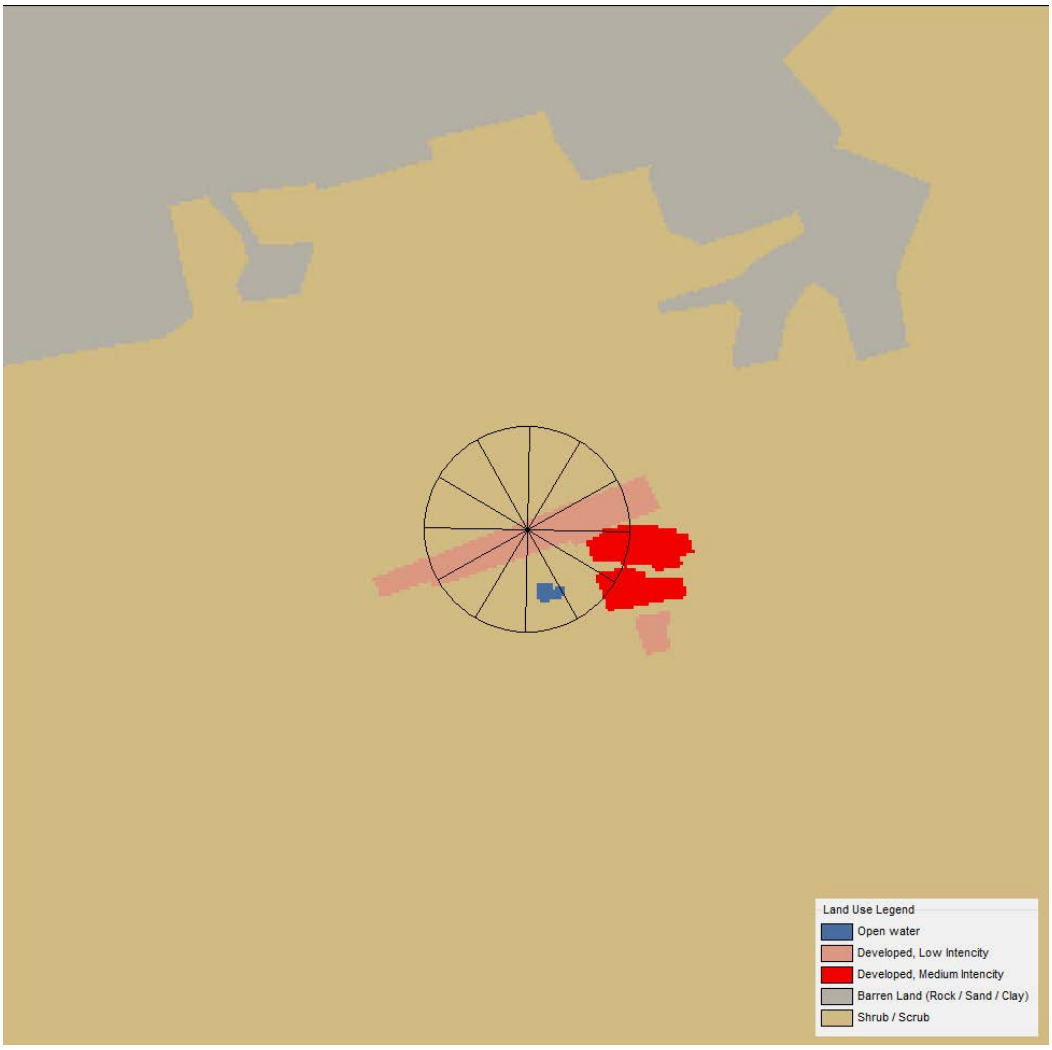


Figure A.11 Land use map for AERSURFACE processing

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

Table A.1 Monthly surface roughness length values by sector

Month	Surface roughness length (m) by sector (degrees)											
	0–30	30–60	60–90	90–120	120–150	150–180	180–210	210–240	240–270	270–300	300–330	330–0
Jan	0.14	0.115	0.043	0.061	0.099	0.065	0.096	0.067	0.06	0.106	0.138	0.131
Feb	0.14	0.115	0.043	0.061	0.099	0.065	0.096	0.067	0.06	0.106	0.138	0.131
Mar	0.138	0.109	0.033	0.054	0.092	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Apr	0.138	0.109	0.033	0.054	0.092	0.062	0.087	0.056	0.049	0.098	0.136	0.128
May	0.138	0.109	0.033	0.054	0.092	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Jun	0.138	0.109	0.033	0.051	0.091	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Jul	0.138	0.109	0.033	0.051	0.091	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Aug	0.138	0.109	0.033	0.051	0.091	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Sep	0.138	0.109	0.033	0.054	0.092	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Oct	0.138	0.109	0.033	0.054	0.092	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Nov	0.138	0.109	0.033	0.054	0.092	0.062	0.087	0.056	0.049	0.098	0.136	0.128
Dec	0.14	0.115	0.043	0.061	0.099	0.065	0.096	0.067	0.06	0.106	0.138	0.131

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

Month	Monthly value (all sectors)	
	Bowen ratio	Albedo
January	3.9	0.24
February	3.9	0.24
March	5.83	0.24
April	5.83	0.24
May	5.83	0.24
June	5.83	0.24
July	5.83	0.24
August	5.83	0.24
September	2.94	0.24
October	2.94	0.24
November	2.94	0.24
December	3.9	0.24

iv Meteorological inputs

Monitoring data from the BoM Olympic Dam Aerodrome AWS were combined with TAPM meteorological modelling outputs for input to AERMET. The following parameters were input as on-site data to AERMET:

- wind speed and direction – BoM Olympic Dam Aerodrome AWS
- temperature (heights of 10 m and 100 m) - BoM Olympic Dam AWS (10 m) and TAPM (100 m)
- station level pressure - BoM Olympic Dam AWS
- cloud cover - BoM Olympic Dam AWS
- solar insolation – TAPM at BoM Olympic Dam AWS
- mixing depth – TAPM at BoM Olympic Dam AWS.

The period of meteorological data input to AERMET was 1 January 2024 to 31 December 2024.

v Upper air profile

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

Appendix B
Emissions inventory calculations

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Table B.1 SRE Project fugitive particulate matter emission calculations

Source name	Source Type	Emission estimate TSP (kg/year)	Emission estimate PM_{10} (kg/year)	Emission estimate $PM_{2.5}$ (kg/year)	Activity rate	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Parameter 1	Unit	Parameter 2	Unit	Parameter 3	Unit	Parameter 4	Unit	Parameter 5	Unit	Reduction factor	Emission control
Site entrance to SRE road junction	Paved haulage	106,289.4	20,402.3	4,936.0	283,328	VKT/year	1.5006	0.2880	0.0697	kg/VKT	9.7	Silt loading (g/m2)	4	Return travel distance (km)	54	Average weight (t)					0.75	Watering
SRE junction to main internal weighbridge	Paved haulage	110,746.2	21,257.8	5,143.0	305,640	VKT/year	1.4494	0.2782	0.0673	kg/VKT	9.7	Silt loading (g/m2)	5	Return travel distance (km)	52	Average weight (t)					0.75	Watering
SRE junction to RC storage shed	Paved haulage	36,284.3	6,964.8	1,685.0	79,573	VKT/year	1.8240	0.3501	0.0847	kg/VKT	9.7	Silt loading (g/m2)	8	Return haul distance (km)	66	Average weight (t)					0.75	Watering
OD concentrate unloading	Material handling	85.3	40.3	6.1	1,695,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
OD concentrate conveyor transfer 1	Material handling	85.3	40.3	6.1	1,695,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
OD concentrate conveyor transfer 2	Material handling	85.3	40.3	6.1	1,695,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
OD concentrate conveyor transfer 3	Material handling	85.3	40.3	6.1	1,695,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
OD concentrate conveyor transfer 4	Material handling	85.3	40.3	6.1	1,695,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
Unloading RC to storage shed	Material handling	3.3	1.6	0.2	1,125,200	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.99	Baghouse
OD/RC concentrate conveyor transfer 1	Material handling	141.9	67.1	10.2	2,821,000	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
OD/RC concentrate conveyor transfer 2	Material handling	141.9	67.1	10.2	2,821,000	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
Bedding Plant dome loading	Material handling	141.9	67.1	10.2	2,821,000	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
Conc/Silica/Revert day bins loading	Material handling	136.9	64.7	9.8	2,721,000	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
Revert/silica transfer	Material handling	136.9	64.7	9.8	2,721,000	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.83	Hooding with fabric filters
Day bins to dryer conveying transfer 1	Material handling	7.9	3.7	0.6	2,661,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.99	Baghouse
Day bins to dryer conveying transfer 2	Material handling	7.9	3.7	0.6	2,661,800	t/y	0.0003	0.0001	0.00002	kg/t	4.28	Average wind speed (m/s)	10.0	Moisture content (%)							0.99	Baghouse
Matte conveyor transfer 1	Material handling	1,232.7	583.1	88.3	975,600	t/y	0.0074	0.0035	0.00053	kg/t	4.28	Average wind speed (m/s)	1.0	Moisture content (%)							0.83	Hooding with fabric filters
Matte conveyor transfer 2	Material handling	1,232.7	583.1	88.3	975,600	t/y	0.0074	0.0035	0.00053	kg/t	4.28	Average wind speed (m/s)	1.0	Moisture content (%)							0.83	Hooding with fabric filters
Molten slag tipping trucks to Slag cooling area	Unpaved haulage	29,304.9	9,834.4	983.4	19,992	VKT/year	10.4702	3.5137	0.3514	kg/VKT	19.0	Road silt content (%)	1.2	Return haul distance (km)	16,660	Loads/year	120	Average weight (t)	80	Load in truck (t)	0.86	Watering, travel speed 40km/hr
Slag transportation to Slag Concentrator	Unpaved haulage	56,973.8	19,119.9	1,912.0	46,648	VKT/year	8.7240	2.9277	0.2928	kg/VKT	19.0	Road silt content (%)	1.4	Return haul distance (km)	33,320	Loads/year	80	Average weight (t)	40	Load in truck (t)	0.86	Watering, travel speed 40km/hr
Slag unloading to Slag Concentrator hopper	Material handling	9,906.4	4,685.4	709.5	1,332,800	t/y	0.0074	0.0035	0.00053	kg/t	4.28	Average wind speed (m/s)	1.0	Moisture content (%)								
Transfer to Slag Concentrator stockpile	Material handling	9,906.4	4,685.4	709.5	1,332,800	t/y	0.0074	0.0035	0.00053	kg/t	4.28	Average wind speed (m/s)	1.0	Moisture content (%)								
Slag concentrator (crushing)	Material processing	266,560.0	26,656.0	2,665.6	1,332,800	t/y	0.2000	0.0200	0.0020	kg/t												
Slag concentrator stockpile wind erosion	Wind erosion	2,986.3	1,493.1	224.0	0.2500	ha	11,945.1	5,972.5729	895.8859	kg/ha/year	10.0	Silt content (%)	42.0	Number of raindays	28.20	Percentage time winds > 5.4m/s						
Slag conveyor transfer 1	Material handling	1,684.1	796.5	120.6	1,332,800	t/y	0.0074	0.0035	0.00053	kg/t	4.28	Average wind speed (m/s)	1.0	Moisture content (%)							0.83	Hooding with fabric filters
Slag conveyor transfer 2	Material handling	1,684.1	796.5	120.6	1,332,800	t/y	0.0074	0.0035	0.00053	kg/t	4.28	Average wind speed (m/s)	1.0	Moisture content (%)							0.83	Hooding with fabric filters
SRE diesel combustion - vehicle movements	Diesel combustion	337.8	337.8	323.3																		
	Total (kg/year)	636,274.2	118,737.7	19,791.3																		
	Total (t/year)	636.3	118.7	19.8																		

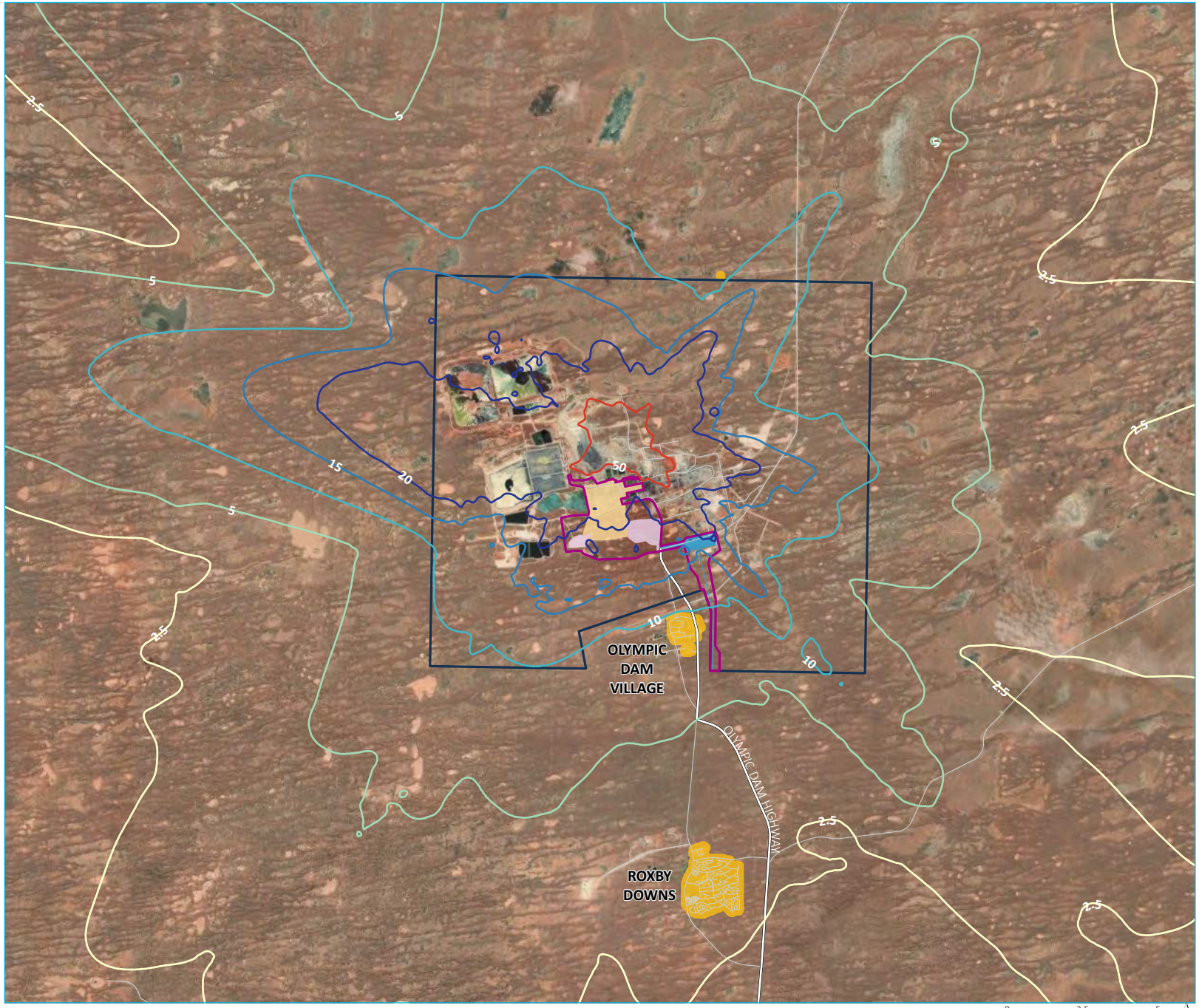
Table B.2 SRE Project fugitive diesel combustion calculations

Pollutant	Very HGV - diesel - kg/m3 (>25t GVM)	HGV - diesel - kg/m3 (12t to 25t GVM)		
	Source: Table 22, NPI Combustion Engines	Source: Table 22, NPI Combustion Engines		
CO	8.5	6.81		
Fluoride	0	0		
NOX	22.3	23.3		
PM2.5	1.12	1.73		
PM10	1.17	1.84		
TSP	1.17	1.84		
PAH	0.000337	0.00071		
SO2	0.0167	0.0167		
VOC	1.02	1.82		
Fuel consumption rate	53.1	L/100km		
Annual VKT	**BAU**	**Stage 1a**	**Stage 1b**	**Stage 2**
Site entrance to SRE road junction	55500.0	169104.0	215840.0	283328.0
SRE junction to main internal weighbridge	63375.0	184360.0	240780.0	305640.0
SRE junction to RC unloading shed	0.0	43328.8	47592.8	79572.8
Annual VKT - less existing	**BAU**	**Stage 1a**	**Stage 1b**	**Stage 2**
Site entrance to SRE road junction	0.0	113604.0	160340.0	227828.0
SRE junction to main internal weightbridge	0.0	115585.0	171405.0	236265.0
SRE junction to RC unloading shed	0.0	43328.8	47592.8	79572.8
Annual Diesel - less existing (L/year)	**BAU**	**Stage 1a**	**Stage 1b**	**Stage 2**
Site entrance to SRE road junction	0.0	60323.7	85140.5	120976.7
SRE junction to main internal weightbridge	0.0	61375.6	91016.1	125456.7
SRE junction to RC unloading shed	0.0	23007.6	25271.8	42253.2
Annual Diesel - less existing (m3/year)	**BAU**	**Stage 1a**	**Stage 1b**	**Stage 2**
Site entrance to SRE road junction	0.0	60.3	85.1	121.0
SRE junction to main internal weightbridge	0.0	61.4	91.0	125.5
SRE junction to RC unloading shed	0.0	23.0	25.3	42.3
Annual Diesel emissions (kg/year)	**Site entrance to SRE road junction**	**SRE junction to main internal weightbridge**	**SRE junction to RC unloading shed**	
CO	1028.3	1066.4	353.2	
Fluoride	0.0	0.0	0.0	
NOX	2637.8	2737.7	842.2	
PM2.5	135.5	140.5	47.3	
PM10	141.5	146.8	49.4	
TSP	141.5	146.8	49.4	
PAH	0.0	0.0	0.0	
SO2	2.0	2.1	0.7	
VOC	123.4	128.0	43.1	
Annual Diesel emissions (g/s)	**Site entrance to SRE road junction**	**SRE junction to main internal weightbridge**	**SRE junction to RC unloading shed**	
CO	0.0326	0.0338	0.0114	
Fluoride	0.0000	0.0000	0.0000	
NOX	0.0855	0.0887	0.0299	
PM2.5	0.0043	0.0045	0.0015	
PM10	0.0045	0.0047	0.0016	
TSP	0.0045	0.0047	0.0016	
PAH	0.0000	0.0000	0.0000	
SO2	0.0001	0.0001	0.0000	
VOC	0.0039	0.0041	0.0014	

Appendix C

Pollution concentration contour plots

EMM
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KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

24-hour average PM_{10} concentration (µg /m³)

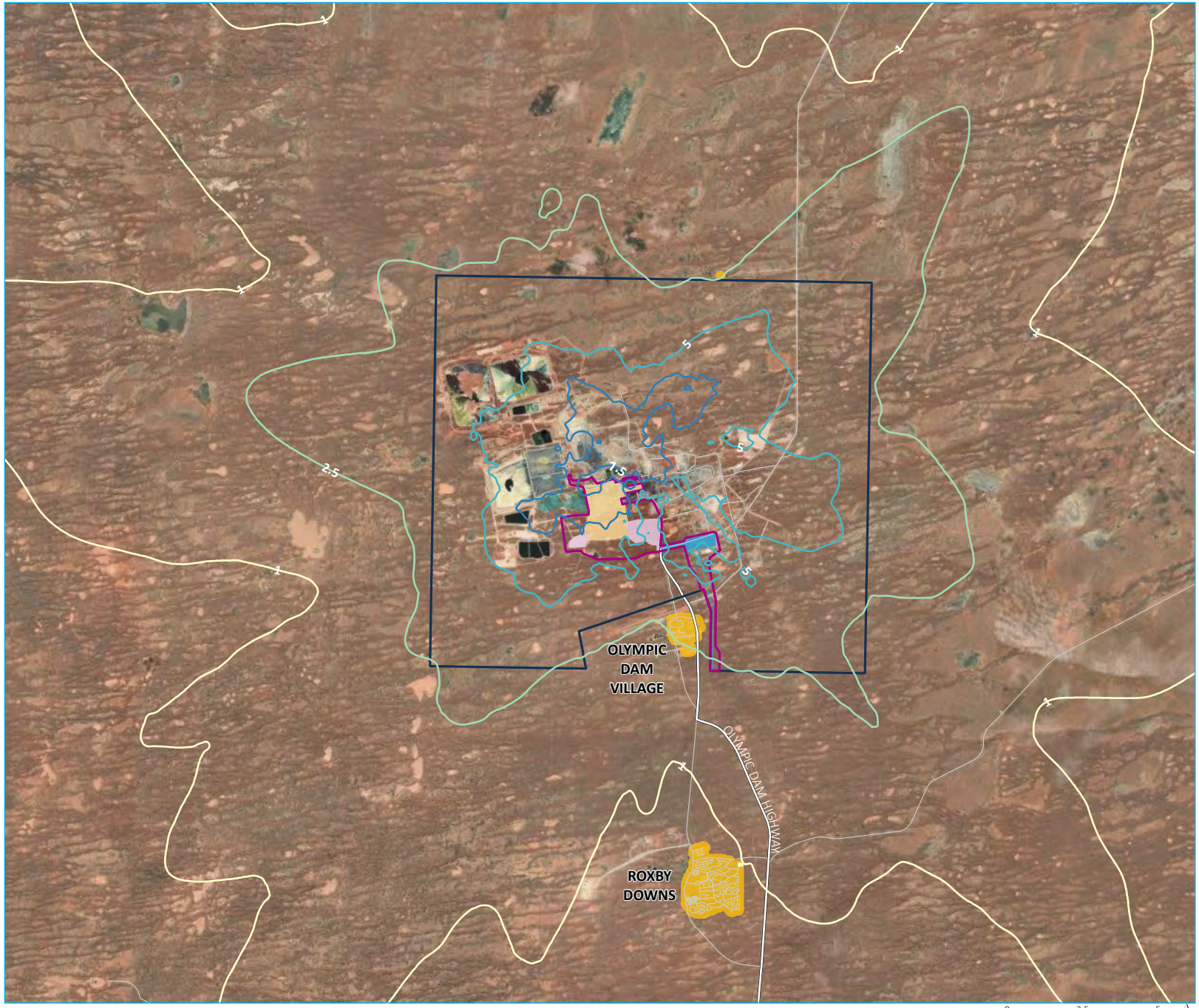
- 2.5
- 5
- 10
- 15
- 20
- 50

*Pollutant criterion limit 50 µg /m³ (EPA SA)

Business as usual operations - Maximum predicted 24-hour average PM_{10} concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.1

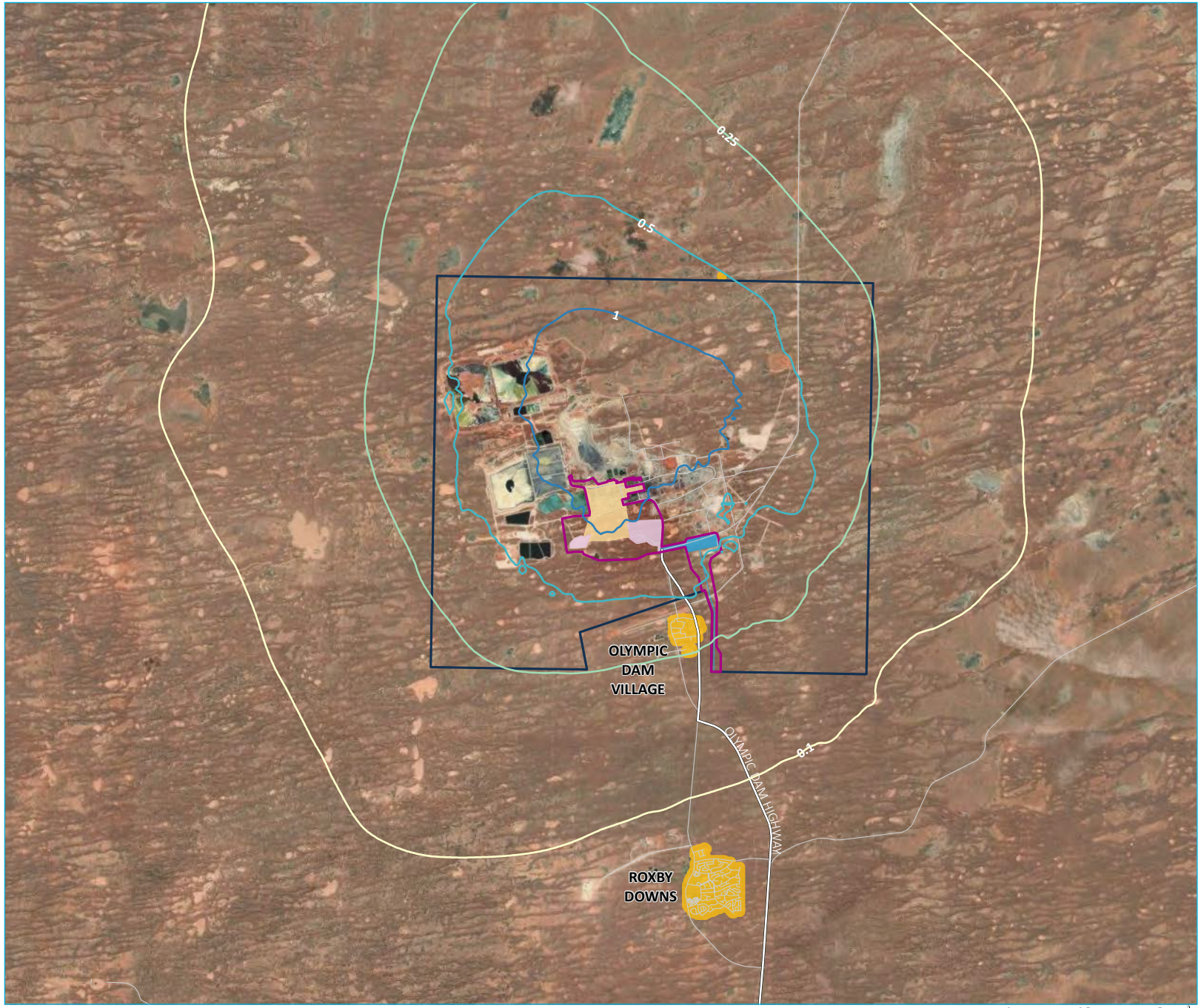
EMM
creating opportunities



Business as usual operations - Maximum predicted 24-hour average $PM_{2.5}$ concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.2

EMM
creating opportunities



KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

Annual average $PM_{2.5}$ concentration (µg /m³)

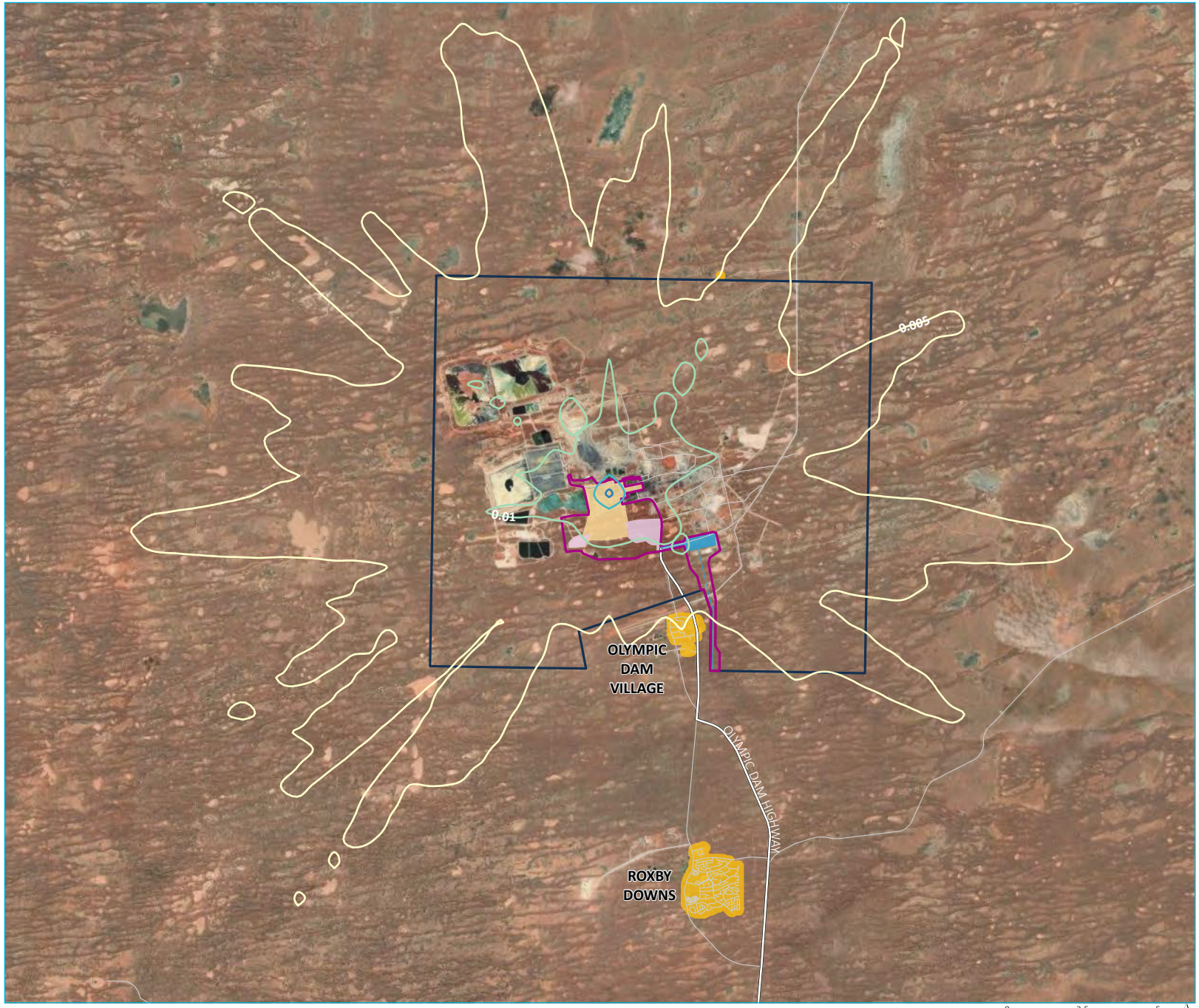
- 0.1
- 0.25
- 0.5
- 1

*Pollutant criterion limit 8 µg /m³ (EPA SA)

Business as usual operations - Maximum predicted annual average $PM_{2.5}$ concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.3

EMM
creating opportunities



KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

1-hour average SO_2 concentration (ppm)

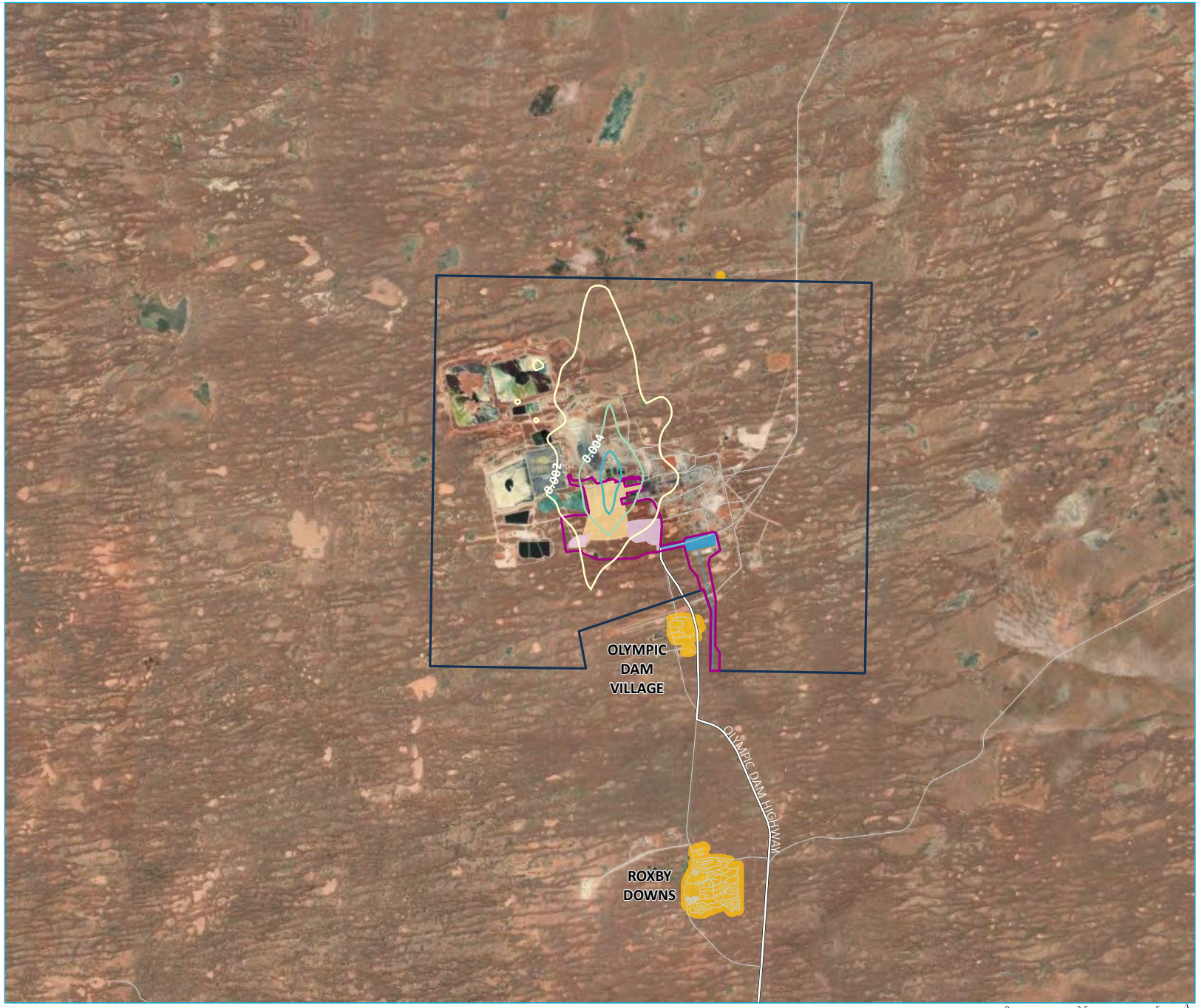
- 0.005
- 0.01
- 0.02
- 0.03

*Pollutant criterion limit 0.1 ppm (EPA SA)

Business as usual operations - Maximum predicted 1-hour average SO_2 concentrations (ppm) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.4

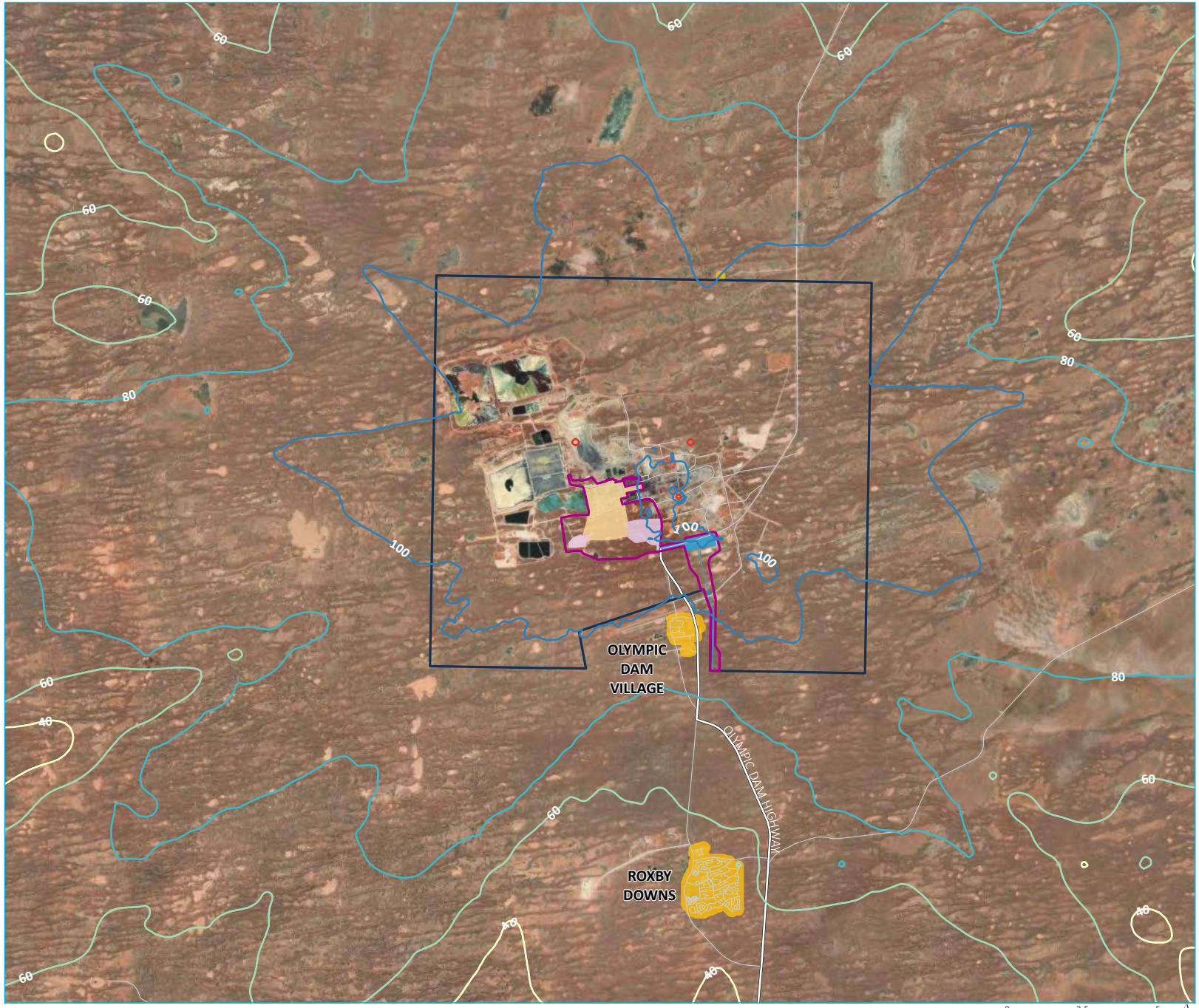
EMM
creating opportunities



Business as usual operations - Maximum predicted 24-hour average SO_2 concentrations (ppm) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.5

EMM
creating opportunities



KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

1-hour average NO_2 concentration (µg /m³)

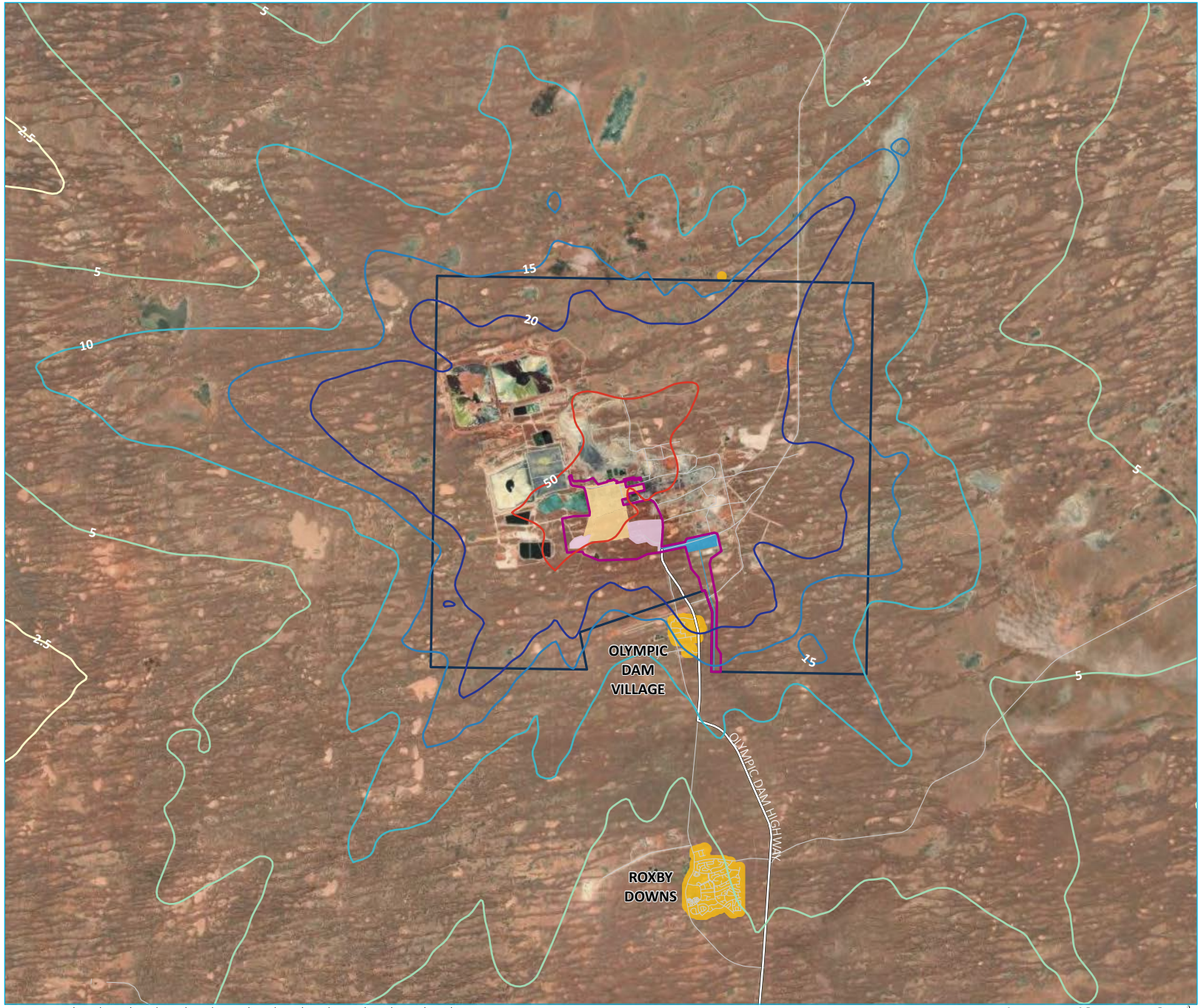
- 40
- 60
- 80
- 100
- 164

*Pollutant criterion limit 164 µg /m³ (EPA SA)

Business as usual operations - Maximum predicted 1-hour average NO_2 concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.6

EMM
creating opportunities



KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

24-hour average PM_{10} concentration (µg /m³)

- 2.5
- 5
- 10
- 15
- 20
- 50

*Pollutant criterion limit 50 µg /m³ (EPA SA)

Source: EMM (2026); BHP(2026); DIT (2026); DEW (2026); GA (2016); DEM (2026); ESRI (2026)

0 2.5 5 km

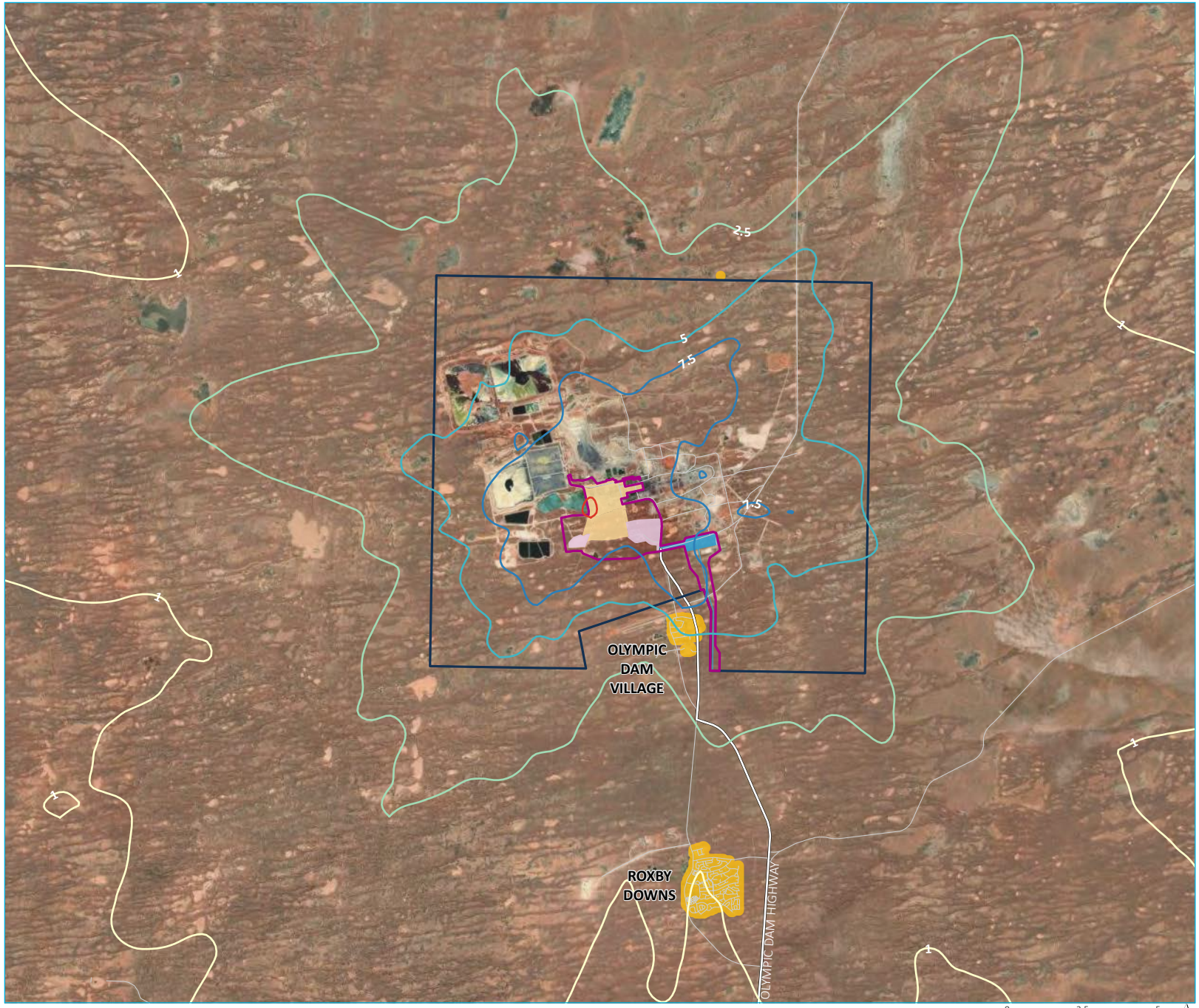
GDA2020 MGA Zone 53

N

SRE Project (Stage 2) operations - Maximum predicted 24-hour average PM_{10} concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.7

EMM creating opportunities



KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

24-hour average $PM_{2.5}$ concentration (µg /m³)

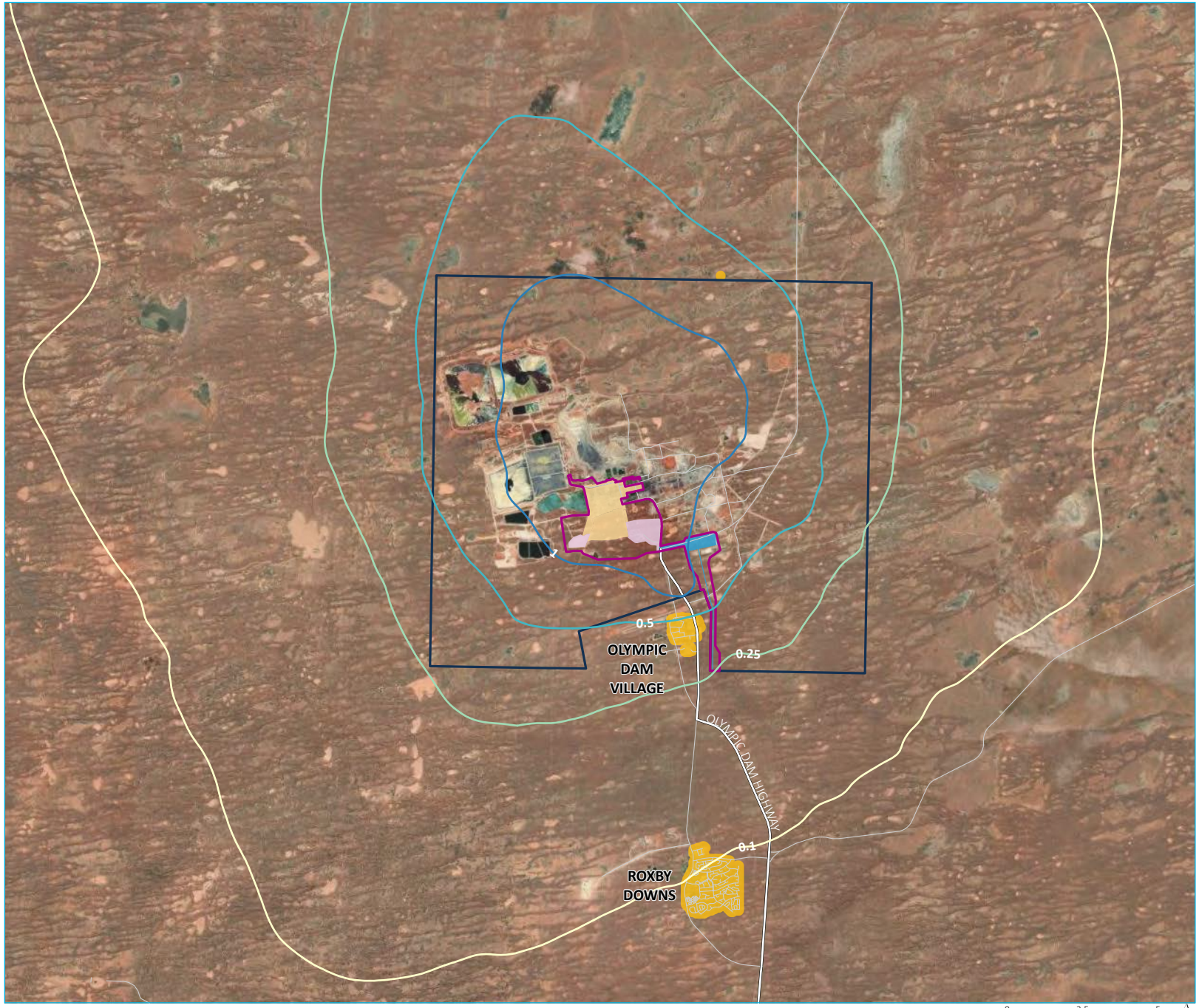
- 1
- 2.5
- 5
- 7.5
- 25

*Pollutant criterion limit 25 µg /m³ (EPA SA)

SRE Project (Stage 2) operations - Maximum predicted 24-hour average $PM_{2.5}$ concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.8

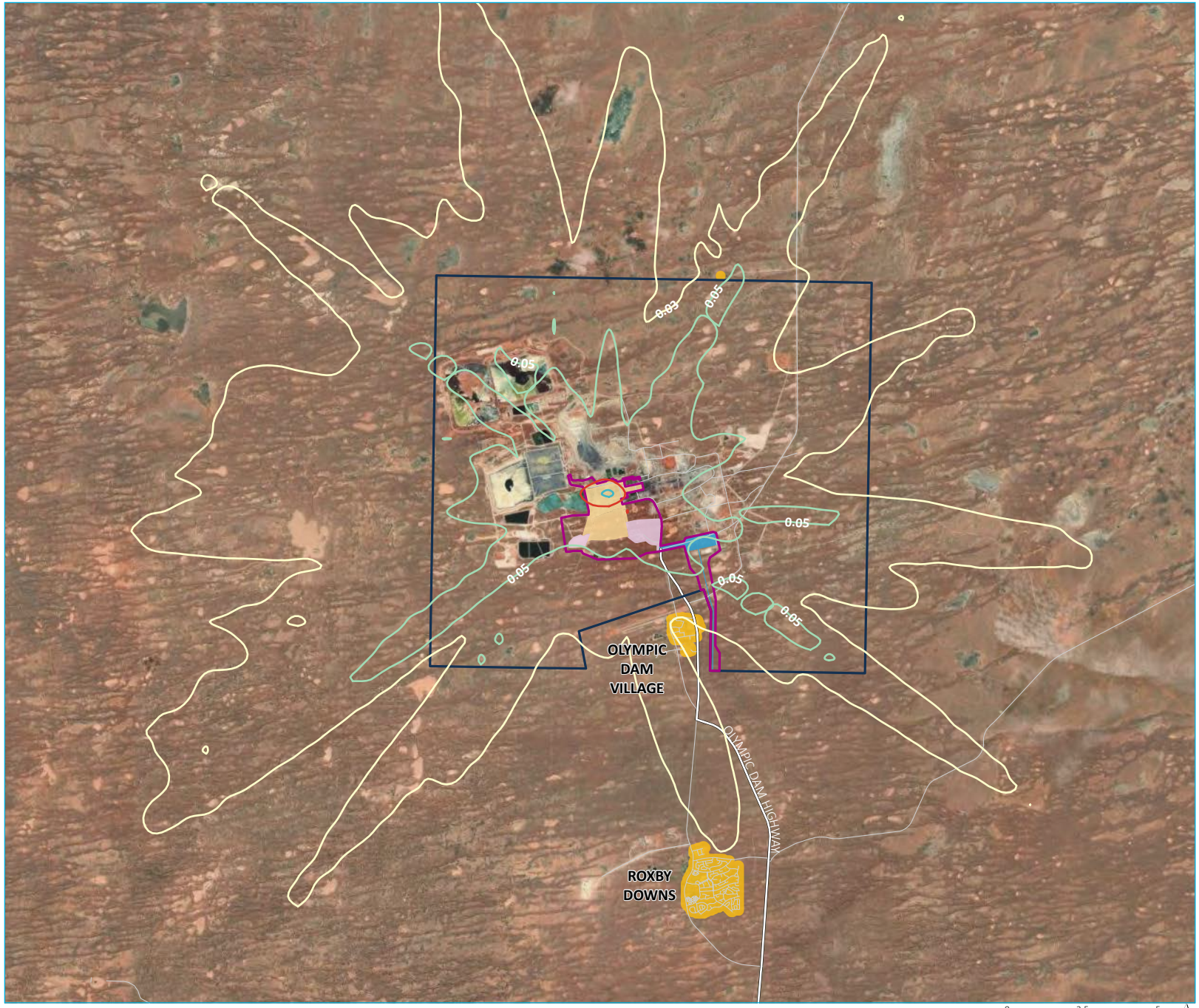
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SRE Project (Stage 2) operations - Maximum predicted annual average $PM_{2.5}$ concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.9

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KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

1-hour average SO_2 concentration (ppm)

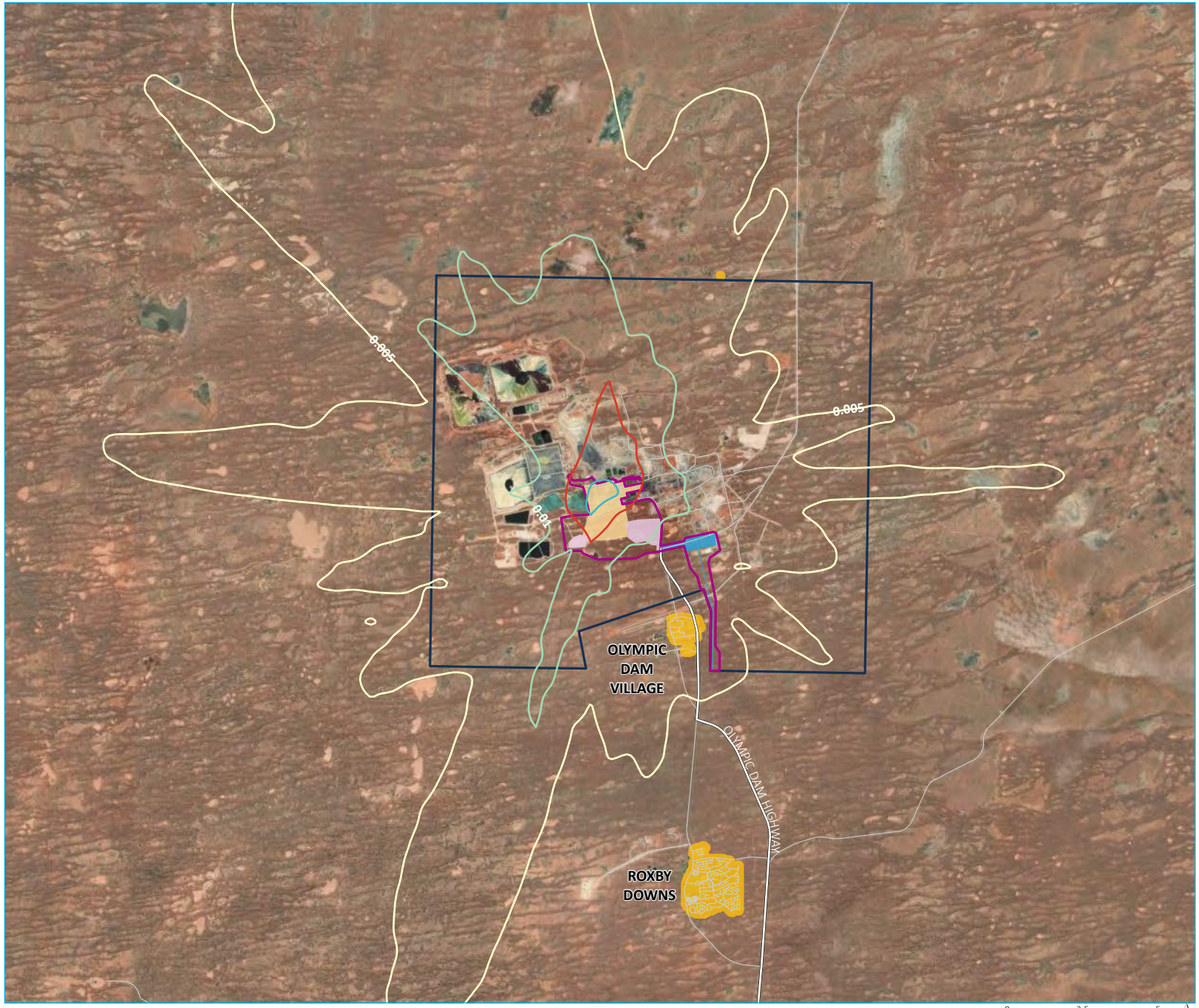
- 0.03
- 0.05
- 0.1
- 0.15

*Pollutant criterion limit 0.1 ppm (EPA SA)

SRE Project (Stage 2) operations - Maximum predicted 1-hour average SO_2 concentrations (ppm) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.10

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KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

24-hour average SO_2 concentration (ppm)

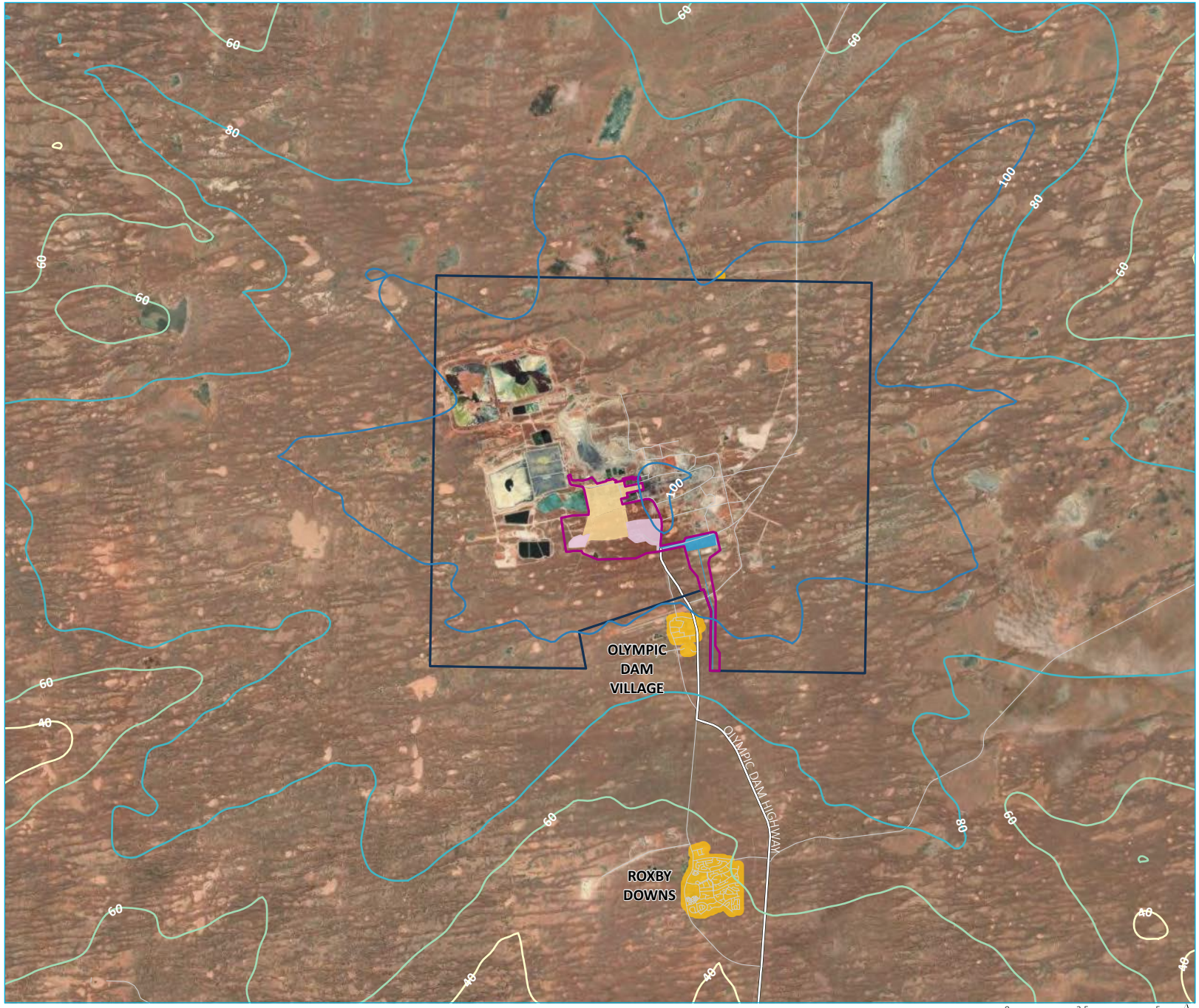
- 0.005
- 0.01
- 0.02
- 0.03

*Pollutant criterion limit 0.02 ppm (EPA SA)

SRE Project (Stage 2) operations - Maximum predicted 24-hour average SO_2 concentrations (ppm) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.11

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KEY

- Special Mining Lease
- SRE Project Area- SML Area
- SRE Area
- General Infrastructure Area
- Water Infrastructure Area
- Model assessment location

Existing environment

- Major road
- Minor road

1-hour average NO_2 concentration (µg /m³)

- 40
- 60
- 80
- 100

*Pollutant criterion limit 164 µg /m³ (EPA SA)

SRE Project (Stage 2) operations - Maximum predicted 1-hour average NO_2 concentrations (µg /m³) – site emissions only

BHP SRE Project
Air Quality Impact Assessment
Figure C.12

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Appendix D
Assessment requirements

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D.1 Assessment requirements

Air quality assessment requirements and cross reference to where these are addressed in this report are outlined in Table D.1.

Table D.1 Assessment requirements

Environmental attributes	Reference	Assessment requirements	Cross reference
Air quality	AEQ1	Provide an air quality impact assessment prepared by an appropriately qualified specialist for all potential sources of dust/particles and gaseous pollutants associated with the construction and ongoing operation of the proposed development and the facility as a whole, to identify any known or potential human health and amenity effects of air emissions (including point source and diffuse sources) on the local residential population (including workers) and describe how these would be mitigated, minimised, managed and monitored.	Section 2, Section 3, Section 4
		Provide a review and identify any proposed upgrades of the point sources and ambient air quality monitoring systems.	Section 3.2.3, Section 3.2.4
		The impact assessment must include modelling undertaken in accordance with the *Environment Protection (Air Quality) Policy 2016* and the EPA's *Ambient Air Quality Assessment 2016* guidance document. Techniques used to obtain the predictions should be referenced and key assumptions and data sets explained.	Section 2.2, Section 3.2.7, Section 3.3
		The impact assessment must consider the current level of emissions (baseline) and the cumulative impacts of increased emissions.	Section 3.3

Australia

SYDNEY
Level 10 201 Pacific Highway
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 2 95 North Quay
Brisbane QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 9.01 Level 9
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 3.03
111 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Yonge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
2015 Main Street
Vancouver BC V5T 3C2
T 604 999 8297

CALGARY
700 2nd Street SW Floor 19
Calgary AB T2P 2W2



linkedin.com/company/emm-consulting-pty-limited



emmconsulting.com.au

Appendix C4.
Radiation

Radiological Impact Assessment

Olympic Dam Smelter and Refinery Expansion Project

Prepared for BHP Olympic Dam Corporation Pty Ltd

May 2026

Radiological Impact Assessment

Olympic Dam Smelter and Refinery Expansion Project

BHP Olympic Dam Corporation Pty Ltd

May 2026

Approved by

Paul Gibbons
Director – Major Projects & Approvals
22 May 2026

Level 4 74 Pirie Street
Adelaide SA 5000
ABN: 28 141 736 558

This report has been prepared in accordance with the brief provided by BHP Olympic Dam Corporation Pty Ltd and, in its preparation, EMM has relied upon the information collected at the times and under the conditions specified in this report. All findings, conclusions or recommendations contained in this report are based on those aforementioned circumstances. This report is to only be used for the purposed for which it has been provided. Except as permitted by the Copyright Act 1968 (Cth) and only to the extent incapable of exclusion, any other use (including use or reproduction of this report for resale or other commercial purposes) is prohibited without EMM's prior written consent. Except where expressly agreed to by EMM in writing, and to the extent permitted by law, EMM will have no liability (and assumes no duty of care) to any person in relation to this document, other than to BHP Olympic Dam Corporation Pty Ltd (and subject to the terms of EMM's agreement with BHP Olympic Dam Corporation Pty Ltd).

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ABN: 28 141 736 558

Executive summary

ES1 Introduction

BHP Olympic Dam Corporation Pty Ltd (BHP) is proposing to develop the Smelter and Refinery Expansion Project (SRE Project) at the Olympic Dam mining operations, in the far north of South Australia (SA) (Figure 1.1).

EMM Consulting Pty Ltd and Lathwida Environmental Pty Ltd (EMM+Lathwida) are preparing an Environmental Impact Statement (EIS) for the SRE Project in accordance with EIS assessment requirements and Practice Direction 17 Impact Assessed Development under the *Planning, Development and Infrastructure Act 2017* (PDI Act) (SA).

JRHC Enterprises was commissioned by EMM+Lathwida to undertake a Radiological Impact Assessment (RIA) of the proposed radiological impacts of the SRE Project activities to:

- determine if the activities have the potential to result in changes to the radiation environment; baseline assessment (baseline condition assessment in Chapter 2 of this report)
- determine the likely magnitude of the change to baseline radiation values as a result of the SRE Project (effects assessment in Chapter 3 of this report)
- quantify the likely impacts resulting from the predicted change to baseline radiation values on identified receptors (impact assessment in Chapter 4 of this report).

ES2 Baseline condition assessment

The radionuclide content of the copper concentrates depends upon the mineralogy of the mined material and copper concentrate production process.

The radiological characteristics of the Olympic Dam copper concentrate are well known (for example, BHP Billiton 2009, BHP 2023) with the uranium decay chain radionuclides in the copper concentrate not in secular equilibrium. (Note that secular equilibrium occurs when the radionuclides have the same activity concentration).

For the Carrapateena, Prominent Hill and Oak Dam copper concentrates, the uranium content has been determined; however, ongoing radionuclide concentration characterisation test work is occurring. For this assessment, it is assumed that radionuclide concentration of the Carrapateena, Prominent Hill and Oak Dam copper concentrates are in the same ratio as that of the Olympic Dam copper concentrate.

The ongoing environmental radiation monitoring has been reviewed for the past five years to determine the existing radiological levels.

ES3 Assessment of effects

The assessment of effects found the following potential radiological impacts due to the SRE Project:

- During construction, radiological impacts are expected to be insignificant due to the existing site management practices.
- During operations, the handling of copper concentrate containing elevated concentrations of radionuclides results in an increased potential for emissions of radon and radionuclides leading to potential changes in airborne concentrations in local communities and residences.
- Gamma radiation and groundwater pathways were not assessed to be credible exposure pathways.

- The conservative estimates of total doses to humans at the receptors, due to the SRE Project, are low and below the recognised public dose limit of 1 millisieverts per year (mSv/y) and dose constraint of 0.3 mSv/y.
- The radiological impact to flora and fauna, as assessed using the ERICA tool, showed dose rates well below the screening level of 10 micrograys per hour (µGy/h), with the maximum absorbed dose rate being 6.93 µGy/h for Australian reptiles.

Internationally recognised radiological assessment methods were used to evaluate potential radiological impacts associated with the SRE Project.

ES4 Impact assessment

The RIA found the following potential radiological impacts due to the SRE Project:

- There were no confirmed radiation-related impact events assessed as having the potential for a significant impact.
- The dose assessment indicates that radiological impacts will be low and below the recognised public dose limit of 1 mSv/y and dose constraint of 0.3 mSv/y (i.e. not significant).

  In accordance with the ICRP (ICRP 2007-103) and the IAEA (IAEA 2014) statement that controls are to be commensurate with the magnitude of the impact, no additional controls for the purposes of radiation protection are considered necessary, other than standard controls.
- The assessment of potential radiological impact to flora and fauna is low with no additional controls justified due to the very low potential impacts (i.e. not significant).

  The standard emission and dust controls that all mining and processing operations generally employ and are currently used for existing operations at Olympic Dam, would act to control potential impacts.

BHP has an existing and well-established radiation management plan (RMP) as part of its overall system of management at Olympic Dam. For the SRE Project, the existing RMP would be updated and expanded to accommodate the SRE Project, as required.

BHP also has an established radioactive waste management plan (RWMP) which lies within the existing environmental management system. The RWMP would be updated to accommodate the SRE Project components.

The list of potential mitigation and management measures that may be applied to reduce the significance of radiological impacts of the SRE Project to ALARA include the following:

- An environmental and occupational radiation monitoring program would be implemented to:
  - assess doses to the public at the sensitive receptors
  - assess any impacts to flora and fauna at the sensitive receptors
  - assess worker doses
  - ensure effectiveness of radiation controls, including the underground ventilation controls.
- Waste management: Demolition materials and equipment from the Olympic Dam processing plant is likely to be contaminated with radioactive materials and generate radioactively contaminated waste. Contaminated waste that is generated will be managed in accordance with the existing Olympic Dam Waste Management Plan, with the overall aim being to minimise waste and maximise recycling.

The controls for radiation for the SRE Project are expected to be identical to, or similar to existing controls at Olympic Dam.

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1 Introduction

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- quantify the likely impacts resulting from the predicted change to baseline radiation values on identified receptors (impact assessment in Chapter 4 of this report).

This report supports the EIS, which will be submitted to the Government of South Australia's Minister for Energy and Mining as the relevant Minister for the SRE Project under the *Roxby Downs (Indenture Ratification) Act 1982* (SA).

1.1 Project area definitions

To maintain consistency throughout the EIS and supporting technical assessments, the following terminology related to project infrastructure have been defined for the SRE Project where the **SRE Project Area** is defined at the boundary around the SRE Project for which BHP is seeking approval, including:

- **Special Mining Lease (SML) Area**, located within the SML (Figure 1.2), which is further delineated by the following areas:
  - **SRE Area**: the extent of the proposed SRE Project infrastructure required for construction and operation of the SRE Project within the SML. Includes the existing brownfield plant area, proposed facility relocation(s), proposed plant and laydown areas.
  - **General Infrastructure Area**: the extent of the proposed ancillary infrastructure and ancillary activities required for construction and operation within the SML. Includes the proposed infrastructure laydown areas, proposed stormwater dam location, proposed topsoil and subsoil storage areas.
  - **Water Infrastructure Area**: the extent of the proposed water infrastructure and ancillary activities required for construction and operation within the SML. Includes the proposed water pipeline and water storage dam locations.
- **Electricity Infrastructure Ground Re-Profiling Area (EIGR Area)**: the extent of the isolated proposed vegetation disturbance required to maintain regulatory clearance distances between the 275 kilovolt (kV) transmission line and the ground surface within Clause 28 land. It is noted that the transmission line and infrastructure are already in place, but additional electricity loads required for the SRE Project will result in increased transmission line temperature and more pronounced line sagging and, therefore, changes to existing clearance distances to enable safe operation (Figure 1.3).

1.2 Regulatory context

The SRE Project was declared an Impact Assessed development pursuant to section 108(1)(c) and 108(7) of the PDI Act on 29 August 2024. The declaration reflects the nature, scale and significance of the SRE Project to SA.

Impact Assessed Development is the most rigorous level of development assessment prescribed under the PDI Act.

Specifically, the Minister made the following declaration:

> Pursuant to Section 108(1)(c) and Section 108(7) of the Planning Development and Infrastructure Act 2016, having taken into account those principles prescribed under Regulation 27(2) of the Planning, Development and Infrastructure (General) Regulations 2017 (the Regulations) and having given consideration to the matters under Regulation 27(3) of the Regulations, I declare that all development of a kind specified in the Schedule to this Notice, to the extent that it is undertaken on land identified in Clause 28(1) of the Indenture as impact assessed development and that references to "development" include a project.

The majority of the SRE Project activities, with the exception of ground re-profiling within the Electricity Infrastructure Area, would be located wholly within the existing SML but does not include business-as-usual (BAU) operations (operations which enable existing approved production of up to approximately 200,000 tonnes per annum (tpa) total copper production) or activities associated with scheduled campaign maintenance 2027 (SCM27) works. These activities are subject to separate regulation (e.g. Environment Protection Authority (EPA) licensing) and approval. The SRE Project may also be supported by low impact development outside the SML, which could include, for example, minor road works and upgrades to accommodation infrastructure. It is proposed that any approvals required for these activities would be sought on an as-needs basis under applicable legislation and guidelines.

1.2.1 Planning Development and Infrastructure Act 2016 (SA)

Development approval is required for the SRE Project under the PDI Act. The PDI Act established a new development assessment system in SA to streamline the assessment process. The PDI Act is supported by subordinate regulations, as well as practice directions and guidelines which are issued by the State Planning Commission, the state's independent principal planning body.

A key feature of the new planning system is the Planning and Design Code (the Code) which contains a single set of planning policy, rules and classifications for SA, which is applied spatially via mapping. The Code establishes a performance-based approach to planning and development assessment by including policies that address the scale, form and design of built structures and the contextual setting of the development.

The planning system established by the PDI Act includes five assessment pathways; accepted development, code assessed development (deemed-to-satisfy or performance assessed) and impact assessed development (restricted and impact assessed). As previously stated, impact assessed development is the most rigorous level of development assessment prescribed under the PDI Act.

i Ministerial declaration – impact assessed development

The declaration subjects the SRE Project to an EIS process requiring detailed environmental, social and economic assessment.

A Scoping Application was prepared by BHP to inform the development of EIS Assessment Requirements by the State Planning Commission (SPC). The EIS Assessment Requirements issued by the SPC summarise all potential issues needing to be addressed by BHP and highlight any further information required by the Minister to enable a proper assessment of the proposed SRE Project.

Due to the operation of the *Roxby Downs (Indenture Ratification) Act 1982*, the Minister for Energy and Mining is the relevant Minister for the SRE Project.

Specific Assessment Requirements for radiation (Annexure D) are as follows:

- Describe and assess the radiation exposure pathways to workers, the public, biota and the environment from relevant components of the development during ongoing operations.
- Describe the measures to control and minimise radiation exposures to workers, the public, biota and the environment from relevant components of the development during construction and ongoing operations.
- Outline how the radiation exposure pathways to workers, the public, biota and the environment from relevant components of the development would be monitored during construction and operation.
- Describe existing radiological characteristics of the environment (original baselines and current conditions) that could be impacted by construction or operation of the development (e.g. air quality, soils, surface and groundwater, etc).

1.2.2 International Framework for Radiation Protection

The regulatory system is based on international standards which are summarised in this section.

The International Commission on Radiological Protection (ICRP) is the international body that establishes the 'system of protection' and publishes recommendations.

In Publication 103, the ICRP (ICRP 2007) describes the 'system of dose protection' as the basis of radiation protection and which is the internationally accepted approach to radiation protection. The approach is adopted as the basis of legislative systems for the control of radiation and based on three key principles as follows:

- Justification – this means that a practice involving exposure to radiation should only be adopted if the benefits of the practice outweigh the risks associated with the radiation exposure.
- Optimisation – this means that radiation doses should be "As Low As Reasonably Achievable", taking into account economic and social factors. This is also known as the ALARA principle.
- Limitation – this means that individuals should not receive radiation doses greater than the prescribed dose limits.

The "As Low As Reasonably Achievable" (ALARA) principle is generally considered to be the most important radiation protection principle. It means that the protection systems and doses should be optimised below the dose limits, where optimisation is the balance of costs and risk. The dose limits establish an absolute level of protection. The limits apply only to the radiation dose received as a result of a 'practice' and excludes the doses that result from natural background radiation.

The dose limits are:

- 20 millisieverts per year (mSv/y) for a worker (whilst at work)
- 1 mSv/y for a member of the public (total year).

When assessing compliance with the limits, occupational doses may be averaged over a five-year period and there is an absolute annual limit of 50 millisievert (mSv) in any one year for workers (ICRP 2007).

1.2.3 Australian Radiation Standards

Radiation protection in Australia is regulated by individual states and territories. Regulations are generally based on national standards and codes of practice which are developed by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and reflect the standards of the International Atomic Energy Agency (IAEA).

The primary ARPANSA standards and codes related to radiation protection in the mining or processing of radioactive materials are:

- Fundamentals for Protection Against Ionising Radiation (2014)
- National Directory for Radiation Protection (2021)
- Code for Radiation Protection in Planned Exposure Situations (2020)
- Code for the Safe Transport of Radioactive Material (2019)
- Code for Disposal of Radioactive Waste by the User (2018)
- Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005) (commonly referred to as the 'Mining Code')
- Safety Guide for Monitoring, Assessing and Recording Occupational Radiation Doses in Mining and Mineral Processing (2011)
- Guide for Radiation Protection of the Environment (2015).

National guidance through the National Directory for Radiation Protection (2021) stipulates that material containing more than 1 Becquerel per gram (Bq/g) of any naturally occurring radionuclides, should be considered as radioactive material. This is equivalent to a natural uranium concentration of 81 parts per million (ppm).

1.2.4 South Australian requirements

In South Australia, the primary legislation for radiation control is the *Radiation Protection and Control Act 2021* (SA) (RPC Act) (SA 2021) and the subsequent Radiation Protection and Control (Ionising Radiation) Regulations 2023.

The RPC Act and Regulations refer to permitting processes and the development of a radiation management plan and a radioactive waste management plan. The RPC Act and Regulations also enact various ARPANSA Standards and Codes of Practice noted above.

The RPC Act requires that a Radiation Management Licence be obtained prior to 'mining or mineral processing' for processes involving material containing more than 1 Bq/g of any naturally occurring radionuclides in the uranium decay chain. A key part of the licence is the development and approval of a Radiation Management Plan (RMP) and regulatory guidance is provided on the required content of the RMP.

BHP Olympic Dam is currently licenced for the existing operations. Changes to the operations are subject to authorisation by the competent authority.

1.3 Overview of radiation and radiation protection

Radiation protection[1] focusses on protecting humans and the environment from the harmful effects of radiation. When assessing the overall radiological impacts of an activity on humans, it is usual to consider the ways that exposures can occur. These are known as the radiation exposure pathways and are:

- exposure to gamma radiation
- inhalation of decay products of radon
- inhalation of radionuclides in airborne dust
- ingestion of radionuclides.

Using recognised international methods, the exposures for each of the pathways are able to be combined to produce a measure of overall radiological impact, known as a total dose.

For non-human biota, the radiological impacts are determined by quantifying the change in exposure conditions for a reference set of flora and fauna.

1.4 Project description

The objective of the SRE Project is to expand BHP's smelter and refinery capacity, enabling the Copper SA growth plan by:

- increasing copper production capacity up to 650,000 tpa of total copper plus associated products from the current average production of approximately 200,000 tpa
- delivering a sustainable, highly productive, and more resilient smelting and refining flowsheet
- ensuring the Cu:S ratio constraint is resolved at Olympic Dam for copper concentrate production
- delivering reliable and predictable production outcomes following the 2023 acquisition of OZ Minerals' Carrapateena and Prominent Hill mining operations to realise Copper SA province opportunities.

Key elements of the SRE Project which may affect the radiological environment are:

- expansion of, and additions to, the existing smelter and refinery to enable total production of up to 650,000 tpa copper plus associated products introduction of a two-stage smelting involving the installation of a new primary flash smelting furnace (FSF) to produce copper matte, adding material smelting capacity
- conversion of the existing direct-to-blister flash furnace (DBF) to a flash-converting furnace (FCF), which would process the matte into blister
- addition of an acid plant of similar nature and scale to the existing acid plant and subsequent upgrade of the existing acid plant
- expansion of the electrorefinery and precious metals recovery facilities to produce cathode copper, gold, and silver.

[1] This RIA assumes a basic understanding of radiation protection. For further information, an introduction is provided by ARPANSA (ARPANSA 2022) and for a more detailed description of radiation and radiation safety in relation to mining and minerals processing, refer to the publicly available Radiation Workers' Handbook (MCA, 2018).

Associated with these key elements, the SRE Project would require new supporting facilities, infrastructure and services and the upgrade, removal and/or relocation of existing facilities and services within the SML Area (Figure 1.2).

External to the SML Area, electricity would be supplied to the SRE Project through the existing 275 kV line from Davenport substation (near Port Augusta) to Olympic Dam mine, located within Clause 28 land[2] (EIGR Area). Whilst the transmission line and infrastructure are already in place, additional electricity loads required for the SRE Project will result in increased transmission line temperature and more pronounced line sagging, reducing the existing electrical clearances that are required to enable safe operation. The maintenance of the required electrical clearances between the 275 kV line and the ground surface would necessitate isolated areas of land disturbance and associated vegetation clearance (Figure 1.3).

The SRE Project would be constructed and operated in a staged manner to enable production capacity up to 650,000 tpa of total copper and associated products, with stages detailed in Table 1.1.

Table 1.1 Project stages and timing

Stage	Smelter concentrate throughput (tpa)	Description	Anticipated timing
Stage 1a	1,100,000	Stage 1a includes: • an increase of smelter throughput to approximately 1,100,000 tpa of concentrate producing an output of approximately 390,000 tpa of total copper • a new regional concentrate receiving, handling and blending facility • upgrade and expansion of the existing smelter feed preparation, including additional concentrate storage, blending and a new steam dryer • installation of a new primary FSF to produce copper matte and conversion of the existing DBF to an FCF to convert matte to blister, including additional anode furnace and anode casting infrastructure and decommissioning of the existing electric slag reduction furnace (EF) if required • expansion of the brownfield slag concentrator supported by FSF slag cooling pits, a new interim slag stockpile and associated environmental management infrastructure • new off-gas management infrastructure, including additional gas and dust handling equipment • a new acid plant, additional acid storage, and an associated acid loading station to allow the export of acid • a new electrorefinery and associated anode preparation infrastructure • a new slimes treatment plant • expansion of the precious-metals refinery (PMR) facility.	2028 to 2032
Stage 1b	1,400,000	Stage 1b includes: • an increase in smelter throughput to approximately 1,400,000 tpa of concentrate producing an output of approximately 500,000 tpa of total copper • installation of additional concentrate leach thickening and filtration infrastructure • development of greenfield slag concentrator and associated stockpile and decommissioning of brownfield slag concentrator • incremental expansion of Stage 1a infrastructure and services, including: – the installation of additional electrorefinery modules – expansion of feed preparation, FCF feed system (including lime addition), off-gas management, acid plant, slimes treatment and PMR capacities.	2032 to 2036

[2] Clause 28 land as defined under the RDIR Act

Stage	Smelter concentrate throughput (tpa)	Description	Anticipated timing
Stage 2	2,000,000	Stage 2 includes: • an increase in smelter throughput to approximately 2,000,000 tpa of concentrate producing an output of approximately 650,000 tpa of total copper • installation of new concentrate leach circuit for treatment of imported concentrate • incremental expansion of Stage 1b infrastructure and services, including: – the installation of additional electrorefinery modules – the installation of an additional anode furnace and associated off-gas management infrastructure – expansion of feed preparation, FSF and FCF feed systems, off-gas and slag management, acid plant, slimes treatment and PMR capacities.	2038 to closure

This radiological technical assessment has been prepared based upon the maximum potential impacts associated with Stage 2 (i.e. the greatest impact scenario) to ensure that the full extent of all potential impacts is identified and assessed.

Development of the SRE Project would require decommissioning of existing metallurgical plant components including dryers, the electric furnace and the existing concentrate storage and transfer system, all of which would require disposal.

Waste generated during construction would be managed as follows:

- Where practicable, demolition materials would be decontaminated, removed from site and recycled.
- Materials not suitable for removal from site would be managed on the SML via existing waste management facilities.

All waste generated from construction of the SRE Project would be managed in accordance with existing site procedures and approved management plans.

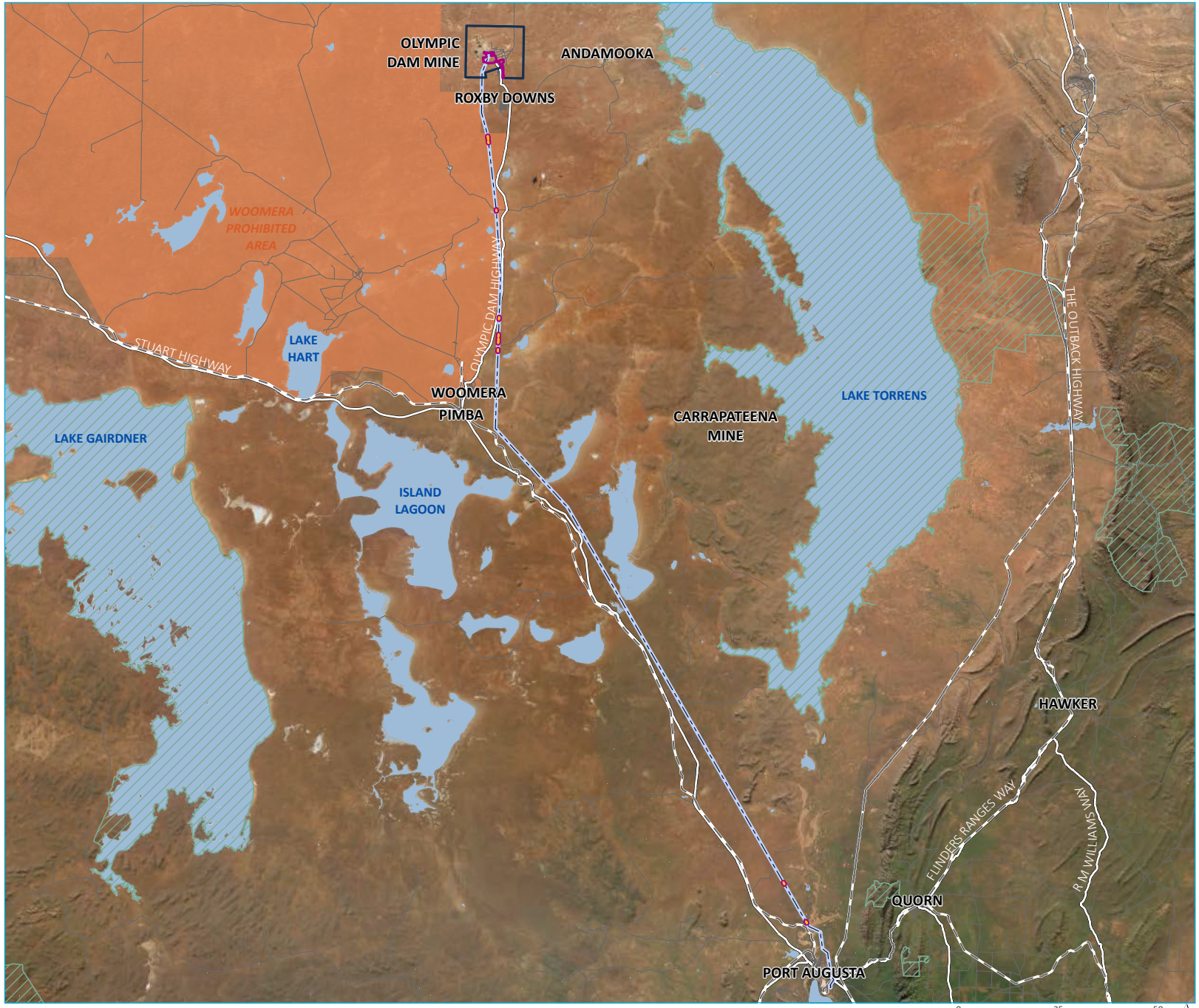
The indicative location of key infrastructure is shown in Figure 1.2 and Figure 1.3, while the key project characteristics are outlined in Table 1.2.

Table 1.2 Key characteristics of the SRE Project

Project element	Summary
Smelter and refinery expansion and additions	Expansion of, and additions to, the existing smelter and refinery to enable production of up to 650,000 tpa copper plus associated products (gold, silver, and acid). This would include: • a new concentrate handling and blending facility • additional concentrate leach capacity • upgrade and expansion of the existing smelter feed preparation • installation of a new primary FSF to produce copper matte and conversion of the existing DBF to a FCF to convert matte to blister, including additional anode furnace and anode casting infrastructure • upgrade of the existing slag concentrator circuit and subsequent development of a new slag concentrator circuit • new off-gas management infrastructure, including additional gas and dust handling equipment • a new acid plant and upgrade of the existing acid plants • a new electrorefinery and associated infrastructure • a new slimes treatment plant • expansion of PMR facility • slag stockpile and treatment.

Project element	Summary
Electricity demand, supply and distribution	An electricity demand of up to 68 mega volt-amperes (MVA) net load increase would be required for the SRE Project. The additional electrical demand due to the SRE Project would be met by capacity from the national grid via the existing 275 kV transmission line (noting potential for below line land disturbance and associated vegetation clearance outside of the SML). Minor augmentation of existing onsite electricity supply infrastructure at Olympic Dam within the SML would be to ensure the additional capacity could be achieved and maintained. New high voltage and low voltage power supply and reticulation infrastructure would be required to all smelter infrastructure.
Water demand	Water demand of between 2 and 16 megalitres per day (ML/day) required for the SRE Project in addition to the existing supply for current operations.
Water supply and distribution	The SRE Project proposes no additional water abstraction from the Great Artesian Basin (GAB) above current and projected daily average BAU volumes. Water supply for the SRE Project would nominally be provided from the Department for Infrastructure and Transport (DIT) Northern Water Project (NWP) infrastructure, following commissioning of the initial 90 ML/d capacity of the NWP. This would require new water storage and distribution infrastructure to connect the SRE Project to the NWP connection point at the SML boundary. The NWP water supply may be supplemented or offset by the provision of local groundwater supply (subject to further approvals). This water supply would occur via existing process storage dams, the desalination plant at the Olympic Dam site, and/or through the distribution of the existing water supply within daily average BAU volumes. The additional water supplies are likely to require augmentation of the existing desalination water treatment plant and water distribution network, and a demineralised water plant will be required to support the SRE Project operations.
Supporting infrastructure	Supporting infrastructure includes: • civil infrastructure works, such as roads and stormwater infrastructure • new offices and crib rooms • new workshops • new laydown areas • process control system upgrades • concrete batching • other supporting infrastructure as required to facilitate the implementation and operation of the SRE Project.
Waste management	Development of the SRE Project may require decommissioning of the existing processing plant components including dryers, the electric furnace and the existing concentrate storage and transfer system. Some of the decommissioned infrastructure would be retained in-situ to preserve operational flexibility or for future management under the site Closure Management and Rehabilitation Plan; however, some elements may require disposal as a component of the SRE Project. Waste generated during construction would be managed as follows: • where practicable, demolition materials would be removed from site and recycled • materials not suitable for removal from site would be managed on the SML via existing waste management facilities. All waste generated from construction of the SRE Project would be managed in accordance with existing site procedures and approved management plans. Operational wastes associated with the SRE Project consist of processing and non-processing wastes where: • processing wastes are limited to low-copper slags generated from the smelting and slag concentrator operations that are not suitable for reprocessing and effluent streams from various process operations that are directed to tailings, including from the PMR and smelter off-gas systems • non-processing wastes including reagent packaging wastes and operational consumables.

<table>
<tr><th>Project element</th><th>Summary</th></tr>
<tr><td>Workforce</td><td>100% fly-in/fly-out (FIFO) workforce is assumed for construction and the SRE operational workforce. Estimated peak construction workforce numbers (in full time equivalents (FTE)) are summarised below.
<table>
<tr><th>Construction stage</th><th>Average FTE</th><th>Peak FTE</th></tr>
<tr><td>Stage 1a</td><td>~708</td><td>~1,313</td></tr>
<tr><td>Stage 1b</td><td>~260</td><td>~515</td></tr>
<tr><td>Stage 2</td><td>~519</td><td>~978</td></tr>
</table>
Following construction, the SRE Project would require the permanent operational workforce as summarised below:
<table>
<tr><th>Operational stage</th><th>Additional SRE Project operational workforce</th><th>Total Olympic Dam Smelter and Refinery workforce</th></tr>
<tr><td>Stage 1a</td><td>~207</td><td>766</td></tr>
<tr><td>Stage 1b</td><td>~57 (additional to Stage 1a)</td><td>823</td></tr>
<tr><td>Stage 2</td><td>~244 (additional to Stage 1b)</td><td>1,067</td></tr>
</table>
SRE Project construction and operational workforce is proposed to utilise existing and new accommodation to be established by BHP for the scheduled campaign maintenance 2027 (SCM27) shutdown, Olympic Dam future campaign maintenance accommodation, and/or greenfield accommodation (subject to separate approvals).</td></tr>
<tr><td>Concentrate import</td><td>Import of copper concentrate from Prominent Hill and Carrapateena mining operations, as well as possible future mining operations (e.g. Oak Dam), and maintain the ability to receive copper concentrate from other third-party suppliers.
Prominent Hill concentrate may be passed through concentrate leach to remove fluorides prior to smelter feed preparation. Carrapateena concentrate to pass directly to smelter feed preparation.
Other, third-party concentrates may be passed through concentrate leach to remove deleterious elements (e.g. fluorides) prior to smelter feed preparation as required.</td></tr>
<tr><td>Production and export</td><td>Total production volumes of up to:
~650,000 tpa of cathode copper
~893,000 ounces per annum of gold
~3,950,000 ounces per annum of silver
~4,900 tpa of uranium oxide concentrate; note that the SRE Project does not materially change existing uranium production, with an increase of approximately 1% expected as a result of the leaching of Prominent Hill concentrate to remove fluoride. No upgrade or modification of uranium production facilities is proposed as a part of the SRE Project
~1,700,000 to 1,900,000 tpa of 98% H_2SO_4, of which up to approximately 810,000 tpa may be exported from Olympic Dam (i.e. operations become ‘net’ sulphuric acid producer).</td></tr>
</table>





KEY

- Special Mining Lease
- SRE Project Area
- EIGR Area

Existing environment

- BHP private transmission line (275 kV)
- Rail line
- Major road
- Minor road
- Named waterbody
- National park
- Woomera Prohibited Area

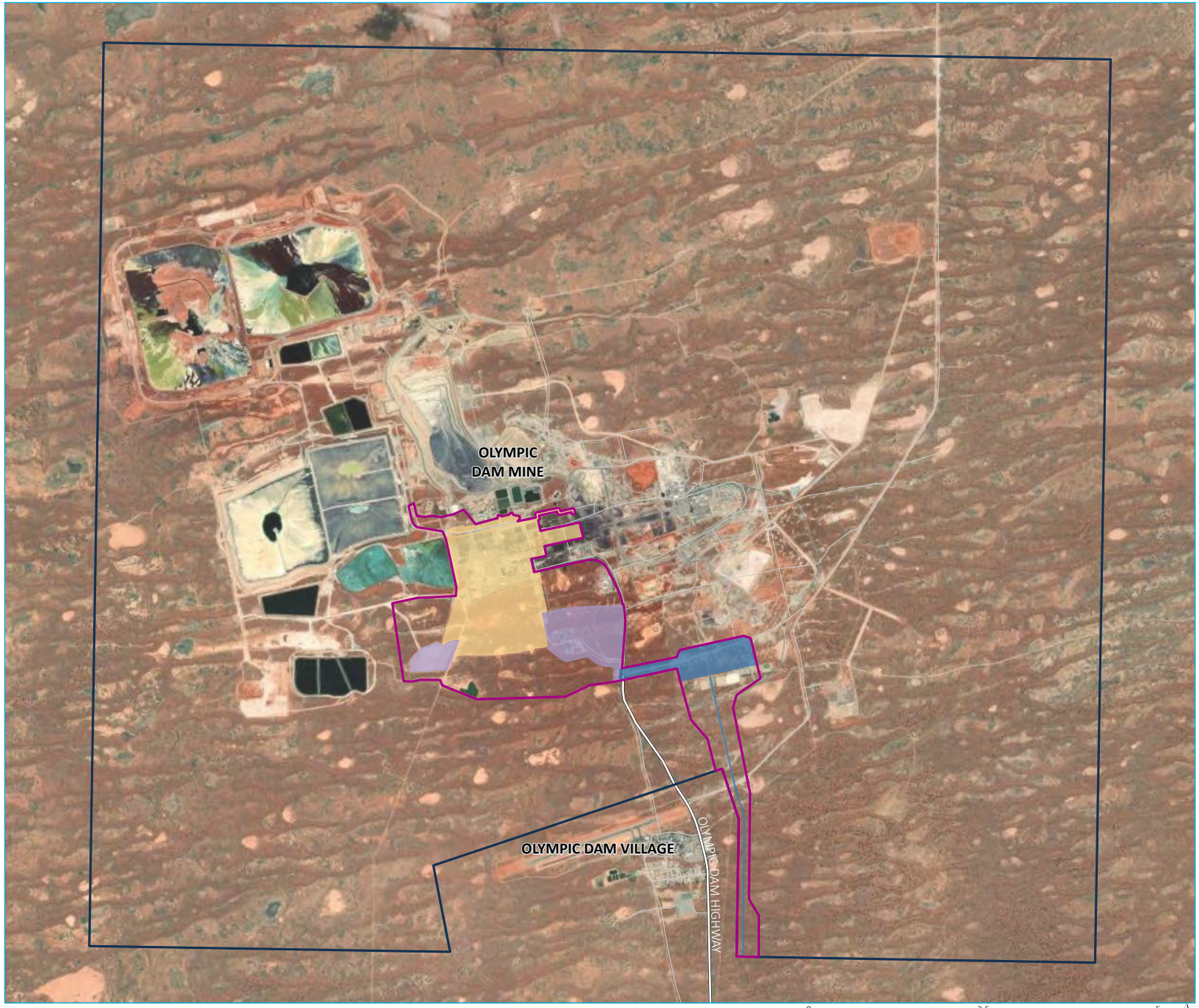
INSET KEY

- Major road
- National park

SRE Project Area - regional locality

BHP SRE Project
Radiological Impact Assessment
Figure 1.1

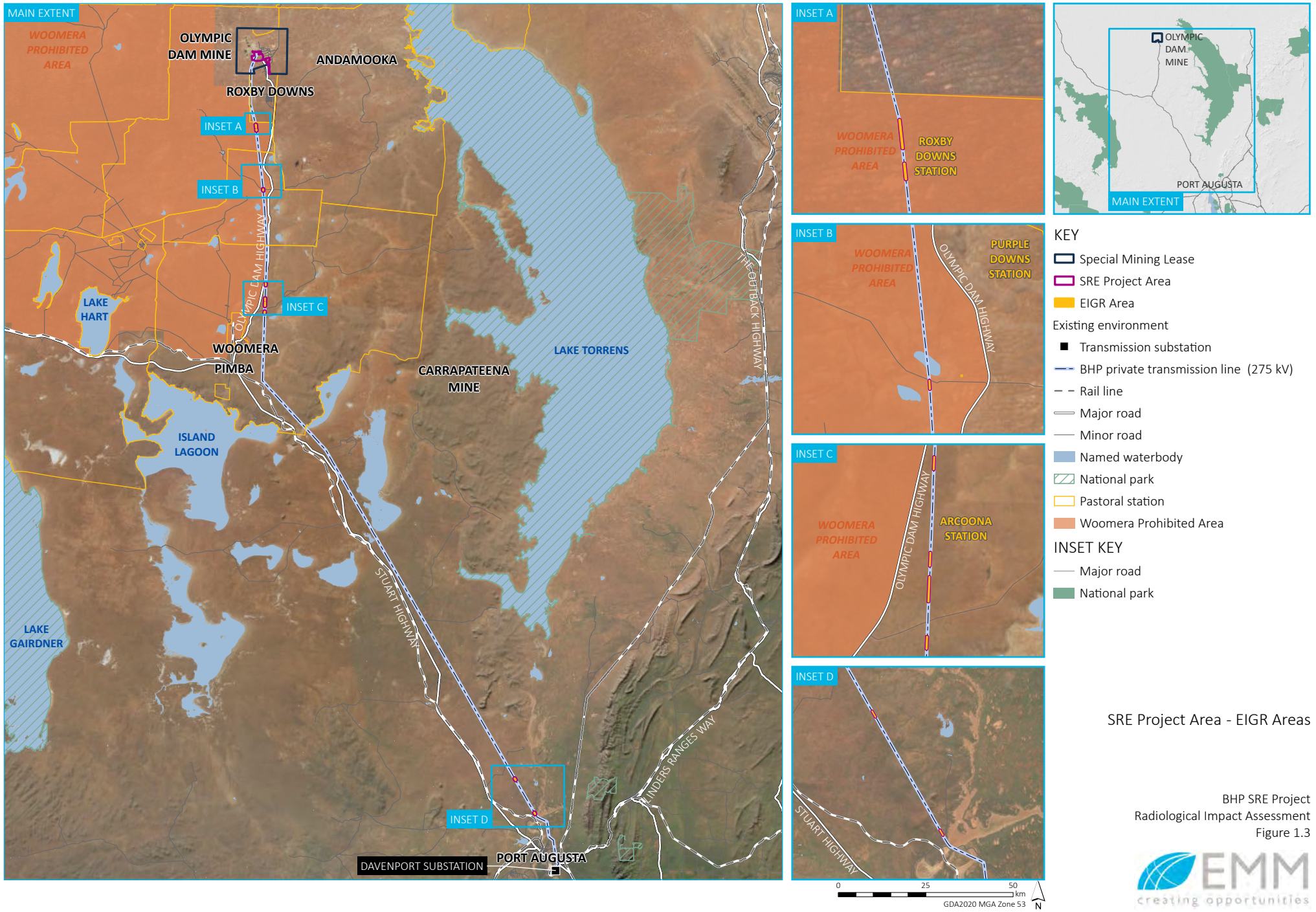
EMM
creating opportunities



SRE Project Area - SML Area

BHP SRE Project
Radiological Impact Assessment
Figure 1.2

EMM
creating opportunities



SRE Project Area - EIGR Areas

BHP SRE Project
Radiological Impact Assessment
Figure 1.3

EMM
creating opportunities

1.5 Basis of assessment

In order to quantify the potential radiological impacts of the SRE Project on humans, the environment and non-human biota, the following approach was adopted:

- consider the existing levels, noting that the Olympic Dam operation has been operating for almost 40 years. The existing levels are based on approximately the last five years of routine monitoring data
- review the radiological characteristics of the materials and the process
- quantify the sources of radiological emissions that may impact the environment
- assess impact on dose (to people) and dose rate (for non-human biota).

In this radiological assessment, the term “existing” is used to describe the radiological conditions against which the SRE Project is assessed. The International Atomic Energy Agency (IAEA) defines an "existing exposure situation" as a situation where exposure to radiation occurs due to residual radioactive material.

1.6 SRE Project uranium inventories

Table 1.3 shows the maximum contained uranium in the feed streams. Note that for the Olympic Dam stream, the majority of the uranium is extracted in the tailings leach circuit, with a minor amount being extracted through concentrate leach. For the SRE Project, the Carrapateena, and future Oak Dam copper concentrates will not be leached. However, the Prominent Hill copper concentrate may be leached for fluorine control.

Table 1.3 Contained uranium in feed materials (Olympic Dam value based on current uranium concentration in the order of 400 ppm)

Total contained uranium (tpa)[3]			
Olympic Dam (all materials)	**Carrapateena**	**Prominent Hill**	**Oak Dam**
6,800	30	30	80

Note that Table 1.3 does not represent additional uranium that will be produced. It is intended to show the contained uranium in the various copper concentrates. It is expected that the uranium from the concentrate will report to the process plant waste streams.

It can be seen that even if all the uranium is extracted from the Carrapateena, Prominent Hill and future Oak Dam copper concentrates, then its contribution to the overall maximum uranium production from Olympic Dam is minor.

[3] Carrapateena contained uranium based upon 270,000 tpa x 240 ppm (U308). Prominent Hill contained uranium based upon 150,000 tpa x 250 ppm (U308)

2 Baseline condition assessment

An understanding of the existing baseline natural radiation levels assists in providing perspective on any changes in levels due to the operation of the SRE Project. Specifically, the characterisation of the baseline enables:

- recording, classification and description of the existing radiological characteristics prior to the development of the SRE Project
- establishment of a basis for subsequent works aimed at describing the likely change in the baseline environment as a result of the development of the SRE Project and quantifying the significance of resultant impacts to receptors.

2.1 Baseline radiological environment

The existing environmental radiological characteristics are described in this section. In general, five years of monitoring data has been summarised. Monitoring data is from a number of sources including:

- continuous radon and radon decay product concentrations at the Olympic Dam Village (ODV) and Roxby Downs air quality monitoring sites
- continuous high volume dust concentrations in air monitoring (with a PM10 prefilter) at the ODV and Roxby Downs air quality monitoring sites
- passive dust deposition monitoring at five monitoring sites (on the northern, eastern, western project lease boundaries and one south of ODV and one south of Roxby Downs)
- radionuclides in groundwater monitoring results as part of the groundwater quality monitoring network.

A summary of the results is provided in this section with graphical representations of the data in Annexure A.

2.1.1 Radon and radon decay products

Full year radon and radon decay products data from the ODV and Roxby Downs monitoring locations were analysed and a summary is shown in Table 2.1. The results show variability from year to year with the ODV values being generally less than the values at Roxby Downs Village. The concentration values do not represent doses, and BHP assesses doses based on prevailing wind directions (e.g. winds from the south of Roxby and ODV contain naturally occurring background radon, while winds from the north contain background plus project originated radon). A summary of the assessed total annual doses at the receptor locations for the previously five years can be seen in Section 2.1.5.

Table 2.1 Annual average radon and radon decay product concentrations

Calendar year	RnDP concentration (µJ/m^3)		Radon concentration (Bq/m^3)	
	Roxby	ODV	Roxby	ODV
2017	0.024	0.029	12.2	8.9
2018	0.036	0.032	17.0	7.8
2019	0.028	0.031	13.9	12.0
2020	0.019	0.028	14.4	15.4
2021	0.025	0.022	16.7	14.4

Calendar year	RnDP concentration (µJ/m³)		Radon concentration (Bq/m³)	
	Roxby	ODV	Roxby	ODV
2022	0.021	0.022	16.8	8.4
~~2023~~	~~0.027~~	~~0.024~~	~~10.0~~	~~7.6~~
~~2024~~	~~0.032~~	~~0.019~~	~~9.6~~	~~8.5~~

2.1.2 High volume dust samples

High volume dust sampling is conducted using a respirable dust PM10 prefilter, which removes dust particles that are greater than 10 microns. Dust samples are collected on filters which are analysed for a range of contaminants including long lived radionuclides. Note that radiological dose assessment requires the use of total suspended particulates (TSP) concentrations, and as a rule of thumb, the TSP concentration is approximately twice the PM10 values. Summary data is shown in Table 2.2.

Table 2.2 Annual average radionuclide concentrations in high volume dust (PM10) samples

Year	Annual Average Radionuclide Concentration (µBq/m³)									
	U238		Th230		Ra226		Pb210		Po210	
	ODV	RD	ODV	RD	ODV	RD	ODV	RD	ODV	RD
2018–2019	3.3	1.8	2.5	1.7	22.4	27.7	287	318	11.1	13.4
2019–2020	7.3	4.6	4.7	2.1	14.1	12.2	355	285	29.6	12.1
2020–2021	3.5	1.7	3.1	1.1	4.7	2.9	348	317	44.4	37.5
2021–2022	3.3	1.4	3.9	2.2	7.7	4.9	301	286	15.0	3.3
2022–2023	2.8	1.5	2.9	1.6	6.6	9.1	270	309	98.9	26.1
2023–2024	3.5	1.4	3.7	1.8	8.6	6.6	322	371	15.3	9.8
2024–2025	5.6	2.8	4.7	2.3	7.3	5.9	334	334	16.8	4.9
Background (TSP)	0.6	0.6	0.7	0.7	1.5	1.5	318	318	36.3	36.3

The “background” values reported in the final row of Table 2.2 are the previously established BHP values for the Roxby Downs Homestead. It can be seen that annual average concentrations for U238, Th230 and Ra226 constantly exceed the background values. Pb210 and Po210 values are consistent with the background values.

Note that while the values represent an increase over background levels, the total inhalation dose from the dusts represent is less than 10 µSv/y at both ODV and Roxby Downs (including a doubling for the PM10 to TSP conversion).

2.1.3 Dust deposition results

Dust deposition monitoring has been occurring at five monitoring sites as follow:

- PD1 – northern boundary of SML
- PD4 – 1 km to west of western SML
- PD8 – eastern boundary of SML

- PD13 – south of SML halfway between ODV and Roxby Downs
- PD14 – approximately 5 km south of Roxby Downs.

Samples are collected in deposition gauges (glass jars) with monthly changeover. The samples are composited for each monitoring site through the year and then gravimetrically and radiometrically analysed. The radionuclide deposition results are used to assess radiological impacts to flora and fauna and also for human ingestion dose assessment.

Table 2.3 to Table 2.7 provide a summary of the radionuclide deposition by monitoring site. Note that the Po-210 values are "corrected" values. This means that account has been taken of the ingrowth in of Po-210 from Pb-210 in the sample and, therefore, represent the amount of Po-210 depositing.

Table 2.3 Annual radionuclide deposition – PD1

Financial year	PD1 – northern boundary of SML (mBq/m^2 month)				
	U-238	Th-230	Ra-226	Pb-210	Po-210
2018–2019	100	80	91	1109	407
2019–2020	85	119	12	858	3491
2020–2021	78	67	68	1116	<MDL
2021–2022	29	21	66	870	146
2022–2023	54	66	103	852	596
2023–2024	94	140	26	971	372
2024–2025	159	97	232	1180	453

Table 2.4 Annual radionuclide deposition – PD4

Financial year	PD4 – 1 km to west of western SML (mBq/m^2 month)				
	U-238	Th-230	Ra-226	Pb-210	Po-210
2018–2019	41	41	<MDL	1218	85
2019–2020	52	31	<MDL	729	3078
2020–2021	38	44	57	881	111
2021–2022	27	10	34	941	<MDL
2022–2023	24	32	75	816	191
2023–2024	44	48	100	777	257
2024–2025	74	41	42	893	427

Table 2.5 Annual radionuclide deposition – PD8

Financial year	PD8 – eastern boundary of SML (mBq/m^2 month)				
	U-238	Th-230	Ra-226	Pb-210	Po-210
2018–2019	26	16	<MDL	1062	48
2019–2020	41	70	<MDL	983	622
2020–2021	10	27	2	1197	<MDL
2021–2022	10	<MDL	28	707	197
2022–2023	16	20	79	931	<MDL
2023–2024	16	13	16	913	75
2024–2025	30	32	66	1436	298

Table 2.6 Annual radionuclide deposition – PD13

Financial year	PD13 – south of SML halfway between ODV and Roxby Downs (mBq/m^2 month)				
	U-238	Th-230	Ra-226	Pb-210	Po-210
2018–2019	45	32	<MDL	982	5
2019–2020	59	55	26	607	4182
2020–2021	33	19	33	949	<MDL
2021–2022	27	14	43	1133	357
2022–2023	18	27	243	998	479
2023–2024	13	27	26	788	213
2024–2025	31	14	87	4221	<MDL

Table 2.7 Annual radionuclide deposition – PD14

Financial year	PD14 – approximately 5 km south of Roxby Downs (mBq/m^2 month)				
	U-238	Th-230	Ra-226	Pb-210	Po-210
2018–2019	40	43	<MDL	1009	<MDL
2019–2020	43	15	27	867	201
2020–2021	7	11	25	1051	130
2021–2022	9	<MDL	11	1165	<MDL
2022–2023	13	16	40	1055	750
2023–2024	5	23	28	820	1654
2024–2025	20	20	57	224	<MDL

The results show that there is a large variation within each radionuclide deposition rate. The Pb-210 and Po-210 deposition rates are higher than other radionuclide rates which is due to the decay products of radon. This is a well-documented naturally occurring phenomenon, which can also be seen in radionuclide concentration in dust. Note that the deposition rates are well below the licence condition of 25Bq/m^2/y for U-238. This is the level at which the reference level of 10 µGy/h for impacts on non-human biota above natural background may be exceeded.

2.1.4 Radionuclides in groundwater

It is important to note that radionuclides in groundwater do not constitute a radiological hazard to people or flora and fauna. Summary results are shown in Table 2.8 to Table 2.12.

An assessment of the previous five full years of radionuclide analysis of groundwater sampling has been conducted, and results have been grouped as follows:

- Near TSF1, 2, 3 (LT1,2 ,15, 17, 19, 20, 21, 22, 25, 34, 35, 39).
- Near new TSFs (LT60, 64, 67, 69, 71, 86, 91, 98, 99, 100).
- Mine bores (LM 43 and LM 46).
- Regional limestone bores (LR 2, 5, 8, 9).

Table 2.8 Average Uranium-238 in groundwater samples

Financial year	Annual average U-238 concentrations (Bq/l)			
	Near TSF1, 2, 3	Near new TSFs	Mine bores	Regional limestone bores
2018–2019	2.29	1.81	3.39	0.20
2019–2020	2.35	0.75	4.55	0.20
2020–2021	2.17	0.90	4.68	0.19
2021–2022	2.55	1.02	1.13	0.16
2022–2023	2.02	0.90	1.12	0.27
2023–2024	1.87	0.97	3.18	0.26

Table 2.9 Average Thorium-230 in groundwater samples

Financial year	Annual average Th-230 concentrations (Bq/l)			
	Near TSF1, 2, 3	Near new TSFs	Mine bores	Regional limestone bores
2018–2019	0.01	0.00	0.00	0.02
2019–2020	0.01	0.01	0.02	0.01
2020–2021	0.01	0.01	0.00	0.01
2021–2022	0.01	0.04	0.03	0.02
2022–2023	0.01	0.00	0.00	0.01
2023–2024	0.01	0.01	0.01	0.01

Table 2.10 Average Radium-226 in groundwater samples

Financial year	Annual average Ra-226 concentrations (Bq/l)			
	Near TSF1, 2, 3	Near new TSFs	Mine bores	Regional limestone bores
2018–2019	0.86	0.89	1.06	0.71
2019–2020	0.58	1.10	0.12	0.50
2020–2021	0.66	1.04	0.68	0.60
2021–2022	0.60	0.97	0.93	0.61
2022–2023	0.72	1.48	1.69	0.55
2023–2024	0.69	1.31	1.09	0.47

Table 2.11 Average Lead-210 in groundwater samples

Financial year	Annual average Pb-210 concentrations (Bq/l)			
	Near TSF1, 2, 3	Near new TSFs	Mine bores	Regional limestone bores
2018–2019	0.28	0.00	0.00	0.09
2019–2020	0.42	0.13	0.08	0.34
2020–2021	0.09	0.03	0.04	0.05
2021–2022	0.09	0.07	0.04	0.43
2022–2023	0.10	0.07	0.27	0.19
2023–2024	0.06	0.06	0.01	0.07

Table 2.12 Average Polonium-210 in groundwater samples

Financial year	Annual average Po-210 concentrations (Bq/l)			
	Near TSF1, 2, 3	Near new TSFs	Mine bores	Regional limestone bores
2018–2019	0.15	0.02	0.01	0.05
2019–2020	0.02	0.04	0.03	0.07
2020–2021	0.02	0.03	0.01	0.03
2021–2022	0.04	0.02	0.00	0.19
2022–2023	0.04	0.15	0.19	0.20
2023–2024	0.03	0.07	0.03	0.05

The results show that concentrations of radionuclides in groundwater can vary significantly year by year.

2.1.5 Review of public doses

Every year BHP publishes assessments of total doses to members of the public at Roxby Downs and ODV as a result of operations which are based on monitoring results. The doses incorporate exposures from the inhalation exposure pathways with the gamma and ingestion pathways assessed to be negligible. Results are summarised in Table 2.13.

Table 2.13 Annual average total dose estimates

Financial year	Roxby Downs (mSv/y)	ODV (mSv/y)
2018–2019	0.033	0.034
2019–2020	0.059	0.073
2020–2021	0.039	0.066
2021–2022	0.053	0.053

Member of the public doses from current operations has remained consistent over recent years. This would be expected given the minimal changes in operating parameters.

2.2 Environmental context

2.2.1 Study area and sensitive receptors

The study area for the radiological impact extends to the three main receptor locations.

The assessment considered human impacts (through dose assessments) and environmental impacts (through an ERICA assessment). For this RIA, the identified potential receptors are:

- Olympic Dam Village
- Roxby Downs
- Andamooka.

2.3 Radiological characteristics of materials

The radionuclide content of the copper concentrates depends upon the mineralogy of the mined material and copper concentrate production process.

The radiological characteristics of the Olympic Dam copper concentrate are well known (for example, BHP Billiton 2009, BHP 2023) with the uranium decay chain radionuclides in the copper concentrate out of secular equilibrium[4].

There is evidence that some loss in secular equilibrium occurs during the mining, milling and flotation of copper concentrate and for the Carrapateena, Prominent Hill and Oak Dam copper concentrates; however, the radionuclide concentration test work is ongoing.

To consider a conservative-case scenario, for this RIA it has been assumed that the Carrapateena, Prominent Hill and future Oak Dam copper concentrates have the same radionuclide activity concentration ratios as the Olympic Dam copper concentrate.

[4] Note that secular equilibrium is when the radionuclides in a material have the same activity concentration

The assumed radionuclide concentrations based on the predicted uranium content of the copper concentrates, are shown in Table 2.14.

Note that radionuclides from the naturally occurring Th-232 and U-235 decay chains are present in the copper concentrates. Analysis has shown that natural thorium in all copper concentrates is between approximately 10 and 20 ppm (equivalent to 0.001 to 0.002% by mass), representing 0.05 to 0.1 Bq/g for the Th-232 radioisotope and all Th232 decay products (which are in approximate secular equilibrium). U235 exists naturally with U238 at a mass ratio of approximately 0.7% and activity ratio of approximately 4%. The Th232 and U235 concentrations have been confirmed in sample analyses. The activities of the U-235 and Th-232 radionuclides are minor compared to the U-238 decay chain radionuclides and have, therefore, been excluded from the assessments.

Table 2.14 Indicative radionuclide concentration of copper concentrates

Sample description	Annual mass	Uranium	U-238 & U-234	Th-230	Ra-226	Pb-210	Po-210
	Mtpa	ppm	Bq/g	Bq/g	Bq/g	Bq/g	Bq/g
Olympic Dam copper concentrate to smelter	0.9	220	2.8	2.1	10.0	15.0	30.5
Carrapateena	0.15	200	2.5	1.9	9.1	13.6	27.7
Prominent Hill	0.15	200	2.5	1.9	9.1	13.6	27.7
Oak Dam	0.4	200	2.5	1.9	9.1	13.6	27.7
Weighted average radionuclide concentrations			2.7	2.0	9.6	14.4	29.3

Note: Carrapateena, Prominent Hill and Oak Dam radionuclide concentrations are inferred based on the Olympic Dam ratios

In addition to the radiological characterisation of the copper concentrate, the deportment of radionuclides through the new smelting process has been considered and it has been noted that the radionuclides behave in a similar manner to the that which occurs in the existing smelter. In general:

- uranium, thorium and radium report to slag in the smelting process
- polonium and lead undergo high temperature volatilisation and are captured in the gas and dust handling system and recycled. A bleed system will ensure that concentrations of polonium and lead are managed
- electro refining and precious metal extraction removes remnant radionuclides to the waste streams.

2.4 Input to air quality modelling

To assess radiological environmental impacts, emissions of radon and radionuclides in dust are modelled as part of air quality modelling.

For radon, it was estimated that emission rate from the SRE Project was 0.4 MBq/s. This is based on the total emissions of generated radon in a 20-day stockpile of copper concentrate. The value is calculated by determining the quantity of copper concentrate in a 20-day stockpile (calculated by 20 days/365 days x annual throughput), multiplying by the average Ra226 concentration and then multiplying by the radon generation rate (2.1×10^{-6} Bq (Rn-222) per Bq (Ra-226)). A conservative radon emanation factor of 0.2 was applied to the final figure, based on copper concentrate radon emanation test work (BHP Billiton 2009).

For the proposed slag stockpile, initial air quality modelling was based on a conservative estimate of radon emission rate from slag. Subsequent test work has provided actual radon emission rates from slag samples (SA Radiation 2026). The work showed that the radon emission rates were approximately 100 times less than the original modelled rates. Based on this test work, the outputs of the air quality modelling were linearly scaled.

For dust emissions, the air quality modelling is based on various sources of dust emissions from the SRE Project, and these sources will have different radionuclide compositions. For this RIA, the air quality modelling provided outputs for three broad groups of emissions as follows:

- smelter hygiene stack emissions
- other stack emissions, consisting mainly of matte and slag handling and granulation
- other sources (including copper concentrate and inert road dust).

Table 2.15 shows the relative radionuclide concentrations and the combined incremental radionuclide concentrations for the modelled dusts (both dust concentration and dust deposition).

Table 2.15 Indicative radionuclide concentration of emitted dusts

Sample description	U-238 & U234	Th-230	Ra-226	Pb-210	Po-210	Justification
	Bq/g	Bq/g	Bq/g	Bq/g	Bq/g	
Smelter hygiene stack emissions	0	0	0	1000	1000	Worst case estimate [ANSTO 2009]
Other stack emissions	8.0	6.0	28.8	43.2	87.8	Based on slag being approximately three times higher than copper concentrate [ANSTO 2009]
Other sources	1.3	1.0	4.8	7.2	14.6	50% inert and 50% average copper concentrate

2.5 Conclusion

Extensive environmental radiation monitoring has characterised the existing radiological conditions in the region. This provides the baseline against which to assess the SRE Project.

The radionuclide content of the copper concentrates depends upon the mineralogy of the mined material and copper concentrate production process.

The radiological characteristics of the Olympic Dam copper concentrate and their processing are well known (for example, BHP Billiton 2009, BHP 2023) with the uranium decay chain radionuclides in the copper concentrate not in secular equilibrium. The observations can be conservatively applied to the other concentrates for potential impact assessment. Similarly, the radionuclide deportment characteristics of the Olympic Dam smelting process can be used to provide an estimate of potential radionuclide content of emission from the SRE Project.

For the Carrapateena, Prominent Hill and Oak Dam copper concentrates, the uranium content is understood; however, ongoing radionuclide concentration characterisation test work is occurring. For this assessment, it is assumed that radionuclide concentration of the Carrapateena, Prominent Hill and Oak Dam copper concentrates are in the same ratio as that of the Olympic Dam copper concentrate.

3 Assessment of effects

This chapter identifies and assesses the radiological effects of the SRE Project.

Radiological effects are determined through a review of the exposure pathways and consideration of radionuclide releases from the SRE Project that may impact at the sensitive receptors. The assessment of the impacts is covered in Chapter 4.

For offsite radiological impacts, the majority of the potential impact is attributable to air emissions from the SRE Project. Therefore, the radiological assessment depends upon the air quality modelling. Other potential exposure pathways, including exposure to gamma radiation and exposure from groundwater-based pathways are considered and shown to result in negligible impact.

The assessment methods are based on internationally recognised standards (ICRP 2006, ARPANSA 2011, IAEA 2014) formalised in national standards and local legislation. A simplified assessment framework is shown in Figure 3.1.

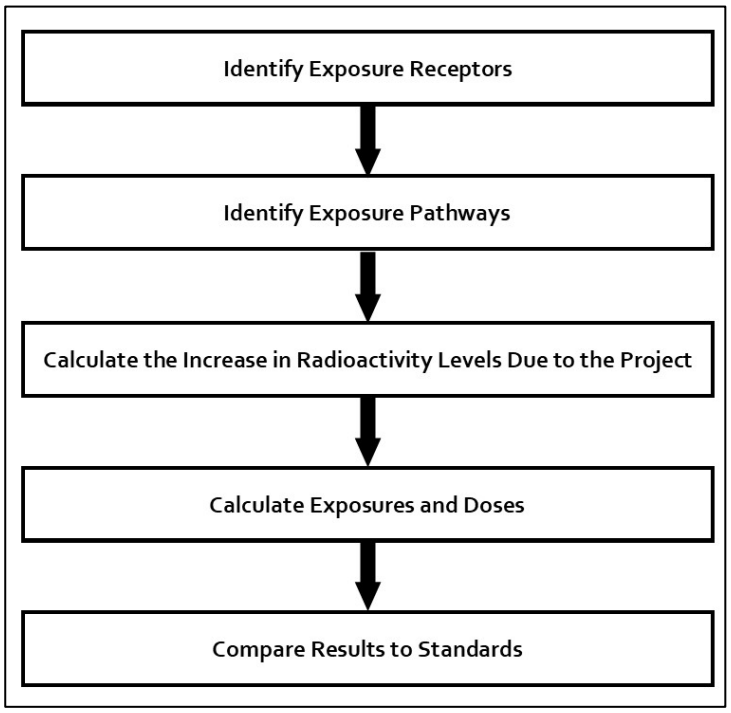


Figure 3.1 Assessment framework

The assessment of effects included the following works:

- Provide qualitative assessment of source terms for the SRE Project for input to the air quality modelling.
- Convert the modelled increments into radionuclide in air concentrations or radionuclide deposition rates.
- Conduct assessment of the gamma and groundwater effects.

3.1 Potential impact events

BHP has identified potential impact events associated with likely changes to the baseline radiation environment as a result of the implementation of the SRE Project. These events represent scenarios for which there is, or is likely to be, a linkage between SRE Project activities, emissions of radiation, and the identified receptors.

To ensure a consistent approach to impact assessment for the SRE Project, sources, pathways, and receptors (SPR) are defined and applied in this assessment as follows:

- Source – the SRE Project activities (i.e. potential impact event) which, alone or in combination, has the potential to impact a receptor.
- Pathway – the pathway, means or route (with consideration of any natural barriers) by which the receptor can be exposed to, or may reasonably be expected to be impacted by, the source.
- Receptor – the receptor that may be impacted by the source via the pathway.

The detailed list of potential impact events is provided in tables appended to the EIS and are summarised for the radiological pathways in Table 3.1. The scope of this assessment of effects presented herein has considered these identified potential impact events.

Table 3.1 Preliminary SPR assessment – potential impact events

SPR ID No.	Potential impact event	Source	Pathway	Receptor	Linkage
A23	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to the local community, impacting health and safety	Emission of radon and/or radionuclide bearing materials	Air (radiation)	Local community (health and safety)	Unconfirmed
A24	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to the local community, impacting amenity	Emission of radon and/or radionuclide bearing materials	Air (radiation)	Local community (amenity)	Unconfirmed
A25	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to flora and vegetation impacting diversity	Emission of radon and/or radionuclide bearing materials	Air (radiation)	Flora and vegetation	Unconfirmed
A26	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to fauna and habitat impacting diversity	Emission of radon and/or radionuclide bearing materials	Air (radiation)	Fauna and habitat	Unconfirmed
A27	Project-related operational activities release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to State and Commonwealth listed threatened species	Emission of radon and/or radionuclide bearing materials	Air (radiation)	State and Commonwealth threatened species	Unconfirmed
GW9	During operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting abundance and diversity of groundwater dependent ecosystems	Loss of control of process liquors leads to seepage of radionuclides into the groundwater	Groundwater (quality)	Terrestrial flora and fauna (groundwater dependent ecosystems)	Unconfirmed
GW10	During operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting the ability of third party users to continue use of groundwater for their purposes	Loss of control of process liquors leads to seepage of radionuclides into the groundwater	Groundwater (quality)	Third party users	Unconfirmed
GW11	During operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting the ability of future users of the groundwater to use of groundwater for their purposes	Loss of control of process liquors leads to seepage of radionuclides into the groundwater	Groundwater (quality)	Future users	Unconfirmed

3.2 Modelled effects

3.2.1 Assessment methodology

The assessment of effects methodology is based on translating the outputs of the air quality modelling. Consideration of increments in the gamma radiation and groundwater levels are also considered.

i Project airborne radiological increments

The predominant exposure pathway is via the release of radionuclides into the air. To determine an exposure, the radiation assessment uses the outputs of air quality modelling, which was performed by EMM (EMM 2025). The output of the modelling provides the following data for each identified sensitive receptor location:

- annual average SRE Project generated Rn-222 in air concentrations (units of Bq/m^3)
- annual average SRE Project generated TSP in air concentrations (units of g/m^3)
- annual average SRE Project generated dust deposition rates (units of g/m^2.month).

As previously noted, the dust mass concentrations and dust deposition rates need to be converted to activity concentration and activity deposition rates taking into account the activity concentration of each of the long-lived radionuclides.

Table 3.2 and Table 3.3 provide the key radiological related outputs of the air quality modelling (EMM 2026). Note that the dust results need to be converted to radionuclide concentrations.

Table 3.2 Air quality modelling radon concentration outputs

Sensitive receptor	Annual average
	Radon concentration (Bq/m^3)
Andamooka	0.01
ODV	0.15
Roxby Downs	0.02

Table 3.3 Air quality modelling dust outputs

Sensitive receptor	Annual average dust concentration ($\mu g/m^3$)			Dust deposition rate ($g/m^2/y$)		
	Hygiene stack	Other stacks	Other sources	Hygiene stack	Other stacks	Other sources
Andamooka	0.01	0.01	0.01	0.001	0.001	0.013
ODV	0.02	0.03	0.79	0.009	0.007	0.919
Roxby Downs	0.01	0.01	0.05	0.004	0.002	0.059

3.2.2 Radionuclides in dust

As previously noted, the dust mass concentrations and dust deposition rates need to be converted to activity concentration and radionuclide deposition rates taking into account the activity concentration of each of the long-lived radionuclides.

Table 3.2 and Table 3.3 show the changes in radionuclide concentrations in air and dust deposition rates. Combining these values gives the changes in radionuclide concentrations as shown in Table 3.4 with the table showing the radionuclide composition of the dust based on the weighted average of the sources of the dusts and their respective radionuclide concentrations.

Table 3.4 Change in concentration in air

Sensitive receptor location	Incremental change in radionuclide concentrations in air (µBq/m^3)				
	U238/U234	Th230	Ra226	Pb210	Po210
Andamooka	0.1	0.1	0.3	10.5	11.0
ODV	1.3	1.0	4.7	27.0	34.2
Roxby Downs	0.1	0.1	0.5	10.8	11.6

For dust depositing into the environment, based on the weighted average radionuclide concentrations in the modelled dust emissions. Table 3.5 shows the change in soil radionuclide concentrations as a result of deposition of SRE Project dusts.

The calculated soil radionuclide increments are based on:

- a nominal 20 years of dust deposition
- a soil mixing depth of 10 mm (Kaste 2007)
- a soil density of 1.5g/cc.

Table 3.5 Change in soil concentrations

Sensitive receptor location	Incremental change in soil radionuclide concentrations due to deposition (mBq/g)				
	U-238/U-234	Th-230	Ra-226	Pb-210	Po-210
Andamooka	0.03	0.02	0.10	1.99	2.15
ODV	1.63	1.23	5.88	20.98	30.10
Roxby Downs	0.13	0.10	0.45	6.29	7.00

It is relevant to note that over time, the Po210 concentrations in soil will decay in proportion to its half-life an ingrowth from Pb210. This means that in the long term (a few years), the Po210 concentration in soil will come into equilibrium with the Pb210 concentration.

3.2.3 Project gamma radiological increments at receptor locations

Gamma radiation levels from the concentrate stockpile (as the main sources) have been modelled using the following assumptions:

- A copper concentrate containing 10 Bq/g (based on current Olympic Dam concentrate), will produce approximately 5.2 µSv/h at 1 m (based on 65 µSv/h per percent natural uranium in secular equilibrium at 1 m from an infinite plane (Thompson 1980).
- Assume a 100,000 tonne (t) stockpile of copper concentrate (based on a stock holding of 20 days), with density of 2 and dimensions of 500 m x 200 m x 5 m.

- The slag stockpile contains Ra226 conservatively estimated to be 30 Bq/g. This gives a gamma dose rate of approximately 15 µSv/h at 1 m (based on the fact that almost all gamma form the uranium decay chain is from Ra226 and, therefore, using the factor of 65 µSv/h per percent natural uranium in assumed secular is appropriate).
- The gamma radiation intensity reduces as the inverse of the distance (and the inverse square of the distance when the distance is greater than ten times the largest dimension of the source).

The gamma dose rates have been calculated for various distances from the stockpile. All sensitive receptors are beyond this distance, so these values represent a conservative assessment. The doserates have also been converted to an annual doserate, with exposure hours of 8,760.

The results are shown in Table 3.6 and indicate that offsite impacts of gamma radiation are negligible.

Table 3.6 Doserates from gamma radiation

Distance from stockpiles (m)	Gamma dose rate
5,000	< 5 nSv/h
10,000	< 1 pSv/h

3.2.4 Groundwater

While groundwater is a potential pathway for radionuclides, it is not considered to be credible due to the physical constraints. To occur, radionuclides must be mobilised into solution from solids and this predominantly occurs under acidic or caustic conditions (such as which occurs in the tailings systems). Under neutral conditions, mobilisation of radionuclides into solution is highly unlikely. In addition, for any radionuclide that do mobilise, there are no identified human or non-human biota pathways to exposure.

3.2.5 Dust generation during construction

Site investigation work has been conducted for the proposed location of the SRE Project and its components (EMM 2026). The work has indicated that in some areas where slag from existing operations had been stored and processed (via colling and crushing) there was a layer of material contaminated with slag.

It is planned that this material be reclaimed for later processing or appropriately disposed using the existing on-site disposal pathways. The site preparation works and contaminated materials reclamation would be undertaken in accordance with existing site earthworks procedures which require dust controls.

Based on this approach, emission of slag contaminated soil dust is not expected to be significant.

3.3 Dose assessment

This section describes the radiation impact dose assessment methods.

3.3.1 Assessment methodology

The radiation assessment quantifies the impacts of radiation from the radiological emissions from the SRE Project. For people, the radiological impact is determined as a potential radiation dose. For non-human biota, an absorbed dose rate is calculated, and this provides a measure of the relative radiological risk. In both cases, the incremental impacts, above natural background radiation levels, are determined and assessed and compared to relevant standards and limits.

Potential doses to the public are calculated for members of the public at the sensitive receptor locations (i.e. ODV, Roxby Downs and Andamooka), assuming full time occupancy. It is usual to use the same locations to assess non-human biota; however, any location can be selected. For this risk assessment, human and non-human biota assessments were conducted at the same locations.

The assessment methods are based on internationally recognised standards (ICRP 2006, ARPANSA 2011, IAEA 2014, ARPANSA 2010).

i Human radiation exposure pathways and assessment method

For this RIA, the SPR model is applicable for a number of potential exposure pathways.

An exposure pathway describes the mechanism by which a person may be exposed to radiation. The dose assessment methodology provides a standardised way of determining impact from the different radiation types and different exposure pathways as shown in Table 3.7.

Table 3.7 Exposure pathways and assessment

Exposure pathway	Assessment methodology
Irradiation by gamma radiation	• Calculate project originated incremental gamma radiation levels at receptor. • Determine exposure hours. • Multiple levels by hours to calculate dose.
Inhalation of radionuclides in dust	• Calculate project originated incremental dust in air concentrations at receptor. • Convert to incremental radionuclide concentrations. • Determine exposure hours. • Multiply radionuclide concentrations by exposure hours and breathing rate to calculate exposure. • Convert exposure to dose using the dose coefficients.
Ingestion of radionuclides in foods	• Calculate project originated incremental radionuclide in media concentrations at receptor. • Calculate flora and fauna radionuclide uptakes using the concentration ratios. • Determine consumption rates. • Calculate the intake of radionuclides. • Convert uptake to dose using recognised dose coefficients.

The assessment method for each exposure pathway results in a dose from that pathway which are summed to give a total dose for comparison against dose limits and constraints.

ii Non-Human Biota (NHB) radiation exposure pathways and assessment method

The method for assessing the radiological impact of the SRE Project on non-human biota is undertaken using an internationally and Australian accepted approach together with a software package called ERICA (ERICA, ARPANSA 2010).

The ERICA software uses changes in soil radionuclide concentrations, and concentration ratios, to provide a dose rate for a list of reference species. The dose rates are then compared to screening levels, which are the levels below which no effects would be observed on a species. The reference terrestrial species are amphibian, annelid, arthropod (detritivorous), bird, flying insects, grasses and herbs, lichen and bryophytes, mammal (large), mammal (small burrowing), mollusc (gastropod), reptile, shrub and tree. For this assessment, the user defined kangaroo species has been added to the assessment.

iii Members of the public at receptor locations

The radiological impacts to the public are assessed by calculating the potential total effective dose from all the exposure pathways. The calculated dose is then compared to the accepted dose limit of 1 mSv/y and dose constraint of 0.3 mSv/y.

3.3.2 Inhalation of dust

The calculation of the dose from the inhalation of radionuclides in dust involved calculating the inhalation intake for each radionuclide and multiplying by the standard dose factor for the radionuclide (Table 3.8). The intake is determined by multiplying the annual average radionuclide concentration in air by a breathing rate (1 m^{3}/h) multiplied by exposure hours (assumed to be a full year of 8,760 hours).

Note that the most recent ICRP public dose factors are in draft form, so for this assessment, worker dose factors have been used and a particle size of 1 µm has been used.

Table 3.8 ICRP dose factors (ICRP 137)

Radionuclide	Dose factors (µSv/Bq)
U-238	20
U-234	23
Th-230	34
Ra-226	23
Pb-210	15
Po-210	2.8

The estimated doses can be seen in Table 3.9.

Table 3.9 Dose estimates from the inhalation of radionuclides in dust

Receptor	Dust concentration (µSv/y)						Dust inhalation dose (mSv/y)
	U238	U234	Th230	Ra226	Pb210	Po210	
Andamooka	0.02	0.02	0.02	0.07	1.38	0.27	0.002
ODV	0.23	0.26	0.29	0.94	3.54	0.84	0.006
Roxby Downs	0.03	0.03	0.03	0.11	1.42	0.28	0.002

3.3.3 Inhalation of radon decay products

Dose due to the inhalation of radon decay products (RnDP) (shown in Table 3.10) were calculated for the three receptor locations based on the following assumptions:

- Determine annual average radon concentration from air quality modelling.
- Apply a dose factor (9 nSv/Bq.h/m^{3}).
- Apply a breathing rate of 1 m^{3}/h and exposure hours of 8,760 hours per year.

Table 3.10 Dose for the inhalation of radon decay products

Receptor	Change in Rn concentration (Bq/m^3)	RnDP dose (mSv/y)
Andamooka	0.01	0.001
ODV	0.15	0.012
Roxby Downs	0.03	0.002

3.3.4 Ingestion of food

The radiological assessment assumes a standard Australian diet (ARPANSA 2019) and that a proportion of the ingested food, (excluding meat, milk and fish), is grown at the sensitive receptor location, where SRE Project dust has deposited and has been taken up into plants. The calculations are based on the soil radionuclide increment after 20 years of dust deposition.

Due to the short half-life of Po210 (approximately four months), simple accumulation for 20 years is inappropriate. The Po210 will be decaying, and the concentration cannot be less than the Pb210 concentration due to its ingrowth. Therefore, for this assessment, the Po210 long term concentrations have been set to the Pb210 values for the ingestion dose assessment.

The food uptake factors are based on IAEA transfer factors [IAEA 2010]. The diet assumptions are as follows:

- Andamooka – 25% of the diet
- ODV – 10% of the diet
- Roxby Downs – 25% of the diet

The ingestion dose factors are from ICRP Publication 72 (ICRP 1996-72) and doses are calculated for four age groups due to differences in dietary intake and dose coefficients and are shown in Table 3.11. Note that the ICRP is reviewing ingestion dose factors.

Table 3.11 Doses from ingestion of food

Receptor	Food ingestion dose (mSv/y)			
	1 year	5 years	10–15 years	Adult
Andamooka	0.002	0.002	0.002	0.001
ODV	0.013	0.014	0.017	0.006
Roxby Downs	0.006	0.006	0.006	0.003

3.3.5 Total estimated dose

The summary of radiological impact to humans at each sensitive receptor location for all exposure pathways is shown in Table 3.12. The results are for the SRE project, without natural background, or impacts from other activities.

Table 3.12 Conservative annual total dose at receptors

Receptor	Total dose estimate (mSv/y)			
	1 year	5 years	10–15 years	Adult
Andamooka	0.004	0.004	0.004	0.003
ODV	0.039	0.040	0.044	0.033
Roxby Downs	0.010	0.010	0.010	0.006
Dose constraint	**0.3**	**0.3**	**0.3**	**0.3**
Dose limit	**1.0**	**1.0**	**1.0**	**1.0**

The conservative estimates of total doses to humans at the receptors, due to the SRE Project, are below the recognised public dose limit of 1 mSv/y.

3.3.6 Flora and fauna

i Impact

The radiological impact to flora and fauna due to the SRE Project was conservatively assessed based on the soil radionuclide increment at the conclusion of the SRE Project (after 20 years of dust deposition, with the Po210 in equilibrium with Pb210 concentration) which was greatest at ODV. The ERICA Tool Tier 2 assessment level was conducted, and the output of the assessment are listed in Table 3.13. Note that the full assessment can be seen in Appendix C.1.

Table 3.13 Outputs of ERICA Tool Tier 2 assessment for flora and fauna

Reference species	Dose rate (µGy/h)
Amphibian	0.23
Annelid	0.37
Arthropod – detritivorous	0.47
Bird	0.06
Flying insects	0.10
Grasses and Herbs	0.36
Lichen and Bryophytes	3.01
Mammal – large	0.14
Mammal – small-burrowing	0.14
Mollusc – gastropod	0.07
Shrub	0.61
Tree	0.06
Kangaroo	0.93
Australian Reptile	6.93

The screening level (which is the absorbed dose rate above which additional assessment is required) for additional or more detailed assessment is conservatively set at 10 µGy/h (ARPANSA 2015). The potential impact to all reference species is below the screening level.

ii Flora and fauna summary

The assessment of potential radiological impact to flora and fauna indicate that no additional controls are justified due to the very low potential impacts. The standard dust controls that all mining and processing operations generally employ would act to control potential impacts.

3.3.7 Worker Doses

For workers, doses were estimated based on the doses currently received by operational smelter and refinery workers. This was because the work categories and tasks being done in the SRE Project will be practically identical to the work being done in the existing Olympic Dam operations. It was also expected that the same operational controls would be implemented. An overview is provided in Annexure B.

3.4 Conclusion

Following completion of the assessment of effects investigation it was determined that there were no SPR linkages for the following potential impact events (Table 3.14):

- project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to:
  - the local community, impacting health and safety
  - flora and vegetation impacting diversity
  - fauna and habitat impacting diversity
  - State and Commonwealth listed threatened species.
- during operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting:
  - abundance and diversity of groundwater dependent ecosystems
  - the ability of third-party and future users to continue use of groundwater for their purposes.

For the former potential community, flora and fauna events (i.e. A23 to A27) these were further assessed to quantify the likely significance of the impact against the Environmental Impact Assessment Framework (EIAF) impact significance criteria, with all impacts determined to be not significant (Chapter 4).

Table 3.14 Final SPR assessment – confirmed impact events

Impact ID	Potential impact event	Receptor	Linkage
A23	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to the local community, impacting health and safety.	Local community (health and safety)	No – whilst emissions from the SRE Project will occur the total doses to humans at the receptors, are below the recognised public dose limit of 1 mSv/y (Section 4.4).
A24	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to the local community, impacting amenity.	Local community (amenity)	No – gamma radiation beyond a few kilometres is not discernible from existing background levels.
A25	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to flora and vegetation impacting diversity.	Ecology (flora and vegetation)	No – whilst emissions from the SRE Project will occur the radiological impact for flora is below the recognised ERICA Tool screening level of 10 µGy/h (Section 4.4). Refer Ecological Impact Assessment.
A26	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to fauna and habitat impacting diversity.	Ecology (fauna and habitat)	No – whilst emissions from the SRE Project will occur the radiological impact for fauna is below the recognised ERICA Tool screening level of 10 µGy/h (Section 4.4). Refer Ecological Impact Assessment.
A27	Project-related operational activities release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to State and Commonwealth listed threatened species.	Ecology (state and Commonwealth threatened species)	No – whilst emissions from the SRE Project will occur the radiological impact for flora and fauna is below the recognised ERICA Tool screening level of 10 µGy/h (Section 4.4). Refer Ecological Impact Assessment.
GW9	During operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting abundance and diversity of groundwater dependent ecosystems.	Terrestrial flora and fauna (groundwater dependent ecosystems)	No – while groundwater is a potential pathway for radionuclides, it is not considered to be credible due to the physical constraints. To occur, radionuclides must solubilise from solids, and this predominantly occurs under acidic or caustic conditions (such as which occurs in the tailings systems). Under neutral conditions, mobilisation of radionuclides into solution is highly unlikely. In addition, for any radionuclide that do mobilise, there are no identified non-human biota pathway to exposure.

Impact ID	Potential impact event	Receptor	Linkage
GW10	During operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting the ability of third-party users to continue use of groundwater for their purposes.	Third party users	No – while groundwater is a potential pathway for radionuclides, it is not considered to be credible due to the physical constraints. To occur, radionuclides must solubilise from solids, and this predominantly occurs under acidic or caustic conditions (such as which occurs in the tailings systems). Under neutral conditions, mobilisation of radionuclides into solution is highly unlikely. In addition, for any radionuclide that do mobilise, there are no identified human pathway to exposure.
GW11	During operations, loss of control of process liquors leads to seepage of radionuclides into the groundwater, increasing concentrations in the natural groundwater impacting the ability of future users of the groundwater to use of groundwater for their purposes.	Future users	No - while groundwater is a potential pathway for radionuclides, it is not considered to be credible due to the physical constraints. To occur, radionuclides must solubilise from solids, and this predominantly occurs under acidic or caustic conditions (such as which occurs in the tailings systems). Under neutral conditions, mobilisation of radionuclides into solution is highly unlikely. In addition, for any radionuclide that do mobilise, there are no identified human pathway to exposure.

4 Impact assessment

4.1 Impact assessment methodology

The impact significance of confirmed impact events associated with the proposed SRE Project activities is described in this section.

The significance of the identified impacts to people is assessed by converting the radiation effects into potential radiation doses. For non-human biota, an absorbed dose rate is calculated, and this provides a measure of the relative radiological risk. In both cases, the incremental impacts, above natural background radiation levels, are determined and assessed and compared to relevant standards and limits.

Potential human doses are calculated for members of the public at the sensitive receptor locations, assuming full time occupancy. It is usual to use the same locations to assess non-human biota; however, any location can be selected. For this impact assessment, human and non-human biota assessments were conducted at the same locations.

The human impact assessment methods are based on internationally recognised standards (ICRP 2006, ARPANSA 2011, IAEA 2014). The assessment considers the exposure pathway which describe the mechanism by which a person may be exposed to radiation. The dose assessment methodology provides a standardised way of determining impact from the different radiation types and different exposure pathways. The assessment method for each exposure pathway results in a dose from that pathway which are summed to give a total dose for comparison against dose limits and constraints.

The method for assessing the radiological impact of the SRE Project on non-human biota is undertaken using an internationally and Australian accepted approach together with a software package called ERICA (ERICA, ARPANSA 2010). The ERICA software uses changes in soil radionuclide concentrations, and concentration ratios, to provide a dose rate for a list of reference species. The dose rates are then compared to screening levels, which are the levels below which no effects would be observed on a species. The reference terrestrial species are amphibian, annelid, arthropod (detritivorous), bird, flying insects, grasses and herbs, lichen and bryophytes, mammal (large), mammal (small burrowing), mollusc (gastropod), reptile, shrub and tree. For this assessment, the user defined kangaroo species and Australian reptiles have been added to the assessment.

4.2 Confirmed impact events

The confirmed impact events are shown in Table 4.2 and summarised as:

- emission of dust leading to exposure of flora and fauna to radionuclides
- emission of dust and radon leading to exposure to people outside of the operational area
- volatilised radionuclide emissions from stacks leading to exposure to flora and fauna
- volatilised radionuclide emissions from stacks leading to exposure to people outside the operational area.

4.3 Impact significance criteria

The impact significance criteria are presented in the EIAF appendix to the EIS. Criteria relevant to the assessment of the radiation-related impact significance is repeated in Table 4.1.

Table 4.1 Consequence definitions and significance determination

Severity level	1	2	3	4	5
Significance	**Not Significant**		**Significant**		
Air pathway					
Radiation (human health)	Public radiation doses less than 0.3 mSv/y.	Public radiation doses greater than 0.3 mSv/y but less than 1 mSv/y.	Public radiation doses averaging greater than 1 mSv/y but less than 5 mSv over a five-year period.	Public radiation doses greater than 5 mSv over a five-year period.	Public radiation doses greater than 20 mSv/year in any year.
Land pathway					
Radiological impacts to non-human biota (terrestrial and aquatic species, vegetation and habitat, threatened and listed species).	Dose rate assessed to be less than natural background or less than the ERICA screening level (10 µGy/y).	Dose rate assessed to be greater than the ERICA screening level (10 µGy/y) but less than 40 µGy/h (level of potential effects on biota reproductive success).	Dose rate assessed to be greater than 40 µGy/h (level of potential effects on biota reproductive success) but less than 400 µGy/h (level of potential effects on biota populations).	Dose rate assessed to exceed 400 µGy/h (level of potential effects on biota populations).	Demonstrated radiological impacts to non-human biota outside the RL boundary.

4.4 Assessment of impact significance

The impact significance associated with the proposed SRE Project activities is described below and summarised in Table 4.2.

Table 4.2 Radiological impact assessment

Impact ID	Confirmed impact event	Impact significance	Significance justification	Uncertainty
A23	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to the local community, impacting health and safety.	Level 1 – not significant	The dose assessment indicates that radiological impacts will be low and below the recognised public dose limit of 1 mSv/y and dose constraint of 0.3 mSv/y. In accordance with the ICRP (ICRP 2007-103) and the IAEA (IAEA 2014) statement that controls are to be commensurate with the magnitude of the impact, no additional controls for the purposes of radiation protection are considered necessary, other than standard controls. The ongoing monitoring would aim to confirm the conclusions. If measured impact is above specified action levels, as outlined in the RMP, mitigation measures will be implemented.	Low – Baseline and existing operational monitoring results verify previous modelling outputs which provides high degree of confidence on impact assessment. Ongoing monitoring to confirm assessment conclusions.

Impact ID	Confirmed impact event	Impact significance	Significance justification	Uncertainty
A24	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to the local community, impacting amenity.	Level 1 – not significant	The dose assessment indicates that radiological impacts will be low and below the recognised public dose limit of 1 mSv/y and dose constraint of 0.3 mSv/y. In accordance with the ICRP (ICRP 2007-103) and the IAEA (IAEA 2014) statement that controls are to be commensurate with the magnitude of the impact, no additional controls for the purposes of radiation protection are considered necessary, other than standard controls. The ongoing monitoring would aim to confirm the conclusions. If measured impact is above specified action levels, as outlined in the RMP, mitigation measures will be implemented.	Low – Baseline and existing operational monitoring results verify previous modelling outputs which provides high degree of confidence on impact assessment. Ongoing monitoring to confirm assessment conclusions.
A25, A26, A27	Project-related operational activities (e.g. from stacks or material handling activities) release emissions of radon and/or radionuclide bearing materials that result in radiation exposure to flora and fauna impacting diversity.	Level 2 – not significant	The assessment of potential radiological impact to flora and fauna is low with no additional controls are justified due to the very low potential impacts. The standard dust controls that all mining and processing operations generally employ would act to control potential impacts.	Low – Ecological surveys spanning several seasons have been undertaken to determine the presence of threatened flora and fauna. Standard dust controls that all mining and processing operations generally employ would act to control potential impacts. Refer Ecological Impact Assessment.

4.5 Management and mitigation

Each confirmed impact event is required to have a description of proposed management and mitigation measures applied, aimed at either breaking the SPR linkage (i.e. avoiding the impact) or otherwise reducing the impact significance to ALARA. These are presented in the following sections.

4.5.1 Impact Significance Level 1 and 2 (not significant)

The list of potential mitigation and management measures that may be applied to reduce the significance of radiological impacts are presented in Section 4.5.3.

4.5.2 Impact Significance Level 3, 4 and 5 (significant)

There were no confirmed radiation-related impact events assessed as having the potential for a significant impact.

4.5.3 Management controls

BHP has an existing and well-established radiation management plan (RMP) (BHP 2021) as part of its overall system of management at Olympic Dam. For the SRE Project, the existing RMP would be updated and expanded to accommodate the SRE Project, as required.

BHP also has an established radioactive waste management plan (RWMP) which lies within the existing environmental management system. The RWMP would be updated to accommodate the SRE Project components.

The controls for radiation for the SRE Project are expected to be identical to, or similar to BAU controls at Olympic Dam.

BHP undertakes a hazard and risk assessment as part of its project development, going through a series of design-phase reviews to ensure that all occupational health, safety and environmental risks are adequately managed in project design. Radiation aspects are an integral part of this assessment and review process.

The system of control for radiation is multilayered, with a focus on controlling exposures and released through good design and complemented with formal management processes. Regular review of the adequacy and effectiveness of the radiation management system ensures that the controls remain relevant and fit for purpose, with a focus on maintaining doses as low as is reasonably achievable (the ALARA principle).

The specific controls for the SRE Project would be outlined in the operational RMP. New controls will be included in the revised RMP as new components come on-line with a list of potential mitigation and management measures that may be applied to reduce the significance of radiological impacts presented below.

i Design controls

In terms of design controls, standard criteria are in place and would apply to all SRE related work, including:

- all tanks containing radioactive process slurries bunded to collect and contain spillages and for ease of clean up
- adequate access and egress for ease of clean up
- wash-down water points and hoses supplied for spillage clean up
- secure compounds
- appropriate ventilation
- consideration of control of process stream recirculation, to ensure that recirculating loads do not act to concentrate radionuclides
- use of dedicated extraction systems in appropriate areas
- tailings pipeline corridor bunded to control spillage in the event of pipeline failures
- management of stormwater to ensure adequate containment of all run-off water.

ii Management controls

Complementing the design controls and management and administrative controls and these include:

- job safety analyses and safe work procedures
- risk assessment
- defining restricted access areas
- monitoring to determine effectiveness of controls and for dose assessment
- worker education and training.

iii Monitoring

An environmental and occupational radiation monitoring program would be implemented to:

- assess doses to the public at the sensitive receptors
- assess any impacts to flora and fauna at the sensitive receptors
- assess worker doses
- ensure effectiveness of radiation controls, including the underground ventilation controls.

iv Waste management

Development of the SRE Project would require decommissioning of existing processing plant components including dryers, the EAF and the existing concentrate storage and transfer system.

It is proposed that the EAF would remain in-situ to be closed as a component of the greater Olympic Dam closure activities due to the significant complexity of working within the existing operational smelter infrastructure. However, other decommissioned processing plant components would, wherever practicable, be removed and disposed of.

Waste generated during construction would be managed as follows:

- Where practicable, demolition materials would be removed from site and recycled.
- Materials not suitable for removal from site would be managed on the SML via existing waste management facilities.

Operational wastes associated with the SRE Project consist of processing and non-processing wastes where:

- processing wastes are limited to low-copper slags generated from the smelting and slag concentrator operations that are not suitable for reprocessing and effluent streams from various process operations that are directed to tailings, including from the PMR and smelter off-gas systems
- non-processing wastes including reagent packaging wastes and operational consumables.

All waste generated from the SRE Project would be managed in accordance with existing site procedures and approved management plans.

From a radiation perspective, the Olympic Dam site maintains a resource recovery centre where all site waste is processed, with a focus on maximising recycling. This involves cleaning of waste, radiometric assessment and then categorisation. The categories of waste material materials are assigned a disposal or recycling pathway from disposal into the contaminated waste area through to unconstrained off-site recycling.

It is expected that this process will apply for the SRE Project.

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Abbreviations and acronyms

Acronym	Expansion
ALARA	As Low As Reasonably Achievable (social and economic factors taken into account)
BAU	Business-as-usual
BHP	BHP Olympic Dam Corporation Pty Ltd
Copper SA	Copper South Australia
DBF	Direct-to-blister flash furnace
DIT	Department for Infrastructure and Transport
EIAF	Environmental Impact Assessment Framework
EIS	Environment Impact Statement
EPA	Environment Protection Authority
FCF	Flash converting furnace
FIFO	Fly-in/fly-out
FSF	Flash smelting furnace
NWP	Northern Water Project
ODV	Olympic Dam Village
PDI Act	Planning, Development and Infrastructure Act 2017 (South Australia)
PMR	Precious metal refinery
RMP	Radiation Management Plan
RWMP	Radioactive Waste Management Plan
RDP	Radon decay products
SA	South Australia
SCM27	Scheduled Campaign Maintenance 2027
SML	Special Mining Lease
SPC	State Planning Commission
SPR	Source-pathway-receptor
SRE	Smelter and Refinery Expansion
TSF	Tailings storage facility
TSP	Total suspended particulate

Units of measure/Isotopes

Unit	Description	Isotopes	Description
Bq/g	becquerels per gram	Pb-210	Plumbum-210
Bq/l	becquerels per litre	Po-210	Polonium-210
Bq/m3	becquerels per cubic meter	Ra-226	Radium-226
Bq/m2/y	becquerels per meter squared per year	Rn-222	Radon-222
m3/h	cubic metres per hour	Th-230	Thorium-230
g/m2/y	grams per metre squared per year	Th-232	Thorium-232
µBq/m3	microbecquerels per cubic meter	U-235	Uranium-235
mBq/m2 month	millibecquerel per square meter per month	U-238	Uranium-238
µJ/m3	microjoules per cubic meter	U-234	Uranium-234
µGy/h	micrograys per hour		
mBq/g	millibecquerels per gram		
µg/m3	micrograms per cubic metre		
mSv/y	millisieverts per year		
Mtpa	million tonnes per annum		
mSv/y	millisieverts per year		
µSv/Bq	microsievert per becquerel		
mg/m3 -	milligram per cubic metre		
nSv/h	nanoSieverts per hour		
pSv/h	PicoSieverts per hour		

Appendix A

Baseline data graphical representation

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A.1 Radon graphs

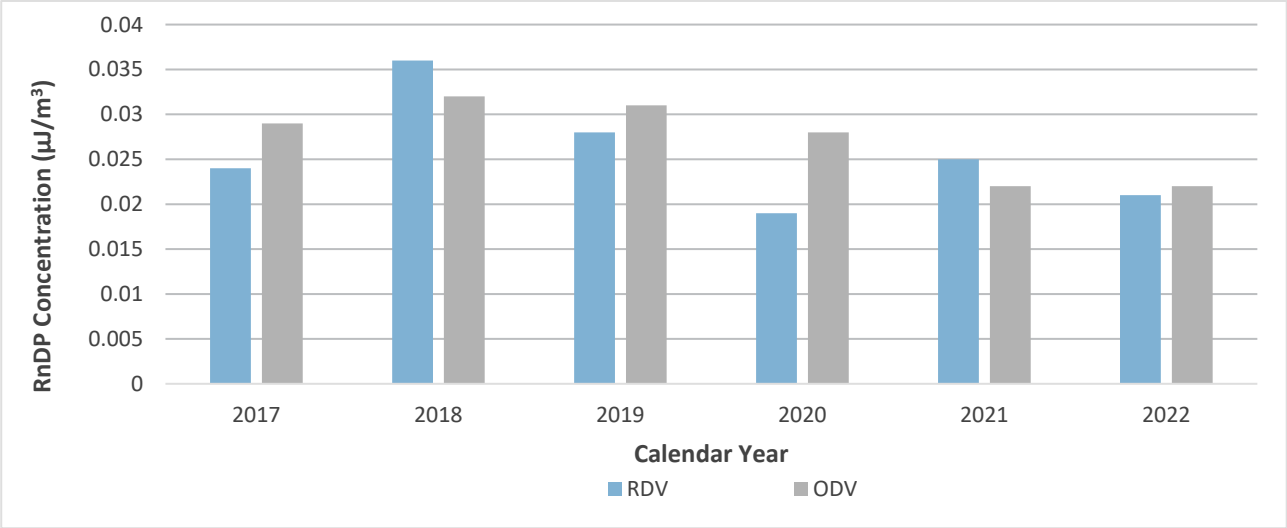


Figure A.1 Annual Average Radon Decay Product in Air Concentrations (µBq/m³)

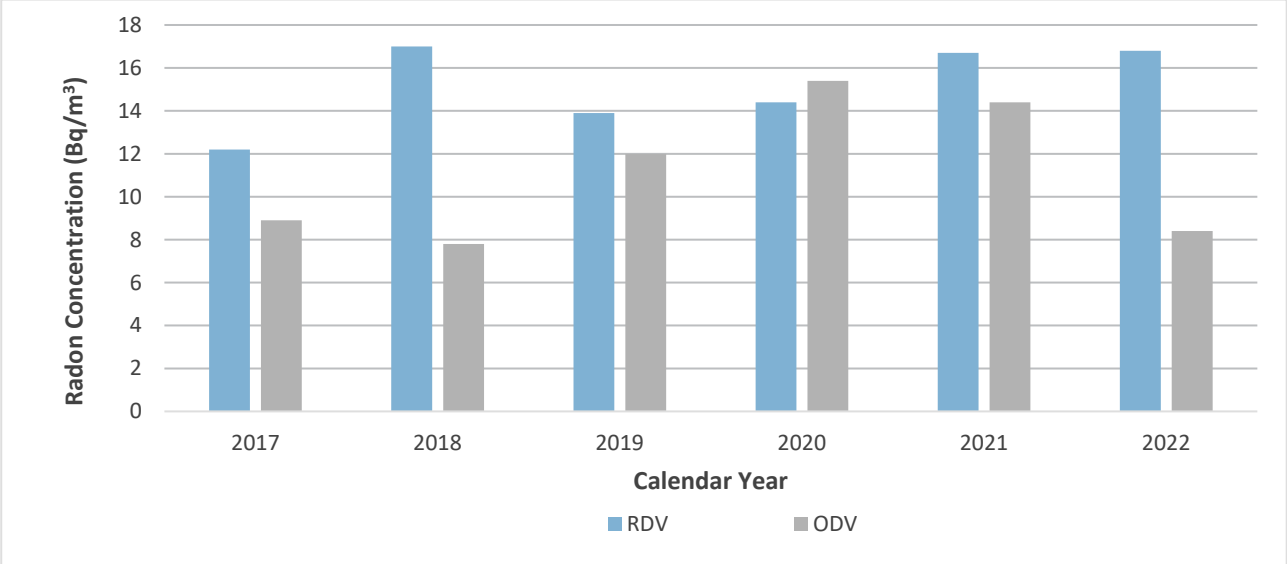


Figure A.2 Annual Average Radon in Air Concentrations (Bq/m³)

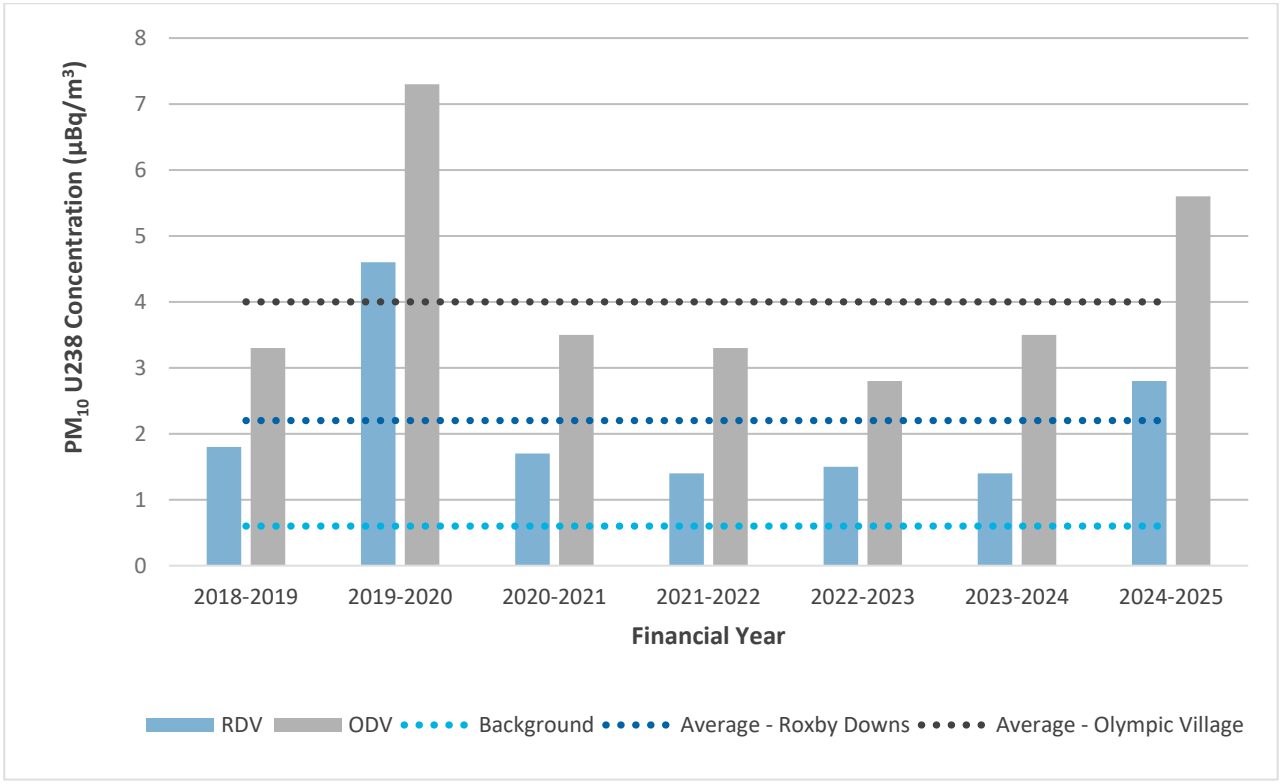


Figure A.3 **Annual Average PM_{10} U_{238} Concentration in Air (µBq/m³)**

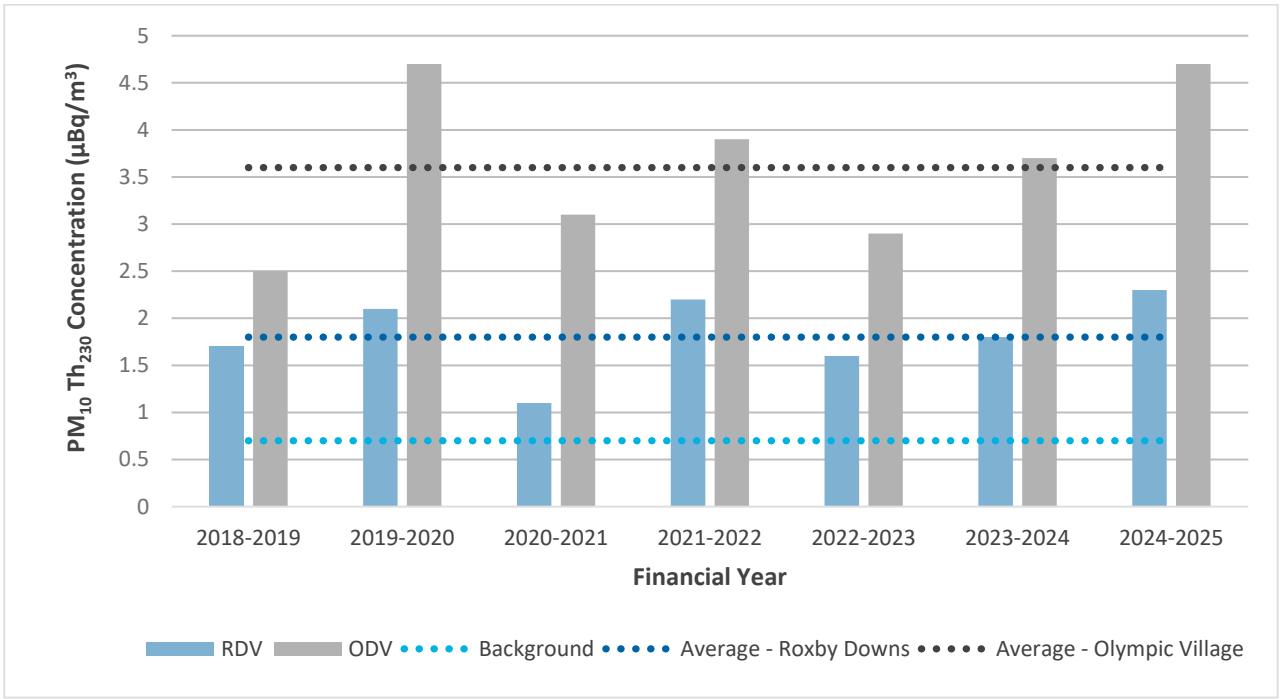


Figure A.4 **Annual Average PM_{10} Th_{230} Concentration in Air (µBq/m³)**

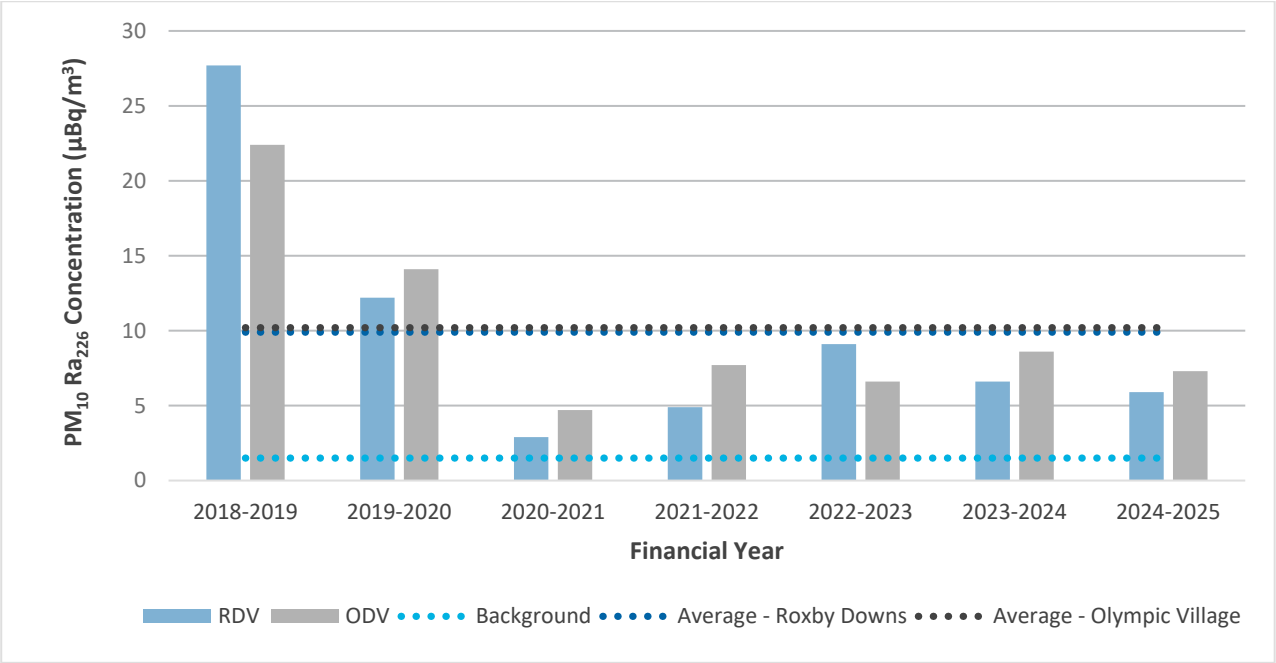


Figure A.5 **Annual Average PM_{10} Ra_{226} Concentration in Air (µBq/m³)**

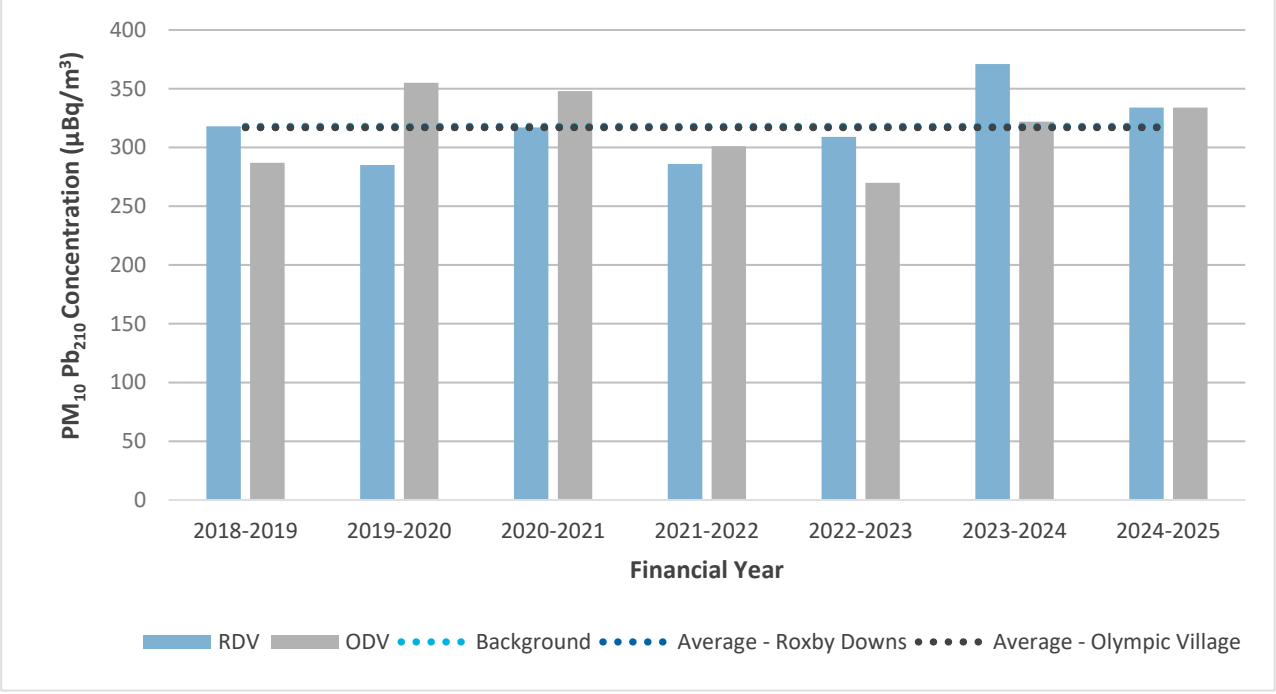


Figure A.6 **Annual Average PM_{10} Pb_{210} Concentration in Air (µBq/m³)**

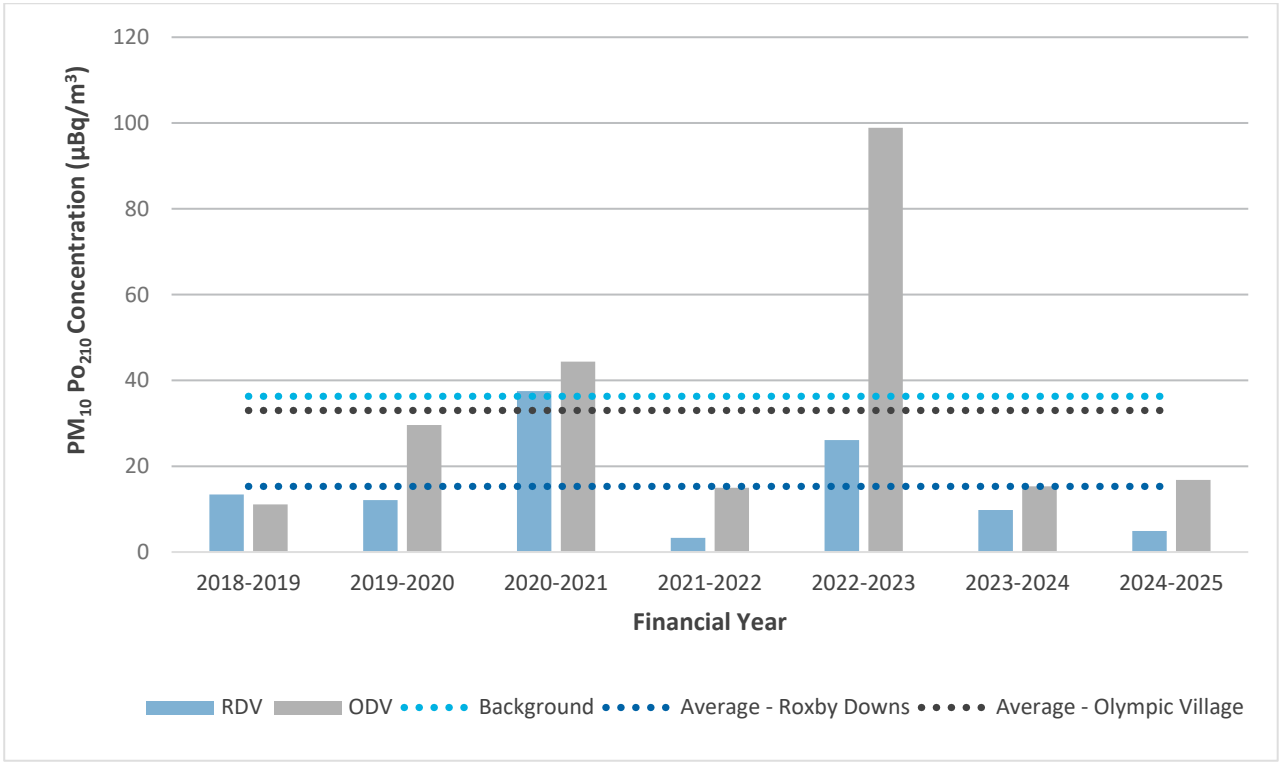


Figure A.7 **Annual Average PM_{10} Po_{210} Concentration in Air(µBq/m^3)**

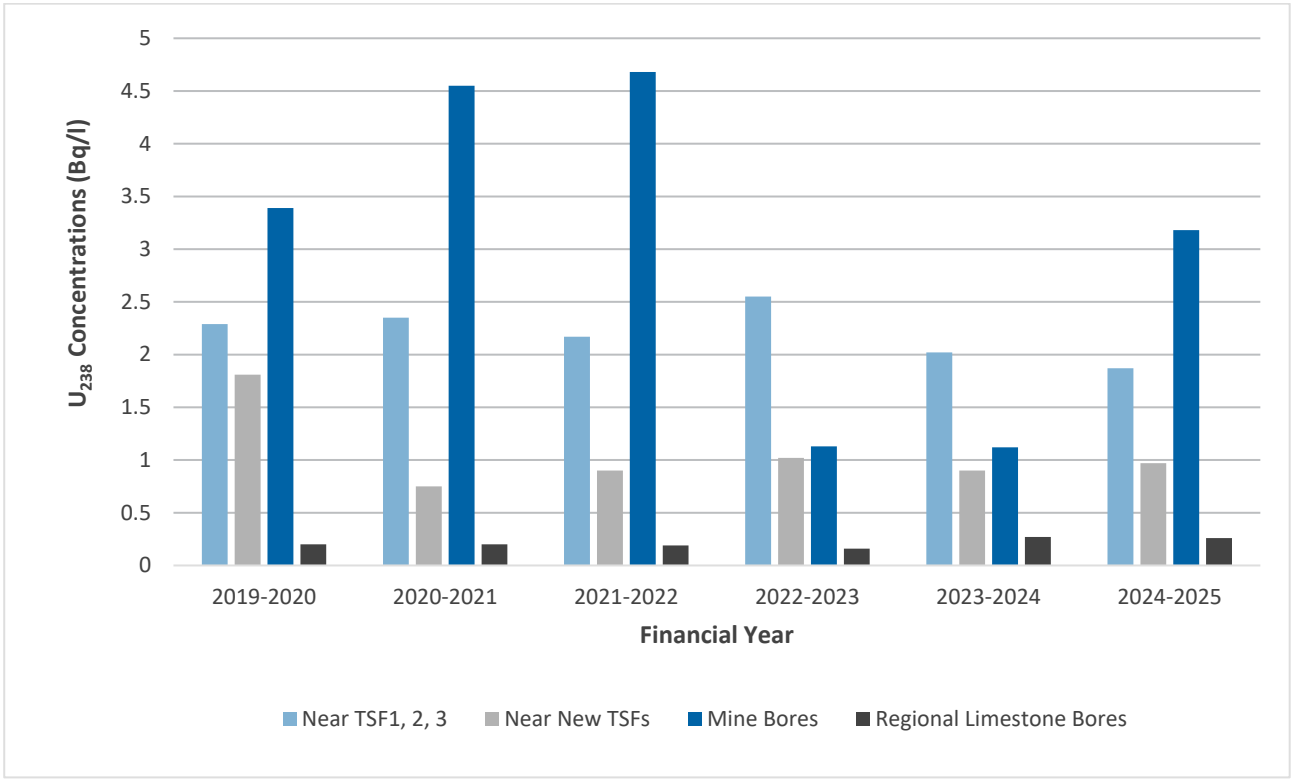


Figure A.8 **Annual Average Groundwater U_{238} Concentrations (Bq/l)**

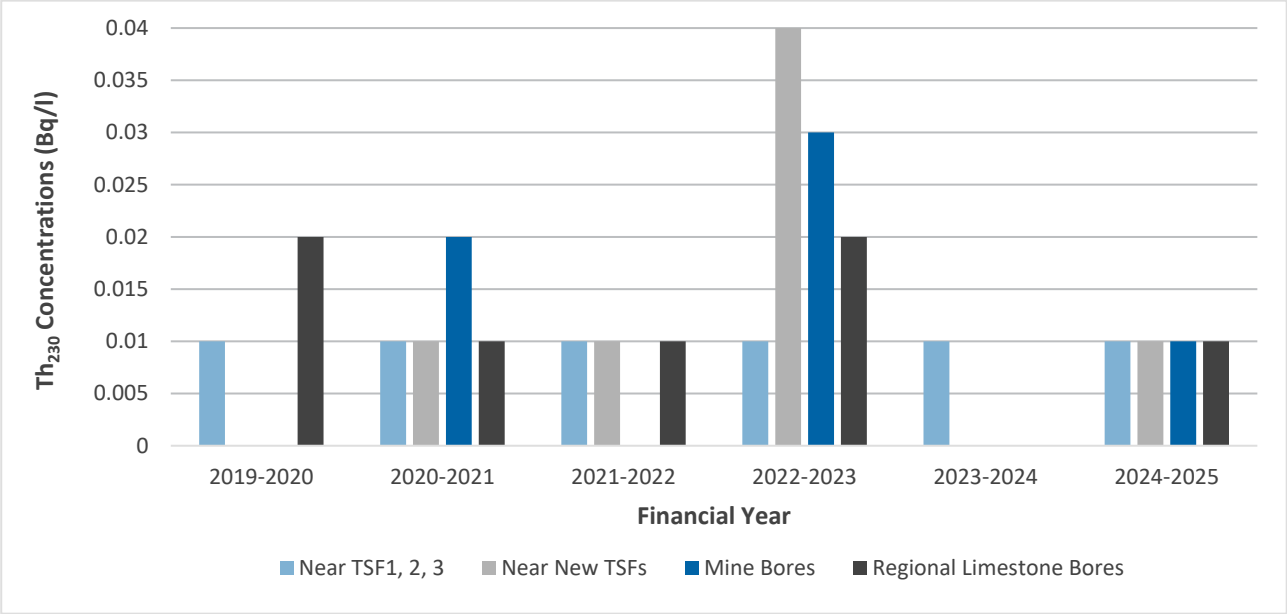


Figure A.9 Annual Average Groundwater Th_{230} Concentrations (Bq/l)

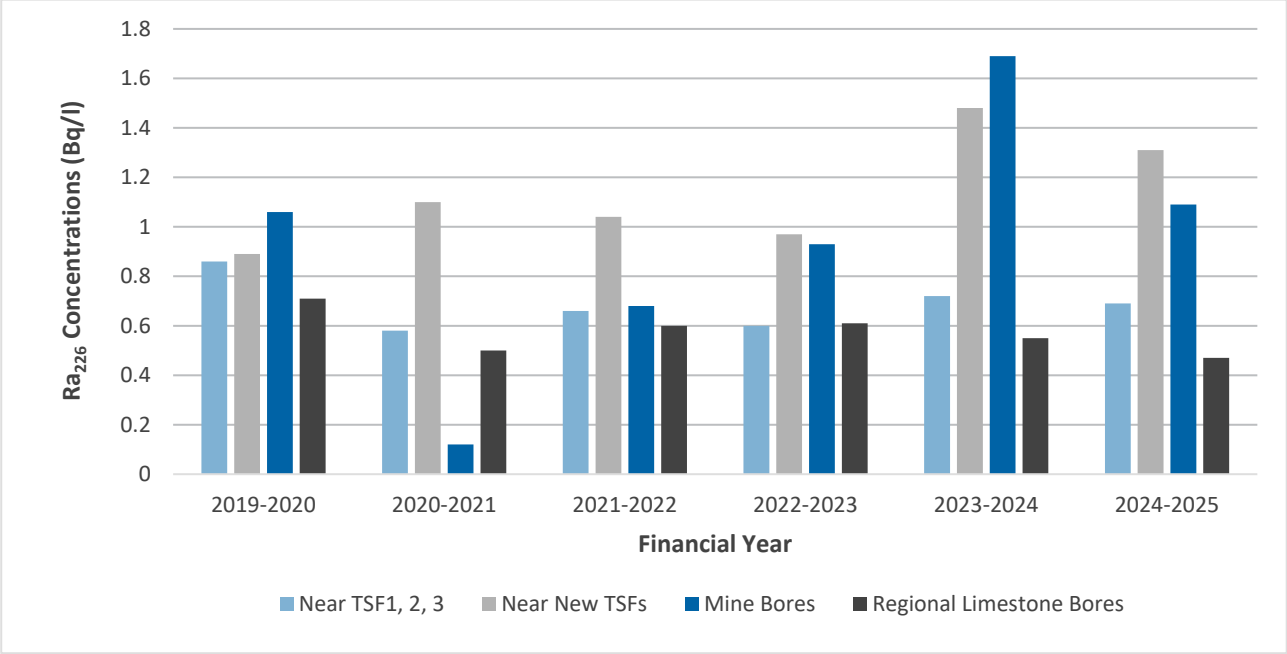


Figure A.10 Annual Average Groundwater Ra_{226} Concentrations (Bq/l)

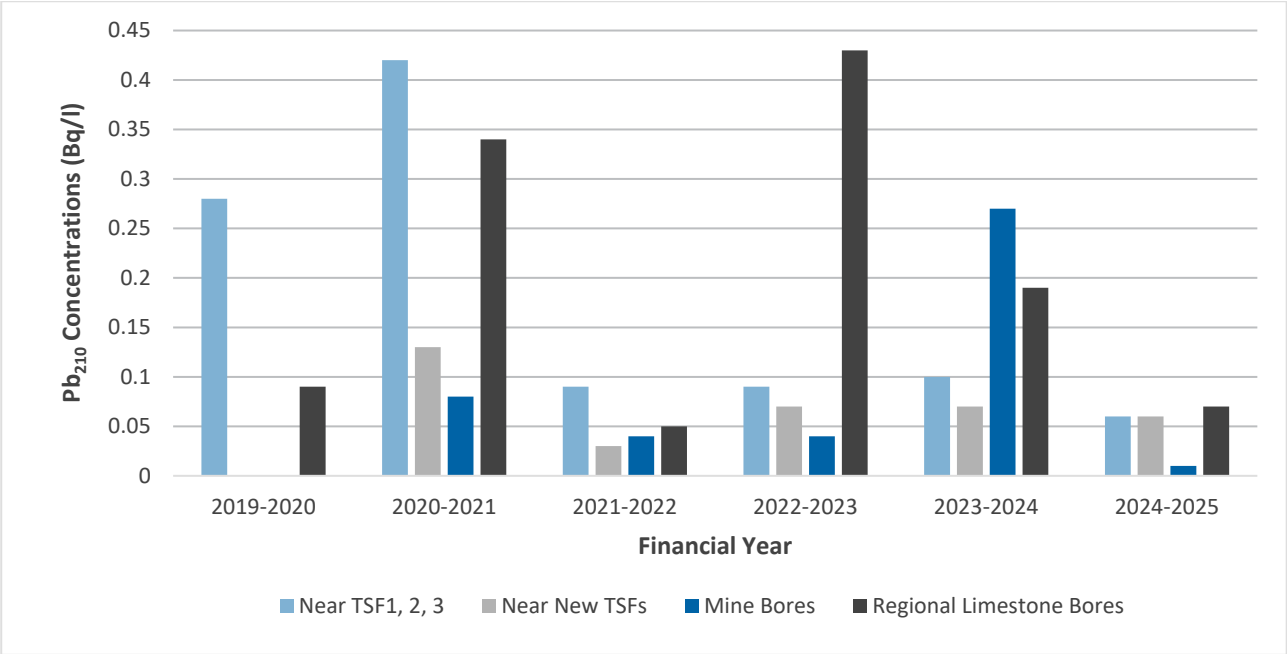


Figure A.11 Annual Average Groundwater Pb_{210} Concentrations (Bq/l)

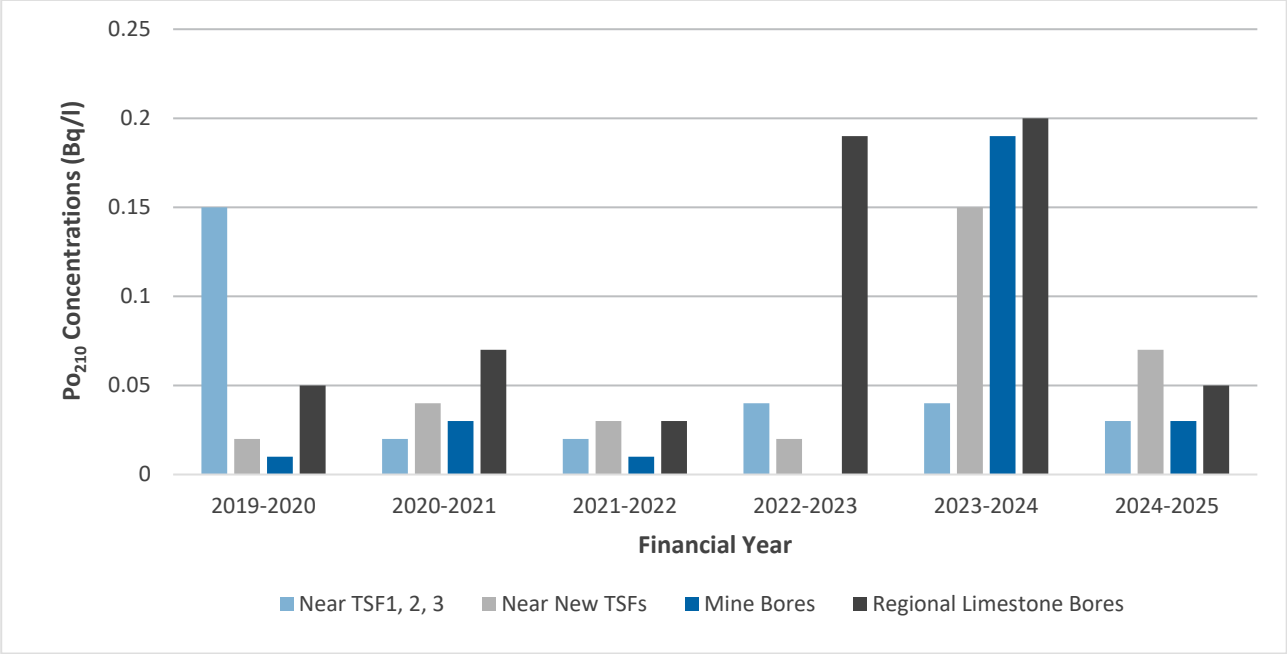


Figure A.12 Annual Average Groundwater Po_{210} Concentrations (Bq/l)

Appendix B

Worker dose assessment

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The relative radiological risk for each main process stream in the two-stage smelting was determined by considering the modelled radionuclide activity concentration and converting to a dose per unit inhalation intake. The radiological risk from the BAU streams was determined from the measured radionuclide concentrations (ANSTO 2008).

The dose per unit intake was calculated by taking each radionuclide concentration, as modelled for the two-stage smelt or measured for the BAU processes, and applying the relevant ICRP dose factors, then summing for all the radionuclides in a particular process stream. This provides a value for each stream in units of inhalation dose (in Sieverts) per gram. The value is then multiplied by the assumed breathing rate of 1.2 m^3/h and expected annual working hours (2,000 h/y) and an assumed long-term dust in air concentration, which for this assessment is assumed to be 1 mg/m^3.

It is important to note that this is a high level semi-qualitative assessment of the potential radiological impacts because, the design details are yet to be finalised. However, it is reasonable to assume that the design controls, such as extraction ventilation and containment, and administrative controls will provide a similar or improved level of protection as that which exist for the BAU smelter.

The relative annual inhalation doses for the various product streams, together with the BAU smelter process streams for comparison are shown in Table B.1. Note that these Potential Dose Estimates are for comparatives purposes and are based on inhalation of each material for a full year – which is not the working case.

Table B.1 Smelting options and inhalation doses

Smelting option	Process stream	Annualised potential inhalation dose (mSv/y)
BAU	Smelter Dust	6.5
	Flash Furnace Blister Cu	0.1
	Flash Furnace slag	1.4
	Anode Furnace Cu	0.1
	Anode Furnace slag	1.1
	Electric Furnace Blister	0.5
	Electric Furnace slag	1.7
	Electric Furnace revert	3.6
Two Stage Smelting Option 1 Flash smelting (FS) followed by Direct to Blister smelting (DBS)	FS Blister	0.2
	FS Slag	1.0
	FS Dust	2.8
	DBS Blister	0.04
	DBS Slag	0.3
	DBS Dust	2.9

Smelting option	Process stream	Annualised potential inhalation dose (mSv/y)
Two Stage Smelting Option 2 Top Submerged Lance followed by DBS	Matte	0.2
	Slag	1.0
	TSL (WHB) Dust	5.8
	TSL (ESP) Dust	41
	Metal	0.04
	Slag	0.3
	Total-dust	2.9
Slag Conversion Furnace (common step)	SCF-blister	0.04
	SCF-slag	0.5
	SCF-dust	2.3

Table B.1 shows that the relative radiological risks from the two-stage smelting and BAU processes are similar, apart from potential exposures to TSL ESP dust, which will require additional controls during maintenance activities in the ESP. Therefore, it is expected that doses will be similar to the doses received by BAU smelter workers.

Appendix C

Non-human biota impact assessment

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C.1 The ERICA tool

A recognised method for assessing radiological impacts to non-human biota is the ERICA software tool (ERICA 2019, ARPANSA 2010). The software fulfils the ICRP requirement (ICRP 2007) for a more detailed approach to assessing the radiological impacts to specific species of flora and fauna. For impacts to non-human biota, the requirement is to consider impacts to species rather than individual organisms.

For this assessment, the impact of radionuclide emissions from the SRE Project on non-human biota is assessed using the ERICA software tool (http://www.erica-tool.com/). The assessment determines a relative radiological risk factor for various species of animals and plants based on changes in the radionuclide concentrations of media (for example soil).

The ERICA approach is based on a series of tiered assessments, each of which require successively more detail. A higher tier of assessment is triggered when the assessed radiological risk exceeds a reference risk quotient.

C.2 Media concentrations

The modelled dust deposition results, in Section 3.3, are combined with the weighted radionuclide concentrations of the source terms, to determine the radionuclide deposition rates. The deposition rates are used to calculate the change in soil radionuclide concentrations, above the naturally occurring concentrations, due to operational emissions. The changes in soil concentrations (in Bq/kg) are then used as input data for the ERICA software.

The determination of the change in soil radionuclide concentrations is based on:

- assuming that as dust deposits, it will mix in the top layer of soil, to a depth of 10 mm (Kaste 2007). Hence, every square metre of soil has a mixing volume of 0.01 m^3
- assuming that the soil has a density of 1.5 tonnes (t) per cubic metre, then there is 0.015 t (15 kg) of mixing soil per square metre
- therefore, for every Bq, of a particular radionuclide, deposited on a square metre, there will be an additional 0.067 Bq/kg (1/15) increase of that radionuclides concentration in the soil
- twenty year deposition period assumed.

The modelled change in radionuclide concentrations of soil are shown in Table C.1. These concentrations are used as the inputs to the non-human biota impact assessment.

Table C.1 Modelled change of soil radionuclide concentrations

Receptor location	Change in soil concentrations (Bq/kg)					
	U-238	U-234	Th-230	Ra-226	Pb-210	Po-210
Andamooka	0.021	0.021	0.021	0.016	0.078	1.010
ODV	0.439	0.439	0.439	0.331	1.582	8.476
Roxby Downs	0.115	0.115	0.115	0.087	0.415	4.275

C.3 Concentration ratios

The key factors in an ERICA assessment are concentration ratios (CR). These represent the ratio of a particular species whole body average radionuclide concentrations to the concentration of the radionuclides in the media (for example soil). ERICA provides a series of standard species and corresponding default CR values; however, there is recently published information that complements the set of default CR values. For this assessment, the standard ERICA species set is used together with additional CR data for kangaroos and reptiles (ARPANSA 2014) as shown in Table C.2. The ERICA default large mammal and reptile CR values have been included for comparison.

Table C.2 Published concentration ratios

Species	Elemental Concentration Ratios (Bq/kg (species fresh weight) / Bq/kg (soil dry weight))					Source
	Uranium	Thorium	Radium	Lead	Polonium	
Red Kangaroo[1]	0.011	No data[2]	0.41	0.022	1.06	ARPANSA 2014
Large Mammal	0.00547	0.000136	0.044	0.037	0.088	ERICA Default
Reptile	2.5	0.27	No data[2]	1.2	11	ARPANSA 2014
Reptile	0.0052	0.0022	0.0443	0.39	0.128	ERICA Default

Notes: 1. ARPANSA 2014 concentration ratios are the average of the two sample sets.

2. Default ERICA values used in assessment.

C.4 ERICA assessment results

The output of the ERICA assessment tool is a standardised measure of the impacts to a reference set of plants and animals (ARPANSA 2010). The software calculates a *dose rate* to the reference plants and animials based on a database of effects. The calculated *dose rate* is compared to a reference level which is 10 µGy/h.

For this assessment, a Tier 2 ERICA assessment was conducted for 20 years of deposition, and the results are shown in Table C.3.

Table C.3 ERICA assessment dose rates at receptor locations

Species	Dose rate (µGy/h)
	ODV
Amphibian	0.030
Annelid	0.039
Anthropod - Detritivorous	0.047
Bird	0.005
Flying Insects	0.020
Grasses and Herbs	0.083
Lichen and Bryophytes	0.703
Mammal - Large	0.024
Mammal - Small Burrowing	0.024

Species	Dose rate (µGy/h)
	ODV
Mollusc - gastropod	0.019
Shrub	0.113
Tree	0.013
Kangaroo	0.253
Australian Reptile	6.93

The results show that all species are well below the screening levels of 10 µGy/h, with the maximum absorbed date rate being 6.93 µGy/h for Australian reptiles.

The output is considered to be acceptable given that reptiles inhabit the entire region and it is highly unlikely that any particular species would be at risk across the broader region. As noted previously, the NHB assessment is intended to consider species impacts. If a species is broad ranging, then a localised potential impact is unlikely to affect the health of the overall species.

Appendix D
Assessment requirements

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D.1 Assessment requirements

Radiation assessment requirements and cross reference to where these are addressed in this report are outlined in Table D.1.

Table D.1 Assessment requirements

Environmental attributes	Reference	Assessment requirements	Responses/Cross references
Radiation	HR1	Describe and assess the radiation exposure pathways to workers, the public, biota and the environment from relevant components of the development during ongoing operations.	The radiation assessment quantifies the impacts of radiation from the radiological emissions from the SRE Project. For people, the radiological impact is determined as a potential radiation dose. For non-human biota, an absorbed dose rate is calculated, and this provides a measure of the relative radiological risk (Section 3.3, Annexure A, Annexure B, Annexure C)
	HR1	Describe the measures to control and minimise radiation exposures to workers, the public, biota and the environment from relevant components of the development during construction and ongoing operations.	The impact significance associated with the proposed SRE Project activities is described in Section 4.4. Each confirmed impact event is required to have a description of proposed management and mitigation measures applied, aimed at either breaking the SPR linkage (i.e. avoiding the impact) or otherwise reducing the impact significance to ALARA (Section 4.5.3)
	HR1	Outline how the radiation exposure pathways to workers, the public, biota and the environment from relevant components of the development would be monitored during construction and operation.	An environmental and occupational radiation monitoring program
	HR1	Describe existing radiological characteristics of the environment (original baselines and current conditions) that could be impacted by construction or operation of the development (e.g. air quality, soils, surface and groundwater, etc.).	The existing environmental radiological characteristics are described in Section 2.1.

Australia

SYDNEY
Level 10 201 Pacific Highway
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 2 95 North Quay
Brisbane QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 9.01 Level 9
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 3.03
111 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Yonge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
2015 Main Street
Vancouver BC V5T 3C2
T 604 999 8297

CALGARY
700 2nd Street SW Floor 19
Calgary AB T2P 2W2



linkedin.com/company/emm-consulting-pty-limited



emmconsulting.com.au

BHP

Appendix C5.
Greenhouse gas

Greenhouse Gas Assessment

Olympic Dam Smelter and Refinery Expansion Project

Prepared for BHP Olympic Dam Corporation Pty Ltd

May 2026

Greenhouse Gas Assessment

Olympic Dam Smelter and Refinery Expansion Project

BHP Olympic Dam Corporation Pty Ltd

May 2026

Approved by

Scott Fishwick
National Technical Lead – Air quality and climate
22 May 2026

Level 10 201 Pacific Highway
St Leonards NSW 2065
ABN: 28 141 736 558

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Executive Summary

BHP Olympic Dam Corporation Pty Ltd (BHP) is proposing to develop the Smelter and Refinery Expansion Project (SRE Project) at the Olympic Dam mining operations, in the far north of South Australia (SA) (Figure 1.1).

EMM Consulting Pty Ltd and Lathwida Environmental Pty Ltd (EMM-Lathwida) are preparing an Environmental Impact Statement (EIS) for the SRE Project in accordance with EIS assessment requirements and Practice Direction 17 Impact Assessed Development under the *Planning, Development and Infrastructure Act 2016* (PDI Act) (SA).

EMM was commissioned by BHP to undertake a greenhouse gas (GHG) assessment of the proposed SRE Project activities to:

- determine if the activities have the potential to result in changes to the annual GHG emissions relative to existing GHG emissions (baseline condition assessment in Chapter 2 of this report)
- determine the likely magnitude of the change to baseline GHG emissions as a result of the SRE Project (effects assessment in Chapter 3 of this report)
- quantify the likely impacts resulting from the predicted change to baseline GHG emissions (impact assessment in Chapter 4 of this report).

GHG emissions are referred to as 'direct' or 'indirect', and defined according to three 'scopes' (1, 2 and 3), as follows:

- Scope 1 relates to direct emissions from sources within the boundary of an organisation (or project), and as a result of the organisation's activities. Scope 1 emissions are determined for the point of release (on-site). They include, for example, emissions from solid and liquid fuel combustion, and clearing of vegetation.
- Scope 2 relates to indirect emissions associated with the purchase of electricity, steam, heat or cooling at a site. Scope 2 emissions are physically generated outside an organisation's boundaries, such as an external power station in the case of electricity, but they are included in an organisation's emissions inventory because they are a result of the organisation's energy use.
- Scope 3 relates to all other indirect emissions (i.e. other than scope 2) which occur outside the boundary of an organisation but as a result of actions by the organisation, and are generated in the wider economy. Scope 3 emissions may occur upstream, such as during the extraction and production of fossil fuels, or downstream, such as from the transport of an organisation's product to customers, or the emissions from outsourced activities.

This GHG Assessment is mainly concerned with scope 1 and scope 2 emissions, as defined under the *National Greenhouse and Energy Reporting Act 2007 (Cwth)* (NGER Act). Annual scope 3 emissions have not been included in this GHG Assessment.

In order to consider existing GHG emissions, seven years (financial year (FY)19 to FY25) of annual emission reports from Olympic Dam were reviewed. Annual scope 1 GHG emissions from Olympic Dam business as usual (BAU) whole-of-site operations are in the order of 221,546 tonnes (t) of carbon dioxide equivalent (CO_2-e) per year, of which 122,938 t CO_2-e/year (~55%) is produced from the existing smelter and refinery. Annual scope 2 GHG emissions from the consumption of purchased electricity are in the order of 347,289 t CO_2-e/year, of which approximately 20% is produced from the existing smelter and refinery.

Annual GHG emissions for the Olympic Dam site for the period from FY26 onwards, including SRE Project operations, were quantified using projected annual energy consumption rates provided by BHP and Hatch Fluor Joint Venture (HFJV). Annual GHG emissions were estimated for the following phases of operations:

- BAU projected (FY26 to FY32), including of SRE Stage 1A construction
- SRE Stage 1A operations (FY33 to FY35), including of SRE Stage 1B construction
- SRE Stage 1B operations (FY36 to FY41), including SRE Stage 2 construction
- SRE Stage 2 operations (FY42 to FY66).

For scope 1 emissions, the sources included were:

- on-site liquid fuel (diesel, fuel oil) combustion
- liquified petroleum gas (LPG) combustion
- coke coal consumption.

For scope 2 emissions, the relevant source was the purchase of grid electricity for on-site use. Scope 2 emissions arise from the generation of the electricity purchased and consumed by an organisation, but are physically produced by the burning of fuels (coal, natural gas, etc.) at power stations.

The annual average scope 1 and 2 emissions during the staged development of the SRE Project are estimated to be 160,218 t CO_2-e/year for Stage 1A, 182,697 t CO_2-e/year for Stage 1B and 192,524 t CO_2-e/year for Stage 2. Relative to estimated annual average BAU period (i.e. FY26 to FY32) projected smelter and refinery emissions (117,834 t CO_2-e/year), the SRE Project returns an increase of approximately 36% for Stage 1A, 55% for Stage 1B and 63% for Stage 2.

Overall, scope 1 emissions from the SRE Project when combined with Olympic Dam BAU projected whole-of-site operations are estimated to be 253,029 t CO_2-e/year for Stage 1A, 279,696 t CO_2-e/year for Stage 1B and 256,891 t CO_2-e/year for Stage 2, or approximately 9% higher, 21% higher and 11% higher respectively.

SRE Project scope 2 emissions for Stage 1A are estimated to be 58,004 t CO_2-e/year, 61,573 t CO_2-e/year for Stage 1B and 78,329 t CO_2-e/year for Stage 2. In terms of the projected change in annual SRE Project emissions compared to the BAU projected operations of the Olympic Dam BAU smelter and refinery, the annual scope 2 GHG emissions during Stage 1A, Stage 1B and Stage 2 are approximately 137% higher, 152% higher and 220% higher respectively.

Overall, Scope 2 emissions from the SRE Project when combined with Olympic Dam BAU projected whole-of-site operations are estimated to be 91,834 t CO_2-e/year for Stage 1A, 98,684 t CO_2-e/year for Stage 1B and 122,952 t CO_2-e/year for Stage 2, or approximately 26% lower, 20% lower and 1% lower respectively.

When considering scope 2 emissions, it is noted that no consideration of sourcing of renewable energy via power purchasing agreements has been made in the calculations. Scope 2 emission calculations in this report, therefore, are highly conservative.

The emission totals calculated show that the introduction of the SRE Project will increase annual scope 1 and 2 GHG emissions relative to BAU projected operational emissions.

Following completion of the assessment of effects investigation, it was determined that there was a total of two confirmed impact events.

These events were assessed to quantify the likely significance of the impact against BHP's environmental impact assessment framework (EIAF) impact significance criteria, one of which (SRE Project construction phase GHG emissions) has been assessed with a significance Level 1 (not significant), and one GHG impact (SRE Project operational GHG emissions) with an assessed significance Level 5 (significant).

Mitigation and management measures are proposed to reduce the impact significance to as low as reasonably achievable (ALARA). The SRE Project has several in-built engineering design features which will limit the growth in

diesel, fuel oil and LPG consumption rates relative to BAU smelter operations despite the increase in annual throughput.

Further, several alternative fuel strategies (e.g. bio-LPG and bio-diesel) are currently under consideration by BHP under the preferred pathway to net zero (P2NZ) Roadmap The viability and timing of P2NZ mitigation strategy options will by shaped by factors such as biofuel availability, feasibility for implementation by site and sufficient PPA to supply renewable energy to the Olympic Dam Complex.

For scope 2 emissions associated with the consumption of purchased electricity, it is noted that emissions based on the SA grid electricity emission factor projections. Under the BHP Renewable Electricity Plan, BHP are also investigating the uptake of 100% renewable electricity from 2030, which would effectively reduce annual scope 2 emissions to zero.

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1 Introduction

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- quantify the likely impacts resulting from the predicted change to baseline GHG emissions (impact assessment in Chapter 4 of this report).

This report supports the EIS, which will be submitted to the Government of South Australia's Minister for Energy and Mining as the relevant Minister for the SRE Project under the *Roxby Downs (Indenture Ratification) Act 1982* (SA).

1.1 Project area definitions

To maintain consistency throughout the EIS and supporting technical assessments, the following terminology related to project infrastructure have been defined for the SRE Project where the **SRE Project Area** is defined at the boundary around the SRE Project for which BHP is seeking approval, including:

- **Special Mining Lease (SML) Area**, located within the SML (Figure 1.2), which is further delineated by the following areas:
  - **SRE Area**: the extent of the proposed SRE Project infrastructure required for construction and operation of the SRE Project within the SML. Includes the existing brownfield plant area, proposed facility relocation(s), proposed plant and laydown areas.
  - **General Infrastructure Area**: the extent of the proposed ancillary infrastructure and ancillary activities required for construction and operation within the SML. Includes the proposed infrastructure laydown areas, proposed stormwater dam location, proposed topsoil and subsoil storage areas.
  - **Water Infrastructure Area**: the extent of the proposed water infrastructure and ancillary activities required for construction and operation within the SML. Includes the proposed water pipeline and water storage dam locations.

- **Electricity Infrastructure Ground Re-Profiling Area (EIGR Area)**: the extent of the isolated proposed vegetation disturbance required to maintain regulatory clearance distances between the 275 kilovolt (kV) transmission line and the ground surface within Clause 28 land. It is noted that the transmission line and infrastructure are already in place, but additional electricity loads required for the SRE Project will result in increased transmission line temperature and more pronounced line sagging and, therefore, changes to existing clearance distances to enable safe operation (Figure 1.3).

1.2 Regulatory context

The SRE Project was declared an Impact Assessed development pursuant to section 108(1)(c) and 108(7) of the PDI Act on 29 August 2024. The declaration reflects the nature, scale and significance of the SRE Project to SA.

Impact Assessed Development is the most rigorous level of development assessment prescribed under the PDI Act.

Specifically, the Minister made the following declaration:

> Pursuant to Section 108(1)(c) and Section 108(7) of the Planning Development and Infrastructure Act 2016, having taken into account those principles prescribed under Regulation 27(2) of the Planning, Development and Infrastructure (General) Regulations 2017 (the Regulations) and having given consideration to the matters under Regulation 27(3) of the Regulations, I declare that all development of a kind specified in the Schedule to this Notice, to the extent that it is undertaken on land identified in Clause 28(1) of the Indenture as impact assessed development and that references to "development" include a project.

The majority of the SRE Project activities, with the exception of ground re-profiling within the Electricity Infrastructure Area, would be located wholly within the existing SML but does not include business-as-usual operations (operations which enable existing approved production of up to approximately 200,000 tonnes per annum (tpa) total copper production) or activities associated with scheduled campaign maintenance 2027 (SCM27) works. These activities are subject to separate regulation (e.g. Environment Protection Authority (EPA) licensing) and approval. The SRE Project may also be supported by low impact development outside the SML, which could include, for example, minor road works and upgrades to accommodation infrastructure. It is proposed that any approvals required for these activities would be sought on an as-needs basis under applicable legislation and guidelines.

Policy and guidance relevant to the assessment of GHG emissions and the planning and delivery of the SRE Project is summarised below.

1.2.1 Planning Development and Infrastructure Act 2016 (SA)

Development approval is required for the Action under the PDI Act. The PDI Act established a new development assessment system in SA to streamline the assessment process. The PDI Act is supported by subordinate regulations, as well as practice directions and guidelines which are issued by the State Planning Commission, the state's independent principal planning body.

A key feature of the new planning system is the Planning and Design Code (the Code) which contains a single set of planning policy, rules and classifications for SA, which is applied spatially via mapping. The Code establishes a performance-based approach to planning and development assessment by including policies that address the scale, form and design of built structures and the contextual setting of the development.

The planning system established by the PDI Act includes five assessment pathways; accepted development, code assessed development (deemed-to-satisfy or performance assessed) and impact assessed development (restricted and impact assessed). As previously stated, impact assessed development is the most rigorous level of development assessment prescribed under the PDI Act.

i Ministerial declaration – impact assessed development

The declaration subjects the SRE Project to an EIS process requiring detailed environmental, social and economic assessment.

A Scoping Application was prepared by BHP to inform the development of EIS Assessment Requirements by the State Planning Commission (SPC). The EIS Assessment Requirements issued by the SPC summarise all potential issues needing to be addressed by BHP and highlight any further information required by the Minister to enable a proper assessment of the proposed SRE Project.

Due to the operation of the *Roxby Downs (Indenture Ratification) Act 1982*, the Minister for Energy and Mining is the relevant Minister for the SRE Project.

Specific Assessment Requirements for GHG (Table D.1) are as follows:

- Undertake a detailed greenhouse gas emissions assessment prepared by a suitably qualified environmental expert for the development which describes measures (preferred and alternatives) proposed to avoid and/or minimise Scope 1 and Scope 2 GHG emissions of the development.
- Quantify the emissions expected to be abated for each avoidance and mitigation measure.
- Compare preferred measures for emission controls and energy consumption with best practice International environmental management in the relevant industry sector.
- Describe mitigation and management measures.

1.2.2 International context

i Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science in relation to climate change. The IPCC prepares comprehensive Assessment Reports about the state scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC). The IPCC released its Sixth Assessment Report (AR6) in 2022/2023. The IPCC also produces a variety of guidance documents and recommendation methodologies for GHG emissions inventories.

ii United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC entered into force in March 2004 and provides the basis for concerted international action to mitigate climate change and to adapt to its impacts. With 198 Parties, the Convention has nearly universal membership. The Conference of the Parties to the Convention (COP) are used to advance the implementation of the Convention.

The objective of the Convention is to stabilise GHG emissions 'at a level that would prevent dangerous anthropogenic interference with the climate system'. It states that 'such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner'[1].

[1] https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change

The UNFCCC:

- puts the onus on developed countries to lead the way in reducing GHG emissions
- direct funds to climate change activities in developing countries
- receives regular reports from developed countries on climate change policies and measures
- recognises adaptation to climate change.

iii Paris Agreement

The Paris Agreement, which the Australian Government has signed, is a legally binding international treaty on climate change. It was adopted by the (then) 196 Parties to the UNFCCC at the 21st United Nations Climate Change Conference (COP21) in Paris, France in December 2015, and entered into force in November 2016. Its overarching goal is to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels.

Under the Paris Agreements, all Parties are required to put forward GHG emissions reduction targets through Nationally Determined Contributions (NDCs). All Parties are required to report on national emissions, with a review of targets set to occur every five years from 2020.

1.2.3 Australian context

i Climate Change Act 2022

The *Climate Change Act 2022* provides the legislative framework for implementing Australia's net-zero commitments under the Paris Agreement, and sets out Australia's GHG emission-reduction targets. Australia has committed to reducing its GHG emissions by 43% below 2005 levels by 2030, and achieving net-zero emissions by 2050. *The Climate Change Act 2022* also introduced a requirement for an annual climate change statement to parliament, supported by independent advice from the Climate Change Authority (CCA). The *Climate Change Act 2022* does not impose any direct obligations on companies or facilities.

ii Global Methane Pledge

The Australian Government has also signed the Global Methane Pledge (GMP). The GMP was launched at the 26th United Nations Climate Change Conference (COP26) by the European Union and the United States. It is a voluntary commitment, with 122 signatories working collectively to reduce global CH_4 emissions across all sectors by at least 30% below 2020 levels by 2030.

iii The National Greenhouse and Energy Reporting Act and Scheme

The *National Greenhouse and Energy Reporting Act 2007 (Cwth)* (NGER Act), administered by the Commonwealth Government, establishes a national framework (the NGER Scheme) for corporations to report GHG emissions, energy consumption and energy production. Companies that exceed the NGER Scheme thresholds[2] of 25,000 t carbon dioxide equivalent (CO_2-e) per year for a facility, or 50,000 t CO_2-e per year for a corporation, are required to register and report annually on their scope 1 and scope 2 emissions.

[2] The thresholds are also stated in terms of energy production/consumption.

The NGER Act is underpinned by the *National Greenhouse and Energy Reporting Regulations 2008* and the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*. The Measurement Determination provides methods, criteria and measurement standard for calculating GHG emissions and energy data and covers scope 1 and scope 2 emissions, energy production and consumption.

iv The Safeguard Mechanism

The NGER Act also provides a framework for Australia's highest emitting facilities to manage and report on their GHG emissions. This framework is the Safeguard Mechanism[3]. The Safeguard Mechanism was first legislated in 2014 and has been in place since 2016. It was reformed in 2023 to ensure that the facilities it covers will contribute to meeting Australia's GHG emission-reduction targets.

In general terms, the Safeguard Mechanism applies to facilities[4] with scope 1 emissions[5] of more than 100,000 t of CO_2-e per year. It sets legislated limits — known as baselines — on the GHG emissions of these facilities. These baselines decrease on a trajectory that is consistent with achieving Australia's GHG emission-reduction targets of 43% below 2005 levels by 2030, and net zero by 2050. The baselines will decrease at 4.9% per year from 2023 to 2030. If a Safeguard facility exceeds its baseline, it must surrender Australian Carbon Credit Units or Safeguard Mechanism Credits (SMCs) equal to their excess emissions. Facilities that 'beat' their baselines may apply to receive SMCs.

There are currently 221 Safeguard Facilities across the mining, manufacturing, transport, oil, gas and waste sectors. These facilities produce around 28% of Australia's GHG emissions.

Scope 1 emissions from existing operations at the Olympic Dam site (see Section 2.5) are above the 100,000 t CO_2-e/year threshold, making the site a Safeguard Facility.

1.2.4 SA context

The overarching SA Government legislation relating to GHG emissions and climate change management is the *Climate Change and Greenhouse Emissions Reduction Act 2007*, which was amended in 2024 with the *Climate Change and Greenhouse Emissions Reduction (Miscellaneous) Amendment Bill 2024*.

The *Climate Change and Greenhouse Emissions Reduction Act 2007* is intended to provide for:

- measures to address climate change with a view to assisting to achieve a sustainable future for SA
- the establishment of targets to achieve a reduction in GHG emissions within SA
- the promotion of renewable sources of energy
- the promotion of business and community understanding about issues surrounding climate change
- facilitate the early development of policies and programs to address climate change.

[3] https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism

[4] Grid-connected electricity generators are treated separately.

[5] The threshold applies to actual (gross) emissions from a facility, and does not take into account any offset or displaced emissions.

1.3 Project description

The objective of the SRE Project is to expand BHP's smelter and refinery capacity, enabling the Copper SA growth plan by:

- increasing copper production capacity up to 650,000 tpa of total copper plus associated products from the current average production of approximately 200,000 tpa
- delivering a sustainable, highly productive, and more resilient smelting and refining flowsheet
- ensuring the Cu:S ratio is resolved at Olympic Dam for copper concentrate production
- delivering reliable and predictable production outcomes following the 2023 acquisition of OZ Minerals' Carrapateena and Prominent Hill mining operations to realise Copper SA province opportunities.

Key elements of the SRE Project are:

- expansion of, and additions to, the existing smelter and refinery to enable total production of up to 650,000 tpa copper plus associated products
- introduction of two-stage smelting involving the installation of a new primary flash-smelting furnace (FSF) to produce copper matte, adding material smelting capacity
- conversion of the existing direct-to-blister flash furnace (DBF) to a flash-converting furnace (FCF), which would process the matte into blister
- addition of an acid plant of similar nature and scale to the existing acid plant and subsequent upgrade of the existing acid plant
- expansion of the electro-refinery and precious metals recovery facilities to produce cathode copper, gold, and silver.

Associated with these key elements, the SRE Project would require new supporting facilities, infrastructure and services and the upgrade, removal and/or relocation of existing facilities and services within the SML Area (Figure 1.2).

External to the SML Area, electricity would be supplied to the SRE Project through the existing 275 kV line from Davenport substation (near Port Augusta) to Olympic Dam mine, located within Clause 28 land[6] (EIGR Areas). Whilst the transmission line and infrastructure are already in place, additional electricity loads required for the SRE Project will result in increased transmission line temperature and more pronounced line sagging, reducing the existing electrical clearances that are required to enable safe operation. The maintenance of the required electrical clearances between the 275 kV line and the ground surface would necessitate isolated areas of land disturbance and associated vegetation clearance (Figure 1.3).

The SRE Project would be constructed and operated in a staged manner to enable production capacity up to 650,000 tpa of total copper and associated products, with stages detailed in Table 1.1.

This technical assessment has been prepared based upon the maximum potential impacts associated with Stage 2 (i.e. the greatest impact scenario).

The indicative location of key infrastructure is shown in Figure 1.2 and Figure 1.3, while the key project characteristics are outlined in Table 1.2.

[6] Clause 28 land as defined under the *Roxby Downs (Indenture Ratification) Act 1982* (SA)

Table 1.1 Project stages and timing

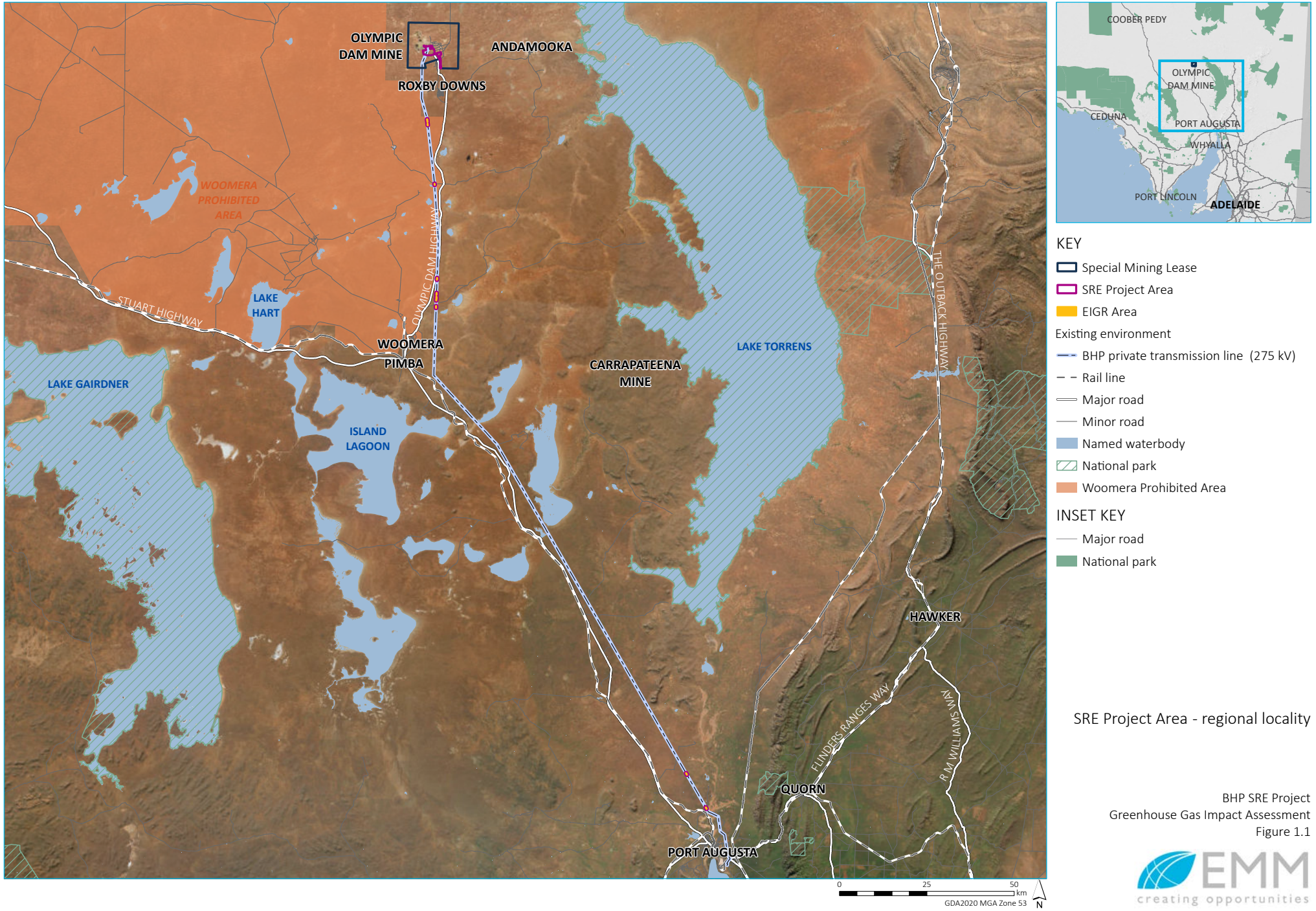
Stage	Smelter concentrate throughput (tpa)	Description	Anticipated timing
Stage 1a	1,100,000	Stage 1a includes: • an increase of smelter throughput to approximately 1,100,000 tpa of concentrate producing an output of approximately 390,000 tpa of total copper • a new regional concentrate receiving, handling and blending facility • upgrade and expansion of the existing smelter feed preparation, including additional concentrate storage, blending and a new steam dryer • iInstallation of a new primary FSF to produce copper matte and conversion of the existing DBF to an FCF to convert matte to blister, including additional anode furnace and anode casting infrastructure and decommissioning of the existing electric slag reduction furnace (EF) if required • expansion of the brownfield slag concentrator supported by FSF slag cooling pits, a new interim slag stockpile and associated environmental management infrastructure • new off-gas management infrastructure, including additional gas and dust handling equipment • a new acid plant, additional acid storage and an associated acid loading station to allow the export of acid • a new electrorefinery and associated anode preparation infrastructure • a new slimes treatment plant • expansion of the precious-metals refinery (PMR) facility	2028 to 2032
Stage 1b	1,400,000	Stage 1b includes: • an increase in smelter throughput to approximately 1,400,000 tpa of concentrate producing an output of approximately 500,000 tpa of total copper • installation of additional concentrate leach thickening and filtration infrastructure • development of greenfield slag concentrator and associated stockpile, and decommissioning of brownfield slag concentrator • incremental expansion of Stage 1a infrastructure and services, including: – the installation of additional electrorefinery modules – expansion of feed preparation, FCF feed system (including lime addition), off-gas management, acid plant, slimes treatment and PMR capacities	2032 to 2036
Stage 2	2,000,000	Stage 2 includes: • an increase in smelter throughput to approximately 2,000,000 tpa of concentrate producing an output of approximately 650,000 tpa of total copper. • installation of new concentrate leach circuit for treatment of imported concentrate. • incremental expansion of Stage 1b infrastructure and services, including: – the installation of additional electrorefinery modules. – the installation of an additional anode furnace and associated off-gas management infrastructure. expansion of feed preparation, FSF and FCF feed systems, off-gas and slag management, acid plant, slimes treatment and PMR capacities.	2038 to closure

Table 1.2 Key characteristics of the SRE Project

Project element	Summary
Smelter and refinery expansion and additions	Expansion of, and additions to, the existing smelter and refinery to enable production of up to 650,000 tpa copper plus associated products (gold, silver, and acid). This would include: • a new concentrate handling and blending facility • additional concentrate leach capacity • upgrade and expansion of the existing smelter feed preparation • installation of a new primary FSF to produce copper matte and conversion of the existing DBF to a FCF to convert matte to blister, including additional anode furnace and anode casting infrastructure • upgrade of the existing slag concentrator circuit and subsequent development of a new slag concentrator circuit • new off-gas management infrastructure, including additional gas and dust handling equipment • a new acid plant and upgrade of the existing acid plants • a new electro-refinery and associated infrastructure • a new slimes treatment plant • expansion of PMR facility • slag stockpile and treatment.
Electricity demand, supply and distribution	An electricity demand of up to 68 mega volt-amperes (MVA) net load increase would be required for the SRE Project. The additional electrical demand due to the SRE Project would be met by capacity from the national grid via the existing 275 kV transmission line (noting potential for below line land disturbance and associated vegetation clearance outside of the SML). Minor augmentation of existing onsite electricity supply infrastructure at Olympic Dam within the SML would be to ensure the additional capacity could be achieved and maintained. New high voltage and low voltage power supply and reticulation infrastructure would be required to all smelter infrastructure.
Water demand	Water demand of between 2 and 16 megalitres per day (ML/day) required for the SRE Project in addition to the existing supply for current operations.
Water supply and distribution	The SRE Project proposes no additional water abstraction from the Great Artesian Basin (GAB) above daily average BAU volumes. Water supply for the SRE Project would nominally be provided from the Department for Infrastructure and Transport (DIT) Northern Water Project (NWP) infrastructure, following commissioning of the initial 90 ML/d capacity of the NWP. This would require new water storage and distribution infrastructure to connect the SRE Project to the NWP connection point at the SML boundary. The NWP water supply may be supplemented or offset by the provision of local groundwater supply (subject to further approvals). This water supply would occur via existing process storage dams, the desalination plant at the Olympic Dam site, and/or through the distribution of the existing water supply within daily average BAU volumes. The additional water supplies are likely to require augmentation of the existing desalination water treatment plant and water distribution network, and a demineralised water plant will be required to support the SRE Project operations.

<table>
<tr><th>Project element</th><th>Summary</th></tr>
<tr><td>Supporting infrastructure</td><td>Supporting infrastructure includes:
civil infrastructure works, such as roads and stormwater infrastructure
new offices and crib rooms
new workshops
new laydown areas
process control system upgrades
concrete batching
other supporting infrastructure as required to facilitate the implementation and operation of the SRE Project.</td></tr>
<tr><td>Waste management</td><td>Development of the SRE Project may require decommissioning of the existing processing plant components including dryers, the electric furnace and the existing concentrate storage and transfer system. Some of the decommissioned infrastructure would be retained in-situ to preserve operational flexibility or for future management under the site Closure Management and Rehabilitation Plan; however, some elements may require disposal as a component of the SRE Project.
Waste generated during construction would be managed as follows:
where practicable, demolition materials would be removed from site and recycled
materials not suitable for removal from site would be managed on the SML via existing waste management facilities.
All waste generated from construction of the SRE Project would be managed in accordance with existing site procedures and approved management plans.
Operational wastes associated with the SRE Project consist of processing and non-processing wastes where:
processing wastes are limited to low-copper slags generated from the smelting and slag concentrator operations that are not suitable for reprocessing and effluent streams from various process operations that are directed to tailings, including from the PMR and smelter off-gas systems
non-processing wastes including reagent packaging wastes and operational consumables.</td></tr>
<tr><td>Workforce</td><td>100% fly-in/fly-out (FIFO) workforce is assumed for construction and the SRE operational workforce. Estimated peak construction workforce numbers (in full time equivalents (FTE)) are summarised below.
<table>
<tr><th>Construction stage</th><th>Average FTE</th><th>Peak FTE</th></tr>
<tr><td>Stage 1a</td><td>~708</td><td>~1,313</td></tr>
<tr><td>Stage 1b</td><td>~260</td><td>~515</td></tr>
<tr><td>Stage 2</td><td>~519</td><td>~978</td></tr>
</table>
Following construction, the SRE Project would require the permanent operational workforce summarised below:
<table>
<tr><th>Operational stage</th><th>Additional SRE Project operational workforce</th><th>Total Olympic Dam Smelter and Refinery workforce</th></tr>
<tr><td>Stage 1a</td><td>~207</td><td>766</td></tr>
<tr><td>Stage 1b</td><td>~57 (additional to Stage 1a)</td><td>823</td></tr>
<tr><td>Stage 2</td><td>~244 (additional to Stage 1b)</td><td>1,067</td></tr>
</table>
SRE Project construction and operational workforce is proposed to utilise existing and new accommodation to be established by BHP for the scheduled campaign maintenance 2027 (SCM27) shutdown, Olympic Dam future campaign maintenance accommodation, and/or greenfield accommodation (subject to separate approvals).</td></tr>
</table>

Project element	Summary
Concentrate import	Import of copper concentrate from Prominent Hill and Carrapateena mining operations, as well as possible future mining operations (e.g. Oak Dam), and maintain the ability to receive copper concentrate from other third-party suppliers. Prominent Hil concentrate may be passed through concentrate leach to remove fluorides prior to smelter feed preparation. Carrapateena concentrate to pass directly to smelter feed preparation. Other, third party concentrates may be passed through concentrate leach to remove deleterious elements (e.g. fluorides) prior to smelter feed preparation as required.
Production and export	Total production volumes of up to: • ~650,000 tpa of cathode copper. • ~893,000 ounces per annum of gold. • ~3,950,000 ounces per annum of silver. • ~4,900 tpa of uranium oxide concentrate; note that the SRE Project does not materially change existing uranium production, with an increase of approximately 1% expected as a result of the leaching of Prominent Hill concentrate to remove fluoride. No upgrade or modification of uranium production facilities is proposed as a part of the SRE Project. • ~1,700,000–1,900,000 tpa of 98% sulphuric acid (H_2SO_4), of which up to approximately 810,000 tpa may be exported from Olympic Dam (i.e. operations become 'net' sulphuric acid producer).



KEY

- Special Mining Lease
- SRE Project Area
- EIGR Area

Existing environment

- BHP private transmission line (275 kV)
- Rail line
- Major road
- Minor road
- Named waterbody
- National park
- Woomera Prohibited Area

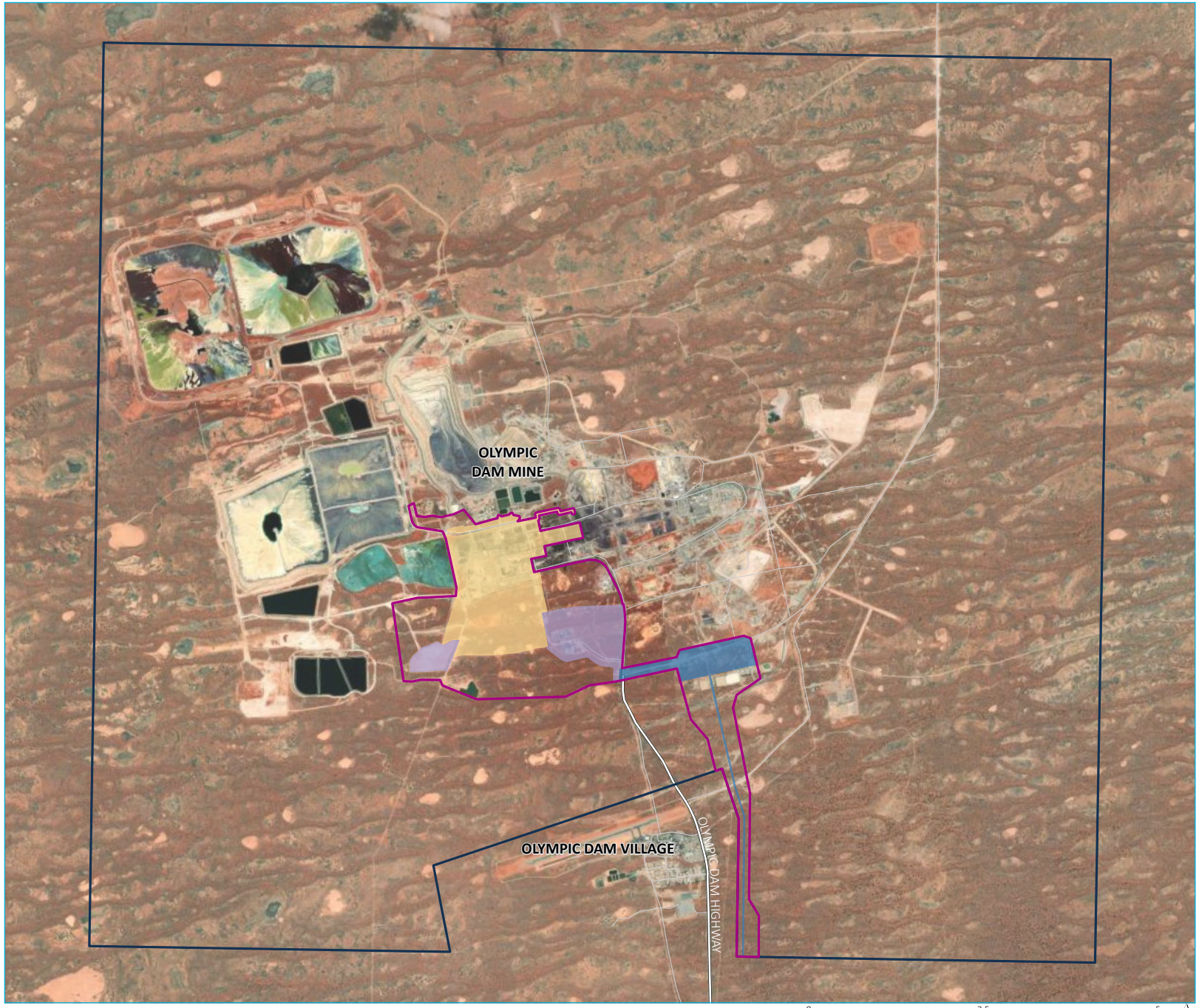
INSET KEY

- Major road
- National park

SRE Project Area - regional locality

BHP SRE Project
Greenhouse Gas Impact Assessment
Figure 1.1

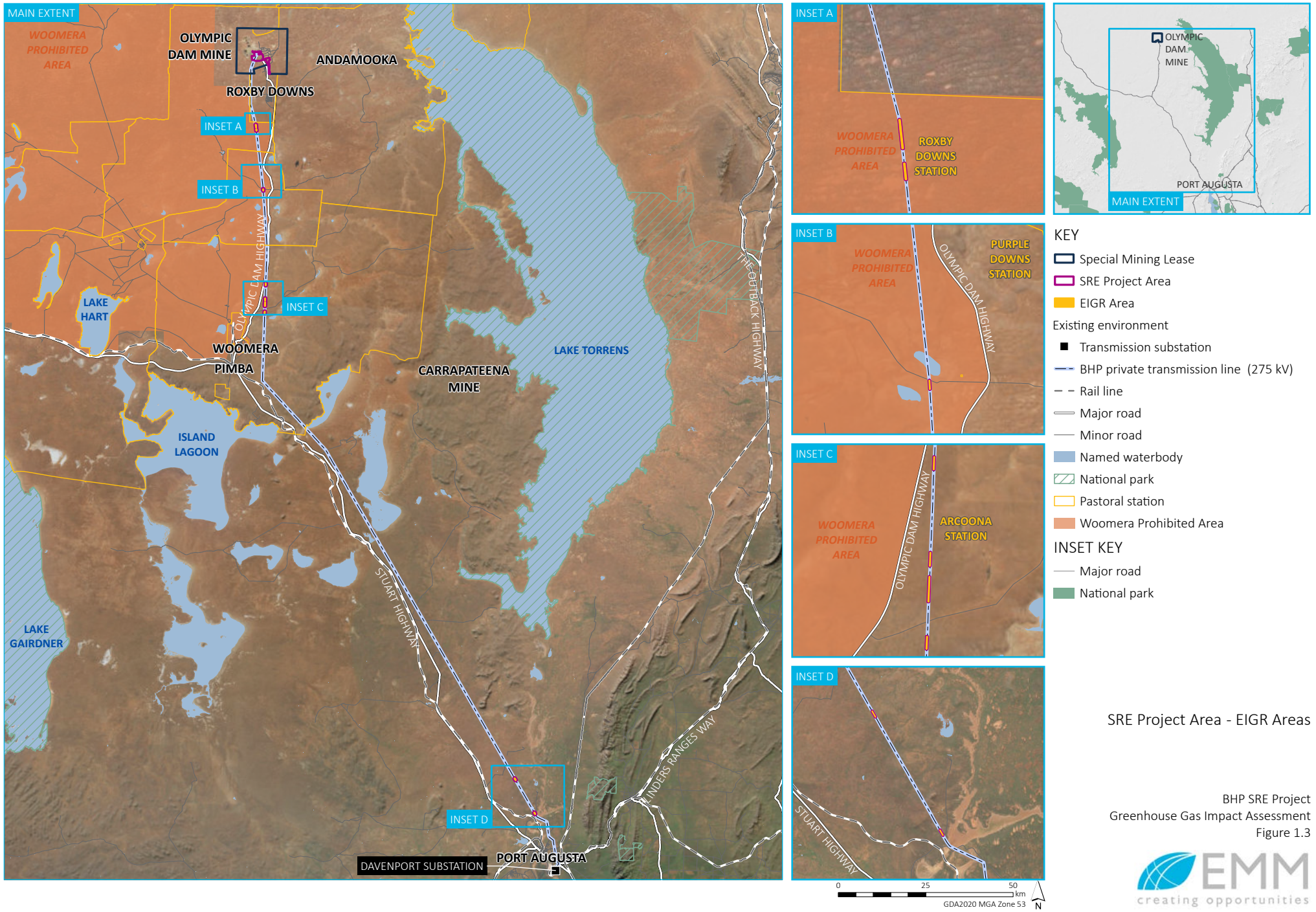
EMM
creating opportunities



SRE Project Area - SML Area

BHP SRE Project
Greenhouse Gas Impact Assessment
Figure 1.2

EMM
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SRE Project Area - EIGR Areas

BHP SRE Project
Greenhouse Gas Impact Assessment
Figure 1.3

EMM
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2 Baseline condition assessment

In order to quantify the potential effects of the SRE Project on GHG values and the subsequent impacts to receptors, it is necessary to understand the existing baseline environment, and specifically:

- to classify and describe the existing air quality environment prior to the development of the SRE Project; baseline assessment
- to provide a basis for project activities aimed at describing the likely change in the baseline environment as a result of the development of the SRE Project and quantifying the significance of resultant impacts to receptors.

2.1 Site location

The SRE Project is located at the Olympic Dam mining operations, approximately, 580 kilometres (km) north of Adelaide in the far north of South Australia (Figure 1.1).

The existing BHP Olympic Dam includes a mining concentrator, smelter and refinery, with the smelter treating high grade copper concentrates through a single-stage DBF smelter, with an average output of approximately 200,000 tpa of total copper (and associated products).

Site access is via Olympic Dam Highway to the existing Olympic Dam mine site. The SRE Project is serviced by internal (and proposed new) access road, with public access restricted at the main entrance to the mine site.

Olympic Dam airport is located approximately 6 km south of the existing Olympic Dam mine. The closest township is Roxby Downs which is approximately 15 km south of the mine site.

2.2 Greenhouse gases

The gases addressed under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act – see section 1.2.3iii) are summarised in Table 2.1.

Table 2.1 Greenhouse gases and characteristics

Greenhouse gas	Global warming potential (GWP)[a]	Atmospheric lifetime (years)[a]
Carbon dioxide (CO_2)	1	N/A[b]
Methane (CH_4)	28	12
Nitrous oxide (N_2O)	265	121
Sulphur hexafluoride (SF_6)	23,500	3,200
Hydrofluorocarbons (HFCs)	Dependent on HFC type	Dependent on HFC type
Perfluorocarbons (PFCs)	Dependent on PFC type	Dependent on PFC type

Notes: a) From Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

b) No single lifetime can be given for carbon dioxide because it moves throughout the earth system at differing rates.

Given that the various GHGs have different global warming potentials, it is convenient to express emissions using a common unit. For this purpose, the term 'carbon dioxide equivalent' (CO_2-e) has been defined. For any quantity and type of GHG, CO_2-e signifies the amount of CO_2 which would have the equivalent global warming impact. CO_2-e emissions are calculated based on the global warming potentials (GWPs) of specific gases adopted by the Parties to the UNFCCC and its Kyoto Protocol. In this assessment, GHG emissions are presented by gas, and for all gases combined, in terms of CO_2-e.

2.3 Emission scopes

For accounting and reporting purposes, GHG emissions are referred to as 'direct' or 'indirect', and defined according to three 'scopes' (1, 2 and 3). Examples of scope 1, 2 and 3 emissions are provided in Figure 2.1.

The three scopes are defined as follows:

- Scope 1 relates to direct emissions from sources within the boundary of an organisation (or project), and as a result of the organisation's activities. Scope 1 emissions are determined for the point of release (on-site). They include, for example, emissions from solid and liquid fuel combustion, and clearing of vegetation.

- Scope 2 relates to indirect emissions associated with the purchase of electricity, steam, heat or cooling at a site. Scope 2 emissions are physically generated outside an organisation's boundaries, such as an external power station in the case of electricity, but they are included in an organisation's emissions inventory because they are a result of the organisation's energy use.

- Scope 3 relates to all other indirect emissions (i.e. other than scope 2) which occur outside the boundary of an organisation but as a result of actions by the organisation, and are generated in the wider economy. Scope 3 emissions may occur upstream, such as during the extraction and production of fossil fuels, or downstream, such as from the transport of an organisation's product to customers, or the emissions from outsourced activities.

This GHG assessment is mainly concerned with scope 1 and scope 2 emissions, as defined under the NGER Act. Annual scope 3 emissions have not been included in this GHG assessment.

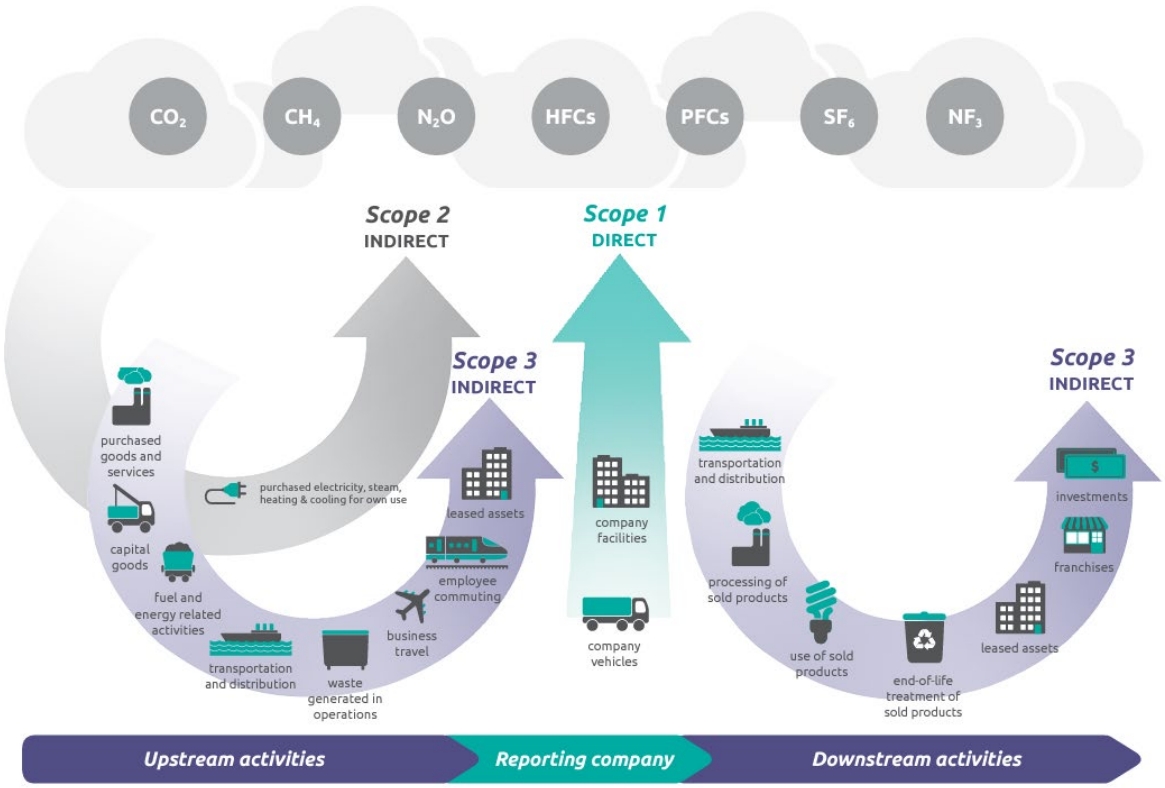


Figure 2.1 Overview of GHG emission scopes (WRI & WBCSD 2013)

2.4 GHG assessment criteria

There are no impact assessment criteria applicable to GHG emissions from an individual project.

As stated in Section 1.2.3iii, facilities or corporations must report under the NGER Scheme if they emit GHG emissions or produce/consume energy at or above the following trigger thresholds:

- greater than 25 kilotonnes (kt) GHG emissions (as CO_2-e) or produce/consume greater than 100 terajoules (TJ) of energy (facility level), or
- greater than 125 kt of GHG emissions (as CO_2-e) or produce/consume greater than 500 TJ of energy (corporate level).

Furthermore, the Australian Government Safeguard Mechanism applies to facilities with scope 1 emissions of more than 100,000 t of CO_2-e per year.

It is noted that annual GHG emissions from the Olympic Dam operations are above both the NGER Scheme and Safeguard Mechanism thresholds.

2.5 Baseline GHG environment

In order to consider existing GHG emissions, the NGER Scheme reports from Olympic Dam for the FY19 to FY25 reporting periods have been reviewed. The reported annual energy consumption rates and associated scope 1 and scope 2 emissions from existing operations have been extracted, with the seven year average emissions and relative percentage to total site emissions presented in Table 2.2.

Based on the reviewed NGER Scheme reporting data, annual scope 1 GHG emissions from existing Olympic Dam operations are in the order of 221,546 t CO_2-e/year. As per Section 1.2.3iv, this annual emission total classifies the Olympic Dam site as a Safeguard Facility.

From the analysis of the seven most recent NGER Scheme reports, it can be seen that the key contributors to annual Olympic Dam GHG emissions are:

- diesel and fuel oil combustion (stationary, transport, electricity production) – 68.6%
- liquified petroleum gas (LPG) combustion – 17.1%
- coke coal – 13.4%.

These three emission source categories constitute approximately 99.1% of total annual scope 1 GHG emissions from existing operations at Olympic Dam.

For the purpose of this GHG assessment, the remaining sources listed in Table 2.2, such as SF_6, soda ash usage, oils and greases, are considered minor contributors to annual scope 1 emissions and will not be considered further.

Annual scope 2 GHG emissions from the consumption of purchased electricity are in the order of 347,289.0 t CO_2-e/year.

Table 2.2 Five-year average scope 1 and scope 2 emissions – NGER Scheme reports – Olympic Dam – FY19 to FY25

Emission scope	Emission source	Type	7-year average emissions (t CO_2-e)	Percentage of 7-year average emissions (%)
Scope 1	Emissions released from combustion of gaseous fuels - Stationary energy purposes	Gaseous fossil fuels other than those mentioned in items 17 to 26	4.9	<0.1%
		Diesel oil	127,998.3	57.8%
		Fuel oil	18,487.2	8.3%
		Liquefied petroleum gas	37,985.4	17.1%
	Emissions released from combustion of liquid fuels other than petroleum oils or greases - Transport energy purposes	Diesel oil - transport	5,248.4	2.4%
		Gasoline (other than for use as fuel in an aircraft) - Transport	8.9	<0.1%
	Emissions released from combustion of petroleum based oils or greases	Petroleum based oils (other than petroleum based oil used as fuel)	160.6	0.1%
		Petroleum based greases	6.7	<0.1%
	Electricity production - Liquid fuels	Diesel oil	180.4	0.1%
	Industrial processes	Soda ash use	285.7	0.1%
		Coal coke	29,707.7	13.4%
		Solid fossil fuels other than those mentioned in items 1 to 5	1,381.0	0.6%
		SF_6	91.1	<0.1%
Scope 2	Purchase and loss of electricity from main electricity grid in a State or Territory		347,289.0	100.0%

2.6 Conclusion

An analysis of existing annual scope 1 and 2 GHG emissions generated by the existing operations at Olympic Dam has been undertaken by reviewing seven years of NGER Scheme reporting data.

The primary contributors to scope 1 GHG emissions are diesel and fuel oil combustion, LPG combustion and the usage of coke coal. Based on the reviewed reported data (FY19 to FY25), annual scope 1 GHG emissions are in the order of 221,546 t CO_2-e/year.

Annual scope 2 GHG emissions from the consumption of purchased electricity are in the order of 347,289 t CO_2-e/year.

3 Assessment of effects

An assessment of effects was undertaken to determine the change in the existing pathway environment as a result of the proposed SRE Project activities. The assessment of effects included the following works:

- Obtained input data (i.e. future energy consumption rates) as required for the development of an annual GHG emissions inventory for the SRE Project.
- Reviewed the SRE Project activities and identified potential impact events to determine representative scenarios for emission calculations.
- Completed emission calculations and assessed GHG effects.

3.1 Potential impact events

BHP has identified potential impact events associated with likely changes to the baseline GHG environment as a result of the implementation of the SRE Project. These events represent scenarios for which there is, or is likely to be, a linkage between SRE Project activities (sources), GHG emissions (pathways) and the identified receptors.

To ensure a consistent approach to impact assessment for the SRE Project, sources, pathways, and receptors (SPR) are defined and applied in this assessment as follows:

- Source – the SRE Project activities (i.e. potential impact event) which, alone or in combination, has the potential to impact a receptor.
- Pathway – the pathway, means or route (with consideration of any natural barriers) by which the receptor can be exposed to, or may reasonably be expected to be impacted by, the source.
- Receptor – the receptor that may be impacted by the source via the pathway.

The detailed list of potential impact events is provided in the Environmental Impact Assessment Tables Appendix to the EIS and are summarised for the GHG pathways in Table 3.1. The scope of this assessment of effects presented herein has considered these identified potential impact events.

Table 3.1 Preliminary SPR assessment – potential impact events

SPR ID No.	Potential impact event	Source	Pathway	Receptor	Linkage
A1	During construction, the combustion of fossil fuels leads to the emission of GHGs which impacts State and Commonwealth matters	Combustion of fossil fuels	Air (GHG)	State and national (State and Commonwealth matters)	Yes
A2	During operation, the combustion of fossil fuels leads directly to the emission of GHGs from combustion of fossil fuels in smelting activities and indirectly via the consumption of purchased non-renewable electricity from the National Electricity Market impacting on State and Commonwealth matters	Combustion of fossil fuels	Air (GHG)	State and national (State and Commonwealth matters)	Yes

3.2 Assessment of effects

This section describes the methods, assumptions, scenario configurations and assessment criteria prepared for the GHG assessment.

3.3 Scope of GHG assessment

3.3.1 GHG assessment boundary and emission sources

For **scope 1** emissions, the sources included were:

- on-site liquid fuel (diesel, fuel oil) combustion
- LPG combustion
- coke coal consumption (assumed to occur until FY28).

For **scope 2** emissions, the relevant source was the purchase of grid electricity for on-site use. Scope 2 emissions arise from the generation of the electricity purchased and consumed by an organisation, but are physically produced by the burning of fuels (coal, natural gas, etc.) at power stations.

3.3.2 Annual GHG emission calculation methodology

The estimation of GHG emissions for the future operation of the Olympic Dam site, including the SRE Project, was generally based primarily on the *National Greenhouse Accounts Factors Workbook* (NGAF) (DCCEW 2025). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

Details of the GHG emission calculation methodology are provided in the following sections and adopted emission factors listed in Annexure A.

The supporting activity data (e.g. fuel consumption, electricity consumption) are given in Annexure B.

The following resources have been referenced to estimate annual energy consumption rates for Olympic Dam featuring the staged development of the SRE Project:

- *SPS Extension Pathway to Net Zero Decarbonisation Plan*, Hatch Fluor Joint Venture (HFJV 2026) – hereafter the HFJV P2NZ report.
- Annual life of asset forecast profiles for diesel, fuel oil, LPG, coke coal and purchased electricity provided by BHP - hereafter LoA forecast.
- Annual NGER Scheme reports FY19 to FY25 for the Olympic Dam Complex, provided by BHP.

The HFJV P2NZ specifically notes that emissions from the mine and concentrator at Olympic Dam were not included in future energy consumption estimates. The LoA forecast profiles provided by BHP were combined with the HFJV P2NZ estimations to derive energy consumption rates for all key sources at the Olympic Dam Complex.

It is noted that BHP have a commitment to the purchase of electricity generated by renewables via Power Purchase Agreement. For the purpose of this assessment, however, scope 2 emissions have been estimated using available South Australian grid emission intensity factors (DCCEEW 2026). Annual scope 2 emissions presented in this report should, therefore, be viewed as conservative.

The results of the emission calculations are presented in Annexure C.

3.3.3 Annual scope 1 and scope 2 GHG emissions – existing operations emissions

In order to incorporate existing annual scope 1 and 2 GHG emissions for the Olympic Dam Complex into this report, the annual reported scope 1 and 2 GHG emissions were directly extracted from the NGER Scheme reports between FY19 to FY25.

3.3.4 Annual scope 1 and 2 GHG emissions calculation approach – BAU emissions

- In order to estimate annual scope 1 GHG emissions from the period of operations between the FY25 NGER Scheme reporting period and the commencement of SRE Stage 1A (BAU operations), the annual LoA forecast projections for diesel, fuel oil, LPG, coking coal and purchased electricity were adopted.
- The individual smelter process LPG allocation from Appendix A of the HFJV P2NZ report was applied to the annual LoA forecast projections for LPG consumption.
- Smelter coking coal consumption is assumed to continue until FY31.
- For scope 2 emissions, the purchased electricity consumption by smelter operations between FY26 and FY32 were sourced from the annual LoA forecast projections.
- The diesel (scope 1) and electricity (scope 2) consumption by mining and other activities at the Olympic Dam Complex were sourced from the annual LoA forecast projections.

3.3.5 Annual scope 1 GHG emissions calculation approach – SRE emissions

- Annual construction diesel fuel consumption is expected to equate to 2,604 kL/year based on Table 4-3 of the HFJV P2NZ Report. Construction emissions are assumed to occur in the following years:
  - Stage 1A - between FY28 and FY32
  - Stage 1B - between FY34 and FY36
  - Stage 2 - between FY37 and FY41.
- The expected fuel consumption rates by SRE stage listed in Appendix A of the HFJV P2NZ report were adopted to estimate operational SRE smelter fuel consumption
- It is assumed that the quoted fuel oil consumption rates in the HFJV P2NZ Report are a mixture of diesel and fuel oil. To estimate future diesel and fuel oil consumption by SRE operations, the existing relationship between annual reported diesel stationary and fuel oil has been calculated from annual NGER Scheme reports, equating to 36% diesel, 64% fuel oil.
- Based on page 12 of the HFJV P2NZ report, the projected fuel consumption rates for the staged development of the SRE project are applied as follows:
  - Stage 1A - between FY33 and FY35
  - Stage 1B - between FY36 and FY41
  - Stage 2 - between FY42 and FY66.

- The HFJV P2NZ identified the following in-built engineering improvements for the SRE Project that have the benefit of reducing energy consumption and associated scope 1 GHG emissions relative to existing smelter operations:
    - Oxygen enrichment for the FSF leading to a 19% reduction in diesel/fuel oil consumption.
    - Upgrade of the anode furnace oxy-fuel burner, leading to a 54% reduction in LPG consumption.
    - Replacement of the Matte Mill heating system from LPG heating to steam air heating supplied from process co-generation.

3.3.6 Annual scope 2 GHG emissions calculation approach – SRE emissions

- The expected annual electricity consumption rates by SRE stage listed in Appendix A of the HFJV P2NZ report were adopted to estimate SRE smelter electricity consumption.
- The 2025 federal government annual grid emissions factors for South Australia (DCCEEW 2026) have been applied for FY25 onwards. This projection accounts for the expected decarbonisation of the grid; however, the projections only extend to FY40, with the FY40 emission factor extended to FY66 for the purpose of this assessment.

3.4 Emission estimates

3.4.1 Scope 1 and Scope 2 emissions

The estimates of scope 1 and scope 2 emissions in t CO_2-e in each year to FY66 are given in Annexure C. The project life emission totals and average annual emissions are also presented.

The contribution by emission source group by year to annual scope 1 and scope 2 GHG emissions is presented in Figure 3.1. The contribution to annual scope 2 GHG emissions is presented in Figure 3.3. The following points are noted relevant to the smelter operations at the Olympic Dam site:

- Relative to BAU projected operations, annual diesel, fuel oil and LPG combustion emissions from the smelter operations are projected to increase for all SRE stages, while coking coal emissions are eliminated from Stage 1A onwards.
- Relative to BAU, mining-related diesel combustion emissions are projected to increase for future operations to Stage 1B before decreasing at Stage 2.
- Smelter emissions (LPG, diesel and fuel oil combustion) are estimated to comprise approximately 38%, 39%, 41% and 44% of total annual scope 1 emissions for BAU, Stage 1A, Stage 1B and Stage 2 operations respectively.
- Based on projected energy consumption rates, annual scope 1 emissions from the Olympic Dam Complex (smelter and mine) are projected to be between 212,195 t CO_2-e/year and 285,684 t CO_2-e/year across all years from FY25 onwards, with an annual average of 255,683 t CO_2-e/year.
- Annual scope 2 emissions decrease year on year to the commencement of SRE Project Stage 1A in FY33, at which is associated with the projected decarbonisation of the electricity grid (DCCEEW 2026). Following the increase in electricity consumption from Stage 1A onwards, the annual scope 2 emissions increase, but do not reach current reported emissions from the FY19 to FY25 NGER Scheme reporting periods.

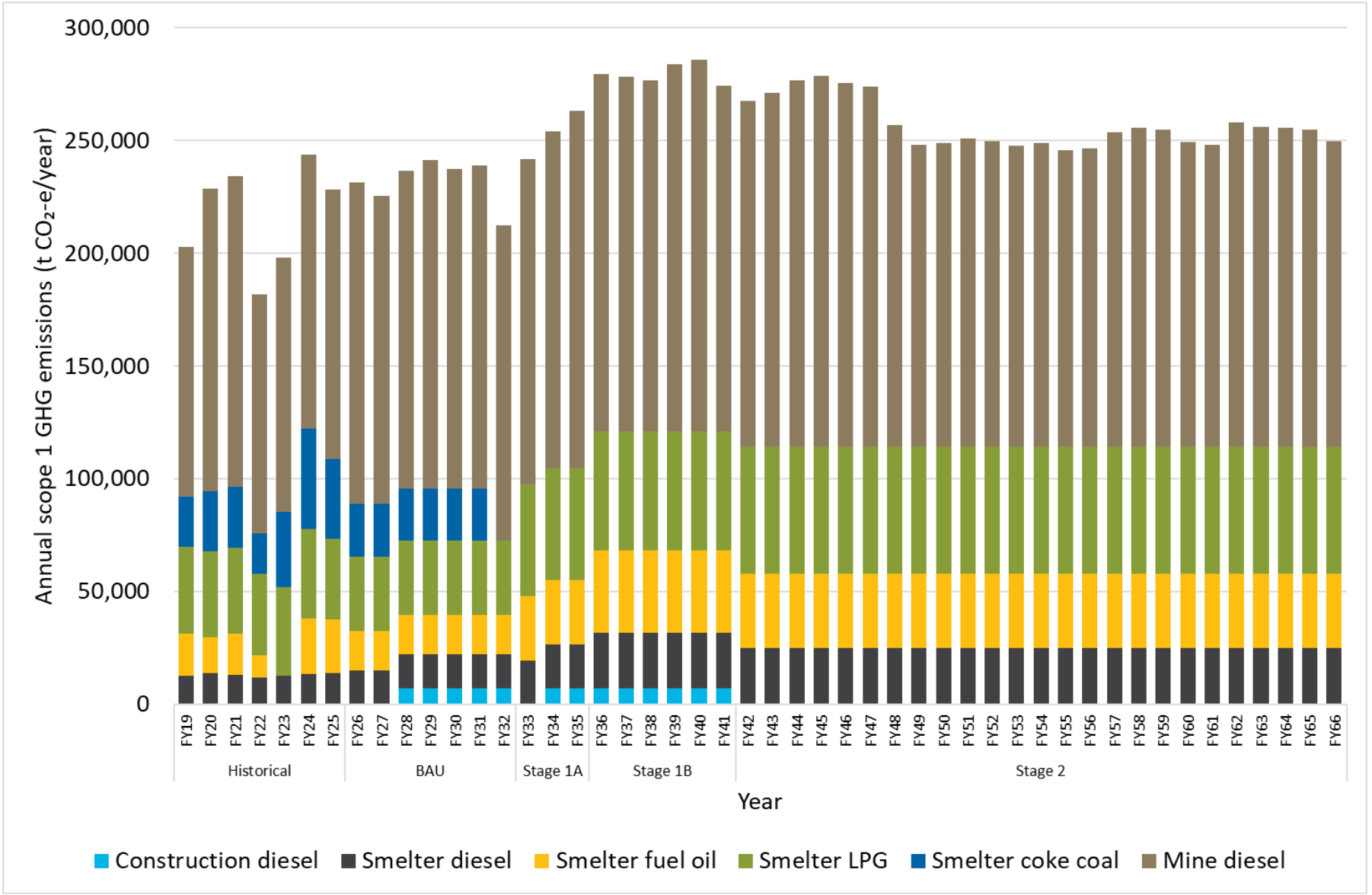


Figure 3.1 **Contribution to annual scope 1 GHG emissions by year – all sources – FY19 to FY66**

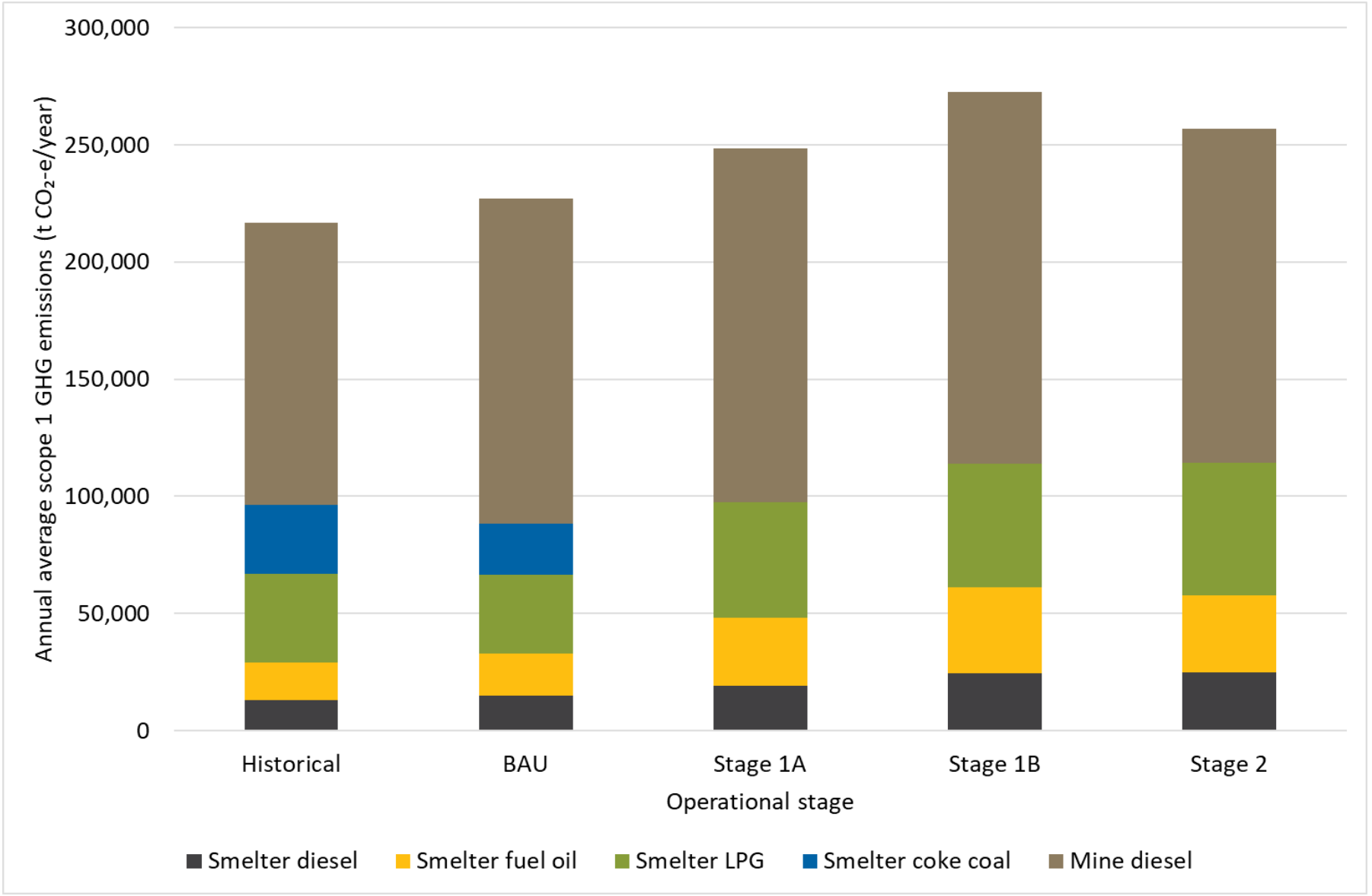


Figure 3.2 **Contribution to annual average scope 1 GHG emissions by project stage – operational sources only**

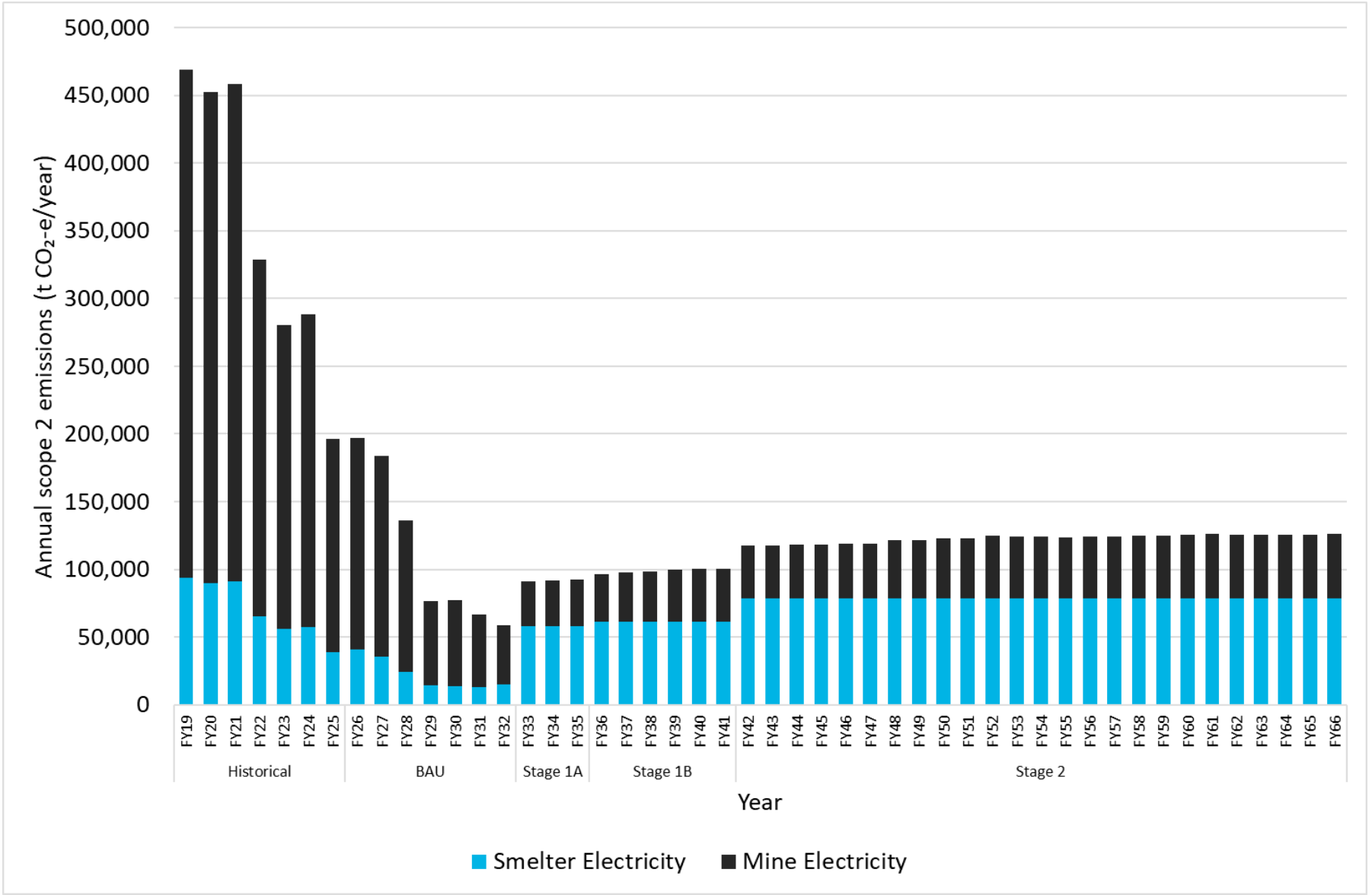


Figure 3.3 **Contribution to annual scope 2 GHG emissions by year – FY19 to FY66**

The significance to total smelter scope 1 emissions by fuel type and use is presented in Figure 3.4. It can be seen from these figures that the consumption of diesel and fuel oil by the furnaces and LPG by the smelting and casting processes are the primary points of scope 1 GHG emissions for the SRE Project.

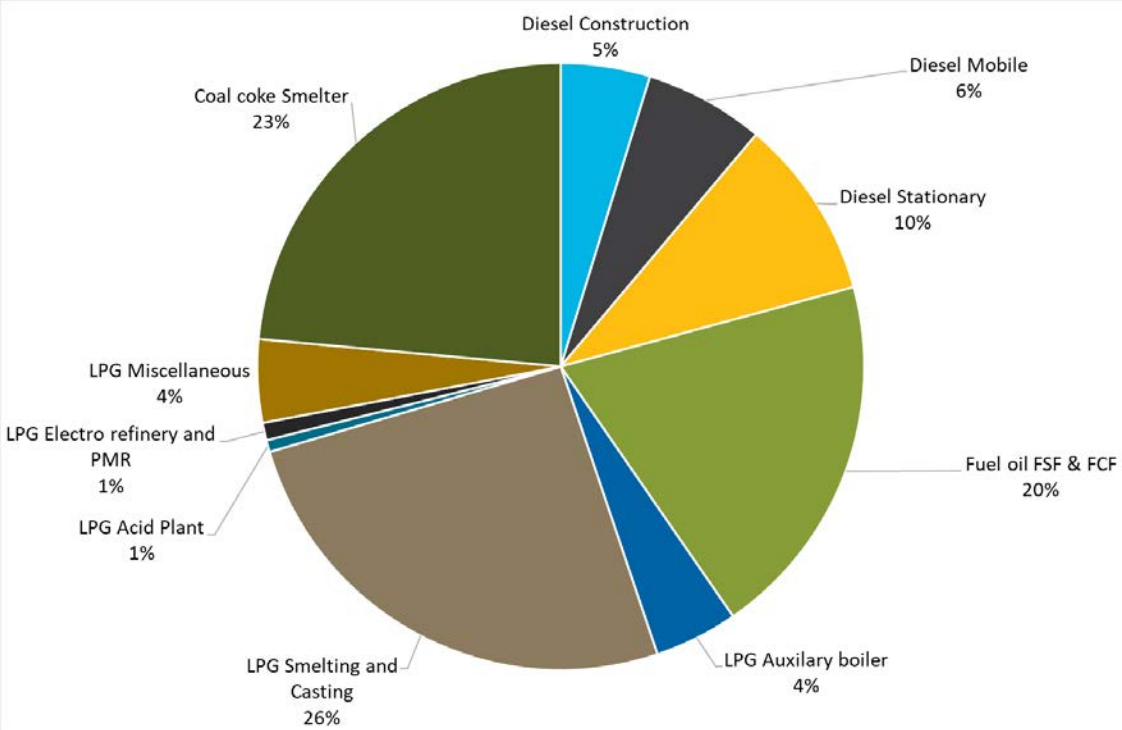


Figure 3.4 Source contribution to annual scope 1 GHG emissions – smelter only - BAU

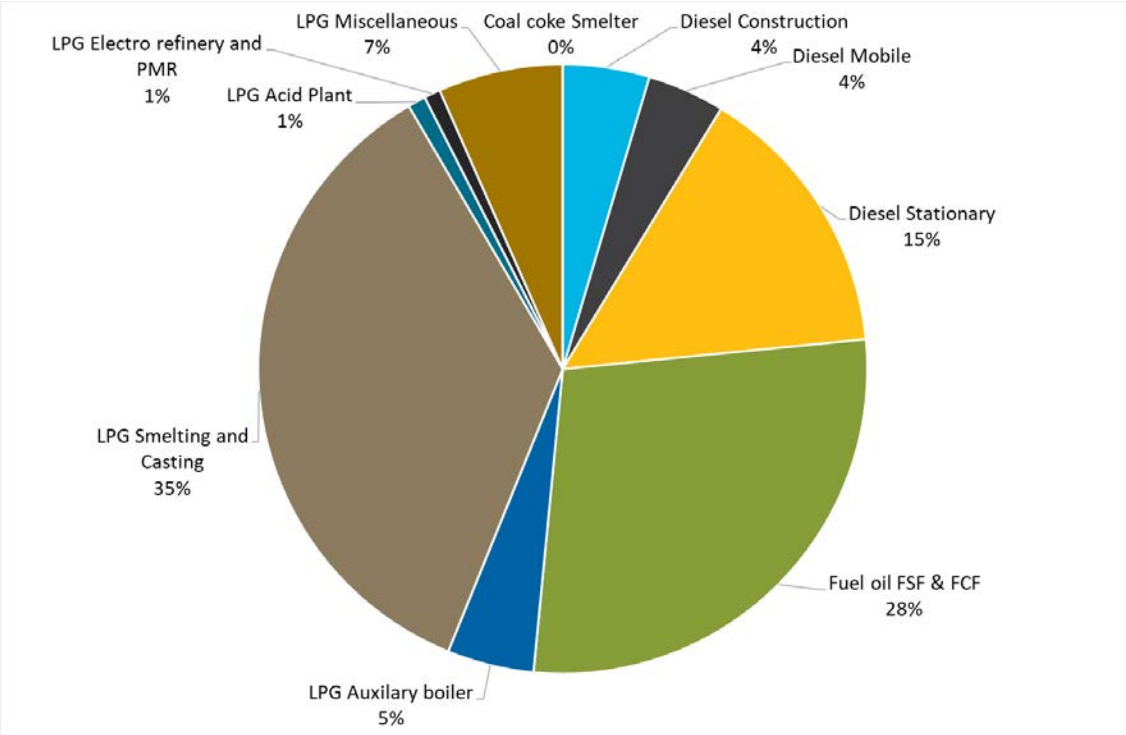


Figure 3.5 Source contribution to annual scope 1 GHG emissions – smelter only - Stage 1A

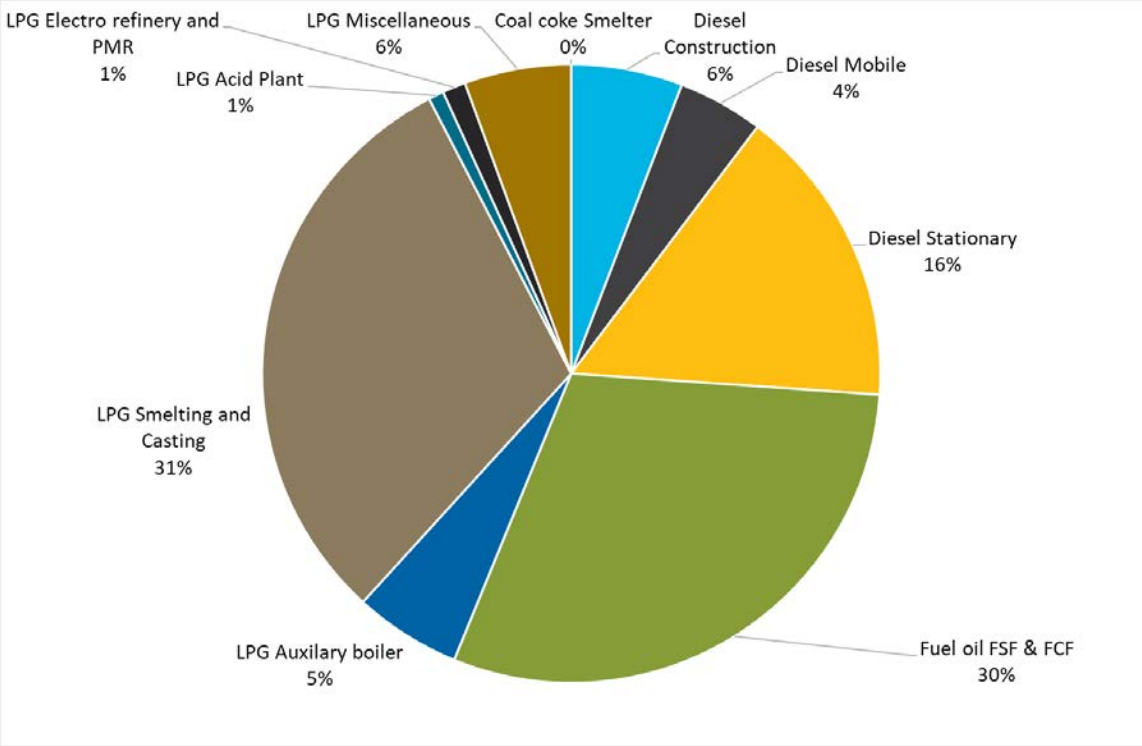


Figure 3.6 Source contribution to annual scope 1 GHG emissions – smelter only - Stage 1B

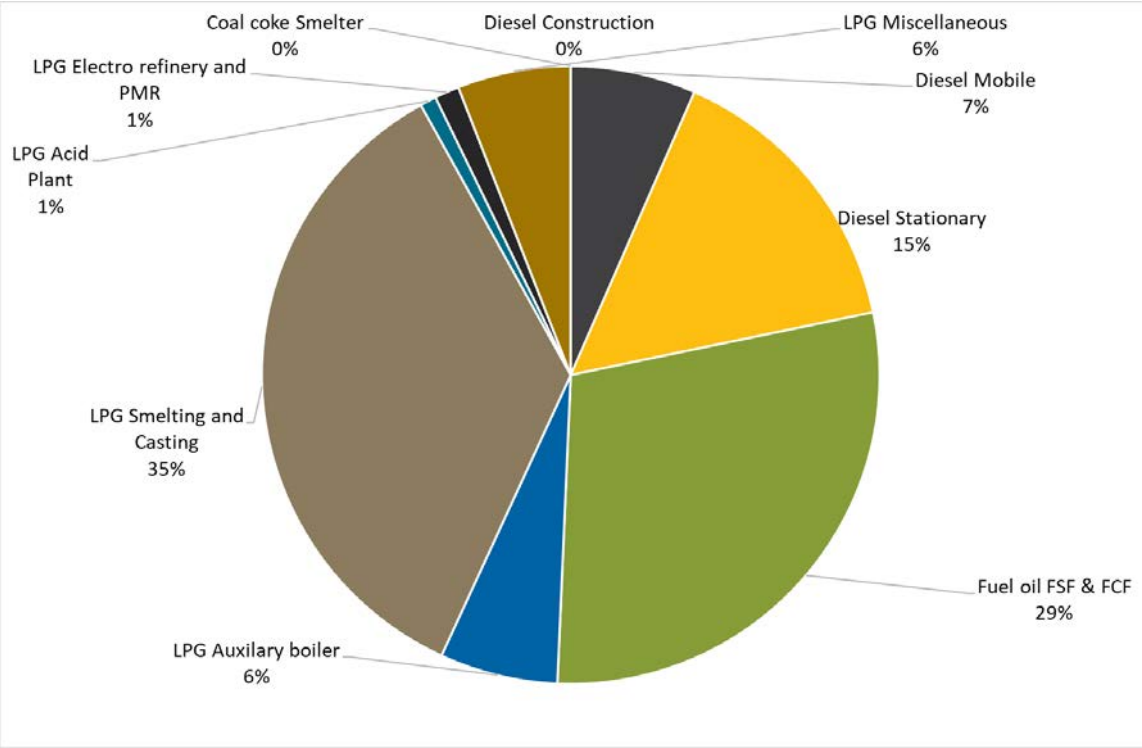


Figure 3.7 Source contribution to annual scope 1 GHG emissions – smelter only - Stage 2

The change in annual GHG emissions from smelter operations in isolation have been reviewed. The change in annual scope 1 only and combined scope 1 and scope 2 GHG emissions relative to reported FY25 has been calculated and is presented in in Figure 3.8 and Figure 3.9 respectively.

In terms of the projected change in annual smelter emissions relative to reported FY25 emissions, the annual scope 1 GHG emissions during Stage 1A, Stage 1B and Stage 2 are approximately 5% lower, 10% higher and 5% higher respectively.

The annual average scope 1 and 2 emissions during the staged development of the SRE Project are estimated to be 160,218 t CO_2-e/year for Stage 1A, 182,697 t CO_2-e/year for Stage 1B and 192,524 t CO_2-e/year for Stage 2. Relative to estimated annual average BAU period (i.e. FY26 to FY32) projected smelter and refinery emissions (117,834 t CO_2-e/year), the SRE Project returns an increase of approximately 36% for Stage 1A, 55% for Stage 1B and 63% for Stage 2.

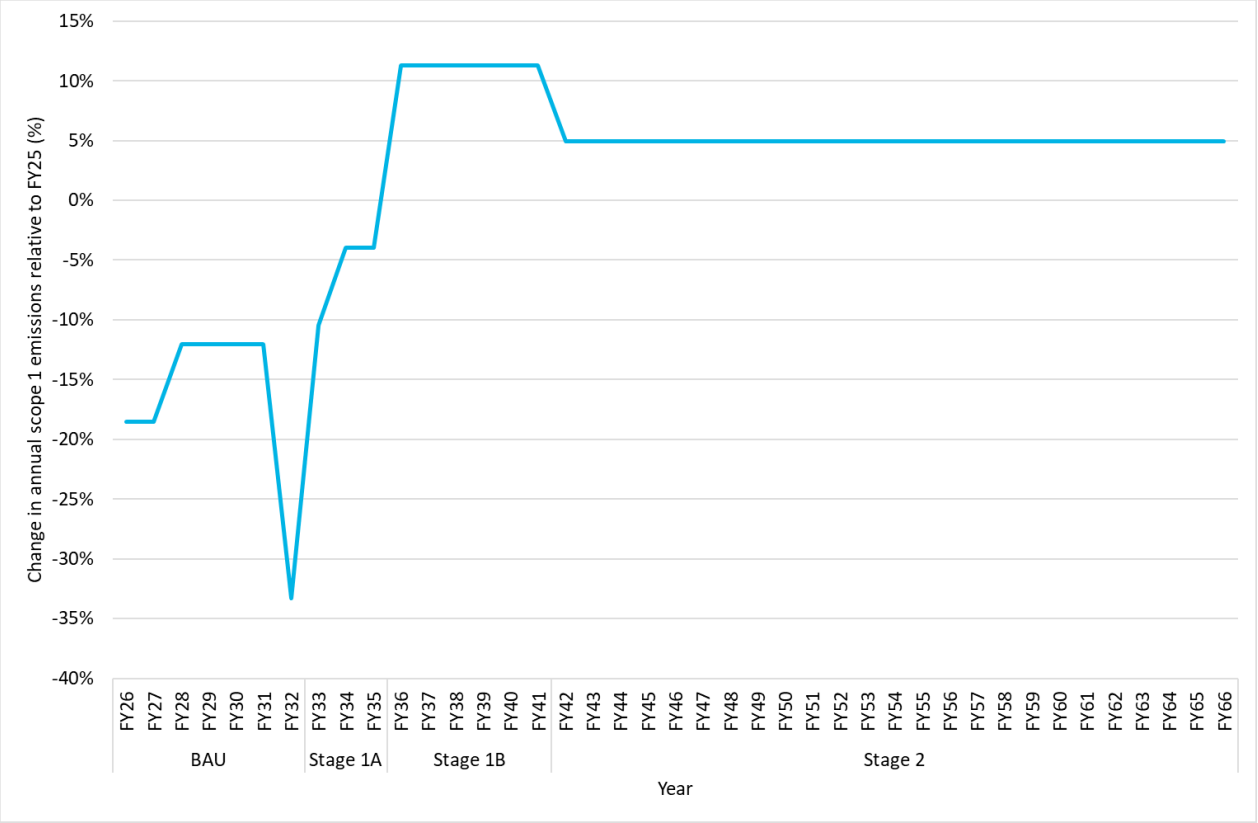


Figure 3.8 Change in annual scope 1 GHG emissions only relative to FY25 emissions – smelter only

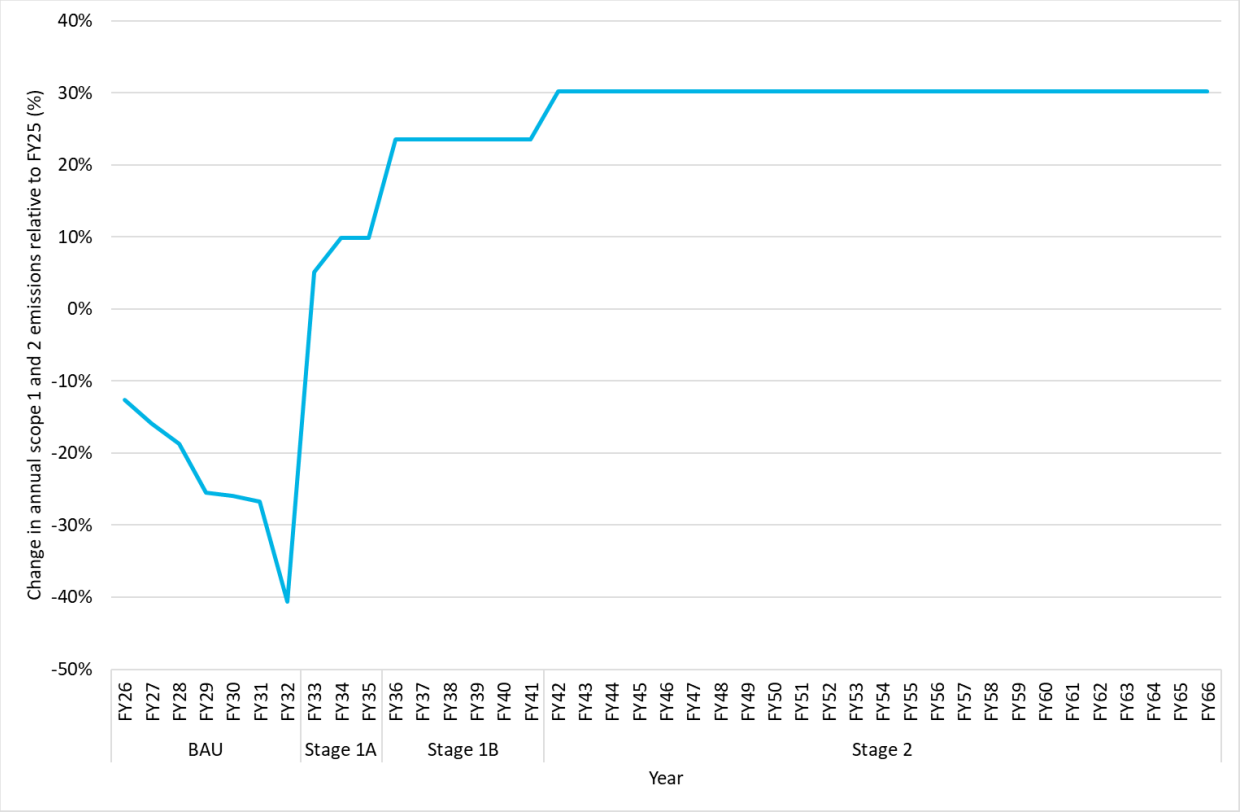


Figure 3.9 Change in annual scope 1 and 2 GHG emissions relative to FY25 emissions – smelter only

3.5 Conclusion

Emissions of GHG emissions have been quantified for the projected energy consumption rates by the Olympic Dam site out to FY66. The emission totals calculated show that the SRE Project will increase annual scope 1 GHG emissions from smelter operations relative to BAU operational emissions.

The annual average scope 1 and 2 emissions during the staged development of the SRE Project are estimated to be 160,218 t CO_2-e/year for Stage 1A, 182,697 t CO_2-e/year for Stage 1B and 192,524 t CO_2-e/year for Stage 2. Relative to estimated annual average BAU period (i.e. FY26 to FY32) projected smelter and refinery emissions (117,834 t CO_2-e/year), the SRE Project returns an increase of approximately 36% for Stage 1A, 55% for Stage 1B and 63% for Stage 2.

Table 3.2 presents the revised SPR assessment with respect to GHG impacts following completion of the assessment of effects. Those potential impact events for which a linkage has been demonstrated have been carried forward for impact assessment (see Section 4).

Table 3.2 Final SPR assessment – confirmed impact events

SPR ID No.	Potential impact event	Receptor	Linkage	Linkage justification
A1	During construction, the combustion of fossil fuels leads to the emission of GHGs which impacts State and Commonwealth matters	State and national (State and Commonwealth matters)	Yes	The combustion of fossil fuels will generate GHG emissions in all years of the SRE Project, including construction
A2	During operation, the combustion of fossil fuels leads directly to the emission of GHGs from combustion of fossil fuels in smelting activities and indirectly via the consumption of purchased non-renewable electricity from the National Electricity Market impacting on State and Commonwealth matters	State and national (State and Commonwealth matters)	Yes	The combustion of fossil fuels and consumption of electricity by the smelter processes, from BAU operations to the SRE Project operations, will generate GHG emissions in all future years

4 Impact assessment

The impact significance of confirmed impact events associated with the proposed SRE Project activities is described in this section.

4.1 Confirmed impact events

Based on the assessment of effects, the impact events presented in Table 4.1, have been confirmed.

Table 4.1 Confirmed impact events

Pathway	Impact ID	Impact event
Air	A1	During construction, the combustion of fossil fuels leads to the emission of GHGs which impacts State and Commonwealth matters
Air	A2	During operation, the combustion of fossil fuels leads directly to the emission of GHGs from combustion of fossil fuels in smelting activities and indirectly via the consumption of purchased non-renewable electricity from the National Electricity Market impacting on State and Commonwealth matters

4.2 Impact significance criteria

The impact significance criteria are presented in the Environmental Impact Assessment Framework (EIAF) Appendix to the EIS. Criteria relevant to the assessment of the GHG related impact significance is repeated in Table 4.2.

Table 4.2 Consequence definitions and significance determination

Severity level	1	2	3	4	5
Environmental value	**Not significant**		**Significant**		
Greenhouse gas (social-economic and environmental values)	Annual scope 1 greenhouse gas emissions less than 50,000 t defined as CO_2 equivalent (CO_2-e)	Annual scope 1 greenhouse gas emissions greater than 50,000 t but less than 100,000 t of CO_2-e	Annual scope 1 greenhouse gas emissions greater than 100,000 t of CO2-e for a single year	Annual scope 1 greenhouse gas emissions greater than 100,000 t of CO_2-e and reduced within a two to five-year period	Annual scope 1 greenhouse gas emissions greater than 100,000 t of CO_2-e and reduced within a five to ten-year period

4.3 Impact assessment

The impact significance associated with the proposed SRE Project activities is described below and summarised in Table 4.3.

4.4 Impact of SRE Project-related GHG emissions

The emission calculations presented within Section 3.4 of this report show that the SRE Project will generate annual scope 1 and 2 GHG emissions greater than 100,000 t CO_2-e/annum; however, annual emission projections represent a reduction relative to BAU smelter operations.

The GHG impact assessment, including the determination of impact significance and the understanding of uncertainties, is summarised in Table 4.3.

Table 4.3 GHG impact assessment

Confirmed impact event	Impact ID	Impact significance	Significance justification	Uncertainty
Air (GHG)				
During construction, the combustion of fossil fuels leads to the emission of GHGs which impacts State and Commonwealth matters	A1	1 (not significant)	Emissions from the construction phase are relatively short lived, and are estimated to be a small proportion of total annual GHG emission from the SRE Project and Olympic Dam site.	**Low-moderate** Emission factors adopted in the calculations are nationally accepted for the estimation of GHG emissions from fuel combustion and energy consumption. Construction GHG emissions have been estimated using projected diesel consumption rates from the HFJV P2NZ Report.
During operation, the combustion of fossil fuels leads directly to the emission of GHGs from combustion of fossil fuels in smelting activities and indirectly via the consumption of purchased non-renewable electricity from the National Electricity Market impacting on State and Commonwealth matters	A2	5 (significant)	The annual average scope 1 and 2 emissions during the staged development of the SRE Project are estimated to be 160,218 t CO_2-e/year for Stage 1A, 182,697 t CO_2-e/year for Stage 1B and 192,524 t CO_2-e/year for Stage 2. Relative to estimated annual average BAU period (i.e. FY26 to FY32) projected smelter and refinery emissions (117,834 t CO_2-e/year), the SRE Project returns an increase of approximately 36% for Stage 1A, 55% for Stage 1B and 63% for Stage 2.	**Low-moderate** Emission factors adopted in the calculations are nationally accepted for the estimation of GHG emissions from fuel combustion and energy consumption. Annual emission calculations are linked to provided future projections for the Olympic Dam site, including the smelter. Accuracy of annual these projections applied in the GHG emission calculations is the primary uncertainty associated with the GHG emission calculations

4.5 Mitigation and management

Each confirmed impact event is required to have a description of proposed management and mitigation measures applied, aimed at either breaking the SPR linkage (i.e. avoiding the impact) or otherwise reducing the impact significance to as low as reasonably achievable (ALARA). These are presented in the following sections.

4.5.1 Impact significance level 1 and level 2 (not significant)

It is expected that diesel combustion would be the primary emission source from the SRE Project construction phase. The following management practices are recommended to minimise emissions from the combustion of diesel from construction fleet:

- minimise material haulage distances as far as practicable to reduce diesel consumption
- routinely maintain haul roads to reduce truck tyre rolling resistance
- review construction practices to minimise double handling of materials
- consider the use of alternative fuels (e.g. low-sulphur fuel) where economically and practically feasible
- minimise the idling of diesel equipment wherever feasible
- routinely service all equipment to maintain manufacturers' emission specifications to ensure that operational efficiency
- perform pre-start inspections at each shift on mobile plant and vehicles
- track fuel usage.

4.5.2 Impact significance level 3, level 4 and level 5 (significant)

As established, the future operation of the SRE Project will continue to generate significant annual scope 1 and 2 GHG emissions. The analysis in this report shows that the primary source of GHG emissions associated with the SRE Project will be the combustion of diesel, fuel oil and LPG by smelter operations. Therefore, strategies to reduce the reliance of the smelter processes on diesel, fuel oil and LPG are central to reducing annual GHG emissions for the SRE Project.

Firstly, it is reiterated that several in-built engineering design opportunities, outlined in the HFJV P2NZ Report and summarised in Section 3.3.5, have resulted in limiting the growth in diesel, fuel oil and LPG consumption rates relative to BAU smelter operations despite the increase in annual throughput.

The HFJV P2NZ Report also identified a range of different energy reduction opportunities for the SRE Project for a pathway to net zero emissions. Following a workshop with BHP, a preferred P2NZ Roadmap was developed, comprising the following options for consideration:

- Scope 1:
    - Alternative fuels or electrification of fleet and stationary equipment for construction phase emissions
    - In-built opportunities in engineering design (summarised in Section 3.3.5 and accounted for in the emission calculations)
    - Bio-LPG replacement in the launder burners, anode furnace and other LPG users

- Bio-diesel replacement in the flash furnaces
- Use of a 50% bio-diesel blend in the mobile fleet
- Either electrification, bio-LPG or thermal energy storage system for the auxiliary boiler (options to be evaluated)
- Carbon offsets: used only to neutralise residual emissions

• Scope 2:

- Fully abated the BHP Renewable Energy Plan

The viability and timing of the above P2NZ mitigation strategy options are currently under consideration by BHP and will by shaped by factors such as biofuel availability, feasibility for implementation by site and sufficient PPA to supply renewable energy to the Olympic Dam Complex.

4.6 Conclusion

Following completion of the assessment of effects investigation, it was determined that there was a total of two confirmed impact events.

These events were assessed to quantify the likely significance of the impact against the EIAF impact significance criteria, one of which (SRE Project construction phase GHG emissions) has been assessed with a significance Level 1 (not significant), and one GHG impact (SRE Project operational GHG emissions) with an assessed significance Level 5 (significant).

Mitigation and management measures are proposed to reduce the impact significance to ALARA. The SRE Project design will feature a number of in-built engineering opportunities designed to reduce energy consumption rates as much as is practicable to do so. Further, several alternative fuel strategy options (e.g. bio-LPG and bio-diesel) are under consideration for implementation by BHP to assist with meeting net zero emission commitments and Safeguard Mechanism emission reduction obligations.

For scope 2 emissions associated with the consumption of purchased electricity, it is noted that emissions based on the SA grid electricity emission factor projections. Under the BHP Renewable Electricity Plan, BHP are also investigating the uptake of 100% renewable electricity from 2030, which would effectively reduce annual scope 2 emissions to zero.

References

DCCEEW 2025a*, Australia's emissions projections 2025,* Department of Climate Change, Energy, the Environment and Water, Canberra, December

DCCEEW 2025b, Australian *National Greenhouse Accounts Factors*, Department of Climate Change, Energy, the Environment and Water, Canberra.

DoE 2014, *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines.*

HFJV 2026, *SPS Extension Pathway to Net Zero Decarbonisation Plan*, H375231-0000-484-050-0001.

WRI & WBCSD 2013, *Technical Guidance for Calculating Scope 3 Emissions, version 1.0*. World Resources Institute and World Business Council for Sustainable Development).

Abbreviations and acronyms

Acronym	Expansion
ALARA	As Low As Reasonably Achievable
BAU	Business-as-usual
BHP	BHP Olympic Dam Corporation Pty Ltd
CH4	Methane
CO2	Carbon dioxide
CO2-e	Carbon dioxide equivalent
Copper SA	Copper South Australia
DBF	Direct-to-blister flash furnace
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EIAF	Environmental Impact Assessment Framework
EIS	Environment Impact Statement
EPA	Environment Protection Authority
FCF	Flash converting furnace
FIFO	Fly-in/fly-out
FSF	Flash smelting furnace
GHG	Greenhouse gas
HFC	Hydrofluorocarbons
N2O	Nitrous oxide
PFCs	Perfluorocarbons
PMR	Precious metal refinery
SA	South Australia
SML	Special Mining Lease
SF6	Sulphur hexafluoride
SPC	State Planning Commission
SPR	Source-pathway-receptor
SRE	Smelter and Refinery Expansion

Units of measure

Unit	Description
%	per cent
Cu	copper
d	day
h	hour
kg	kilogram
kL	kilolitre
km	kilometre
kV	kilovolt
L	litre
m	metre
ML	megalitre
MW	megawatt
MWh	megawatt hours
t	tonne
V	volt
yr	year

Appendix A
GHG emission calculations

EMM
creating opportunities

A.1 Scope 1 emissions

A.1.1 Liquid fuel consumption

For each greenhouse gas *i* (CO_2, CH_4 and N_2O), annual scope 1 emissions from the on-site consumption of liquid fuels were estimated using the following equation:

$$E_i = \frac{Q \times EC \times EF_i}{1{,}000} \qquad \text{Equation A.1}$$

where:

E_i	=	GHG emission for gas *i*	(t CO_2-e/year)
Q	=	quantity of fuel	(kL/year)
EC	=	energy content of fuel	(GJ/kL)[7]
EF_i	=	emission factor for gas *i*	(kg CO_2-e/GJ)[8]

The energy content and GHG emission factors for diesel are presented in Table A.1. The quantities of fuel (kL) used in the assessment are given in Annexure B.

Table A.1 Energy content and scope 1 emission factors – liquid fuel consumption

Fuel	Energy content (GJ/kL)	Scope 1 emission factors (kg CO_2-e/GJ)			Reference
		CO_2	CH_4	N_2O	
Diesel – stationary (on-site)	38.6	69.9	0.1	0.2	DCCEEW (2025b) (Table 8, diesel oil)
Diesel – transport (offsite)	38.6	69.9	0.07	0.4	DCCEEW (2025b) (Table 9, Heavy duty vehicles Diesel oil - Euro iv or higher)
Fuel oil	39.7	73.6	0.04	0.2	DCCEEW (2025b) (Table 8, Fuel oil)
LPG	25.7	60.2	0.2	0.2	DCCEEW (2025b) (Table 8, LPG)

[7] GJ = gigajoules

[8] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

A.1.2 Solid fuel consumption

For each greenhouse gas *i* (CO_2, CH_4 and N_2O), annual scope 1 emissions from the on-site consumption of solid fuels were estimated using the following equation:

$$E_i = \frac{Q \times EC \times EF_i}{1{,}000}$$ Equation A.1

where:

E_i	=	GHG emission for gas *i*	(t CO_2-e/year)
Q	=	quantity of fuel	(t/year)
EC	=	energy content of fuel	(GJ/t)[9]
EF_i	=	emission factor for gas *i*	(kg CO_2-e/GJ)[10]

The energy content and GHG emission factors for coke coal are presented in Table A.2. The quantities of fuel (t) used in the assessment are given in Annexure B.

Table A.2 Energy content and scope 1 emission factors – liquid fuel consumption

Fuel	Energy content (GJ/t)	Scope 1 emission factors (kg CO_2-e/GJ)			Reference
		CO_2	CH_4	N_2O	
Coke coal	27.0	107	0.03	0.2	DCCEEW (2025b) (Table 4, coke coal)

A.2 Scope 2 emissions

Annual scope 2 GHG emissions associated with on-site electricity consumption were estimated using the following equation:

$$E = \frac{Q \times EF}{1{,}000}$$ Equation A.2

where:

E	=	GHG emission	(t CO_2-e/year)
Q	=	quantity of electricity	(MWh/year)[11]
EF	=	emission factor for electricity consumption	(kg CO_2-e/MWh)

The estimated electricity consumption for the project is given in Annexure B.

The scope 2 emission factors for electricity consumption in South Australia were taken from *Australia's emissions projections 2025* (DCCEEW 2025a). These values are presented in Table A.3.

9 GJ = gigajoules

10 kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

11 MWh = megawatt hours

Table A.3 Scope 2 GHG emission factors for electricity consumption

Financial year	Emission factor (t CO_2-e/MWh)	Reference
FY25	0.22	DCCEEW (2025) (values for SA in Table 42, FY25 based on NGAF 2025 factor)
FY26	0.17	
FY27	0.17	
FY28	0.15	
FY29	0.11	
FY30	0.06	
FY31	0.06	
FY32	0.05	
FY33	0.04	
FY34	0.03	
FY35	0.03	
FY36	0.03	
FY37	0.03	
FY38	0.03	
FY39	0.03	
FY40 - onwards	0.03	

Appendix B
Activity data

EMM
creating opportunities

B.1 On-site activity

Fuel based activity data for the emission estimates are presented in Table B.1.

Table B.1 Projected annual activity data

Year	SRE construction	SRE Project phase	Smelter											Mine	
			Diesel	Diesel	Diesel	Fuel oil	LPG	LPG	LPG	LPG	LPG	Coal coke	Electricity	Diesel	Electricity
			Construction	Mobile	Stationary	FSF & FCF	Auxilary boiler	Smelting and Casting	Acid Plant	Electro refinery and PMR	Miscellaneous	Smelter	Load	Mobile	Load
			kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	t/annum	MWh/annum	kL/annum	MWh/annum
FY19		Historical	-	2,006.2	2,632.9	6,315.8	3,076.3	17,710.4	439.1	641.9	3,060.7	7,253.4	183,195.8	40,854.2	736,324.2
FY20		Historical	-	1,928.4	3,199.1	5,378.1	3,030.1	17,444.4	432.5	632.2	3,014.7	8,609.4	204,753.2	49,638.6	822,970.2
FY21		Historical	-	1,511.0	3,276.2	6,229.6	3,010.7	17,332.8	429.8	628.2	2,995.4	8,946.0	212,542.0	50,835.6	854,276.1
FY22		Historical	-	1,837.2	2,524.5	3,412.7	2,850.7	16,411.5	406.9	594.8	2,836.2	5,947.5	204,753.2	39,171.6	822,970.2
FY23		Historical	-	1,983.0	2,686.0	0.0	3,117.2	17,945.5	445.0	650.4	3,101.3	11,462.6	223,357.6	41,677.7	897,747.4
FY24		Historical	-	2,068.5	2,889.3	8,349.7	3,150.7	18,138.6	449.8	657.4	3,134.7	14,875.8	229,872.4	44,832.3	923,932.7
FY25	-	BAU	-	2,179.3	2,839.9	8,108.2	2,833.6	16,313.0	404.5	591.2	2,819.2	12,334.3	229,774.1	44,064.8	923,537.6
FY26	-	BAU	-	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	8,000.0	238,529.3	52,684.1	919,862.1
FY27	-	BAU	-	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	8,000.0	237,805.5	50,423.0	988,847.8
FY28	Stage 1A construction	BAU	2,604	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	8,000.0	222,292.9	52,019.1	1,013,429.4
FY29	Stage 1A construction	BAU	2,604	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	8,000.0	239,668.8	53,718.5	1,030,801.0
FY30	Stage 1A construction	BAU	2,604	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	8,000.0	229,354.6	52,284.2	1,061,904.7
FY31	Stage 1A construction	BAU	2,604	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	8,000.0	253,333.4	52,857.7	1,075,150.1
FY32	Stage 1A construction	BAU	2,604	2,181.0	3,364.0	5,930.0	2,624.1	15,106.7	374.6	547.5	2,610.7	-	380,294.7	51,518.0	1,093,829.5
FY33	-	Stage 1A	-	1,545.8	5,556.7	9,795.3	3,024.0	23,247.0	623.7	567.0	4,347.0	-	1,933,475.7	53,227.9	1,092,502.2
FY34	Stage 1B construction	Stage 1A	2,604	1,545.8	5,556.7	9,795.3	3,024.0	23,247.0	623.7	567.0	4,347.0	-	1,933,475.7	55,216.0	1,134,625.7
FY35	Stage 1B construction	Stage 1A	2,604	1,545.8	5,556.7	9,795.3	3,024.0	23,247.0	623.7	567.0	4,347.0	-	1,933,475.7	58,526.8	1,155,882.3
FY36	Stage 1B construction	Stage 1B	2,604	1,994.8	7,055.6	12,437.4	4,347.0	23,814.0	623.7	945.0	4,347.0	-	2,052,426.6	58,474.4	1,151,341.1
FY37	Stage 2 construction	Stage 1B	2,604	1,994.8	7,055.6	12,437.4	4,347.0	23,814.0	623.7	945.0	4,347.0	-	2,052,426.6	57,963.8	1,207,036.7
FY38	Stage 2 construction	Stage 1B	2,604	1,994.8	7,055.6	12,437.4	4,347.0	23,814.0	623.7	945.0	4,347.0	-	2,052,426.6	57,468.2	1,234,479.9
FY39	Stage 2 construction	Stage 1B	2,604	1,994.8	7,055.6	12,437.4	4,347.0	23,814.0	623.7	945.0	4,347.0	-	2,052,426.6	60,034.6	1,260,311.3
FY40	Stage 2 construction	Stage 1B	2,604	1,994.8	7,055.6	12,437.4	4,347.0	23,814.0	623.7	945.0	4,347.0	-	2,052,426.6	60,729.2	1,286,344.8

Year	SRE construction	SRE Project phase	Smelter											Mine	
			Diesel	Diesel	Diesel	Fuel oil	LPG	LPG	LPG	LPG	LPG	Coal coke	Electricity	Diesel	Electricity
			Construction	Mobile	Stationary	FSF & FCF	Auxilary boiler	Smelting and Casting	Acid Plant	Electro refinery and PMR	Miscellaneous	Smelter	Load	Mobile	Load
			kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	kL/annum	t/annum	MWh/annum	kL/annum	MWh/annum
FY41	Stage 2 construction	Stage 1B	2,604	1,994.8	7,055.6	12,437.4	4,347.0	23,814.0	623.7	945.0	4,347.0	-	2,052,426.6	56,446.9	1,282,650.9
FY42	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	56,584.6	1,312,088.5
FY43	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	57,918.8	1,312,080.5
FY44	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	59,929.5	1,327,793.0
FY45	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	60,743.4	1,336,358.8
FY46	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	59,481.8	1,349,922.4
FY47	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	58,926.4	1,348,829.1
FY48	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	52,653.3	1,436,607.6
FY49	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,441.5	1,447,716.6
FY50	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,653.5	1,493,003.0
FY51	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	50,452.6	1,491,304.7
FY52	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	50,056.6	1,543,883.5
FY53	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,312.5	1,526,663.3
FY54	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,671.9	1,531,438.6
FY55	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	48,576.8	1,509,811.5
FY56	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	48,869.7	1,522,056.1
FY57	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	51,411.2	1,536,542.0
FY58	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	52,170.0	1,546,873.2
FY59	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	51,939.7	1,549,581.3
FY60	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,826.6	1,572,822.6
FY61	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,449.1	1,595,382.4
FY62	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	53,115.6	1,576,414.8
FY63	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	52,319.6	1,578,592.6
FY64	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	52,182.3	1,570,965.5
FY65	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	51,896.2	1,570,581.3
FY66	-	Stage 2	-	2,757.9	6,397.5	11,277.5	4,536.0	25,704.0	623.7	945.0	4,347.0	-	2,610,957.2	49,932.3	1,598,408.3

Appendix C

Emissions data (CO_2-e)

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The emission estimates (CO_2-e) for scope 1 and scope 2 for each year of the project life are presented in Table C.1

Table C.1 GHG emissions by year – scope 1 and 2

Year	SRE construction	SRE Project phase	Smelter											Mine	
			Diesel	Diesel	Diesel	Fuel oil	LPG	LPG	LPG	LPG	LPG	Coal coke	Electricity	Diesel	Electricity
			Construction	Mobile	Stationary	FSF & FCF	Auxiliary boiler	Smelting and Casting	Acid Plant	Electro refinery and PMR	Miscellaneous	Smelter	Load	Mobile	Load
			Annual scope 1 emissions t CO_2-e/year										Annual scope 2 emissions t CO_2-e/year	Annual scope 1 emissions t CO_2-e/year	Annual scope 2 emissions t CO_2-e/year
FY19		Historical	-	5,460.0	7,134.5	18,514.0	4,791.1	27,582.5	683.9	999.7	4,766.7	22,168.0	93,429.8	110,703.5	375,525.2
FY20		Historical	-	5,247.0	8,668.6	15,766.0	4,719.1	27,167.6	673.6	984.6	4,695.0	26,326.0	90,091.3	134,506.7	362,106.7
FY21		Historical	-	4,108.0	8,877.6	18,261.0	4,688.8	26,993.6	669.3	978.3	4,665.0	27,142.0	91,393.1	137,750.3	367,338.9
FY22		Historical	-	4,992.0	6,840.7	10,004.0	4,439.8	25,559.9	633.8	926.4	4,417.2	17,924.0	65,465.3	106,144.0	263,126.7
FY23		Historical	-	5,389.0	7,278.3	0.0	4,854.7	27,948.4	693.0	1,012.9	4,830.0	33,137.0	55,839.3	112,934.9	224,436.7
FY24		Historical	-	5,621.0	7,829.2	24,609.0	4,906.9	28,248.9	700.4	1,023.8	4,881.9	44,422.0	57,468.0	121,483.1	230,983.0
FY25	-	BAU	-	5,919.7	7,695.2	23,768.8	4,413.1	25,406.2	630.0	920.8	4,390.6	35,710.5	39,061.6	119,403.3	157,001.4
FY26	-	BAU	-	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	23,161.7	40,550.0	142,759.2	156,376.6
FY27	-	BAU	-	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	23,161.7	35,670.8	136,632.2	148,327.2
FY28	Stage 1A construction	BAU	7,056	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	23,161.7	24,452.2	140,957.3	111,477.2
FY29	Stage 1A construction	BAU	7,056	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	23,161.7	14,380.1	145,562.2	61,848.1
FY30	Stage 1A construction	BAU	7,056	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	23,161.7	13,761.3	141,675.6	63,714.3
FY31	Stage 1A construction	BAU	7,056	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	23,161.7	12,666.7	143,229.5	53,757.5
FY32	Stage 1A construction	BAU	7,056	5,924.2	9,115.5	17,383.5	4,086.8	23,527.4	583.4	852.7	4,066.0	-	15,211.8	139,599.4	43,753.2
FY33	-	Stage 1A	-	4,198.8	15,057.1	28,714.4	4,709.6	36,205.3	971.4	883.1	6,770.1	-	58,004.3	144,232.7	32,775.1
FY34	Stage 1B construction	Stage 1A	7,056	4,198.8	15,057.1	28,714.4	4,709.6	36,205.3	971.4	883.1	6,770.1	-	58,004.3	149,619.9	34,038.8
FY35	Stage 1B construction	Stage 1A	7,056	4,198.8	15,057.1	28,714.4	4,709.6	36,205.3	971.4	883.1	6,770.1	-	58,004.3	158,591.2	34,676.5
FY36	Stage 1B construction	Stage 1B	7,056	5,418.4	19,118.6	36,459.7	6,770.1	37,088.4	971.4	1,471.8	6,770.1	-	61,572.8	158,449.2	34,540.2
FY37	Stage 2 construction	Stage 1B	7,056	5,418.4	19,118.6	36,459.7	6,770.1	37,088.4	971.4	1,471.8	6,770.1	-	61,572.8	157,065.7	36,211.1
FY38	Stage 2 construction	Stage 1B	7,056	5,418.4	19,118.6	36,459.7	6,770.1	37,088.4	971.4	1,471.8	6,770.1	-	61,572.8	155,722.8	37,034.4
FY39	Stage 2 construction	Stage 1B	7,056	5,418.4	19,118.6	36,459.7	6,770.1	37,088.4	971.4	1,471.8	6,770.1	-	61,572.8	162,676.9	37,809.3

Year	SRE construction	SRE Project phase	Smelter											Mine	
			Diesel	Diesel	Diesel	Fuel oil	LPG	LPG	LPG	LPG	LPG	Coal coke	Electricity	Diesel	Electricity
			Construction	Mobile	Stationary	FSF & FCF	Auxiliary boiler	Smelting and Casting	Acid Plant	Electro refinery and PMR	Miscellaneous	Smelter	Load	Mobile	Load
			Annual scope 1 emissions t CO_2-e/year										Annual scope 2 emissions t CO_2-e/year	Annual scope 1 emissions t CO_2-e/year	Annual scope 2 emissions t CO_2-e/year
FY40	Stage 2 construction	Stage 1B	7,056	5,418.4	19,118.6	36,459.7	6,770.1	37,088.4	971.4	1,471.8	6,770.1	-	61,572.8	164,559.1	38,590.3
FY41	Stage 2 construction	Stage 1B	7,056	5,418.4	19,118.6	36,459.7	6,770.1	37,088.4	971.4	1,471.8	6,770.1	-	61,572.8	152,955.2	38,479.5
FY42	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	153,328.3	39,362.7
FY43	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	156,943.8	39,362.4
FY44	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	162,392.1	39,833.8
FY45	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	164,597.7	40,090.8
FY46	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	161,178.9	40,497.7
FY47	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	159,674.0	40,464.9
FY48	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	142,675.8	43,098.2
FY49	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	133,972.5	43,431.5
FY50	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	134,547.0	44,790.1
FY51	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	136,712.3	44,739.1
FY52	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	135,639.5	46,316.5
FY53	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	133,623.0	45,799.9
FY54	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	134,596.9	45,943.2
FY55	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	131,629.6	45,294.3
FY56	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	132,423.3	45,661.7
FY57	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	139,310.1	46,096.3
FY58	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	141,366.2	46,406.2
FY59	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	140,742.1	46,487.4
FY60	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	135,016.1	47,184.7
FY61	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	133,993.3	47,861.5
FY62	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	143,928.5	47,292.4
FY63	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	141,771.4	47,357.8
FY64	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	141,399.5	47,129.0
FY65	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	140,624.1	47,117.4
FY66	-	Stage 2	-	7,491.2	17,335.5	33,059.3	7,064.5	40,031.9	971.4	1,471.8	6,770.1	-	78,328.7	135,302.5	47,952.2

Appendix D
Assessment requirements

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D.1 Assessment requirements

Greenhouse gas assessment requirements and cross reference to where these are addressed in this report are outlined in Table D.1.

Table D.1 Assessment requirements

Environmental attributes	Reference	Assessment requirements	Cross reference
Greenhouse Gas Emissions	CCRE2	Undertake a detailed greenhouse gas emissions assessment prepared by a suitably qualified environmental expert for the development which describes: measures (preferred and alternatives) proposed to avoid and/or minimise Scope 1 and Scope 2 GHG emissions of the development.	Section 3.3, Section 4
		Quantify the emissions expected to be abated for each avoidance and mitigation measure.	Section 3.4, Section 4.3
		Compare preferred measures for emission controls and energy consumption with best practice International environmental management in the relevant industry sector.	Section 4.4
		Describe mitigation and management	Section 4.5

Australia

SYDNEY
Level 10 201 Pacific Highway
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 2 95 North Quay
Brisbane QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 9.01 Level 9
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 3.03
111 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Yonge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
2015 Main Street
Vancouver BC V5T 3C2
T 604 999 8297

CALGARY
700 2nd Street SW Floor 19
Calgary AB T2P 2W2



linkedin.com/company/emm-consulting-pty-limited



emmconsulting.com.au

BHP